

# ANNUAL REPORT

# 2022-23



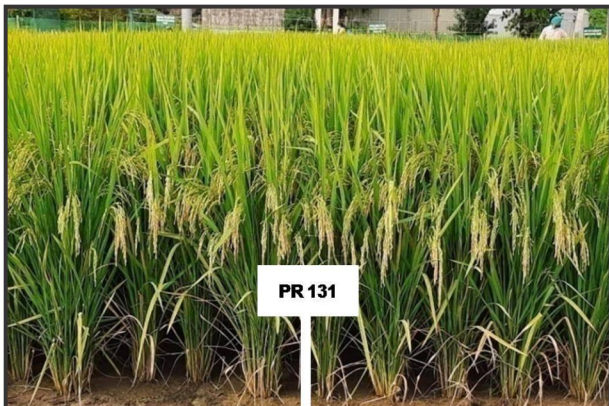
**Punjab Agricultural University  
Ludhiana**



PB 7



PBW 1 CHAPATTI



PR 131



PR 126



SML 1827



GSC 7



Paddy Straw Bale Shredder-cum-Mulcher



Mat Type Nursery Seeder

# ANNUAL REPORT

## 2022-23



Punjab Agricultural University  
LUDHIANA



## **ANNUAL REPORT OF PUNJAB AGRICULTURAL UNIVERSITY**

(July 1, 2022 to June 30, 2023)

### *Editors*

**Dr Bharpoor Singh Sekhon and Dr Ashoo Toor**

### *Printed and Published by*

Dr Tejinder Singh Riar

Additional Director Communication, Communication Centre,  
Punjab Agricultural University, Ludhiana.

E-mail: [adcomm@pau.edu](mailto:adcomm@pau.edu)

Website: [www.pau.edu](http://www.pau.edu)

### *Photographs*

- Communication Centre

We are also available at:



[www.pau.edu](http://www.pau.edu)



[www.facebook.com/pauldhpunjab](https://www.facebook.com/pauldhpunjab)



[www.twitter.com/PAU\\_LDH](https://www.twitter.com/PAU_LDH)



Punjab Agricultural University Official



82880-57707 Add to your WhatsApp groups (*Kheti Sandesh* a digital newspaper)



PAU Kisan App



<http://www.pau.edu/fportalnew/>

# Contents

|                                                                        |                  |
|------------------------------------------------------------------------|------------------|
| <b>RESEARCH .....</b>                                                  | <b>1-40</b>      |
| CROP IMPROVEMENT .....                                                 | 1                |
| FIELD CROPS.....                                                       | 1                |
| VEGETABLE CROPS .....                                                  | 2                |
| FRUIT CROPS .....                                                      | 3                |
| FLOWER CROPS.....                                                      | 5                |
| GERMPLASM COLLECTION, EVALUATION AND UTILIZATION .....                 | 5                |
| BIOTECHNOLOGY .....                                                    | 8                |
| SEED, NURSERY AND BIOFERTILIZER PRODUCTION .....                       | 11               |
| CROP PRODUCTION .....                                                  | 12               |
| CROP PROTECTION .....                                                  | 14               |
| PESTICIDE RESIDUE ANALYSIS.....                                        | 21               |
| RODENT, BIRD AND VERTEBRATE PEST MANAGEMENT .....                      | 21               |
| FOOD SCIENCE AND TECHNOLOGY .....                                      | 22               |
| FOOD AND NUTRITION .....                                               | 25               |
| POST-HARVEST MANAGEMENT .....                                          | 27               |
| AGRO-FORESTRY .....                                                    | 29               |
| BEEKEEPING .....                                                       | 30               |
| MUSHROOM CULTIVATION .....                                             | 31               |
| LAC CULTURE .....                                                      | 32               |
| FARM MACHINERY AND POWER ENGINEERING .....                             | 33               |
| RENEWABLE ENERGY AND WASTE UPCYCLING.....                              | 34               |
| APPARELS AND TEXTILES.....                                             | 35               |
| AGRICULTURAL ECONOMICS AND SOCIOLOGY.....                              | 36               |
| ENVIRONMENTAL STUDIES .....                                            | 39               |
| TECHNOLOGIES COMMERCIALISED.....                                       | 40               |
| <br><b>EDUCATION.....</b>                                              | <br><b>41-77</b> |
| ADMISSIONS .....                                                       | 41               |
| EXAMINATION CELL .....                                                 | 42               |
| NEW COURSES .....                                                      | 43               |
| STUDENTS' ACADEMIC ACCOMPLISHMENTS.....                                | 69               |
| SCHOLARSHIPS AND FINANCIAL ASSISTANCE.....                             | 72               |
| STUDENTS' WELFARE ACTIVITIES .....                                     | 76               |
| <br><b>EXTENSION .....</b>                                             | <br><b>78-89</b> |
| KISAN MELAS.....                                                       | 78               |
| ADAPTIVE RESEARCH TRIALS (ARTS) .....                                  | 80               |
| ON FARM TRIALS (OFTS).....                                             | 80               |
| TRAININGS, CAMPS AND EXHIBITIONS.....                                  | 84               |
| DEMONSTRATIONS .....                                                   | 85               |
| WORKSHOPS .....                                                        | 86               |
| FARMERS' ORGANIZATIONS .....                                           | 86               |
| FIELD DAYS AND TECHNICAL GUIDANCE .....                                | 86               |
| PLANT CLINIC .....                                                     | 86               |
| KRISHI VIGYAN KENDRA ACTIVITIES AND FARM ADVISORY SERVICE SCHEME ..... | 86               |
| PAU DOOTS .....                                                        | 87               |

|                                                                    |                |
|--------------------------------------------------------------------|----------------|
| COMMUNICATION THROUGH MASS MEDIA.....                              | 87             |
| TRAININGS TO FARMERS.....                                          | 88             |
| FARM PUBLICATIONS .....                                            | 89             |
| INFORMATION AND COMMUNICATION TOOLS (ICTs) .....                   | 89             |
| <b>HUMAN RESOURCE, FINANCE AND INFRASTRUCTURE DEVELOPMENT.....</b> | <b>90-110</b>  |
| NEW APPOINTMENTS, PROMOTIONS AND RETIREMENTS .....                 | 90             |
| NATIONAL AND INTERNATIONAL LINKAGES.....                           | 90             |
| FACULTY AWARDS AND HONOURS .....                                   | 91             |
| TRAININGS AND VISITS ABROAD .....                                  | 98             |
| EMINENT VISITORS .....                                             | 99             |
| IMPORTANT EVENTS ORGANIZED AT PAU .....                            | 100            |
| FACULTY PARTICIPATION IN NATIONAL AND INTERNATIONAL EVENTS .....   | 104            |
| NEW EQUIPMENT ACQUIRED .....                                       | 106            |
| NEW LABORATORIES AND INFRASTRUCTURE CREATED AND UPDATED .....      | 109            |
| FINANCES .....                                                     | 110            |
| <b>MOHINDER SINGH RANDHAWA LIBRARY.....</b>                        | <b>111-112</b> |
| <b>IMPACT.....</b>                                                 | <b>113-114</b> |
| <b>ADMINISTRATION.....</b>                                         | <b>115-121</b> |
| BOARD OF MANAGEMENT .....                                          | 115            |
| ACADEMIC COUNCIL .....                                             | 117            |
| IMPORTANT DECISIONS OF THE BOARD OF MANAGEMENT .....               | 119            |
| IMPORTANT DECISIONS OF THE ACADEMIC COUNCIL .....                  | 121            |
| <b>ANNEXURE I.....</b>                                             | <b>122-123</b> |
| <b>ANNEXURE II.....</b>                                            | <b>124-174</b> |
| <b>SUMMARY AND HIGHLIGHTS OF ANNUAL REPORT .....</b>               | <b>175-193</b> |

# Research

Research is central to the mission of Punjab Agricultural University. Research output emerges not only from the efforts made by the research cadre of the university, but research conducted by students has also been complementary in a significant way. Collaborative research, especially inter-disciplinary and adaptive, at the national and international level and digital technology are two other important leverages in the research system of the university. In addition to the conventional mandate of engaging current and emerging challenges and opportunities in the agriculture of the region, the research programmes of the university are aligned with overarching sustainability challenges like climate change and environmental pollution. This section provides an annual account of salient achievements of research activities in key domains, namely crop improvement and associated production-protection technologies, with special focus on crop diversification, eco-friendly crop stress management and natural resource conservation; farm mechanization; value addition through post-harvest engineering and nutrition-based interventions; commodity analysis; subsidiary occupations, waste management and environmental studies.

## CROP IMPROVEMENT

Crop improvement research programmes at the PAU continue to expand their focus towards diversification crops. Key considerations within diversification crop agenda include not only broadening the varietal or crop menu but also leveraging integrated farming systems for enhancing livelihoods, nutritional security, and tapping premium markets and processing traits. The university developed/released 17 varieties of different crops. These included four of different field crops (one each of wheat, maize, sorghum, and oat), seven of vegetable crops (two each of potato and brinjal and one each of *Tarwanga*, okra, and coriander), five of fruit crops (two each of apple and dragon fruit, and one of sweet orange), and one of tuberose. Twelve varieties of different field crops and two brinjal varieties marked their presence at the national level. Out of these, nine varieties have been identified/released in the zones which do not include Punjab.

## FIELD CROPS

- **PBW 826 (Wheat):** This variety is recommended for cultivation in the Punjab state under timely sown and irrigated conditions. It has an average 100 cm plant height and matures in 148 days. It is moderately resistant to yellow and brown rusts. The grains are lustrous and bold. The average grain yield is 24.0 quintal per acre.



- **PMH 14 (Maize):** This single cross hybrid has tall plants with broad and erect leaves. It has semi-open and medium tassels, long and medium-placed ears, and yellow-orange flint-capped grains. On average, it matures in 98 days and yields 24.8 quintal grains per acre.



- **SL 46 (Sorghum):** It is a dual-purpose (both for fodder and grain purposes) composite variety. It is characterized by a greater number of tillers, long and broad leaves, and a juicy and sweet stem. The grains have good popping potential and are rich in iron and zinc, thereby making it amenable to



flour-based and other types of value addition. It is resistant to red leaf spot and moderately resistant to zonate leaf spot diseases. It has good fodder quality owing to its high crude protein content and in vitro dry matter digestibility, and lower hydrogen cyanide (HCN; a toxic chemical) content. On an average, it yields 275 quintal green fodder and 7.0 quintal per acre of grain yield.

- **OL 16 (Oat):** It is a dual-type variety and has been recommended for irrigated areas of Punjab. The plants are medium-tall, leafy and exhibit profuse tillering. It has good fodder, grain and flour quality. The first fodder cut of 90 quintal per acre becomes available 65-70 days after sowing. Thereafter, the regenerated crop, upon maturity, can yield on average 7.0 quintal per acre of grains.

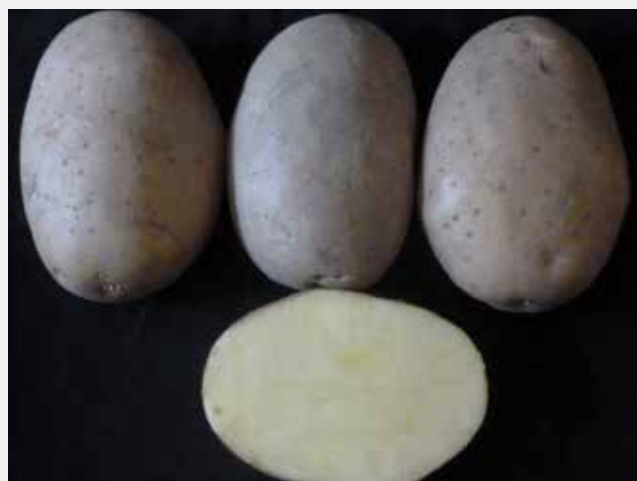
## VEGETABLE CROPS

- **Punjab Potato 101:** It is one of the maiden two varieties arising from the recently intensified in-house potato breeding programme of the university. It is an early bulking table-purpose variety, having light brown and oval round tubers with a creamy flesh. The average early tuber yield



is 100.5 quintal per acre, whereas the average total tuber yield is 188 quintal per acre. Average tuber weight is 97g.

- **Punjab Potato 102:** It is one of the maiden two varietal products given by the in-house potato breeding programme of the university. It is a medium-maturing table - purpose variety. The tubers are light brown, oblong and have a creamy flesh. The average tuber yield is 199 quintals per acre.



- **Punjab Himmat (Brinjal):** Plants of this long fruit variety are medium in height, compact and thornless with green foliage. Flowers are purple and borne in clusters. The fruits are long, medium, thick, and shining purple with a green calyx. It yields 243 quintal per acre in normal soils; however, it can also be grown in salt-affected soils; the fruit yield potential may, however, dip to 205 quintal per acre.
- **PBHL 56 (Brinjal):** It is an early-maturing hybrid of long fruit group of brinjal and is characterized by medium-statured, compact and thornless



plants with green foliage. It bears purple flowers in clusters. The fruits are medium-long, thin and black purple with green calyx. The average yield is 278 quintal per acre.

- Punjab Tarwanga 1 (Tarwanga):** It is a new salad-purpose variety which harnesses *Wanga* (a salad favourite in southwest Punjab and adjoining Rajasthan) for its unique taste and long melon (*Tar*) for its shape. The fruits are medium-sized and cylindrical, which stay dark green at the early stage and turn brown at maturity. It yields on average 77.6 quintal per acre during spring season.



- Punjab Lalima (Okra):** Plants of this variety are medium-tall and moderately glabrous with dark red stem and petiole. Leaves are lobed and serrated with a purple spot at the base. The fruits are thin, long, dark red, tender and five ridged; and are rich in anthocyanins and iodine. It can tolerate yellow vein mosaic virus disease. The average marketable yield is 50 quintal per acre.



- Punjab Khushboo (Coriander):** Plants of this variety are semi-erect and branch out profusely. The leaves are medium-broad, green, tender and have an excellent aroma. It does not bolt early and lets five harvests of green foliage. Average green foliage yield is 184 quintal per acre and seed yield is 3.2 quintal per acre.

## FRUIT CROPS

- Dorsett Golden (Apple):** It is a low-chilling and early-maturing variety of apple. The fruits are round-conical and greenish-yellow in colour. Fruits start becoming available from the first fortnight of June and have 13.0% total soluble solids (TSS) and 0.3% acidity. The fruit size stays smaller (55-65 mm in diameter) and the average yield is 30 kg per plant.



- Anna (Apple):** It is a low-chilling and early-maturing variety of apple. Fruits are oblong-conical and greenish-yellow. Some fruits exhibit a slight red blush. The fruits have 12.7% TSS and 0.38% acidity. These remain relatively smaller (55-65mm in diameter) and become available from the last week of May to mid-June. The average fruit yield is 32 kg per plant.



- Vaniglia Sanguigno (Sweet orange):** It is an early-maturing variety: it matures during mid-October to end-October (in comparison to the Early Gold, which matures during end-October to mid-November). It bears attractive pink fleshed fruits that have lower acidity (0.21%) in comparison to the previously recommended Early Gold, which bears yellow fleshed fruits with 0.64% acidity.



### Varieties released at the National Level

| Variety (crop)                     | National Zone                                                                                                                                                                                                                                                                        |
|------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| PBW 826 (Wheat)                    | Northwest Plains Zone [Punjab, Haryana, Delhi, western Uttar Pradesh (except Jhansi division), Rajasthan (excluding Kota and Udaipur division), Jammu and Kathua district of Jammu and Kashmir, Paonta valley and Una district of Himachal Pradesh, and Terai region of Uttarakhand] |
|                                    | Northeast Plains Zone (eastern Uttar Pradesh, Bihar, West Bengal, Jharkhand, Odisha, Assam, and northeast states)                                                                                                                                                                    |
| PBW 872 (Wheat)                    | Northwest Plains Zone                                                                                                                                                                                                                                                                |
| PBW 833 (Wheat)                    | Northeast Plains Zone                                                                                                                                                                                                                                                                |
| LL 1613 (Lentil)                   | Northwest Plains Zone (Punjab, Haryana, western Uttar Pradesh, north Rajasthan, and Jammu & Kashmir)                                                                                                                                                                                 |
| ML 1839 ( <i>Kharif</i> mungbean)* | Northeast Plains Zone (Eastern Uttar Pradesh, Bihar, Jharkhand, Assam and West Bengal)                                                                                                                                                                                               |
| ML 2015 ( <i>Kharif</i> mungbean)* | Northeast Plains Zone                                                                                                                                                                                                                                                                |
| Mash 878 ( <i>Kharif</i> urdbean)* | Northwest Plains Zone (Northwest Rajasthan, Punjab, Haryana, Delhi, and western Uttar Pradesh)                                                                                                                                                                                       |
| PFM 13 (J 1009) (Fodder maize)     | Central Zone (Uttar Pradesh, Madhya Pradesh, Chhattisgarh, and Maharashtra)                                                                                                                                                                                                          |
| BL 46 (Berseem)                    | North West Zone (Punjab, Haryana, Uttarakhand, Rajasthan, and Uttar Pradesh), East/North Zone (Uttar Pradesh, Jharkhand, West Bengal, Odisha, Assam, Manipur and Bihar), and Central Zone (Gujarat, Madhya Pradesh, Maharashtra, and Chhattisgarh)                                   |
| LLC 6 (Lucerne)                    | Northwest Zone                                                                                                                                                                                                                                                                       |
| PCB 166 (Bajra)                    | North West Zone and South Zone (Karnataka, Tamil Nadu, Kerala, Telangana, Andhra Pradesh, and Puducherry)                                                                                                                                                                            |
| PCB 168 (Bajra)                    | North West Zone                                                                                                                                                                                                                                                                      |
| Punjab Himmat (Brinjal)*           | Zone IV (Punjab, Bihar, Uttar Pradesh, and Uttarakhand-Terai area)                                                                                                                                                                                                                   |
|                                    | Zone VII (Madhya Pradesh, Maharashtra, and Goa)                                                                                                                                                                                                                                      |
| PBHL 56 (Brinjal)*                 | Zone IV (Punjab, Bihar, Uttar Pradesh, and Uttarakhand-Terai area)                                                                                                                                                                                                                   |
|                                    | Zone VI (Rajasthan, Gujarat, Haryana, and Delhi)                                                                                                                                                                                                                                     |

\*Identified at national level

- **Red Dragon 1 (Dragon fruit):** This variety bears fruits during July to November. The fruits are oblong with red-green brackets. The average fruit weight is 334g. Fruits have a dark red flesh embedded with small black seeds. Fruits are rich in  $\beta$ -carotene (42.91  $\mu$ g per 100 g), phenols (48.33 mg per 100 g), flavanols (30.66 mg per 100 g), potassium, calcium, and magnesium.



- **White Dragon 1 (Dragon fruit):** It bears fruits during July to November, which are oblong with red-green brackets and have a white flesh embedded with small black seeds. The fruits have on an average 9.24 percent TSS and 0.62 percent acidity and weigh on average 287g per fruit.



## FLOWER CROPS

- **Arka Prajwal (Tuberose):** This variety bears single-type flowers on long and sturdy spikes, which are 87 cm long and bear on average 41 florets per spike. The florets open on average in 114 days after planting during the first year and in 94 days during the second year. The buds graduate from a light pink to white colour after opening. The cut spike yield is 24.41 thousand spikes per acre in the first year and 65.44 thousand spikes /acre in the second year. This variety is a very good multiplier with production of 88.93 thousand /acre flowering-grade bulbs and is suitable for both cut and loose flower production under Punjab conditions.



## GERMPLASM COLLECTION, EVALUATION AND UTILIZATION

Wild and improved genetic resources provide strong underpinnings to various crop improvement programmes. The university continues to scout around for vital germplasm materials by maintaining collaborations with a host of national and international peer institutes.

- In the case of rice, International Rice Research Institute, Manila, Philippines provided 52 breeding lines for their evaluation under Punjab conditions. The Indian Council of Agricultural Research (ICAR) – National Bureau of Plant Genetic Resources, New Delhi and ICAR – Indian Agricultural Research Institute, New Delhi provided 500 land races, which were screened for bacterial leaf blight, brown plant hopper, and nitrogen use efficiency.
- In case of maize, 132 field corn inbred lines were procured from the Winter Nursery Centre of the ICAR-Indian Institute of Maize Research (IIMR), Hyderabad with the purpose of developing early- and late- maturing lines. International Maize and Wheat Improvement Center (CIMMYT) – Asia, Hyderabad provided 112 entries. It also provided 75 temperate field corn lines for potential use in silage-purpose and late-maturing varieties. Five lines were sourced from the ICAR-IIMR, New Delhi for strengthening popcorn specialty segment. One teosinte entry was obtained from Govind Ballabh Pant University of Agriculture & Technology, Pantnagar, Uttarakhand for tapping some biotic stress resistance-related genes.
- Forty-eight accessions of barley were secured from the International Center for Agricultural Research in the Dry Areas (ICARDA) in order to identify promising lines for different traits.
- In order to strengthen genetic pool of pulse crops, mungbean and urdbean accessions (48 each) were sourced from the ICAR-Indian Institute of Pulses Research (IIPR), Kanpur for yield and yield component traits and Yellow Mosaic Disease (YMD) resistance. The International Crop Research Institute for Semi-Arid Tropics (ICRISAT), Hyderabad and the ICAR – National Bureau of Plant Genetic Resources, New Delhi provided 1584 chickpea accessions, which are being employed for pre-breeding programme and for resistance against Ascochyta blight and Botrytis grey mould. The ICAR-IIPR, Kanpur and the ICRISAT, Hyderabad provided 40 and 10 pigeonpea lines, respectively, which are under evaluation for yield and related traits. In the case of fababean, ICARDA – Food Legume Research Programme (FLRP) provided 35 entries, which are being evaluated for grain yield and component traits.

- Germplasm base in the case of soybean was strengthened by securing 106 (vegetable soybean) entries from the World Vegetable Center South and Central Asia, Hyderabad to develop food grade varieties. The ICAR – Indian Institute of Soybean Research, Indore shared 26 wild types for biotic and abiotic stress resistance traits. Groundnut improvement programme benefited from single-seed descent (SSD; F5 generation) shared by the ICRISAT, for collar rot resistance. Likewise, the SSD (F4) population was deployed in breeding for high oleic acid and bold seeds. High oleic acid interests were also nurtured by the genetic wealth of GIRNAR 4 and GIRNAR 5 varieties developed by the ICAR – Directorate of Groundnut Research, Junagadh. Regional Research Station, Bikaner of the Directorate also shared four advanced-generation populations, which are being screened for high yield and collar rot resistance.
- In the case of forage crops, the ICRISAT, Hyderabad provided 100 lines to support breeding efforts for grain colour, maturity, and disease resistance.
- In order to promote adoption of medicinal and aromatic plants in the state through the introduction of promising germplasm, the university teamed up with some central institutes like the ICAR-National Research Centre on Seed Spices (ICAR-NRCSS) for fennel variety Ajmer Fennel 2; CSIR- Central Institute of Medicinal and Aromatic Plants, Lucknow for Mentha (CIM Unnati) and turmeric (Pitamber) varieties; and the ICAR-Indian Institute of Spices Research, Calicut for Pragati variety of turmeric. Dr. Rajendra Prasad Central Agricultural University, Pusa shared Rajendra Sonia and Rajendra Sonali cultivars of turmeric for evaluation under Punjab conditions.
- In order to expand genetic stock for various vegetable crop improvement programmes, the university scouted the farms of various progressive vegetable growers both within and outside the state besides securing germplasm from various national and state counterparts. Yellow Plum line of cherry tomato was procured from a Panipat (Haryana) farmer for utilizing indeterminate growth and higher yield traits. Likewise, Harike Local chilli material was collected from Harike (Tarn Taran district) for screening against leaf curl virus. Bottlegourd germplasm was collected from some farmer fields of Himachal Pradesh and Rajasthan.

Advanced okra lines of amphidiploids were sourced from the Regional Station, Thrissur of the ICAR-NBPGR for utilization in breeding programme. Sher-e-Kashmir University of Agricultural Sciences and Technology, Srinagar provided 21 lines of French bean, whereas 15 entries of pole-type and 28 of bush-type French bean were collected from the northeast region.

## Screening of germplasm

### Wheat

- Variability in asparagine biosynthesis from representative set of wheat landraces and cultivars from 7 days post-anthesis (DPA) to 35 DPA was evaluated. BWL5429 had the highest specific activity of asparagine synthetase at 21 DPA. Free asparagine accumulation was observed during the grain filling period; free amino acid concentration rose up to 21 DPA and decreased thereafter.
- More than 100 gene sequences of sHSP23.5 protein retrieved from whole genome assemblies of wheat cultivars, progenitor and non-progenitor species were evaluated for physio-chemical properties of proteins, three-dimensional tertiary structures, conserved motifs, and domains. Altered protein phosphorylation patterns in progenitor and non-progenitor species may be attributed to S8K, S177I, S108G, S35C, T81D, Y72V, S71E, S33A, and S32V.
- Genotypes BWL 7502, BWL 7509, BWL 7511 and PBW 857 with protein content in the range of 14.6-15.3%, showed a minimum decrease in activities of sucrose metabolism enzymes during heat stress, indicating built-up source-sink strength that resulted in sustained yield under heat stress.
- *Berbet* introgression lines and 5 checks (PBW 803, PBW 725, KRL 210, *Berbet* and HD 2967) were evaluated under saline conditions (150mM NaCl) at seedling stage and adult plant stage. A significance difference was observed in all the seedling traits (germination, root and shoot length, fresh and dry biomass and vigour index). *Berbet* and its rust-resistant derivatives were further assessed in field irrigated with canal water (EC=0.3 to 0.4 dS/m, RSC=0.3 meq/l) and tubewell water (EC=3.8 to 4.2 dS/m, RSC=1.42 meq/l) at Regional Research Station, Bathinda. A significant difference was observed for the following traits: plant height, days taken to flowering, days taken to maturity, SPAD value, spikelet per spike, grain

per spike, 1000-grain weight, grain yield, and harvest index. The *Berbet* derivatives L1 (0.44 kg/ha), L2 (0.36 kg/ha), L42 (0.40 kg/ha) and L 47(0.40kg/ha) maintained stable grain yield under saline conditions. On the basis of vigour index, six derivatives (L1, L2, L10, L45, L47 and L50) were selected and their physiological basis of tolerance was deciphered. These lines can potentially be used as donors of tolerance in various wheat breeding programmes

### Barley

- Analysis of malting potential of 29 barley genotypes indicated that low malt  $\beta$ -glucanase activity led to high  $\beta$ -glucan content and low diastatic power, affecting profile of fermentable sugars in the wort. A weighted scoring system based on malt quality traits identified three barley genotypes (BL1523 > PL807 > BL1748) which outperformed the check varieties.
- Methylglyoxal pathway evaluation in four barley genotypes upon infection with *Bipolaris sorokiniana* depicted an increase in the glyoxalase III activity of the flag and lower leaves of resistant genotype PL 807 at growth stage (GS) 55 (half inflorescence emerged) and GS 87 (hard dough). Whereas, it declined in other genotypes indicating the action of glutathione-independent pathway. Methylglyoxal reductase activity also increased in the leaves of both the resistant genotypes PL 891 and PL 807 and was negatively correlated with methyl glyoxal.

### Maize

- Teosinte accessions (Acc.1 and Acc.2), I-172 and PMH-1 seedlings showed a differential behaviour towards waterlogging stress. The highest nitrate, nitrite and nitric oxide contents in roots of Acc.1 seedlings optimally maintained glutamine synthetase–glutamate synthase (GS-GOGAT) pathway in the waterlogged roots. Unaltered nitrate and high nitric oxide content in roots and shoots of I-172 seedlings resisted the effects of waterlogging stress.

### Pulses

- Imazethapyr, a post emergent herbicide, affects the acetolactate synthase (ALS) gene expression and enzyme activity in herbicide-tolerant (LL1397 and LL1612) and susceptible (FLIP2004-7L and PL07) genotypes at different days after spray. Two homologous genes, *LcALS2* and *LcALS3*, in the

lentil genome were present on chromosomes 2 and 3, respectively. After imazethapyr treatment, however, only *LcALS2* gene expression in tolerant genotypes surpasses that in susceptible genotypes

- Methylglyoxal detoxification pathway contributes towards resistance in pigeonpea genotype AL1747 against *Maruca vitrata* infestation.

### Cotton

- Phenotypic assessment and entomological evaluation revealed that LD 491 variety of *Gossypium arboreum* was tolerant to whitefly and thrips. Ascorbate peroxidase (APX) activity in tolerant parent LD491 continuously increased till 60 days of pest infestation. However, the catalase activity was higher in susceptible parent LH2107 as compared to LD491 two weeks after infestation.

### Nutritional profiling of millet germplasm

- Two germplasm lines of each of Foxtail millet (R1F4, R3 F3) and Proso millet (65BP 1, 707P3) were selected and nutritionally evaluated. Foxtail millet line R3F3 and Proso millet line 707P3 were richer in proteins (13.59, 12.28g/100g), calcium (54.85, 40.95mg/100g), total dietary fibre (14.06, 18.46g/100g) and resistant starch (27.01, 20.91g/100g) and had lower predicted glycemic index (48.94, 54.39) and glycemic load (28.83, 32.51) than other two germplasm lines. The selected lines were used to prepare a variety of products such as rusk, *kheer*, *pinni*, *sattu*, vegetable *dalia*, *papad*, cookies and millet bar. Foxtail millet based products had higher acceptability than the products prepared from Proso millet. *Papad* had the highest acceptability score (8.46) followed by rusk (8.04) and *sattu* (8.00). Foxtail millet and Proso millet based *Kheer* preparations had the highest protein content (16.1, 15.1g/100g), whereas *sattu* had highest fibre (13.47, 14.86g/100g) and iron content (4.21, 4.10mg/100g). The millet based food products recorded low to moderate glycemic index ranging from 46.12-57.72 and had slower *in vitro* starch digestion rate ranging from 49.2 to 89.6% at the end of 3 hours of digestion.

### Vegetables

- Yellow vein mosaic disease (YVMD) increased total carbohydrates and total soluble sugars but decreased total soluble and crude proteins in susceptible bittergourd genotypes (Punjab-14,

PAUBG-301, PAUBG-229 and PAUBG-31). Phenols, hydrogen peroxide, catalase, superoxide dismutase, ascorbate peroxidase, phenylalanine ammonia lyase, polyphenol oxidase and peroxidase activity registered a higher increase in infected resistant genotypes (Jhar Karela, Punjab-15, Punjab Kareli1, PAUBG-407, PAUBG-200 and PAUBG-1514)

- In the case of jassid infestation in brinjal, the APX activity and APX transcripts were overexpressed in resistant *Solanum melongena*-*S. insanum* derived lines; whereas the catalase (CAT) activity and CAT transcripts were upregulated in susceptible introgression lines. APX is a key resistance determinant, which is planned to be employed for tapping resistance from wild *S. insanum* in the brinjal breeding programmes.
- Seven potato germplasm lines, namely Kufri Ganga, Kufri Pukhraj, LP/16-6-5, KP/16-3-12, KC-1, KP/16-9-61 and KP/16-27-15, were evaluated for screening against late blight. KC-1 outperformed others with 30% disease severity followed by LP/16-6-5 registering moderately-resistant reaction with 35% severity. The remaining five lines exhibited high susceptibility with disease index varying from 77-96%. Similarly, KC-1 and LP/16-6-5 performed better against black scurf (*Rhizoctonia solani*) with disease index of 0.98% (incidence - 4.93%) and 1.08% (incidence- 5.41%), respectively.
- In pot grown cucumber plants, PBRK-16, PBRK-28, PBRK-31, PBRK-24, PCG-10, PBRK-38, PBRK-37, and Punjab Kheera-1 lines were found to be moderately resistant to downy mildew. The Area under Disease Progress Curve (AUDPC) values were the lowest for PBRK-16 and Punjab Kheera-1 in the pots screened using artificial inoculation, whereas PBRK-28 and Punjab Kheera-1 had the lowest AUDPC values under natural conditions in polyhouse.

### Agroforestry germplasm evaluation

- In order to identify clones suitable for Punjab region, evaluation trials of *Casuarina* were planted during the year 2022 under the central plains of Punjab, at PAU Ludhiana; in the southwestern arid plains of Punjab, at Chak Ruldu Singh Wala Farm, Bathinda; and in a saline and waterlogged soil at University Farm, Ratta Kherra, district Shri Muktsar Sahib. After preliminary selection, identified clones were planted and raised to provide propagules for multiplication of clonal plants. Under semi-

arid conditions, the clones IFGTB CJ-9, IFGTB CH-1, IFGTB CH-2, IFGTB CH-4, IFGTB PAU-2, PAU-3 and PAU-5 showed above average performance with respect to plant height. In case of saline and waterlogged environment, IFGTB CJ-7, IFGTB CJ-9 and IFGTB CH-2 showed full survival as recorded six months after planting.

- In the case of *Toona ciliata*, various growth and physiological parameters were observed in Oct-Nov, 2022 on the progeny trial established in year 2018. Overall, seed source  $S_6$  (Chabutra) and  $S_2$  (Kamahi Devi) and progenies of  $S_6G_2$  (Chabutra),  $S_2G_1$  (Kamahi Devi) and  $S_3G_2$  (Ludhiana) were found superior.
- Observations on early growth and physiological traits of *Salix* clones planted at three different spacings (1 x 1 m, 1 x 2 m and 2 x 2 m) in February, 2020 were recorded in September, 2022. In general, clones UHFS 40, UHFS 08 and UHFS 34 were found at par with maximum volume index at 2 x 2 m spacing. The UHFS 08 clone produced maximum volume index (37803.86 cm<sup>3</sup>) at 2 x 2 m spacing.

### Biochemical profiling of aloe vera varieties

- Different Aloe Vera varieties Sheetal, local and the non-edible grown under Punjab conditions were analysed for their biochemical and functional properties. Leaves and gel were dried at different temperatures viz 50°C, 60°C and -40°C (freeze dried). Irrespective of temperature of drying, carbohydrate and ascorbic acid contents were higher in gel than in leaves whereas fibre, protein, ash as well as phenolic content were higher in leaves than in gel of all the three varieties. Gel powder of all varieties contained considerable amount of water swelling, oil holding, foaming capacity and stability, emulsion property and stability whereas leaf powder showed only water swelling and oil holding properties. These functional properties decreased with increase in drying temperature.

### BIOTECHNOLOGY

A host of biotechnologies related to abiotic and biotic stress management; nutraceutical, processing and premium market traits; and adaptation traits continue to feed into various crop breeding programmes of the university. Resistance biotechnologies are further complemented by molecular level studies on various insect-pests and causal pathogens.

## Wheat

- Novel genes were identified and mobilized for biotic and abiotic stress into elite cultivars.
- *Triticum dicoccoides* derived backcross introgression lines have been developed after transfer of traits related to higher grain size and weight, stripe rust resistance, and leaf rust resistance.
- *Aegilops triuncialis* derived leaf rust resistance and powdery mildew resistance have been mapped on chromosome 5A.
- *T. dicoccoides* derived leaf rust and stripe rust resistance genes have been mapped on chromosome 7A and 3A.
- Marker trait association identified for terminal heat stress tolerance was transferred from two important wild germplasm species of *Ae. tauschii* and *Ae. speltoides*.
- Early heat stress tolerance was identified in *Ae. tauschii* derived synthetics.
- Heat shock factors (HSF) responsible for heat stress tolerance at seedling stage have been identified in *Ae. speltoides*.
- Three wheat varieties - PBWRS1 (low glycemic index), PBW833 (for late sown irrigated conditions) and PBWZn2 (high grain Zn, Fe and protein content) were developed by introgressing different quality traits and rust resistance through marker assisted selection.

## Rice

- Three putative genes (LOC\_Os04g35180, LOC\_Os04g35190, LOC\_Os04g35210) are being cloned for characterization of *Bph34* resistance gene in rice.
- Transfer of sheath blight resistance from wild rice *Oryza nivara* through linked marker RM 212 is in progress.
- Pyramiding of *Bph33* and *Bph34* genes, implicated in resistance to brown plant hopper in basmati and non-basmati cultivars, is under process.
- Major quantitative trait loci (QTL) for rice root-knot nematode resistance from *O. glaberrima* on chromosome 6 have been fine-mapped.
- Kompetitive Allele Specific PCR (KASP) markers for the traits improving grain yield and adaptability of rice under direct seeded environment have been developed and validated.

- Marker-assisted selection (MAS) derived breeding lines were evaluated under deep placement and anaerobic conditions.

## Maize

- Twelve promising BC<sub>2</sub>F<sub>3</sub> southern leaf blight resistant pyramided lines carrying two QTLs (qSLB3.1 and qSLB8.2) were identified for further use in maize breeding.
- Water-use efficient lines which were developed in the background of LM23 and LM24 by introgressing drought-tolerant QTL, *qKNPE9.1*, are being evaluated for their breeding value.
- Promising waterlogging tolerant lines were identified and are being utilized for pyramiding QTLs into the elite backgrounds.
- Maize haplotypes (23) were identified for high alpha-tocopherol content.
- The CIMMYT maize panel has been evaluated for shoot fly and banded leaf and sheath blight (BLSB) resistance; identified lines are being used in maize crossing programme.

## Citrus

- *Phytophthora* tolerant rootstock hybrids are being developed and tolerance is being mapped in an intergeneric F<sub>1</sub> population using single nucleotide polymorphism (SNP) markers.
- Two intergeneric populations consisting of 230 intergeneric hybrids have been developed for mapping citrus greening resistance genes.
- Flowering Locus T (FT) gene from *Citrus reticulata* L. (Accession number: MW033323) has been cloned and characterized, and will be utilized for inducing early flowering in citrus.

## Guava

- Guava draft genome has been assembled.
- The PCR based Simple sequence repeat (SSR)/ Insertion-Deletion (InDel)/SNP markers have been developed.
- Guava germplasm was evaluated for traits of commercial importance like seed strength, seed weight, number of seeds, pulp colour, pulp thickness, core thickness, peel colour, total soluble solids, titratable acidity, lycopene content, and total anthocyanin content. These traits are being

mapped in different populations. Mapping for purple trait may enhance nutraceutical potential of new guava hybrids.

### Papaya

- Micropropagation protocols have been optimized for cultivar Red Lady 786.

### Vegetable crops

- In case of muskmelon, male sterility gene ms-1 was fine-mapped on chromosome 6 and is being used for developing hybrids. Fusarium wilt disease resistance gene has been mapped on chromosome 5.
- In case of bittergourd, three QTLs associated with yellow mosaic disease resistance have been mapped on chromosome 3,4 and 5 and major QTLs were detected for earliness, fruit and seed related traits.
- Mitochondrial genome of 97A and 97B lines of onion has been assembled and analysed.
- Genes involved in parthenocarpy in cucumber have been identified and their expression analysis provided potential candidate genes for parthenocarpy.

### Genome editing and genetic engineering

- CRISPR/Cas9-mediated genome editing is being undertaken for pectate lyase gene, the enzyme implicated in enhanced shelf life of tomato; Lox3 gene for rice bran oil quality; resistant starch and high tillering in wheat; beany flavour in soybean, and herbicide tolerance in wheat and rice.
- Transgenic sugarcane has been developed by expressing endochitinase gene cloned from *Trichoderma*.
- A new floral drop genetic transformation in two year old guava cv. Allahabad Safeda plants with marker-free RNAi construct (pFGC1008-*BdECR*) has resulted in seven RNAi guava plants as confirmed through genomic DNA-PCR.

### Insect pest biotechnologies

- The CAPAr and ETHr genes in whitefly were subjected to pharmacological characterization. The CAPAr gene isoform *i.e.* BtabCAPAr-2 was amplified, cloned into pGEMT-Easy and subsequently into pcDNA3.1+ mammalian expression vector. The CAPA gene isoform along with aequorin gene

was expressed into Chinese Hamster Ovary (CHO) cell line and three peptides. These peptides did not activate the isoform, BtabCAPAr-2. The ETHr receptor gene was also amplified and cloned in pcDNA3.1+ vector. The gene was transfected to CHO cell line but was found not to have expressed itself in CHO cell line.

- Different genes vital for physiological functioning of whitefly were screened by using RNAi for their effect on whitefly survival. A total of nine gene constructs *viz.* Aquaporin, Ultra Spiracle Protein, Sucrase, Ecdysone receptor, Glutathione S-transferase, Alpha tubulin, Beta tubulin, Juvenile hormone binding protein, Trehalase, AP4, AP9, AP12, CH2 and vATPe were silenced through RNAi. The EcR, GST, CH2 and AP9 were identified for prospective studies.
- Based on mtCOI nucleotide sequence homology, mite samples collected from Hanumangarh, Bikaner and Jaisalmer regions were identified as *Raoiella indica*.
- DNA barcoding helped identify two natural enemies of fall armyworm: *Charops bicolor* and *Coccigodium* sp.
- Bacteria capable of degrading insecticide Imidacloprid were identified as *Bacillus* sp., *Pseudomonas* sp. and *Enterobacter* sp. through sequencing of 16sRNA.

### Molecular characterization of *Fusarium* species associated with the *Bakanae* disease

- All isolates (25) showed amplification of the *TEF-1<sup>α</sup>* gene. The primer pair EF1/EF2 produced a typical amplified band of 680 bp in size. Another primer EF3/EF22T produced an amplified product of 580 bp. Successful amplification of *RPB2* gene also produced a typical amplicon of 928 bp. The amplification of 502 bp also was obtained in all the isolates from universal primers ITS1/ITS4 and ITS4/ITS5, which amplified the *ITS* gene.
- Four representative isolates from different districts of Punjab, namely FR4 from Jalandhar, FR11 from Amritsar, FR14 from Ludhiana, and FR24 from Patiala were sequenced for the identification of *Fusarium* species. On the basis of amplification of three genes, two *Fusarium* species were identified: *Fusarium fujikuroi* and *Fusarium sacchari*. BLAST and phylogenetic analysis of three isolates (FR4, FR14, and FR24) showed 99-100% similarity with

*Fusarium fujikuroi*, and one isolate FR11 identified with *Fusarium sacchari*.

### Multilocus sequence typing of Pokkah Boeng causal organism

- Six isolates were characterized on the basis of three genes- ITS, RpoB and *TEF-1 $\alpha$* . The isolates Fs7, Fs20, Fs27 and Fs29 showed 100 percent similarity with the ITS, *RPB2* and *TEF-1 $\alpha$*  gene sequences of *Fusarium sacchari* available in GenBank. Isolates Fs13 and Fs17 showed 99 percent similarity with *F. proliferatum*. These two species were reported to be the causal pathogens associated with Pokkah Boeng disease of sugarcane in Punjab.

### Multilocus sequence typing of the pathogen associated with stem rot in berseem

- Molecular variability of *Sclerotinia* isolates was assessed by using genus and species specific primers. Majority of the isolates (90%) belonged to *S. sclerotiorum* and the remaining were *S. trifoliorum*. Molecular variability studies confirmed that stem rot of berseem is caused by *S. trifoliorum* and *S. sclerotiorum*.

### Molecular characterization of citrus greening pathogen

- Samples positive for citrus greening (Huanglongbing, HLB), as confirmed by CGB/OA/Las primer pairs were used for molecular

characterization by targeting different genomic regions of *Candidatus Liberibacter Asiaticus* (Las). The CLIBASIA\_01645 region amplified 650 bps of band with LapGP-1f/LapGP-1r primers. Gel electrophoresis confirmed the expected amplification band of ~ 600-650 bps in all greening positive isolates. But, in some cases, variations in the amplicon size were observed. Gel electrophoresis confirmed the expected amplification band of 963 bps, 2.0 kb, 1.3 kb, 420 bps and 480 bps, respectively, in all HLB isolates except one primer i.e. CL 345 F/R which did not amplify any specific amplification on any infected samples. The obtained sequences were matched with online nucleotide database using BlastN (NCBI). Homology searches using the BLAST protocol implemented at NCBI database revealed significant sequence similarity with the published *Ca. Las* (Asian) strains.

## SEED, NURSERY AND BIOFERTILIZER PRODUCTION

Punjab Agricultural University has a large and rigorously monitored in-house seed and nursery production programme to cater to the quality planting material needs of the farmers of the region. Of late, surging demand for biofertilizers owing to the increased interest around eco-friendly ways of production has provided considerable momentum to their production and distribution at PAU.

### Seed Production (Q) of Field and Vegetable Crops during 2022-23

#### FIELD CROPS

| Season        | Breeder Seed | Foundation Seed | Certified Seed | Truthfully Labelled Seed | Total    |
|---------------|--------------|-----------------|----------------|--------------------------|----------|
| Kharif 2022   | 635.29       | 2468.09         | 6580.09        | 7339.42                  | 17022.89 |
| Rabi 2022-23* | 3500.32      | 7350.21         | 13656.44       | 2842.23                  | 27349.20 |
| Total         | 4135.61      | 9818.30         | 20236.53       | 10181.65                 | 44372.09 |

#### VEGETABLE CROPS

| Season          | Breeder Seed | Foundation Seed | Certified Seed | Truthfully Labelled Seed | Total   |
|-----------------|--------------|-----------------|----------------|--------------------------|---------|
| Summer 2022     | 43.55        | 0.14            | -              | 395.75                   | 439.44  |
| Winter 2022-23* | 25.00        | 10.00           | -              | 410.00                   | 445.00  |
| Sub-Total       | 68.55        | 10.14           | -              | 805.75                   | 884.44  |
| Potato          | -            | 582.50          | 2123.00        | 1400.00                  | 4105.50 |
| Total           | 68.55        | 592.64          | 2123.00        | 2205.75                  | 4989.94 |

\*Provisional: Grading of Rabi 2022-23 seed in progress.

- During 2022-23, the university produced 44, 372 quintal seed of various field crops for distribution among farmers of the region (See Table).
- The university produced 884.4 quintal seed of various vegetable crops. Besides, potato propagation material (4990 quintal) was produced during the report period.
- The university provided quality fruit nursery plants (2.40 lakh worth Rs. 2.06 crore), vegetable propagation material (worth Rs.3.16 lakh) and agroforestry seedlings (89, 143) to the farmers/households of the region.
- The university produced biofertilizers (worth 69 thousand acres) for 15 crops (wheat, rice, maize, sugarcane, onion, potato, summer moong, gram, pea, lentil, mash, moong, soybean, pigeonpea, and berseem).

## CROP PRODUCTION

Crop production related research delivered important outcomes in respect of residue management, nutrient management, organic cultivation, micro-irrigation, integrated farming systems and farm waste management.

### Field crops

#### Surface seeding-cum-mulching of wheat

- Surface seeding-cum-mulching of wheat in combine-harvested paddy fields is the latest and a promising addition to the large repertoire of technologies developed by the PAU for in situ management of paddy straw. Shorter time window is an important constraint that requires to be effectively navigated in both cost-effective and time-effective ways for enhanced uptake of paddy straw management technologies. This technology allows timely field preparation as it does not have any special purpose machinery and tractor requirements which can entail some waiting period. The technology involves sowing wheat at the time of paddy harvesting itself by retrofitting a seeding attachment onto the combine harvester followed by one cutter-cum-spreader operation and irrigation. Alternatively, after paddy harvest, seed and basal fertilizer dose can be broadcast manually followed by cutter-cum-spreader use and irrigation. Salient advantages over the conventional method include cost-effectiveness (three-four times lower

straw management and wheat sowing costs), no requirement for special purpose machinery and heavy use tractor, increased readiness towards adoption of in-situ straw management owing to easy straw management, and complete mulching and salutary effects on terminal heat stress management, weed control, etc.

#### Foliar application of nitrogen in wheat

- Existing nitrogen fertilizer recommendations in case of timely sown wheat entail, besides use of diammonium phosphate (DAP) @ 55 kg/acre at the time of sowing, topdressing with 45 kg urea each at the time of the first and second irrigation. However, chances of the second irrigation getting delayed owing to winter rains and restricted infiltration under prolonged rice-wheat sequence have become increasingly common. In order to ensure timely application of N fertilizer and improve N use efficiency, the recommended emergency response under such situations requires that in the fields where water stagnates around the time of second irrigation, two sprays of 7.5% urea solution (15 kg urea in 200 litre water per acre) at 42 and 54 days after sowing on sunny days be applied to substitute surface application of urea fertilizer granules. For better crop coverage, foliar application should be undertaken in a criss-cross or bilateral pattern.

#### Phosphorus management in wheat under residue retaining fields

- Phosphorus nutrition in wheat crop, predominantly met through DAP, is the costliest nutrient intervention. Prolonged in situ management of paddy straw leads to build up of soil organic carbon. This contributes towards improving soil P availability. It has been recommended that when soil organic carbon in such fields reaches 'high' (>0.75%), P fertilizer can be cut down by half (12 kg/acre).

#### Seed priming in direct seeded rice

- Seed priming with potassium nitrate (2% solution) for 12 hours has been recommended for improving establishment and productivity of direct seeded rice.

#### Ideal climatic requirements for rice cultivation

- Weather and rice yield data recorded over two decades (2000-2019) was employed to identify

ideal climatic parameters for rice cultivation in Punjab state. Results suggested that during vegetative, flowering, and grain development stages, the respective maximum temperature ranges were 34-40 °C, 30-35, and 32-35 °C. The respective minimum temperature ranges were 23-28, 25-27, and 20-25 °C.

#### **Subsurface drip irrigation in maize-pea-spring maize sequence**

- A subsurface drip irrigation and fertigation regime has been recommended in maize-pea-spring maize system for moderating groundwater depletion concerns. The system not only helps save irrigation water (48.5% over conventional flood irrigation system) but also gives higher (9.1%) maize equivalent yield. It also results in 20% saving in fertilizer costs.

#### **Nutrient management of Japanese mint under organic farming**

- Nutrient needs of Japanese mint (*Mentha arvensis* L.) under organic cultivation can be met by using 3 ton FYM per acre and the biofertilizer consortia @ 4 kg/acre.

#### **Nutrient management in maize-pea-summer moong organic cropping system**

- Package of production technologies for the new maize-pea-summer moong under organic cultivation has been recommended. The recommended package mainly involves seed treatment with biofertilizer consortia specifically developed for each of the three crops. Nitrogen requirement can be met from the combined use of FYM, vermicompost, and castor cake at different rates (1.7 ton FYM [1%N]+1.1 ton vermicompost [1.5%N]+ 0.7 ton castor cake [2.5% N] in maize; 2 ton FYM or 0.7 ton FYM+0.44 ton vermicompost +0.28 ton castor cake in pea; and in case of summer moong by 0.5 ton FYM or by combination of 0.17 ton FYM, 0.11 ton vermicompost, and 0.07 ton castor cake).

#### **Fish pond sediment as a nutrient source**

- Fish ponds require dredging on a regular basis (after every 3-4 years) in order to provide a habitable aquatic ecosystem for fish. Use of dredged sediment @ 6 ton/acre in maize and paddy can help save 25% of the recommended fertilizer dose in maize and wheat crop.

#### **Vermicompost from maize silage waste**

- Surplus/waste maize silage can be upcycled into vermicompost. Adequately moistened silage waste needs to be laid as 3 feet wide and 6 feet long beds (one foot high). It should then be overlaid similarly by a layer of 4-5 day old cow dung. Thereafter, *Eisenia foetida* earthworms (@ one kg per bed) should be mixed thoroughly. Moisture level (60-70%) in the beds should be maintained by spraying water periodically and by a protective two inch layer of soaked paddy straw. Weekly turnings are required to maintain aeration for earthworms and for faster decomposition. The compost gets ready for use in about 52 days.

#### **In situ paddy straw degradation trials**

- Trials for microbial degradation of paddy straw were initiated in the month of October, 2022 at two locations using PAU consortium, which is a mixture of bacterial and fungal cultures selected over the previous six year trials. PUSA Decomposer was also evaluated along with. The decomposer did not affect key soil parameters (pH, electrical conductivity, organic carbon, phosphorus and potassium) significantly way at both the sites. At one site, maximum lignin degradation was observed in control plot (51.42%). However, at the other location, lignin degradation varied from 43.4 to 46.9 in control and decomposer sprayed plots, respectively. Microbial culture spray did not impact wheat yield in a significant measure.

#### **Vegetable crops**

##### **Organic production technology for brinjal-pea system**

- It has been recommended that to meet nutrient needs of the brinjal-pea system under organic environment, farmyard manure (FYM) @ 5 ton per acre in brinjal and @ 2 ton per acre in pea should be applied. For effective weed control, paddy straw mulch can be used @ 5 ton per acre in brinjal and @ 4 ton/acre in pea.

##### **Clove size for garlic planting**

- Seed clove size is an important determinant of growth and yield of garlic. Seed clove size larger than 9mm (A and B grade) was found to cause 35% increase in the marketable yield.

### Production technology for clusterbean

- Package of practices for Punjab Vegetable Guar 1 variety, maiden vegetable purpose clusterbean variety developed by the university, has been standardized.

### Plant factory

- Plant factory, a fully automated indoor system for production of leafy vegetables has been established. The four-tier rack set up employs artificial light source, nutrient film technique (NFT) based hydroponic system, UV enabled leachate filtration, oxygenation system, and an exhaustive wi-fi enabled environmental control system. Double door entry and air curtain system render the enclosure insect-proof. In-house Arduino based low cost environmental control systems have been employed for imparting cost-effectiveness.

### Paddy straw based growing media

- Briquettes made from paddy straw were able to substitute upto 25 % percent cocopeat without any significant drop in tomato fruit yield.

### Flower crops

#### Fertigation schedule for orchid cultivation under advanced protected cultivation

- NPK (19:19:19) fertilizer @ 1.2g per litre can be used to meet the nutrient requirements of orchid (*Dendrobium* sp. ) grown in hi-tech greenhouse. It should be dispensed twice a week through stake drippers.

### Biofertilizers

- Three bacterial strains *Advenella kashmirensis*, *Brevundimonas diminuta* and *Pseudomonas aeruginosa* exhibited a significant increase in plant growth, chlorophyll content and yield parameters of sunflower in comparison to uninoculated control. Consortium of the three strains demonstrated 25% saving in recommended dose of fertilizers.
- *Sphingobacterium spiritivorum*, *Bacillus* sp., *Pseudomonas aeruginosa* and *Serratia liquefaciens* exhibited 35.4 to 92.0% growth inhibition of *S. sclerotiorum*, isolated from sunflower. The bacterial treatments singly or in combinations also significantly enhanced the vigour index of sunflower ranging from 250 to 630.5.
- Integrated application of FYM and two potential plant growth promoting (PGP) bacterial strains

i.e., *Pseudomonas flavescens* and *Pseudomonas putida* exhibited a significant increase in microbial population and enzyme activities over treatment with recommended fertilizer rates as well as uninoculated control in broccoli crop. The study has helped identify a potential PGP consortium for broccoli.

- Integrated application of consortium biofertilizer (*Azotobacter*, *Bacillus* and *Pseudomonas*) along with FYM resulted in significantly higher microbial population and enzyme activities in rhizospheric soil under pumpkin cultivation.
- Wheat and rice bran-based liquid media formulae (50% w/v already screened on the basis of growth of consortium biofertilizer cultures), were optimized for enhanced shelf life of consortium biofertilizer (compatible combination of *Azotobacter*, *Bacillus* and *Pseudomonas* sp.) using cost effective cell protectants i.e., trehalose (5 mM, 10 mM and 15 mM), carboxy methyl cellulose (0.05 and 0.1 %), and glycerol (0.5 and 1.0 %).

### CROP PROTECTION

Research in the domain of crop protection laid emphasis on devising chemically minimalist interventions. Economic threshold levels are being worked out for increasing number of crops. Use of PAU homemade neem extract continues to be validated across a broader spectrum of crops. Proximal and remote sensing technologies are being evaluated for pest and disease monitoring and drone-based spray modules are being standardized.

### Rice

#### Physio-biochemical and histological alterations in response to sheath blight

- Post sheath blight infection, an increase in endogenous salicylic acid and other antioxidant enzymes was observed as a secondary defence response of the host plant. It was accompanied by down regulation of chlorophyll synthesis, reduced carbohydrates and accumulation of secondary metabolites. Scanning Electron Microscopy analysis revealed that the hyphae could intercept trichomes or other surface structures in order to rely on chemotaxis for further pathogenesis. Plugging of vascular bundles led to collapse of translocation channels after infection. Cells of infected tissue were observed to be surrounded by fungal mycelium.

### Essential oils for managing sheath blight

- Fenugreek (*Trigonella foenum-graecum* L.) seeds and leaves were used to extract essential oils, which were then characterized by GC-MS. Benzyl acetate (51.70%) and  $\gamma$ -tocopherol (42.09%) were identified as the major compounds. These compounds were tested for their antifungal activity against *Rhizoctonia solani* and *Drechslera oryzae*. The oil exhibited highest effectiveness with ED<sub>50</sub> values of 850 ppm against *R. solani* and 1120 ppm against *D. oryzae*.

### Bio-control of sheath blight

- Two biocontrol agents *Trichoderma harzianum* and *Bacillus amyloliquefaciens* FDK 21 were tested as seed treatment (@ 15 g/kg seed), seedling dip (15g/litre of water) and as a spray (15 g /litre of water) against sheath blight under field conditions during Kharif 2022 season. Results indicated that out of nine treatments, *Bacillus amyloliquefaciens* seedling dip exhibited 30.67% disease severity followed by 31.33% under seed treatment with *Bacillus amyloliquefaciens*. However, standard chemical control recorded 22.67% disease severity.

### Detection and characterization of virus associated with dwarf disease of rice

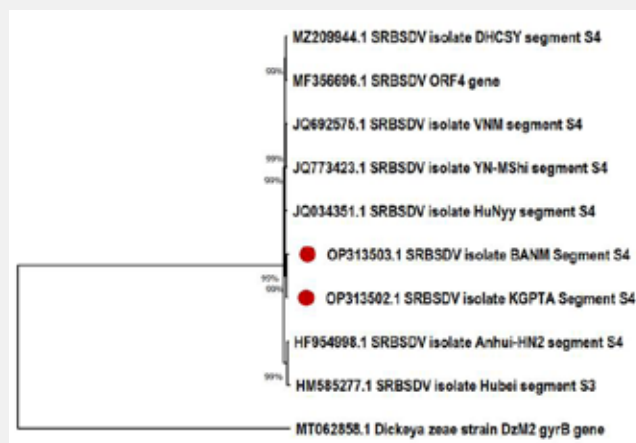
- During Kharif 2022, 22 samples of dwarf rice plants (See photographs below) were tested with primers specific to nine viruses and one MLO (mycoplasma like organism) reported to infect rice in different parts of world. Fifteen samples showed a typical ~1170 bp amplicon with southern rice black streak dwarf virus (SRBSDV) specific primers. Amplicons



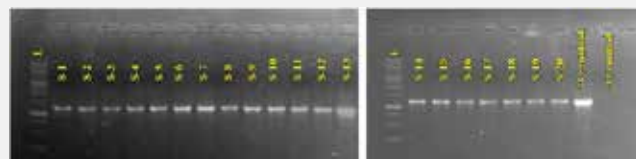
Dwarfing symptoms on rice plants



PCR amplification of 22 plant samples apparently infected with Southern rice black streaked dwarf virus collected from different rice growing areas of Punjab



Phylogenetic analysis on the basis of S4 segment of SRBSDV isolates from two infected rice samples (marked in red) showed more than 99% similarity to the already available SRBSDV sequences in GenBank



PCR amplification of dwarf plant samples (20) apparently infected with Southern rice black streaked dwarf virus collected from infected rice fields

from two samples were cloned and sequenced. The sequence data analysed using BLASTn revealed 99% similarity with already sequenced segment 4 of SRBSDV in GenBank submitted from the countries where this disease has already been reported, whereas no similarity was observed with any of the other viruses. The data was further validated on 12 dwarf rice plant sampled from rice fields of Punjab Agricultural University campus, six from Hoshiarpur and two samples from SAS Nagar. In these samples, the PCR yielded a typical ~1170 bp amplicon. Subsequently, additional validations were made with SRBSDV specific primers, thereby confirming the association of SRBSDV with dwarfing symptoms of rice.

### Study on weeds as the off-season hosts of SRBSDV

- In order to study the off season survival of the SRBSDV on weeds, more than 100 samples of different weeds, namely *Poa annua*, *Avena fatua*, *Phalaris minor* and *Dicanthium annulatum* were tested for the infection of SRBSDV by using SRBSDV specific primers, but none of the sample showed any amplification with these primers.

### *Bakanae* foot rot: Role of seed and soil borne inocula

- The highest disease incidence (6.92%) was observed where naturally infected seeds were sown in uninoculated soil. This treatment also carried forward pathogen inoculum to the field and led to the highest disease incidence (10.13%) in transplanted crop also. When infected seeds were sown in inoculated soil, the disease incidence was 5.96% in nursery and 8.63% in transplanted field. Similarly, where infected seeds were sown in soil inoculated with FYM (treated with pathogen culture), incidence was 4.79% in nursery and 9.80% in field. Contrarily, very low disease incidence was observed in case of healthy seed material. This suggested that seed borne inoculum is the primary source of disease and the soil borne inoculum cannot be implicated.

### Efficacy of plant based extracts against foot rot

- Two formulations of Citronella essential oil were tested as seed treatment at different concentrations (0.125%, 0.25%, 0.5%, 1% to 2% v/w of seed) against foot rot under artificial inoculation conditions. Out of the three concentrations of two Citronella essential oil formulations tested, Formulation 1 applied @1% or 2%v/w showed lesser disease incidence of 2.5% and 2.8%, respectively as compared to other treatments after two months of transplanting. Correspondingly, formulation 2 remained comparatively less effective. Final observations taken at 10 days before harvesting (terminal disease incidence) revealed that both the formulations were at par in controlling the disease.

### Potential hosts for rice root knot nematode (*Meloidogyne graminicola*)

- Preliminary studies could not evidence penetration of *M. graminicola* larvae in barley, berseem, gobhi sarson, turnip, radish, carrot, garlic and potato. However, larval penetration and some adult stages

were observed in other crops like wheat, oats, tomato, pea and onion.

### Bio-control in *basmati* rice

- Trichoderma based biopesticide (total six quintal) was distributed during *Kharif* 2022-23 to the state farmers for managing foot rot of *Basmati* rice and for citrus crops.
- Large scale demonstrations of biocontrol based IPM in organic *basmati* rice (mechanical control by passing the 20-30 m long coir/jute rope before flowering, and 5-6 releases of *Trichogramma chilonis* and *T. japonicum* each @ 1,00,000 parasitoids/ha) over 336 acres in 7 districts of Punjab showed lower incidence of rice insect pests and provided higher grain yield (additional benefit of Rs. 7231/- per hectare over untreated control; cost-benefit ratio of 1:2.89).

### Wheat

#### Yellow rust: Surveys and eco-friendly management

- Off-season surveys were undertaken in Janjehli valley (Mandi district), Lag valley (Kullu), Shimla, Narkanda (Shimla district) and Nohradhar (Sirmaur district) of Himachal Pradesh during June 2023. High yellow rust severity was witnessed in Janjehli valley and Lag valley.
- Foliar sprays of salicylic acid @ 0.01%, chitosan @0.25% and fermented butter milk @ 20% gave 69.2, 34.6 and 30.7 percent inhibition of yellow rust, respectively as compared to control, but they were equivalent in terms of yield.

### Post-harvest diseases

- Grain samples (n=2521) were collected and analysed for the presence of Karnal bunt and black point infected grains and shrivelled grains. Tarn Tarn, Gurdaspur, Hoshiarpur and Amritsar districts had high percentage of Karnal bunt infected samples (13.17 to 70.31%). Ropar led in black point infection and in shrivelled grains (82.5%, 97.5%). Mansa district recorded the lowest black point and shrivelled grain incidence.

### Dynamics of wheat diseases under different paddy straw management practices

- Yellow rust severity showed significant differences across paddy straw management practices. The lowest severity (8.33%) was observed under Super Seeder and zero drill interventions. Karnal bunt,

however, did not exhibit significant differences across various straw management practices.

### Characterization of different *Fusarium* spp. associated with Fusarium Head Blight

- Identity of *Fusarium* species was confirmed using two genes i.e. TEF1, RPB2 and ITS region. *Fusarium proliferatum* isolated from Hoshiarpur area was the most virulent isolate (66.35% severity) followed by *F. equisetii* (62.75 %) during testing at Ludhiana campus. At Gurdaspur, 21 days after inoculation, the test isolate *F. graminearum* produced maximum severity (83.59 percent) followed by *F. incarnatum* (75.82 percent).

### Pink stem borer

- Study on carryover of pink stem borer, *Sesamia inferens*, from paddy to wheat revealed that this pest remains active throughout the year on different crop hosts, namely rice (mid-August to November), wheat (mid-November to mid-March), maize (March to mid-October) and sugarcane (May-June). Damage recorded on true hosts- rice, wheat, maize and sugarcane- ranged from 1.05-5.10, 1.00- 4.50, 2.85-6.15 and 1.05-2.15 %, respectively. The highest pink stem borer damage in rice was observed in October, whereas in wheat, it was observed in the second fortnight of December.
- With regard to residue management practices, wheat sown with Happy Seeder recorded highest pink stem borer incidence (3.69 percent damaged tillers) whereas minimum pink stem borer damage (0.51% damaged tillers) was recorded under conventional tillage practices. Next to conventional method, mould board plough and rotavator were found to be effective for pink stem borer management (1.23 and 1.97% damaged tillers, respectively).

### Reinvigoration of shrivelled seeds

- Wheat seed treatment with chitosan (@ 0.25%) was found effective in reinvigorating shrivelled seeds. This treatment improved germination (95.2%) and vigour index (1993.1) and curtailed mycoflora load (1.37%).

### Pulses

- Identification of economic threshold level (ETL) plays an important role in rationalizing pesticide use. The ETL in case of spotted pod borer, *Maruca*

*vitrata*, in pigeonpea was worked out as two webs per plant ( on 10 or more randomly selected plants) on the basis of web count, cost of plant protection, yield loss and average market price of the produce.

- Whitefly, *Bemisia tabaci*, in mungbean can be managed by using homemade neem extract @ 1000 ml/acre. The results suggested considerable effectiveness of the recommended intervention as gauged through key parameters of whitefly count per trifoliate leaf and grain yield. A week after the second dose of the extract led to 40.3 percent reduction (over the control) in whitefly population.
- Pod sucking bug, *Clavigralla gibbosa* Spinola, has been identified as a new pest of mungbean in the region. Use of homemade neem extract @ 1250 ml/acre provided effective control in terms of key parameters: count of podbugs per plant, seed damage and grain yield. A follow-up spray, after one week, led to 43.8 percent drop (over control) in the pest population.
- Minimum percent pod damage (7.02%) by *Helicoverpa armigera* in chickpea was recorded in *Bacillus thuringiensis kurstaki* (DOR Bt 1 0.5 WP) @ 8g/ litre followed by NIBSM Bt 18 1% @ 10ml/litre (8.87%). However, chemical control (chlorantriliprole 18.5SC) recorded significantly lowest pod damage (1.56 %).

### Biocontrol in cotton

- Bio-intensive pest management (BIPM) including timely sowing; placing pheromone traps (Funnel type) @ 20 traps/acre; releases of *Trichogrammatoidea bactrae* 1,00,000/ha (8 releases starting from 55 days after germination at weekly interval) and application of azadirachtin 1500 ppm @ 2500 ml/ha (conducted in Khiali Chaihanwali under Mansa district) resulted in lowering the incidence of pink bollworm. However, the lowest damage was recorded in chemical control.

### UAV based spray system

- Unmanned aerial vehicles (UAVs) like drones and their use in agriculture for diverse purposes mark an important milestone in the technological transformation of agriculture. The UAVs continue to find considerable use in stress management

of various crops as they provide a rapid, effective, and precise application of chemicals. Hexacopter drones fitted with appropriate spray systems were developed and evaluated. Standard, extended flat fan nozzles and anti-drift/air induction nozzles were found suitable for the system. For higher efficiency, the ideal operating parameters have been identified as: pressure of 1.38 kg/cm<sup>2</sup>, forward speed of 2-3 m/s, and flying height of 2-3m above the crop canopy.

- Crop safety implications of Pyriproxifen 10 % EC application through hexacopter drone against whitefly and of fenprothrin 10%EC against pink bollworm in Bt cotton were investigated during *kharif* 2022 in Mansa district. Drone sprayer fitted with rotary nozzle (20 litres water per ha) was used to impose the spray. The chemicals applied by drone sprayer and by knapsack sprayer at recommended and at double rate were found to be safer with regard to phytotoxicity in any form, namely scorching and leaf injury on tips/surface; hyponasty and epinasty; yellowing and vein clearing; necrosis and crop discoloration; chlorosis and deformation, and wilting and stunting.

### Maize

- A BIPM module involving *Trichogramma chilonis* for managing fall armyworm, *Spodoptera frugiperda*, in maize crop was demonstrated over 10 acres in Hoshiarpur, Jalandhar and Ludhiana districts. The module involved two releases of *Trichogramma chilonis* @ 1,00,000 parasitized eggs/ha, one and two weeks after germination, followed by two sprays of *Bacillus thuringiensis* (NBAIR Bt 25 @ 10 ml/L) and two sprays *Metarhizium anisopliae* (NBAIR Ma 35 @ 5 g/L) at 10 days interval. The intervention resulted in 15.47% plant infestation (as compared to 32.4% in untreated control and 3.87% in chemical control).

### Biocontrol in sugarcane

- Large-scale demonstrations (over 6122 acres) were conducted in 10 districts of the state on effectiveness of *Trichogramma chilonis* in managing stalk borer (*Chilo auricilius*). The module involved 10-12 releases of *Trichogramma chilonis* @ 50,000 per ha at 10 days interval during July to October, 2022. The intervention reduced the pest incidence by 56.58 percent (over untreated control).

- Releasing *T. chilonis* during mid-April to June helped manage early shoot borer, *C. infuscatellus*. Eight releases of *T. chilonis* @ 50,000 per ha were made at 10 days interval over 726 acres of sugarcane crop in 8 districts of Punjab. It helped curtail the pest incidence by 57.3 % (as compared to 80.3% in chemical control through chlorantraniliprole 18.5 SC @ 375 ml/ ha). Releasing *T. japonicum* @ 50,000 per ha eight times at 10 days interval during the same period helped manage top borer, *Scirpophaga excerptalis*. The module reduced the pest incidence by 54% in comparison to 79% in chemical control (chlorantraniliprole 0.4 GR @ 25 kg/ha).

### New agrochemicals

- Spiro(dihydropyrimidinone-isatin) derivatives were synthesized by adding urea to the C-3 position of isatin under acidic conditions. These derivatives were evaluated for their nematicidal potential against the root knot nematode *Meloidogyne incognita*. All compounds exhibited significant inhibition of *in vitro* egg hatching and mortality of *M. incognita*. The compound ethyl-6'-methyl-2-oxo-2'-thioxo-2',3'-dihydro-1'H-spiro[indoline-3,4'-pyrimidine]-5'-carboxylate showed the highest egg hatching inhibition and mortality potential.
- Derivatives of bromo-substituted 4-methylsalicylic acid, ethoxy-substituted salicylic acid, and salicyl anilides were synthesized. *In vitro* antibacterial studies were conducted against *Streptomyces sp.* and *Dickeya sp.* using well diffusion assay. The derivative 4-(bromoethyl)-2-hydroxybenzoic acid exhibited the best antibacterial activity against the Gram-positive strain *Streptomyces sp.*, whereas the derivative ethyl-2-ethoxy-4-methylbenzoate showed the best antibacterial activity against the Gram-negative strain *Dickeya sp.*

### Vegetable crops

#### Eco-friendly red spider mite management in cucumber

- Cucumber has significant share in crops under protected cultivation. Eco-friendly plant protection helps tap premium market avenues. Red spider mite in the protectively cultivated cucumber can be managed by employing PAU homemade neem extract @ 1400 ml/acre in 100 litres of

water. A week after the application, it provided 67.8 percent control over the unsprayed (control) plots. Dried neem fruit extract @ 5 kg/acre in 100 litres of water proved slightly more effective (71.2 percent over unsprayed) control and can thus be used as an alternative measure.

#### **Effect of crop rotation on population dynamics of *Streptomyces reticuliscabies* infecting potato**

- The greatest decrease over two years (3<sup>rd</sup> year vs. 1<sup>st</sup> year) in potato tuberospheric population of *S. reticuliscabies* was observed in fallow-rice-potato rotation (95.8%), followed by cowpea-rice-potato (93.2%) and sunhemp-rice-potato rotation (93.0%, 22). Accordingly, this decrease in pathogen population led to reduced disease severity.

#### **Effect of days to harvesting on russet scab development in potato**

- Observations recorded over a period of three years showed that days to harvesting had had a significant effect on russet scab incidence and severity. Tubers harvested at 70 days after planting showed minimum disease incidence (15.2%) and disease severity (1.3%). These values were significantly lower than disease incidence and severity in the potatoes harvested at 80 days or more after planting. Results signify use of disease free seed and early harvesting to check the disease development and build-up of soil inoculum of the pathogen.

#### **Identification of late blight of potato using multispectral data**

- Combinations of near-infrared, green, red and SWIR bands of Sentinel- 2 were successfully used to discriminate the healthy plants from diseased plants.
- Sensitive wavelengths for detecting the disease (with  $\geq 20\%$  disease infestation) in field experiments included 583 nm, 603, 1080 and 1301 nm. The disease water stress index (DWSI), a spectral index for detecting late blight, was related with rainfall, and maximum and minimum temperature.

#### **Ecofriendly management of late blight of potato**

- Some essential oils viz., Citronella oil (0.5, 1.0, 2.0 ml/liter), Dill seed oil (0.5, 1.0, 2.0 ml/liter) and Clove oil (0.5, 1.0, 2.0 ml/liter) provided disease control of 20-30% under curative conditions.

#### **Essential oils for managing *Phomopsis* blight in brinjal**

- Lemon and citronella grass essential oil formulations were developed and evaluated for emulsion stability, cold resistance, accelerated storage, and foam stability. The EC formulations of citronella grass essential oil showed effectiveness against *Phomopsis vexans* in brinjal, comparable to the effectiveness of Zineb 75 WP.
- Nanoemulsion formulations of leaf and flower extracts of *Ageratum conyzoides*, as well as the essential oil, were prepared and evaluated as fungicides against the phytopathogenic fungus *Phomopsis vexans* in brinjal. GC-MS analysis of the methanolic extract of leaves revealed presence of precocene II (60.47%),  $\beta$ -caryophyllene (15.31%), and precocene I (0.99%). Major compounds in the methanolic extract of flowers were precocene II (34.93%) and 6-hexahydrofarnesyl acetone (16.58%). The essential oil from leaves showed precocene II (89.9%) and  $\beta$ -caryophyllene (2.01%) as major compounds. Nanoemulsions of the extracts and essential oil were characterized using SEM, TEM, and zeta potential. The essential oil nanoemulsion exhibited the highest antifungal activity against *P. vexans* ( $EC_{50} = 80 \mu\text{g/ml}$ ). Methanolic leaf extract and its nanoemulsion were more effective compared to the leaf and flower extracts alone. However, the activity was lower than that of the synthetic fungicide Zineb (Indofil 75WP). The essential oil nanoemulsion resulted in the lowest disease severity (39.8%) with reduced progression over time under field conditions.

#### **Identification of new diseases**

##### **Leaf spot and fruit rot of chilli**

- The developed colonies appeared as white in the beginning and gradually evolved towards olive-green to black colour. The conidiophores were light brown, septate and generally branched. Conidia (borne singly or in chains) were multicellular, and obclavate to obpyriform. Both transverse and longitudinal septa were present. Based upon these morphological traits, the fungus was identified as *Alternaria* sp.

##### **Pink rot of onion**

- Fungal colonies were developed after five days of isolation. Two distinct types of colonies were

found on the potato dextrose agar (PDA) medium. Both the colonies were grown separately on the PDA. One of the colonies had pinkish red colour, whereas the other colony had white to greyish appearance. Microscopic examination confirmed the pathogen identity as *Phoma* and *Rhizoctonia* sp.

### Survey on viruses in muskmelon

- Yellowing and leaf curl were the most predominant virus infection symptoms in muskmelon crop throughout Punjab state. Whitefly transmitted begomoviruses viz. tomato leaf curl, New Delhi virus, and Tomato leaf curl Palampur virus were observed to be associated with these symptoms.

### Biocontrol in vegetable crops

- During Rabi 2022 season, biocontrol agents, namely *Trichoderma harzianum* and *Pseudomonas fluorescens* were evaluated as tuber dip treatment (@ 15g/litre water), soil treatment (@ 2.5 kg of talc formulation in 25 kg of FYM/acre) and as their combination for managing black scurf of potato. The greatest inhibition of black scurf of potato was observed in tuber dip treatment with *Trichoderma harzianum* (35.90%) followed by tuber dip treatment with *Pseudomonas fluorescens* (32.48 %). However, 55.6% inhibition was recorded with chemical use (Moncern).
- During Rabi 2022-23 season, *Trichoderma harzianum*, *T. viride* and *Pseudomonas fluorescens* were tested as seed (@ 15g/ seed), soil treatment (2.5 kg of talc formulation in 25 kg of FYM/acre) and as their combination under pot house conditions for engaging with white rot in brinjal (var. PBHR 41). The highest control (85.0%) of brinjal white rot was found in *Pseudomonas fluorescens* based soil treatment followed by combined seed and soil treatment using *T. harzianum*, which showed 75.0 % disease control. However, the control treatment exhibited 100% disease incidence, reflecting thereby the effectiveness of biocontrol agents in managing white rot of brinjal.
- Three biocontrol agents, namely *Trichoderma harzianum*, *Trichoderma viride* and *Pseudomonas fluorescens* were tested as seed treatment, soil treatment and their combination for managing damping off in chilli (Punjab Sindhuri). Maximum disease control (85.0%) was noted in treatment of *P. fluorescens* + *T. viride* (seed +soil) followed

by combined seed and soil treatment with *T. viride* (78.0 %). Complete damping off damage in pathogen control treatment proved effectiveness of biocontrol in managing the disease.

- For managing cucumber wilt, three biocontrol agents, namely *Trichoderma harzianum*, *Pseudomonas fluorescens* and *Bacillus amyloliquefaciens* were evaluated as seed, soil (@ 15g/ seed), and their combination treatment (2.5 kg of talc formulation in 25 kg of FYM/acre) under field conditions. Maximum disease control ( 74.02%) of cucumber wilt was found in *T. harzianum*+ *P. fluorescens* +*B. amyloliquefaciens* (seed +soil )treatment followed by *T. harzianum* + *B. amyloliquefaciens* (seed+ soil) treatment (72.02 % disease control). However, pathogen control treatment exhibited 100% disease incidence.

### Fruit crops

#### Management of citrus pests with vegetable oils

- A host of citrus pests, namely, citrus psylla, aphids, thrips and mites can be effectively managed by spraying soybean or cottonseed oil (10 litres per acre) mixed with 1.25 kg of detergent powder (acts as a surfactant) in 500 litres of water. Soybean oil and cottonseed oil provided 55.6 percent and 52 percent drop, respectively, over control in psylla population. The respective dip in aphid population was 53.5 and 50.8 percent. Likewise, in the case of thrips and mites, both the oils provided satisfactory control in comparison to that provided by Ethion.

#### Nano-emulsified essential oils for pest management in citrus

- In vitro* studies assessed the efficacy of *Monarda citriodora* essential oil, as well as its micro and nanoemulsions, against *Penicillium digitatum*, a major postharvest fungal pathogen of Kinnow. Promising *in vitro* antifungal activity was observed in the nanoemulsion formulated with 1% oil and 1:1 oil-surfactant ratios (OSR). This nanoemulsion, treated with ultrasonic waves for 15 minutes, demonstrated 100% inhibition at 200 mg L<sup>-1</sup>.
- Essential oils extracted from black cumin seeds (*Nigella sativa* L.) and clove buds (*Syzygium aromaticum*) were characterized by GC-MS. Thymoquinone (18.07%) and eugenol (68.64%) were identified as major constituents.



Thymoquinone exhibited the most effective antifungal activity, with MIC values of 7.0 ppm against *P. digitatum* and 8.5 ppm against *Colletorichum gloeosporoides*. Molecular docking studies indicated that thymoquinone bound itself effectively to the targeted fungal protein,  $\alpha$ - $\beta$ -tubulin, with a docking score of -5.15 kcal mol<sup>-1</sup>.

#### **Integrated management of mango hopper**

- The IPM module developed for management of mango hopper involves cultural control measures like pruning of branches in dense orchards, avoiding high density planting, and spraying twice at weekly interval with PAU homemade neem or PAU homemade dharek extract @5 litres.

#### **Bio-control in litchi**

- The BIPM module developed for fruit borer (*Conopomorpha sinensis*) control in litchi involves ploughing orchards during March-April, clean cultivation, regular collection and destruction of infested shed fruits during May-June, and six releases of *Trichogramma embryophagum* @ 4000 parasitized eggs per tree (at 7-10 days interval, starting from fruit initiation to colour break stage). It resulted in 64.14 percent decrease in fruit damage over untreated control as compared to 67.76 percent in chemical control.

#### **Pest management in new fruit crops**

- Mite populations collected from date palm in Hanumangarh, Bikaner and Jaisalmer have been identified as *Raoeilla indica*.
- Seasonal incidence studies on *Raoeilla indica* carried out on two varieties, Barhee and Medjool at Abohar (Punjab) and 8Md, Hanumangarh (Rajasthan) revealed peak incidence of eggs in 49<sup>th</sup> SMW (standard meteorological week; 101.15 - 114.55 per 2cm x 2cm area) and active stages (45.35- 46.45 per 2cm x 2cm) in 46<sup>th</sup> SMW in 8Md, Hanumangarh, whereas in Abohar, peak incidence of eggs was recorded in 10<sup>th</sup> SMW (31.10- 101.15 per 2cm x 2cm area) and active stages (22.20 - 28.11 in 39<sup>th</sup> SMW) in 46<sup>th</sup> SMW.
- Various plant products, namely aqueous extracts of neem (*Azadirachta indica*), dharek (*Melia azadirachta*), and pongamia were evaluated against date palm mites under laboratory and field conditions. Under laboratory conditions, 45-60% reduction in mites was observed two days after treatment. Under field conditions, the pooled

mean of first spray revealed 26.79 – 36.58 % reduction of *R. indica*. After second spray, more than 50 % drop was observed with PAU homemade neem extract, 46.92 with dharek extract and 46.82% with pongamia extract.

#### **PESTICIDE RESIDUE ANALYSIS**

- Out of 1294 vegetable samples, 100 (7.73%) were found to be contaminated and 7 samples (0.54%) were contaminated with pesticides above prescribed maximum residue limit (MRL).
- Out of 300 fruit samples, 33 (11%) were contaminated and one sample had pesticide residues above MRL.
- Ten rice samples (out of 252) were contaminated. Seven samples (2.78%) had pesticide residues above MRL.
- No pesticide contamination was detected in water (27), pulses (50), and wheat (27) samples.

#### **RODENT, BIRD AND VERTEBRATE PEST MANAGEMENT**

- Repellent based formulations (RBF) were developed against rodents and blue bull and tested in laboratory, simulated field conditions, real field conditions and commensal situations. Under both field and commensal situations, integration of RBF with other methods provided 50-90% reduction in rodent and Blue bull activity for 30-50 and 14-42 days, respectively.
- Neem seed and adrographolide (NSA) based palatable bait (with toxic and irreversible antifertility effects against both sexes of rats) earlier developed and validated under laboratory conditions against house rats was also tested under commensal situations and in small patches of reservoir bajra crop fields. Application of this bait in reservoir fields can lead to cost effective and long term management of rodents in surrounding fields also.
- To enhance and prolong bioavailability and bioefficacy of papaya seed extract as an anti-fertility agent against rodent pests, papaya seed chloroform extract based solid lipid nanoparticles (PSCEN) were prepared and tested against field rodent species. The bait containing 10% nanoparticles was found to cause significant antifertility effects which stayed unreversed up to 105 days after treatment withdrawal.

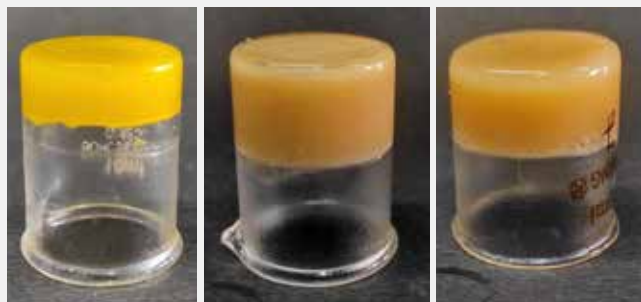
- At present 11 rodent species are reported to inhabit Punjab state. Barcodes from cytochrome *b* and cytochrome *c* oxidase 1 genes were employed for identification of rodent species using fecal, fur, ear and tail samples. Two new species and two new sub species of rodents from Punjab State were identified.
- The rats gavaged orally @2mg/Kg body weight quineestrol for 10 days showed decrease in number of proteins in membrane of spermatozoa from testis to epididymis as ascertained by SDS-PAGE. The western blotting and ELISA confirmed the reduced expression and quantity of 35 kDa protein in treated rats indicating contraceptive effect of quineestrol.
- A checklist of 213 bird species belonging to Punjab region was compiled and published.
- T-perches @ 25/acre were installed in cotton and paddy fields for attracting insectivorous birds at all stages. Out of 39 bird species observed, 44-52 % were insectivorous species during the vegetative and maturing stage of the crop.

## FOOD SCIENCE AND TECHNOLOGY

Research activities in the field of food science and technology put focus on developing healthy food alternatives, especially those based on millets, vegetables and fruits in order to create demand for diversification crops.

### Oleogels

- Notwithstanding their harmful effect on cardiac health, trans-fats and saturated fats continue to find considerable use in food products due to their favourable organoleptic properties. Oleogelation technology provides a safe and healthy alternative to these technologies by providing a matching organoleptic profile. Plant based oils (rice bran oil, virgin coconut oil and mustard oil) were transformed



Mustard oleogel

Virgin coconut  
oleogel

Rice bran oleogel

to oleogels using different oleogelators i.e. stearic acids, linoleic acid, candelilla wax and beeswax at varying concentrations of 3, 6 and 9%. The resultant oleogels exhibited properties of solid fats and their functionality was evaluated in different food products such as muffins, cookies, and indigenous products.

### Herb-based pasta

- Some commonly used medicinal herbs, namely *tulsi*, *ashwagandha*, *brahmi* and *shatavari* were incorporated (@ 2.5, 5.0, 7.5 and 10.0%) into pasta. These blends were assessed for functional properties and pasting profile. The products were subjected to compositional analysis, cooking quality, bioactive profile, *in vitro* nutrient digestibility, colour and texture analysis, and sensory evaluation. Herbs enriched pasta had enhanced functional properties and bioactive profile.

### Black carrot pomace extract based edible packaging films

- Black carrot pomace (BCP) extract (@ 0, 15, 25, 35 and 45%) was used for developing edible packaging films. Results showed that with increasing level of extract, thickness, moisture and solubility of the films increased progressively. Incorporation of BCP extract enriched the films with anthocyanins, flavonoids and total phenol content, along with enhanced antioxidant properties. Film with anthocyanins demonstrated better thermal stability and enthalpy change in comparison to control.

### Essential oils from *galgal*

- Different cultivars of *galgal* collected from Punjab, Haryana, and Himachal Pradesh were evaluated for their morphological, chemical, and nutritional characteristics. The fruits from Himachal Pradesh outperformed those collected from Punjab and Haryana with respect to length (110.2 mm), weight (333.4g), colour ( $L^*$ ,  $a^*$ ,  $b^*$ : 64.83, -13.12, 61.33), peel thickness (3.92mm), yield (72.14%), and number of seeds (18).
- The seed oil exhibited a good profile of palmitic (22.36 to 22.87%), oleic (27.77 to 29.25%), linoleic (31.43 to 32.14%), and linolenic acids (6.32 to 6.70%) along with other minor fatty acids.
- *Galgal* fruits collected from the Punjab region exhibited the highest seed oil yield (9.4%) with

supercritical fluid extraction. Clevenger apparatus was found to be the best method based upon the ease of use and cost-effectiveness. Highest antioxidant activity was observed in the oil obtained from the peel of Punjab region fruits, followed by Haryana and Himachal Pradesh. D-Limonene and Trans- $\alpha$ -Ocimene were the predominant compounds in Punjab region material, D-Limonene and  $\alpha$ -Myrcene in Haryana, and D-Limonene predominated in the oil extracted from *galgal* collected from Himachal Pradesh.

#### Bread premix fortified with sorghum and foxtail millet flour

- Sorghum and foxtail millet flour can be successfully substituted up to 30% for the formulation of bread premix. This substitution improved the nutritional profile of bread premix. These premixes can be stored up to 4 months in aluminium laminates under ambient temperature conditions.



#### Okra flour based value-added products

- Okra flour was prepared from autoclaved and dried okra fruits. Level of okra flour incorporation was standardized in *pinni*, muffins and *bhalla* based on sensory evaluation. These confections showed significantly ( $p < 0.05$ ) higher protein, fibre, minerals, total phenolic content, antioxidant activity and *in vitro* protein digestibility as compared to control.



Okra flour incorporated (a) muffin (b) pinni, and (c) bhalla

#### Date powder from immature *khalal* dates

- Khalal* dates (TSS 35°B and moisture 55%) were artificially ripened (at 45-50°C for 72 hrs) and converted into soft dates (TSS: 60°B and

moisture 40%). Using 1:1 mixture of date paste and maltodextrin as a carrier agent, soft dates were converted to powder by both spray drying and tray drying technique (45-50°C/72 hrs). Tray dried powder exhibited higher yield, bioactive compounds and antioxidant activity than spray dried powder. However, functional properties were found to be superior in the spray dried powder.



Spray dried and tray dried date powders

#### Functional toffees from immature dates

- Soft date paste was used to replace sugar in the toffee formulations at various levels (25%, 50%, 75%, and 100%) in order to enhance

#### Products from coloured potato varieties

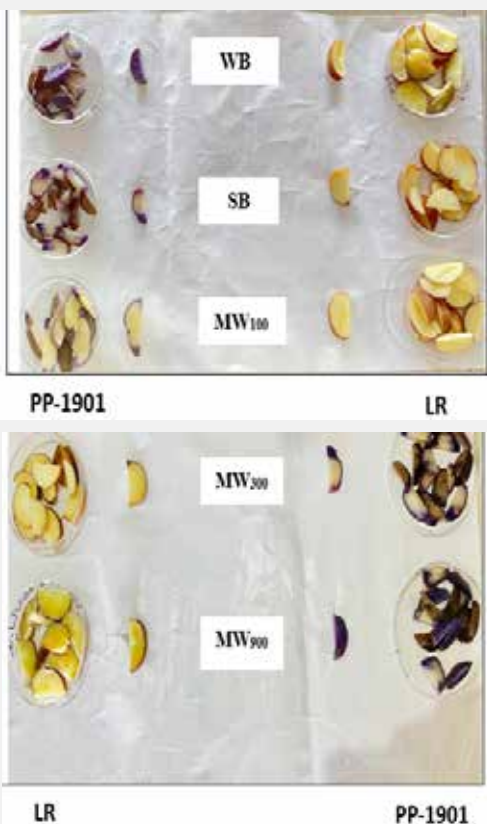
- Drum and tray drying methods were compared for preparing potato flakes from Lady Rosetta (white fleshed) and PP-1901 (purple flesh) varieties. Drum drying significantly reduced colour values, but the sample had higher water and oil absorption capacities. On contrary, tray-dried flakes had higher phenolics, flavonoids, anthocyanins, ascorbic acid, and antioxidant activity. Fourier transform infrared spectroscopy confirmed greater phytochemical retention in tray-dried samples whereas drum drying led to more pregelatinization, changes in crystallinity, and lower pasting temperature. These findings are important for potato flake industry, particularly where novel coloured potato varieties are employed.



Purple and white coloured flakes

### Blanching of potato

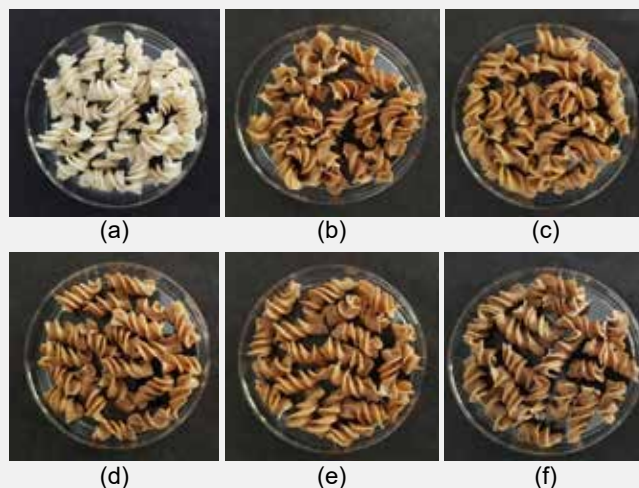
- Three blanching methods - steam, hot water, and microwave – were evaluated for their effect on phytochemicals and structural properties of potato tubers from two varieties PP-1901 and Lady Rosetta. Microwave blanching demonstrated the highest preservation of bioactive compounds, followed by steam and hot water methods. Blanching increased antioxidant activity across all samples. Fourier transform infrared spectroscopy indicated maximum retention of phytochemicals in microwave-blanching samples, particularly at 300 W. Blanching also altered thermal properties and matrix structure of potatoes.



**WB: Water blanching, SB: Steam blanching and MW: Microwave blanching; LR: Lady Rosetta**

### Whole wheat flour incorporated pasta

- Extrusion processing conditions for producing modified whole wheat flour with pasta compatible properties have been optimized. Optimized extrusion processing conditions are: 147.5° extrusion temperature, 15% feed moisture and 434 rpm screw speed. Extruded whole wheat flour can be incorporated up to 30%.



**Semolina pasta (b) Whole wheat flour pasta (c) 10% extruded whole wheat flour pasta (d) 20% extruded whole wheat flour pasta (e) 30% extruded whole wheat flour pasta (f) 40% extruded whole wheat flour pasta**

### Accelerated aging of rice

- Bath ultrasound treatment was developed for accelerating aging of paddy. The optimized variables included: power 200 W, 35.5°C temperature and 88.4 minutes time. Ultrasonication of paddy led to an increased milling efficiency and cooking quality of rice; however, it negatively affected the head rice yield and cooking loss. Rice milled from ultrasound-treated paddy took comparatively less time for cooking and showed more water absorption with high-volume expansion.

### 'Ready to reconstruct' (RTR) smoothie drink from processing waste

- Seven different formulations of RTR smoothie mix were prepared using apple and grape pomace powder, dairy whitener, powdered sugar, hydrocolloid, anticaking agent, cocoa powder, dried mint, ginger and cardamom powder. For tray drying of wet pomace, time and temperature combination of 50 °C for 14 hours was selected as best using colour parameters and browning index



**Smoothie mix**



**Rehydration (in water)**

as responses. Powder particle size of 90-120 and 150-180 micron came out to be ideal sizes for apple and grape pomace, respectively. Combination of acacia and xanthan gum in the ratio of 60 to 40 was used as hydrocolloid.

### Dried figs and fig bars

- In order to obviate concerns around loss of nutrients and deterioration of texture and structure in case of conventional drying, osmotic dehydration method was developed for drying figs. This method resulted in higher concentration of total phenols, antioxidants, total sugars, and reduced titratable acidity. Bars were developed by substituting sugar with honey and jaggery in different concentrations. Both types of bars demonstrated higher total phenols and antioxidants. Upon substitution, both showed lower total sugars and reducing sugars content. However, acidity and ascorbic acid content increased with the substitution. Full jaggery replacement led to the best quality bars.



**Fig pulp bar**

**Fig pulp bar  
(100% honey  
replacement)**

**Fig pulp bar  
(100% jaggery  
replacement)**

### Galgal juice preservation

- Optimum levels for salt and oil based preservation of *galgal* juice included: 3.54% white salt, 3.41% black salt and 3.32% mustard oil cap concentration. The juice, so preserved, had shelf stability for three months at ambient conditions and for 10 months under refrigerated conditions. Optimum conditions for preserving *galgal* juice using herbs and spices were: 2.5 ml spice extract and 2.5% salt concentration. This type of preservation prolonged acceptability up to three months under ambient conditions and for 8 months under refrigeration. The chemically preserved juice (KMS [potassium metabisulphite] and sodium benzoate) retained its acceptability for 9 months under ambient conditions and up to one year under refrigerated

environment. Thermally treated juice maintained its acceptability for one year under ambient conditions. With Hurdle technology, ambient shelf stability lasted for one year. The study has significant implications for harnessing premium off season market.

## FOOD AND NUTRITION

### Microgreens

- Some microgreens, namely spinach, coriander, broccoli, and carrots raised outdoors using seeds soaked overnight and harvested on 10<sup>th</sup> day were evaluated. Broccoli microgreens, dehydrated using microwave technology, were able to retain nutritional quality in terms of ascorbic acid, chlorophyll, antioxidant activity, zinc, iron, calcium, potassium and magnesium. The dehydrated microgreen sprinkler added to daily diet enhanced nutritional composition of the meals in terms of certain bioactive compounds and antioxidant activity.
- Different postharvest parameters [MAP- Modified Atmospheric Packaging, GRAS (Generally recognized as safe) chemical treatments and storage temperature] were optimized to prolong shelf life of microgreens. Among the organic chemical treatments, ascorbic acid + citric acid treated samples maintained significantly ( $p < 0.05$ ) higher nutrient status with respect to  $\beta$ -carotene, total phenols, flavonoids, chlorophyll and physiological quality in terms of instrumental colour and microbial enumeration. The samples stored under MAP (15% CO<sub>2</sub>, and 5% O<sub>2</sub>) showed higher bioactive compounds as compared to control, with the lowest physiological weight loss and tissue electrolyte leakage. The best variant out of all the postharvest treatments (combination of ascorbic acid + citric acid stored under MAP at 5°C) maintained significantly ( $p < 0.05$ ) higher nutritional value in terms of vitamins, bioactive compounds and antioxidant activity. Shelf life of microgreens can be enhanced up to 16 days with post-harvest treatment while maintaining the nutritional quality.

### Production and post-harvest management of wheatgrass

- Good quality wheatgrass can be raised by broadcasting wheat seeds in cocopeat trays @ 50 g/ft<sup>2</sup> followed by covering seed with a thin layer

of cocopeat and sprinkling of water. Wheatgrass can be harvested at about 15 cm height and dried in a hot air oven at 50° C. It can then be used to reconstitute juice enriched, comparably with fresh wheatgrass, in respect of bioactive and antioxidant compounds. Also, harvested wheatgrass can be freeze- or shade-dried and then ground to a powder for subsequent use in bread, biscuits and spice mix.

### Heavy metal analysis

- Some commonly consumed foods were analysed for their heavy metal/metalloid content and their impact on human health. Arsenic, cadmium, lead and mercury were within their permissible limits in wheat *chapatis*, cooked rice, cooked pulses, cooked vegetables, milk and water. The target hazard quotient (THQ) of arsenic, cadmium and lead was less than permissible level of 1 for all other foods consumed by the sampled population. The Hazard Index (HI) from all the four metals was more than 1 for *chapatis* consumed by urban population of Ludhiana district.

### Fatty acid profiling

- Fatty acid profiling of 50 bakery products revealed that decanoic acid, palmitic acid and myristic acid were the major saturated fatty acids (SFA) observed in breads. Palmitic acid was the major SFA found across all the biscuit products. Range of palmitic acid in all the sweet biscuits lay between 42.95±0.81 to 58.13±1.68 percent. Caprylic acid was the major SFA among all the cakes and pastries sourced from different bakeries. It varied between 27.17±0.39 to 57.29±0.46 percent. Free fatty acid and peroxide values of all the products stayed within permissible limits during storage period.

### Antioxidant and prebiotic potential of fruit peels

- Fruit peels (8) were evaluated for prebiotic and antioxidant potential. With regard to antioxidant capacity, the maximum total phenolic content (69.23 mg GAE/g) was recorded in pomegranate peel powder. Raw mango peel powder had the highest total flavonoid content (15.20 mg QE/g). Pomegranate peel powders exhibited the highest antioxidant activity i.e., 84.46% DPPH radical scavenging activity and 34.94 mg FeSO<sub>4</sub> Ferric Reducing Antioxidant Power activity. The FTIR characterization suggested presence of prebiotic oligosaccharides such as inulin, fructo-

oligosaccharides, galacto oligosaccharides and  $\beta$ -glucan. With regard to prebiotic potential, powder of kinnow peel without albedo showed the highest value for probiotic viability i.e. 7.61 CFU/ml (at 0 day) and 7.20 (at 28th day). The study has relevance in selecting fruit peels suitable for developing prebiotic rich products.

### Beetroot based drink

- Beetroot based metabiotic drink was developed and evaluated for nutritional and functional properties and for shelf life. The developed drink had lower TSS (5.13° Brix) and pH (5.77) values as compared to beetroot juice. Total sugar (9.00%), reducing (6.45%) and non-reducing sugar (2.55%) content of the metabiotic drink was significantly ( $p \leq 0.01$ ) lower than the beetroot juice. Similarly, bioactive compounds i.e. betalains (340mg/100ml) and antioxidants in terms of phenols (77.85mg/100ml), flavonoids (33.45mg/100ml) and ascorbic acid (16.16mg/100ml) in the metabiotic drink were significantly ( $p \leq 0.01$ ) higher than in beetroot juice. Total lactic acid bacterial count in metabiotic drink was 6.48 log cfu /ml initially which surged significantly ( $p \leq 0.05$ ) up to 9.64 log cfu /ml after 48 hours of fermentation. Though the metabiotic drink was organoleptically acceptable for 3 months mineral content, bioactive compounds and antioxidant activity stayed stable for one month only. The developed metabiotic holds promise for managing metabolic disorders.

### Foxnut based confectionery

- Bakery products were prepared by incorporating foxnut powder at levels ranging from 10-25 percent with refined flour. Foxnut incorporated bakery products, namely cake, cookies, bread and doughnuts were highly acceptable at 20, 25 12.5 and 12.5 percent level of incorporation of foxnut powder. Calcium, potassium, and iron content of developed products had a range of 15.75-36.83, 18.39-39.72 and 0.53-1.73 mg per 100g, respectively. Total phenols and flavonoid content ranged from 26.36 to 52.05 mg GAE/100g and 20.54 to 43.43 mg QE/100g, respectively. Incorporation of foxnut powder in bakery products also resulted in an increase in antioxidant potential as measured in terms of DPPH, reducing power, metal chelating and ABTS (The 2,2'-azino-bis(3-ethylbenzothiazoline-6-sulfonic acid) assay).

### Wild melon based products

- In order to tap antioxidant, anti-inflammatory and analgesic value of wild melons, a range of products were prepared. These included jam I (with seeds unblanched), jam II (with seeds blanched), jam III (seedless unblanched), chutney I (with seeds), chutney II (without seeds), chutney III (fresh chutney powder) and pickle. Shade-dried powder of wild melon had higher antioxidant activity than oven dried powder. The products were also studied for the sensory parameters, antioxidants and bioactive compounds at one month interval during the 3-month storage period. The percent retention of antioxidants during storage of three months in jam I, jam II and jam III ranged between 94.47-43.65%, 83.03-36.23% and 88.73-59.50%, respectively. Whereas, in case of chutney I, chutney II and chutney III, it ranged between 92.38-49.45%, 82.06-47.63% and 88.73- 59.50%, respectively. The percent retention ranged between 96.27- 60.10 % in pickle.

### Gum berry based products

- Unripe and ripe gum berry fruits were analysed for their nutritional composition and antioxidant activity. Unripe fruits had higher content of ascorbic acid (20.16 mg/100g on fresh and 36.57 mg/100g on dry weight basis), whereas the total phenols, flavonoids, and antioxidant activity as analysed by DPPH and ABTS method were higher in ripe fruits. During three months of storage, retention of antioxidant activity of jam, *chutney* and pickle prepared from unripe *gum berry* slid from 92.77 to 74.54, 87.63 to 76.88, 90.01 to 77.98% and 93 to 75.84, 87.74 to 79.83, 90.53 to 78.69%, respectively. Antioxidant activity in case of jam, *chutney* and syrup prepared using ripe *gum berry* ranged between 91.69-77.18, 94.96-71.28, 87.66-67.47% and 91.90-80.76, 96.53-74.65, 89.70-65.10% respectively. The study concluded that processed products prepared using gum berry retained good antioxidant potential till 3 months.

### Effect of processing techniques on nutritional make-up of millets

- Effect of processing techniques on the nutritional profile and shelf life of Foxtail and Proso millet was studied. The four processing techniques roasting, germination, boiling and pressure cooking were applied to two lines each of Foxtail

(R1F4, R3F3) and Proso (65BP1, 707P3) millet. Soluble, insoluble and total dietary fibre in foxtail and proso millet increased only with germination by (21.65, 17.85%), (10.05, 8.5%), and (10.7, 7.3%), respectively. Analysis of raw, roasted and germinated flour at monthly interval over six months revealed that roasting resulted in increased shelf life of the flour up to 5 months with a slow rise in moisture content (10.38 to 15.62%), peroxide value (3.21 to 16.03 meq/kg), acid value (3.24 to 14.85 KOH/g) and free fatty acids (0.97 to 5.45 % as oleic acid) from the start to 150<sup>th</sup> day in foxtail millet. In case of proso millet, respective changes were moisture content 10.28 to 15.99%, peroxide value 4.12 to 16.91 meq/kg, acid value 3.74 to 15.94 KOH/g and free fatty acids 1.11 to 5.47 % as oleic acid. Overall acceptability of *Chapati* prepared from stored roasted flour was higher and stayed acceptable up to 150<sup>th</sup> day.

### POST-HARVEST MANAGEMENT

Research in the domain of post-harvest management at PAU spans many departments. The salient output during the report period embraced fruit and vegetable processing; advanced, cost-effective and waste cycling storage options; and development of domestic/small scale technologies for fermented drinks and plants with purported health benefits.

### Micro-processed pear products

- Micro-processed products, namely fruit bar (4-5 mm thick), fruit candy cubes (9 x12 x 7 mm), nectar and jam were prepared using pear fruits. Fruit bar can be prepared by using sugar (25%), citric acid (0.3%), and pectin (0.25%). Ready base can then be dried at 60°C for 16-18 hours. For preparing fruit candy, pear cubes can be subjected to osmosis for three days in sugar solution (TSS 70° Brix) followed by drying at 60°C for 22-24 hours. Pear fruit nectar can be prepared using 40% pear juice (TSS 15° Brix and 0.45% titratable acidity) sterilized at 100°C for 20 minutes. Pear fruit jam can be prepared by using sugar @ 750g/kg pulp, citric acid @ 2g/kg sugar, pectin (0.7%), and 40 ppm KMS. All these products showed a minimum six month shelf life.

### Fresh-cut papaya and guava fruits

- In order to sustain quality of fresh-cut papaya and guava fruits, disinfectant pre-treatment has been standardized and recommended. Five different

disinfectants – sodium hypochlorite (NaOCl), potassium metabisulphite (KMS), citric acid, acetic acid, and benzoic acid – were evaluated for their microbicidal efficacy. Disinfectant pre-treatment with NaOCl (100 ppm) at pH 6-7 and 19-20°C temperature for 25-35 minutes proved most effective in curtailing microbial load over fresh cut fruits. This helped in extending shelf life of fresh-cut papaya and guava to 9-10 days in comparison to 3-4 days without any disinfectant treatment.

### Preparation of Kombucha

- Fermentation of black tea for producing Kombucha functional drink can potentially provide a workable alternative to sweetened carbonated beverages. A domestic scale (5 litre capacity) fermentation technology has been developed and recommended for preparing Kombucha. Symbiotic culture of bacteria and yeast (SCOBY) was used (@ 5%) for fermenting the sweetened black tea brew (containing sugar @ 80g/l and black tea @ 15 g/litre)

### Modified Aloe Polysaccharide

- Modified Aloe Polysaccharide (MAP) powder of acceptable quality was developed for use in health products and pharmaceutical industries. Based on nutritional quality, glycerol monostearate (GMS) foamed MAP powder developed through foam mat drying (3mm drying bed thickness and 50°C drying air temperature) retained significantly higher functional and nutritional quality attributes followed by soy protein isolate (SPI) treated MAP powder and fresh aloe powder.

### Processing of medicinal plants

- Optimum parameters for extraction of sweeter component from stevia powder using ohmic heating at constant voltage gradient of 40 V/cm included: heating temperature 55.3°C, holding time 22.2 minutes, and solvent-leaf ratio 7.25:1.
- Process for extraction of stevioside and spray dried powder was developed. In order to extract stevioside, the green powder was mixed with solvent in 1:10 ratio and then the extract was supplemented with maltodextrin (2.0 g/100 mL of extract) and spray dried by maintaining hot air temperature 160°C and flow rate 12 mL/s. Powder thus obtained was evaluated for its functional, flow and biochemical properties.

- Process parameters for extraction of essential oil from semi dried aerial parts of *Mentha* (*Mentha arvensis*) using three methods viz. hydro distillation, microwave assisted extraction method and enzyme assisted extraction method were optimized using response surface methodology. Optimized process parameters for hydro distillation were 69.1°C temperature, 173.6 minutes time and water: solute ratio of 10.04, resulting in 1.5% yield and 49.4% menthol content. Optimized process parameters for microwave assisted oil extraction were: 766.9 W power, 46.9 minute time, water: solute ratio of 9.72 which gave menthol yield of 1.52 % and 49.4%. For enzyme assisted method, bio-enzyme produced from moringa leaves was used and optimized process parameters were 8% enzyme concentration, 119.2 minutes time and 38.7°C temperature for enzyme incubation. Under these conditions, the yield and menthol content was 3.68% and 72.82%, respectively.

### Processing for juice

- Suitability of high intensity ultrasound for inactivating polyphenol oxidase (PPO) and peroxidase (POD) in fresh Indian Gooseberry juice and the subsequent effects on biochemical attributes were studied using response surface methodology. Numerical optimization suggested that an optimized process carried out at 70% (energy density: 1610 Wcm<sup>-2</sup>) pulsed at 5 s on-5 s off for a duration of 8 minutes should result in PPO and POD inactivation of the order of 77.69% and 64.80%, respectively.
- An automated manothermo sonication (MTS) pilot scale plant for pre-treatment of juices has been designed and fabricated. It consists of three compatible treatment tanks i.e. tank 1 storage tank (70 litres) for juice with sensors and mild steel stand; tank 2 system for sonication treatment to juice and tank 3 of capacity 70 litre consisting of heater, temperature controller, nitrogen cylinder and pressure gauge for thermal and pressure treatment.

### Freezing system

- A Cell Alive System/Magnetic Assisted Freezing System (CAS) setup was developed for uniform and rapid freezing of water (present in fresh and fresh-cut produce) under the influence of external magnetic field for preparing frozen products. A

magnetic field of desired strength can be used to treat food products placed in an effective peripheral volume of 2.5 litres inside the core and according to the bulk density of the produce to be frozen.

### Storage interventions

- A gadget with compatible suffice pouches was developed for effective application of essential oil to stored chickpea. In order to control *Callosobruchus chinensis* in stored chickpea grains, essential oils viz. mint oil @ 30 µl, garlic oil @ 40 µl and tulsi oil @ 150 µl proved effective in dis-infested stored chickpea grains (thermal treatment given to chickpea grains @ 60°C for one hour to make them free from any other insect infestation) in plastic containers; it can be stored for six months. Among oils, only garlic oil proved to be effective in retail packets. Garlic oil @ 40 µl proved to be effective against *C. chinensis* in dis-infested chickpea grains (thermal treatment given to chickpea grains @ 60°C for one hour).
- Storage behaviour and techno-economic feasibility of paddy, wheat and canola in hermetic bag and cocoon bag were studied. Cocoon bag yielded the highest profit margin (6.39%) due to minimum grain loss and limited decline in quality parameters followed by 3-layer hermetic bag (2.98 %). However, the 1-layer, 2-layer and jute bag had negative profit margins owing to insect damage.
- With combined ozonation-roasting treatment and vacuum packaging in 5-layer modified polymeric laminate, dried groundnut kernels can be stored upto 12 months under ambient conditions without compromising quality significantly.

## AGRO-FORESTRY

### Determination of wood properties in *Casuarina* clones

- The *Casuarina* wood samples were taken from 6 ¼ year old clonal evaluation trial established at University Seed Farm, Ladhowal, Ludhiana for determination of physical, chemical and anatomical properties of different clones. These clones were earlier procured from the Institute of Forest Genetics and Tree Breeding, Coimbatore. The IFGTB CJ 9 recorded significantly higher wood density (751.15 kg/m<sup>3</sup>) over other clones. The lowest shrinkage percentage was observed in the

clone IFGTB CJ-108 (10.01%) followed by clone IFGTB CH6 (10.04%). Clone IFGTB CJ-10 (11.85%) recorded significantly higher value for shrinkage over other clones. Minimum swelling percentage was observed for clone IFGTB-CJ108 (11.09 %). Holocellulose, an important enabler of pulp-making use, was the highest in IFGTB-CH2 (64.40%) clone. Fibre dimensions constitute another quality parameter for pulp and paper industry. The highest mean value was observed in clone IFGTB CH 6 (1068.6µm) followed by clone IFGTB CJ7 (1053.9µm) and clone IFGTB CH 4 (881.2µm) recorded the lowest value. Clone IFGTB-CH4 had shorter and thinner fibre which is related to paper sheet density and to pulp digestibility and, in turn, increases tearing resistance.

### Intercropping in casuarina

- *Casuarina* trees were planted in three different spacing arrangements (7 m x 3 m, 5 m x 3 m and 3 m x 3 m) at Ruldu Singh Wala farm of PAU, Regional Research Station, Bathinda. Four crops - wheat, gobhi sarson, chickpea and oat - were sown as intercrops along with a sole crop check. In general,



Medicinal crops intercropped with *Casuarina*

7m x 3m spacing provided higher intercrop yield, whereas 3m x 3m spacing gave the lowest performance.

- Six medicinal crops, namely *lemon grass*, *ashwagandha*, *ajwain patta*, *sada bahar*, *brahmi* and *tulsi* were planted under the three tree spacings. The experiment is in progress and observations are being recorded regularly.

### Standardization of clonal propagation of *Casuarina*

- Studies have been initiated to identify the type and concentration of growth regulator, cutting type, etc. Preliminary results suggest that for higher rooting percentage of cuttings, Indole butyric acid is more effective than Indole acetic acid, Naphthalene acetic acid alone and in combination. Among the cutting types, the cuttings taken from apical portion of the branches exhibited higher rooting and survival percentage as compared to those taken from middle and basal ends.



**Sprouting of cuttings**



**Plant propagation**

### Waste water irrigation

- Growth parameters and biomass of five tree species (Bamboo, Arjun, Gmelina, Burma Dek and Eucalyptus) were observed under five types of waste water: sewerage treatment plant (STP) water, untreated water flowing into STP, Buddha Nullah water, domestic sewage water, and normal water (as check). Collar diameter, height, and shoot weight were the lowest with normal water and increased with application of different waste waters. Growth parameters and biomass of all the plants were higher in case of untreated water from STP than under treated water. Buddha Nulla water and domestic sewage water also outperformed normal water.
- Performance of eucalyptus was assessed under different levels of sewage sludge along with application of inorganic fertilizers. Diameter at breast height (DBH) and height after two years of growth were lowest in control (4.87 cm and 6.66 m, respectively) and highest with the application of full recommended dose of fertilizers along with 15 kg/plant sludge (8.11 cm and 8.52 m, respectively).

### BEEKEEPING

Apiary research programme laid emphasis on diversifying product portfolio and harnessing pollination related collateral advantages.

#### Bee venom

- The highest bee venom collection (16.57 mg) was achieved when bee venom collection device was installed in 8 bee-frame *A. mellifera* colonies for 60 minutes.

### Phenotypic screening for royal jelly production

- Comparative evaluation of royal jelly production by *A. mellifera* colonies headed by F1 queen bees reared from the selected colonies during 2023 revealed that royal jelly production per colony per grafting attempt was significantly higher in F1 queen colonies ( $5.647 \pm 0.300$  to  $10.852 \pm 1.642$  g) compared to control colonies ( $2.410 \pm 0.394$  g).

### Breeding for less defensive behaviour

- Observations made on three defensive parameters of the selected mother colony and 50 F<sub>1</sub> colonies in comparison to control colonies suggested that selected colony and its F<sub>1</sub> colonies had significantly lesser stinging tendency; 62 percent F<sub>1</sub> colonies

qualified for the least stinging category against 10 percent in the original stock.

### Cataloguing

- Nineteen bee samples collected from different parts of the state have been submitted to the IARI National Insect Museum for detailed identification. These bees belonged to five families under suborder Apocrita; Apidae (4), Halictidae (3), Megachilidae (6), Andrenidae (3), and Colletidae (3).

### Pollination

- Pollination carried out by *Apis mellifera* in muskmelon (MM 1426) grown under polyhouse conditions resulted in mean fruit weight of  $550 \pm 132$  g in comparison to  $533 \pm 29$  g under hand pollination. On average, 69 more healthy seeds can be obtained through bee pollination than with hand pollination.

### Screening for hygienic behaviour

- Screening of the selected 92 *Apis mellifera* colonies revealed 41 colonies (44.6 percent of the stock screened) as highly hygienic (80.7-95 percent hygienic behaviour), 27 colonies (29.3 percent of the stock screened) were intermediary (70.6-79.6% hygienic behaviour) and 24 colonies (26 percent of the stock screened) were the least hygienic (36.7-66% hygienic behaviour).

### Migration routes

- Migration routes being recently followed by the beekeepers of the state to shift their honey bee colonies on different bee flora available in Madhya Pradesh, Rajasthan, Haryana, Punjab, Himachal Pradesh, and Jammu and Kashmir have been documented.

## MUSHROOM CULTIVATION

Important research advances were registered in the domain of mushroom cultivation technology, biofortification and other value addition, and identification and documentation of novel strains as candidates for prospective research projects.

### Cultivation technology

- Agaricus bisporus* using U3 as parental strain was evaluated on different crop residues. Maximum yield of *Agaricus bisporus* was harvested with the wheat straw based compost (19.34 kg/q compost) followed by paddy straw based (17.63 kg/q compost) and sugarcane bagasse (15.14 kg/q compost) based compost.

- A. bisporus* strains AVTB-22-201 to AVTB-22-206 were grown on wheat straw based short method compost. The yield data showed highest yield for the strain AVTB-22-204 (20.53 kg/q compost) followed by AVTB-22-205 (18.72 kg/q compost) with 1642 and 1337 fruit bodies, respectively. Mushroom weight range was 9.5-13.2 g.
- Six strains of white *Agaricus bisporus*, AVTB 22-101 to AVTB 22-106 were cultivated on wheat straw based compost. Highest yield was recorded for strain AVTB 22-105 (19.89 kg/q compost), followed by AVTB 22-102 (18.02 kg/q compost), fruit body count being 1876 and 1750, respectively.
- Six *Volvariella volvacea* strains (VV22-201 to VV22-206) were evaluated on paddy straw. *Volvariella volvacea* strains VV-22-205 and VV-22-206 gave the highest yield (15.38 and 14.93 kg/q dry straw, respectively). Fruit body count in two week harvest period was 1332 and 1585, respectively.
- Six strains of *Calocybe indica* Ci 22-201 to Ci 22-206 were evaluated on wheat straw. The yield data indicated maximum yield for the strain Ci-22-205 (72.40 kg/q straw), Ci22-204 (69.60 kg/q straw) and Ci-22-202 (58.60 kg/q straw). Strains Ci-22-202 and Ci-22-203 led others in fruit body count (2220 and 2000, respectively).
- Calocybe indica* strains, Ci 22-01 to Ci 22-12, were evaluated on wheat straw and paddy straw. In wheat straw based trials, Ci 22-07 and Ci 22-11 gave the highest yield (72.3 and 65.6 kg/q straw) and number of fruit bodies (1674 and 1704). In paddy straw based trials, the yield was found to be low, being the highest in strain Ci 22-11 (53.20 kg/q straw) and Ci 22-07 (52.10 kg/q straw).

### Biofortification

- Fruit body extracts of *Pleurotus djamor* and *P. sajor-caju* were used for the synthesis of Se and ZnO nanoparticles (NPs) using the precursor salts at different concentrations. Visual colour change in the extracellular extracts of *Pleurotus* spp. treated with salts indicated the formation of biogenic NPs for both Se and Zn salts. Characterization of the NPs through UV-Vis spectroscopy revealed the optimized precursor salt concentration (0.4 mM for *P. djamor* and 0.8 mM for *P. sajor-caju*) and incubation time spans (72 hours for BioSeNPs-PD, BioZnONPs-PD, BioSeNPs-PSC and 96 hours for BioZnONPs-PSC). TEM imaging revealed spherical

and roughly spherical shape for Se and ZnONPs, respectively. The highest yield was found in BioZnNPs-PSC treated *P. sajor-caju* and BioZnNPs-PD treated *P. djamor* fruit body showed the highest total soluble protein content. Biofortification of *P. djamor* with BioZnONPs exhibited the highest  $H_2O_2$  and FRAP (ferric reducing antioxidant power) activities, whereas that of *P. sajor-caju* with BioZnONPs showed the highest DPPH radical scavenging activity.

### Value added products

- Lactic acid fermented paste formulations of *Volvariella volvacea* (paddy straw mushroom) were developed for enhancing shelf life. Salted and spiced paste was fermented using *Lactobacillus rhamnosus* GG for 2 days at  $35\pm 2^\circ\text{C}$ . Sodium benzoate was used as preservative in unfermented pastes, whereas fermented formulations were kept devoid of any chemical preservative. In organoleptic evaluation, the spiced fermented mushroom paste scored significantly higher (8.3) than the salted fermented formulation (7.7). Spiced fermented mushroom paste had the highest crude protein and moisture content. Highest fat was recorded in salted formulation. Thus, the fermentation of *Volvariella volvacea* spiced mushroom paste with *L. rhamnosus* GG culture for two days significantly enhanced its nutritional properties, antioxidant activity and shelf life (upto 56 days).
- Intensity and duration of UV-B light exposure for maximum conversion of ergosterol to vitamin  $D_2$  in *Pleurotus florida* was optimized. Irradiation at intensity  $2.00\text{ W/cm}^2$  for 60 minutes was found to be appropriate for ensuring maximum conversion. Total soluble proteins, total phenolic and flavonoid contents increased significantly. Riboflavin, however, decreased significantly.
- Effect of different drying techniques on stability of vitamin  $D_2$  was studied. Highest stability of vitamin  $D_2$  was found in sun dried, hot air dried and microwave dried samples. Drying significantly reduced the ergosterol content, and increased protein and total phenolic content. Out of the three techniques, air drying was the best in retaining colour and physical appearance. The proximate analysis of UV-irradiated hot air dried samples showed a significant increase in vitamin  $D_2$  and fat as compared to non-irradiated control hot air dried samples.

### Wild mushrooms of Punjab and diversification of mushroom portfolio

- Wild mushroom flora was surveyed during July, 2022 to March, 2023. Twenty mushrooms were collected and identified as *Lentinus squarrosulus* (DMRX-2073), *Pleurotus cystidiosus* (DMRX-2074), *Agrocybe pediades* (DMRX-2075), *Calocybe gambosa* (DMRX-2076), *Podaxis pistillaris*, *Volvariella volvacea* (DMRX-2077), *Daedalea querecina* (DMRX-2187), *Podoscypha multizonata* (DMRX 2188), *Schizophyllum commune*, (DMRX-2189), *Marasmiellus ramealis*, *Terminotomycetes fuliginosus*, *Agaricus compestris* (DMRX-2190), *Macrocybe crassa* (DMRX-2191), *Thelephora palmata* (DMRX-2192), *Chlorophyllum molybdites*, *Panaeolus foenisecii* (DMR-2193), *Tyromyces chioneus* (DMRX-2194), *Leucocoprinus rhodolepsis* (DMRX-2195), *Lepiota cristata*, and *Gymnopilus purpureosquamulosus* (DMRX-2196).

### LAC CULTURE

#### Germplasm

- Surveys were conducted for lac insect and host plants in Punjab, Delhi and Uttar Pradesh. In Punjab, eight lac insect samples were collected from two host plants - *ber* (*Ziziphus mauritiana*) and *pilkhan* (*Ficus virens*). Infestation ranged from medium to high. In Delhi region, only one lac insect sample was recorded in South East Delhi over *Z. Mauritiana*. Uttar Pradesh survey did not yield any lac insect.
- As a part of ex situ conservation and brood multiplication at the Regional Field Gene Bank, 55.74 kg broodlac was multiplied on various host plants: 46.49 kg in Baisakhi crop during July, 2022 from four host plants, and 9.25 kg during November, 2022 from three host plants in Katki crop.

### Biological and productivity linked parameters of lac insects

- Life cycle and productivity-linked parameters of lac insects (*Rangeeni* strain; *Baisakhi* crop) were studied on *Butea monosperma* under Punjab conditions. Duration of *Baisakhi* crop varied from 216-245 days.

### Lac based fruit coating

- *Kinnow* mandarin fruits coated with Citrasol, Citrasine and a lac-based formulation prior to storage under ambient conditions were able to retain their post-harvest quality for 15 days,

in comparison to 60 days under cold storage conditions. This post-harvest intervention has implications for tapping premium off-season or remote markets.

## FARM MACHINERY AND POWER ENGINEERING

### PAU Surface Seeder

- PAU Surface Seeder ensures simultaneous sowing of wheat and cutting and spreading of paddy straw in combine harvested paddy fields. It has a cutting and spreading unit over which a seed and fertilizer fluted roller metering system has been mounted. In comparison to other conventional paddy residue machines like Happy Seeder, Super Seeder and Roto-drill, PAU Surface Seeder is not only economical but also enhances ease and pace of straw management by way of higher field capacity (0.67 ha/hour) with low tractor power requirement of 40hp.



### Paddy straw bale shredder-cum-mulcher in widely spaced crops

- A tractor operated paddy straw bale shredder-cum-mulcher for spreading mulch in widely spaced crops has been developed and recommended. Average field capacity of the



machine is 0.25 ha/hour (using 38hp tractor). Optimized operating parameters are: forward speed of 2.25 km/hour, shredding rotor tip speed 41.48 m/s, and deflector angle of 25°.

### Tractor operated potato digger cum collector

- A tractor operated potato digger has a hydraulically operated bucket attachment for tuber collection. It is a semi-mounted and tractor P.T.O powered machine. Two 42 cm long blades are provided to harvest two rows. Elevator chain made up of MS rods is provided to elevate and clean the potato tubers. The machine was evaluated for cut and bruised tubers, output capacity, fuel consumption, field capacity and collection over 19 acres in farmer fields. Average collection recorded at different farmer fields varied between 96.55 - 98.89 % during long run field test. Average cut and bruised tuber damage lay between 0.57 – 0.68 % and 1.86- 3.14 %, respectively.

### Tree Shaker for fruit harvesting

- Conventional fruit harvesting approach entails life threatening manual picking by climbing high on the trees besides being labour intensive. Mechanical harvesting may prove to be a cost-effective alternative, especially for fruit varieties which display high yields and synchronous maturity. A tractor operated hydraulically controlled tree shaker has been developed which is capable of generating enough vibrations to shake any tree along with provision of holding of trunk at desired position up to a height of 2438 mm (8 ft.). Vibration unit also carries the grippers for gripping and vibration transfer. A separate collection unit of retractable umbrella type has been developed. The extended diameter of a fully opened umbrella is around 6705.6 mm (22 ft). The machine has been evaluated on *Aonla* and *Jamun* trees. During harvesting of *Aonla*, 74-78 % good quality mature fruits, 14-16 % damaged fruits and 8-10% immature fruits were obtained. In case of *Jamun*, 83-85 % good quality mature fruits, 8-11 % damaged fruits and 6-7% immature fruits were obtained. Overall labour saving varied between 79-84%.

### Survey on farm accidents

- Twenty villages from each of the three districts (Sangrur, Shaheed Bhagat Singh Nagar, and Ferozepur) were surveyed for farm accidents

during the period July 2021 to June 2022. A break-up of the total 143 cases reported is : entanglement in machines (47 cases), collisions (26 cases), cuts (26 cases), falls/slips (9 cases), and overturning incidents (8 cases). Other accidents were reported due to chemical exposure, snakebites, electric shocks, animal-related incidents, heat stroke, fire, suffocation, and machine part failure. Out of the total accidents, 9.8% were fatal. Fatal accidents primarily involved farm machinery and snakebites. Human factors were identified as the leading cause of agricultural accidents, accounting for 55.2% of the cases. These factors included ignorance, lack of skill and training, absence of personal protective equipment, over-speeding, falls, and other human errors. Machine factors contributed to 30.1% of the accidents and were related to issues such as lack of safety devices, machine breakdown, overloading, and absence of protective devices. Environmental factors accounted for 14.7% of the accidents and included slippery ground, snakebites, animal-related incidents, and poor visibility.

### **Dust management in combine harvesting**

- Dust generation during wheat harvesting constitutes an important health hazard. Dust concentration at operators level during wheat harvesting season ranged between 0.402-1.331 mg/m<sup>3</sup> for 1 micron size, 1.149-2.670 mg/m<sup>3</sup> for 2.5 micron size, and 1.750-4.359 mg/m<sup>3</sup> for 10.0 micron size. Dust concentration at operators level during paddy harvesting season ranged between 0.419-0.572 mg/m<sup>3</sup> for 1 micron size, 0.543-0.864 mg/m<sup>3</sup> for 2.5 micron size, and 1.395-1.613 mg/m<sup>3</sup> for 10.0 micron size.
- During threshing of wheat crop, the particles were found to have no fixed shape. Different commercially available dust filters and masks were procured from local market. These included various masks, disposable filters, and use of common clothes. Shape and thickness of filter elements, fibre and void spaces were measured under microscope to check their suitability for use as respirable dust filters. The smallest void dimensions (in microns) were recorded in the filter element 7 followed by 11L and 9, respectively. However, the irregular crisscross orientation of the individual fibres in these three filter elements makes them most appropriate for filtering out the 2.5 µm suspended air particulates.

### **Immersive virtual reality environment for operating remotely controlled 2-wheel paddy transplanter**

- To minimize the operator's physiological and psychological stress, a virtual reality (VR) based remotely controlled system was developed for the operation of 2-wheel paddy transplanter. An Integrated Development Environment (IDE) with VR system was developed to remotely operate a 2-wheel paddy transplanter. Two front and rear first-person view (FPV) cameras were mounted for real-time transplanting operation, allowing the operator to perceive the field view through head mounted display (HMD) and control the machine via hand-held remote controller while comfortably sitting outside the field. The results showed that the effective field capacity went up by 25.0% while the manpower need slid by 47%. The developed system had a much lower mean deviation from the straight-line path than the system without the VR system.

### **Machinery testing**

- During the period under report, 34 machines, namely, Super Seeder (2), Rotary tiller (12), Multipurpose raised bed maker (1), Seed-cum-fertilizer drill (3), Laser leveller (2), Baler (1), Smart Seeder (6) chaff cutter (1), Mulcher (3), Paddy thresher (1) and Super Planter (2) were tested. Besides, 18 Fuel Consumption Certificates of generator sets and tractors were awarded to KVK's, different departments of PAU and GADVASU on their request. During this period, 32 machines including Super Seeder (3), Rotary Tiller (6), D.S.R cum multi crop planter (1), Seed-cum-fertilizer drill (1), Rotary Rake (1), Baler (1), Smart Seeder (6), chaff cutter (2), Paddy Thresher (1), Mulcher (3), Inter row Rotary Weeder (2), Tedder (1), Super Planter (2), Forage Chopper-cum-trolley loader (1) and tractor operated Combine Harvester (1) were received for commercial testing. This mandate earned a revenue of Rs. 50.73 lakh.

### **RENEWABLE ENERGY AND WASTE UPCYCLING**

#### **Solar drying**

- A solar dryer having latent heat storage for use after sunshine hours has been developed. It has a loading capacity of 30 kg of farm produce. The solar collector is of evacuated tube type of



aperture area 3.0 sq.m. It has six 51cm x 67cm trays for loading drying product. The dryer was tested on bitter gourd and ginger slices; it exhibited an average thermal efficiency of 36.7% and 37.9%, respectively. Specific energy consumption for the two materials was 59.7 and 69.7 MJ/kg, respectively. Quality of dried ginger slices was found better than under open sun drying (OSD) in terms of antioxidant capacity, ascorbic acid and total colour difference. Bitter gourd slices were found better than under OSD in terms of phenolic, chlorophyll, and ascorbic acid content and total colour difference. Cost payback period of the dryer is 1.71 and 2.40 year (150 use days) for bitter gourd slices and ginger slices, respectively.

- Solar assisted refractance window dryer was evaluated for drying of onion and coriander purees. Quality of the samples dried using solar assisted refractance window dryer was comparable with electrically operated refractance window dryer.
- Mushrooms were sliced, pre-treated with KMS solution and then dried using refractance window dryer. Various parameters like solution concentration, slice thickness and water temperature were optimized in the context of quality. The optimized sample was then compared for quality with three-stage convective drying and solar drying samples. Refractance window dried pre-treated samples were able to retain nutritional content far better than other methods.

### **Paddy straw based energy and other products**

- Chopped paddy straw based binderless briquetting technology has been developed and recommended. The technology employs chopped paddy straw and does not involve conventional biomass grinding. This helps save significant amount of energy during the process of briquetting.
- Maize and mustard stover, and shelled maize cobs were individually mixed with paddy straw in different proportions (10:90, 20:80, 30:70, 40:60 and 50:50). It was observed that the ash content decreased with increase in blending of other biomass in paddy straw.
- In order to make paddy straw and other biomass amenable to densification, a continuous type torrefaction machine having capacity of 20 kg per

hour was fabricated. The 8 feet long machine is fitted with a screw conveyer (8"). The optimized parameters for single pass of torrefaction included temperature 270°C or higher and chopped paddy straw of about 50 mm length.

### **Bioenzymes from fruit and vegetable waste**

- Process technology for preparation of bioenzymes from fruit and vegetable wastes has been developed. These bioenzymes have been characterized for pH, enzymatic activity, antimicrobial potential and for presence of various bioactive compounds. These are being evaluated for different household and other applications like organic cleanser, fruit washing, drain declogging, and for wastewater treatment.

### **APPARELS AND TEXTILES**

#### **Sisal fibre (*Agave americana*) for designing handloom textile products**

- Three blended yarns were developed by blending sisal and cotton fibres at carding stage in 65:35, 50:50 and 35:65 ratio. Blended yarns in 35:65(12s) and 50:50 (8s) ratio were found optimum due to their desirable physical and mechanical properties. Nine samples of union fabrics were developed using given yarns and weave (plain, basket, and twill). Six samples in power loom and three samples were developed in handloom. Powerloom union fabric cost lower than handloom fabrics. Majority of the panel respondents perceived the fabrics as being suitable for six end products, namely cushion cover, dining table mat, Nehru jacket, shopping bag, straight skirt and table runner.

#### **Development of union fabrics using non-conventional Bast fibres**

- Fibres extracted from six plant materials, namely Spider hibiscus, Sleeping hibiscus, Lobster claw, Yellow oleander, Gardenia and Black mulberry, were studied for their physio-chemical properties. Chemical composition analysis revealed that cellulose content of Gardenia was higher (84%) than Spider hibiscus (80 %), Black mulberry (79 %), Sleeping hibiscus (70%), Yellow oleander (52%) and Lobster claw fibre (42%). The FTIR analysis evidenced the presence of functional groups, C-O and -OH across all the fibres. Thermogravimetric (TGA) analysis showed all the extracted fibres as thermally stable up to 250-350°C. Yellow oleander

fibre showed highest crystalline index (78.75%) followed by Black mulberry (78 %), Gardenia (76.41 %), Sleeping hibiscus (69.56%), Spider hibiscus (68%) and Lobster claw (63.63%). Lobster claw fibre showed larger diameter than others. Spider hibiscus fibre exhibited maximum bundle strength (45.80g/tex), followed by Sleeping hibiscus (39.87g/tex), Lobster claw (29.77 g/tex), Yellow oleander (28.37 g/tex), Gardenia (27.80 g/tex) and Black mulberry fibre (18.79 g/tex). Sleeping hibiscus fibre showed highest fibre length of 91.22 mm. In terms of fibre yield percentage, Lobster claw fibre proved the best.

- On the basis of fibre properties and ease of extraction, three fibres- Spider hibiscus, Sleeping hibiscus and Lobster claw- were selected for yarn development. However, due to coarser nature of Lobster claw fibre, it was not suitable for developing yarn and was directly used as a weft to develop fabric. Total four hand spun blended yarns, (two yarns each from Spider hibiscus and Sleeping hibiscus fibre), Spider hibiscus/viscose rayon (30:70), Spider hibiscus/viscose rayon (50:50), Sleeping hibiscus/wool (30:70) and Sleeping hibiscus/wool (50:50) were developed and their properties were studied. Spider hibiscus/viscose rayon (30:70) and Sleeping hibiscus/wool (50:50) yarn were selected for fibre development as these exhibited better TPI, breaking load, elongation at break and yarn crimp (%) than Spider hibiscus/viscose rayon (50:50) and Sleeping hibiscus/wool (30:70). Six union fabrics in plain, rib and twill weaves using Spider hibiscus/viscose rayon (30:70, 2.89s) and Sleeping hibiscus/wool (50:50, 1.77s) were developed. Physical and mechanical properties of developed union fabrics indicated their suitability for developing home textiles and apparel products.

## AGRICULTURAL ECONOMICS AND SOCIOLOGY

### Maize market analysis

- Production, trade, consumption and other aspects of maize at the global and national level were examined with special reference to Punjab. India exports about 80% of its maize largely to Bangladesh and Nepal. Major maize producing states of India such as Karnataka, Madhya Pradesh, Tamil Nadu and Uttar Pradesh have much lower cost of production ranging between Rs 1170 per quintal and Rs 1214 per quintal than Rs. 1447 per quintal in Punjab. High cost of production and price fluctuations are two major deterrents in large scale expansion of maize area in the state. Supply chains of different maize producers are broadly classified into four categories i.e., maize grain, baby corn, maize silage and maize starch. Among the modern supply chains, profitability in baby corn is relatively higher than in maize starch and maize silage. Apart from promoting value addition and strengthening of supply chain, maize productivity also needs to be raised.
- The study titled, “Production status, market integration and the law of one price: an exploration of the major maize markets of India” showed that India experienced the highest growth in maize crop output and consistent upticks in area, production, and yield. For the next five years, from 2020 to 2025, the chosen ARIMA model anticipated a rise in maize area, production, and yield of 10.58 million ha, 35.65 MT, and 3390.50 kg/ha, respectively. The market integration status depicted a unidirectional causality from the Punjab market to the other two selected markets (Madhya Pradesh and Uttar Pradesh). Madhya Pradesh and Uttar Pradesh showed no inter-causality. The situation demands for developing market intelligence in every market and augmenting online marketing systems through networking and computerization.

### Trade performance of millets

- The study on “Indian millets trade potential-cum-performance: economic perspective” examined the trade performance of millets, competitiveness and their impact on growth of agriculture. Empirical findings revealed that Indian millet exports contributed significantly to the global basket during the period 2000–2020. Revealed Comparative Advantage (RCA) analysis showed that Pakistan, Saudi Arabia, Vietnam, and Yemen were the major millet importing countries; they exhibited RCA value greater than unity, indicating that India had a significant advantage in exporting millets to these partner countries during the period 2011–2020. Gravity model, calibrated by using the variables like Gross Domestic Product (GDP), exchange rate and population of the respective countries, suggested that increase in millet export will promote GDP growth. However, export may be adversely impacted by the increasing population.

### Crop planning for edible oil needs

- The study on production and marketing of oilseeds in India with special reference to Punjab was undertaken to highlight the performance of oilseed cultivation in Punjab. It was found that the state of Punjab mainly focuses on four oilseed crops, namely groundnut, rapeseed-mustard, sunflower and sesamum. Area under oilseeds has declined from 86 thousand hectares to 40 thousand hectares during the period 2000-01 to 2019-20, which covered 0.49 percent of gross cropped area in TE 2019-20. The area and production instability in Punjab was found to be maximum in sunflower (95.6 %) followed by groundnut (88.6 %), sesamum (38.8 %) and rapeseed-mustard (13.3 %). Returns over variable costs in case of paddy were Rs 32818 per acre and Rs 29057 for groundnut. Substantial progress of the state with respect to canola (GSC-5, GSC-6, GSC-7 and RLC-3) suggests potential of the state in meeting edible oil needs of the country. Strong position of the state with respect to area and productivity of rice hints at a major role the state can play in enhancing rice bran oil production in the country.

### Decentralized procurement of wheat

- The study titled “Decentralized procurement of wheat: insights from Punjab state” suggested that overall Pungrain had used 60 percent of its godown/plinth capacity for decentralised procurement. Total acquisition cost of wheat (Rs 2174 per quintal) was same for both covered and plinth (CAP) and covered storage. Minimum support price (MSP) of wheat followed by cost of bags, arhtiya commission, market fee, interest charges and handling and labour charges were as major cost items. Results of the field survey conducted in Ludhiana and Bathinda districts of Punjab during the year 2022 identified low institutional credit availability as the major handicap (reported by 66 farmers). Under marketing problems, high transportation cost emerged as the main constraint followed by financial irregularities by middlemen and non-realization of remunerative prices. Procurement staff suggested undertaking research on climate resilient varieties of wheat crop and expanding harvest window for preventing glut.

### Price behaviour and integration analysis

- Uncertain prices, if not monitored and managed consistently, in staple food commodities put agrarian economies at risk. Price behaviour and integration across major wholesale and retail markets for rice and wheat in India were examined. Monthly data (July 2000 to June 2022) on prices viz. wholesale and retail were sourced from the Food and Agriculture Organization and analysed using growth rate, instability index, seasonal price index, Bai-Perron’s test for structural breaks, Johansen’s test on cointegration, Granger causality test, and impulse response function. Findings indicated strong evidence of price dynamics in the selected markets in terms of spatial and temporal variation, clear-cut seasonality linked to production, and price divergence between wholesale and retail markets. Johansen’s test indicated a strong cointegration between wholesale and retail prices after accounting for structural breaks, exhibiting unidirectional-, bidirectional- and no causality. It was concluded that strengthening the market intelligence and managing distortion in markets will improve the existing overall performance.

### Analysis of farm credit in Punjab

- The study on “Agricultural credit in Punjab: trends and future potential” examined various aspects of agricultural credit in Punjab using primary and secondary data. Under state-directed lending policies, institutional agricultural credit has witnessed massive expansion since 2004-05. However, the credit disbursement far outpaced the actual demand for agricultural credit. It caused a significant credit diversion towards house construction, immigration of family members, purchase of vehicles, expenditure on social ceremonies, etc. Changing consumption habits and rising incomes enhance the demand for processed products and increase the potential for credit expansion for agro-processing. Crop diversification efforts will also require a substantial allocation of institutional agricultural credit. Skill development, farm start-ups, FPOs, agro-machinery service centres, etc, are other important sources for expanding institutional agricultural credit in Punjab.

### Land ownership and credit availability

- A study was planned to analyse the benefits of clear land titles in accessing institutional credit, government schemes, overcoming of risks and uncertainties, improvement in net profits and other key variables. The survey covered 240 agricultural households, 120 each in groups of 'clear titles' and with 'non-clear titles'. Farmers in 'clear title group' were more experienced. Size of owned operational holding is larger in 'clear titles' group, whereas leasing- in of land is more prevalent in 'non-clear title' group. In 'clear title' group, 96 percent heads of the family were main cultivators and average size of land owned by the head of the family was 6.24 acre. About 47 percent of the households also have titles in the name of other than family members and average rent paid was Rs.43,594 per acre. But in the 'non-clear title' group, no piece of land was owned by the head of the household and average size of farm holding came out to be 2.94 acres.

### Farmer suicides

- The study "Farmer suicides: causes and policy prescription in Punjab" was undertaken to analyse the causes leading to farmer suicides in Punjab and to recommend suitable policy interventions for engaging with the issue. Results, drawn on a sample of 30 victim families, suggested that total suicide rate in the state has shown an increasing trend since the year 2014, but has started ebbing after attaining a peak in the year 2017. Socio-economic profile of impacted houses was not found to be encouraging and was dominated by less educated, disturbed marital relations, greater number of dependents, and absence of any support from extended family. Crop failure due to a variety of severe crop stresses and low yields attributed allegedly to poor quality inputs were other reasons. Credit repayment liability, unrealized expectations with respect to higher productivity or loan waiver relief aggravated mental stress. Major fallout of suicide tragedies spanned over abandoning of farming, disposing of land, poor mental health of fellow family members, and discontinuation of children's education.

### Irrigation water pricing

- In a case study of Punjab state, cropping pattern optimization and volumetric water pricing were examined with respect to their impact on

conserving natural resource base and enhancing farm income. The findings suggest that curtailing area under rice and taming groundwater depletion would remain remote possibility unless externalities of agricultural production, mainly the natural resource depletion, are internalized into the cost of production. Simulation of two possible alternatives for internalizing the externalities through two different volumetric water pricing policies gave a clear differential effect on water saving and the overall agricultural income in Punjab and strongly suggested compensating farmers to mitigate any adverse economic impacts. Direct and visible incentives are required to diversify the state's cropping pattern. As long as water is accessible, the tendency for its indiscriminate use will remain until an incentive-oriented pricing mechanism is in place. Volumetric water pricing will also encourage the efficient use of surface water. A policy of volumetric irrigation water pricing system can be implemented in a phased manner starting with well/tubewell irrigated areas which allow easy measurement. The long-time policy goals should involve phasing out the power subsidies for pumping groundwater and mainstreaming the payment for ecosystem services.

### Direct benefit transfer

- The study titled, "Direct Benefit Transfer (DBT) Scheme in marketing of Farm Produce in Punjab: Performance and Perceptions" involved a sample of 450 farmers and 40 commission agents. About 70 percent of the farmers reported that they merely heard of and did not act with regard to the scheme "Direct Benefit of Transfer for the Farm Produce" launched during the Rabi Marketing Season 2021-22; whereas 22 percent of the sampled farmers were scantily aware of the provisions of the scheme. The scheme though launched with the purpose of instant disbursement of the proceeds, 67.7 % farmers had reported that they had received payment on an average after 10 days. One-fourth of the farmers had reported a waiting period beyond 10 days. However, the response improved during the subsequent seasons.

### Economics of farming

- The university has been regularly conducting a study on "Economics of farming and the pattern of income and expenditure distribution among farmers in Punjab" for analysing the dynamics



of landholding structure, cropping pattern, farm investment details, income and expenditure pattern, and their distribution among different categories of Punjab farms. For the year 2020-21, the average size of operational holding was 4.05 ha, out of which leased-in land formed 24.49 percent and had direct relationship with the farm size. Overtime, cropping pattern got dominated by wheat-rice crops irrespective of the size of holding, covering about 87.11 percent area among the sample households. Average cropping intensity was 200.8 percent. The herd size varied inversely with farm size; average number of animals in terms of adult cattle unit (ACU) being about four animals per household. Annual employment in crop and dairy sector was estimated at 51 man days on per ha basis and about 33.5 percent manpower engaged in agriculture remained unutilized. Farm machinery had the largest investment share (Rs. 2,39,460) followed by livestock (Rs. 1,03,635), irrigation (Rs. 73,854) and farm-buildings (Rs. 62,450). The net family income was estimated at Rs 7.57 lakh per household; crop and dairy income constituted 72 percent and 15 percent, respectively.

### Economics of paddy straw management

- A study aimed at evaluating impact of the Central Sector scheme for Promotion of Agricultural Mechanization (CSSPAM) on in situ paddy straw management in Punjab involved 110 villages in 22 districts of Punjab (five from each district). More than 97 percent of the farmers suggested that the scheme should focus on high powered tractors. More than 80 percent of farmers additionally highlighted with inadequate availability of straw management machinery and skilled manpower for operating the machinery. The cost of land preparation and sowing of wheat slid with the pre-sowing use of SMS with Super Seeder and with Happy Seeder by 8.8 percent and 12.2 percent, respectively. For all mulching options, the cost increased by 12-30 percent. Adoption of the management machinery did not affect wheat productivity adversely. In six out of 10 options, the wheat yield increased significantly by 2.5-6 percent.

### Women entrepreneurship

- A study aimed at assessing the status of establishments owned by women entrepreneurs in Punjab vis-a-vis India showed that the women-

owned establishments formed 13.76 percent of the total enterprises, whereas for Punjab, it was only 7.33 percent at the state level and a mere 1.38 percent of total women establishments at the national level. Sangrur district had the highest number of rural women establishments (11.3%) whereas Jalandhar district had the highest (18.9%) women-owned urban enterprises. More than three-fourth establishments were operated without hired workers. Number of women establishments involved in agricultural activities constituted about one-fourth of the total number of establishments owned by women in Punjab as compared to about 34 percent in India. Self-finance was the major source of financial support in both Punjab (85%) and India (79%). Women faced different socio-cultural and production related challenges, institutional credit and marketing competitiveness being the major ones.

## ENVIRONMENTAL STUDIES

### Water quality in Beas river

- Findings of the study funded by the Punjab Pollution Control Board suggested the presence of coliforms and faecal coliforms in water flowing in Beas river. This makes water unsafe for drinking, but it can be used for irrigating agro-forestry plantations. However, its use on raw consumed vegetables and low growing fruit trees should be avoided.
- Trace and nutrient elemental concentration was below the prescribed limits (World Health Organization and Bureau of Indian Standards).
- Some pathogens like urinary tract infection (UTI) bacteria, *Vibrio cholera*, *V. parahaemolyticus*, *Aeromonas hydrophilia*, *Salmonella typhi*, *Shigella sp.*, *Listeria monocytogenes*, *Campylobacter jejuni* and *Staphylococcus aureus* have emerged as a major public health concern in river Beas. Relative abundance of these emerging pathogens during different seasons revealed dominance of *Vibrio sp.* Abundance of *Listeria sp.* in River Beas was found to be 36.2%. Phytoplanktons and aquatic animals have been implicated as main sources of *Vibrio* and *Listria* in water of Beas river.

### Nanocomposites

- $Mn_3O_4$  and  $MgFe_2O_4$  nanoparticles and nanocomposites were synthesized using sol-gel and ultra-sonication methods. The  $MgFe_2O_4@$

Mn<sub>3</sub>O<sub>4</sub> nanocomposite exhibited unique catalytic features and showed the best polyphenol oxidase (PPO) mimic activity among the synthesized materials. Nanocomposites had a higher binding affinity than pristine manganese oxide. MgFe<sub>2</sub>O<sub>4</sub>@Mn<sub>3</sub>O<sub>4</sub> (2:1) demonstrated the best photocatalytic potential for the degradation of catechol and resorcinol in aqueous solution. These findings indicate that MgFe<sub>2</sub>O<sub>4</sub>@Mn<sub>3</sub>O<sub>4</sub> nanocomposites have promising performance as photocatalysts and PPO mimics for polyphenol degradation.

### Chemosensors

- A chemosensor named TPC, based on thymol, was synthesized by reacting thymol and piperidine in methanol. TPC exhibited absorption at 277 nm, which increased by 2-fold and 1.5-fold in the presence of Cu<sup>2+</sup> and Pb<sup>2+</sup> ions, respectively. The binding constants for TPC-Cu<sup>2+</sup> and TPC-Pb<sup>2+</sup> complexes were calculated as 1.55 × 10<sup>5</sup> M<sup>-1</sup> and 1.47 × 10<sup>5</sup> M<sup>-1</sup>, respectively. Limit of detection (LOD) and limit of quantification (LOQ) for Cu<sup>2+</sup> were 623.64 µM and 1889.85 µM, whereas for Pb<sup>2+</sup>, LOD and LOQ were 676.70 µM and 2050.60 µM, respectively. Binding stoichiometry was determined as 1:1 using Job's continuous variation plot method for both TPC-Cu<sup>2+</sup> and TPC-Pb<sup>2+</sup> complexes. TPC demonstrated reusability for up to two cycles and was effective in determining the concentration of Cu<sup>2+</sup> and Pb<sup>2+</sup> ions in spiked tap water samples, with recovery percentages ranging from 80.1% to 81.0% and 80.1% to 81.9%, respectively. TPC showed no toxicity against tested plant growth-promoting rhizobacteria (PGPR) at all concentrations.
- An azomethine linkage-based synthesized chemosensor RM1 exhibited a colour change from colourless to light yellow in the presence of Al<sup>3+</sup> ions in pure acetonitrile. UV-vis studies of RM1 revealed absorption bands at 278 nm and 347 nm, with the addition of Al<sup>3+</sup> ions resulting in a new band at 412 nm. A complex between RM1 and Al<sup>3+</sup> ions was formed with a binding constant of 7 × 10<sup>3</sup> M<sup>-1</sup>. Limit of detection (LOD) and limit of

quantification (LOQ) for RM1 in analyzing Al<sup>3+</sup> ions were determined as 207.81 µM and 629.73 µM, respectively.

### TECHNOLOGIES COMMERCIALISED

In order to ensure rapid uptake of various recommended interventions for tangible gains in agricultural productivity of the region, various technologies generated by the PAU are in general passed onto the farmers and allied entrepreneurs directly in a welfare mode. In addition, however, the university has been making consistent efforts in transitioning its technologies to market through various entrepreneurs for fostering innovation and academia-business/industry linkages.

- During the report period, the university extended non-exclusive rights for 13 different farm machinery, varietal, post-harvesting, and waste-to-energy technologies to 32 entrepreneurs (See Table below)

| Technology Commercialized                                                                                                    | Number |
|------------------------------------------------------------------------------------------------------------------------------|--------|
| PAU Smart Seeder Technology                                                                                                  | 8      |
| Modified PAU fixed Dome Type Janta Model Biogas Plant having capacity from 25 m <sup>3</sup> /day to 500 m <sup>3</sup> /day | 7      |
| Sugarcane Juice Bottling Technology                                                                                          | 5      |
| Paddy Straw Based Biogas Plant made up of Mild Steel Sheet (above the ground)                                                | 3      |
| Electric Soil Disinfector                                                                                                    | 1      |
| Gluten-free Atta                                                                                                             | 1      |
| Chilli Hybrid CH 27                                                                                                          | 1      |
| Maize Hybrid PMH 14                                                                                                          | 1      |
| Rooftop Vegetable Nutrition Garden Model using Soilless Media                                                                | 1      |
| PAU fixed Dome Type Family size Biogas Plant having capacity from 1 m <sup>3</sup> /day to 25 m <sup>3</sup> /day            | 1      |
| Evacuated tube collector solar dryer employing conventional evacuated tubes.                                                 | 1      |
| Apple Cider (Vinegar)                                                                                                        | 1      |
| Potato parantha/samosa mix                                                                                                   | 1      |

# Education

## ADMISSIONS

Academic programmes of the University are run through its five constituent colleges at Ludhiana, namely College of Agriculture (CoA), College of Agricultural Engineering and Technology (CoAE&T), College of Basic Sciences and Humanities (CoBS&H), College of Community Science (CoCS), College of

Horticulture and Forestry (CoH&F); two Institutes of Agriculture (IoA) at Gurdaspur and Bathinda; and College of Agriculture at Ballawal Saunkhri, Shaheed Bhagat Singh Nagar. During 2022-23, the University offered 09 Undergraduate, 44 Masters', 29 Doctorate and two Diploma programmes as per the following details:

| Sr. No.              | Programme                                                               | Number of Seats              |      | Number of students admitted | Number of students passed out† (01.01.2022 to 31.12.2022) |
|----------------------|-------------------------------------------------------------------------|------------------------------|------|-----------------------------|-----------------------------------------------------------|
|                      | Class/Programme                                                         | General Reserved/ Additional | ICAR |                             |                                                           |
| <b>UNDERGRADUATE</b> |                                                                         |                              |      |                             |                                                           |
| 1                    | B.Sc. (Hons.) Agri. 4 year                                              | 80                           | 14   | 93                          | 83                                                        |
| 2                    | B.Sc. (Hons.) Horticulture 4 year                                       | 62                           | -    | 62                          | 0                                                         |
| 3                    | B.Tech. Food Tech. 4 year                                               | 62                           | -    | 62                          | 56                                                        |
| 4                    | B.Tech. Biotechnology 4 year                                            | 60                           | -    | 51                          | 45                                                        |
| 5                    | B.Sc. (Hons.) Community Science 4 year                                  | 50                           | 9    | 15                          | 43                                                        |
| 6                    | B.Sc. Nutrition & Dietetics 4 year                                      | 60                           | -    | 50                          | 52                                                        |
| 7                    | B.Sc. (Hons.) Agribusiness Mgt. 4-year                                  | 40                           | -    | 19                          | 0                                                         |
| 8                    | B.Sc. (Hons.) Agri. 4 year at Ballawal Saunkhri                         | 64                           | -    | 64                          | 0                                                         |
| 9                    | B.Sc. (Hons.) Agri. 2+4 year at Bathinda & Gurdaspur*                   | 126                          | -    | 126                         | 110                                                       |
| 10                   | B.Tech. Agril. Engg. 4 year                                             | 70                           | 12   | 32                          | 71                                                        |
| 11                   | B.Sc. (Hons.) Fashion Designing 4 year                                  | -                            | -    | -                           | 1                                                         |
| 12                   | B.Sc. (Admission made through 5 year Integrated M.Sc. (Hons.))          | -                            | -    | -                           | 24                                                        |
| <b>POSTGRADUATE</b>  |                                                                         |                              |      |                             |                                                           |
| 1                    | 5 year Integrated M.Sc. (Hons.)                                         | 90                           | -    | 22                          | 40                                                        |
| 2                    | M.Sc. Agriculture                                                       | 140                          | 39   | 153                         | 156                                                       |
| 3                    | M.Sc. Horticulture                                                      | 42                           | 12   | 54                          | 43                                                        |
| 4                    | M. Tech. including Remote Sensing & Geographic Information System (GIS) | 58                           | 8    | 30                          | 19                                                        |
| 5                    | M.Sc. Basic Sciences                                                    | 117                          | 26   | 45                          | 79                                                        |
| 6                    | M.Sc. Community Science                                                 | 43                           | 12   | 34                          | 31                                                        |
| 7                    | MBA                                                                     | 50                           | -    | 23                          | 28                                                        |
| 8                    | MBA (Agribusiness)                                                      | 31                           | 10   | 38                          | 32                                                        |
| 9                    | MCA 3 year and MCA (lateral entry) 2 years                              | 60                           | 0    | 0                           | 0                                                         |
| 10                   | Ph.D.                                                                   | 170                          | 43   | 129                         | 109                                                       |

| OTHERS |                                                              |    |   |    |    |
|--------|--------------------------------------------------------------|----|---|----|----|
| 1      | Two year Diploma in Agriculture at Ludhiana and RRS Faridkot | 90 | - | 25 | 27 |
| 2      | Diploma course in Hybrid seed Production Technology 1-year   | 40 | - | -  | -  |

\* The students of B.Sc. (Hons.) Agri. 2+4 year programme study the basic courses of 10+2 (Med. Stream) at Institutes of Agriculture at Bathinda and Gurdaspur and after clearing the courses they are shifted to PAU, Ludhiana.

† Number of students passed out from 1.1.2022 to 31.12.2022.

## EXAMINATION CELL

The Examination Cell of PAU conducted Entrance Tests to induct meritorious students in various Undergraduate, Masters' and Ph.D. programmes in PAU. Besides, it also conducted several Recruitment Tests and Higher Standard Departmental Examinations. Various activities of the Examination Cell under the Controller of Examinations of PAU for the period 01.07.2022 to 30.06.2023 of the Punjab Agricultural University are given below:

### Entrance Tests

- **Undergraduate Programmes:** The Examination Centre conducted the Common Entrance Test (CET) for admission to B.Sc. Hons. (Agri.) 4-year, B.Sc. Hons. (Hort.) 4-year, B. Tech. (Biotechnology) 4-year, B. Tech. Food Tech. 4-year, B.Sc. (Hons.) Community Science 4-year, B.Sc. (Hons.) Nutrition & Dietetics 4-year, B.Sc. (Hons.) Agribusiness Management 4-year and 5-year Integrated M.Sc. (Hons.) programmes on 24.7.2022 for which 1308 candidates applied for admission. The Entrance Test for admission to B.Sc. Hons. (Agri.) 4-year programme at Ballawal Saunkhri was conducted on 21.08.2022 for 200 candidates. The Entrance Test for admission to B.Sc. Hons. (Agri.) 6-year programme was conducted on 15.07.2022 for which 445 candidates applied for admission.
- **Masters' Programmes:** The Examination Cell also conducted Masters' Entrance Tests for admission to M.Sc./MBA/MBA (AB) /MJ/M. Tech. programmes in the College of Agriculture, College of Horticulture & Forestry, College of Community Science, College of Basic Sciences & Humanities, and College of Agricultural Engineering & Technology of the Punjab Agricultural University, Ludhiana for the academic session 2022-23.
- **Ph.D. programmes:** The Examination Cell conducted Entrance Tests for admission to 29 Ph.D. programmes in the College of Agriculture, College

of Community Science, College of Basic Sciences & Humanities, College of Agricultural Engineering & Technology, and College of Horticulture & Forestry of the Punjab Agricultural University, Ludhiana, during November-December, 2022.

### Recruitment Tests

- Written Test for recruitment to the post of drivers at KVK on 05.07.2022.
- Written Test for recruitment to the post of Programme Assistant (Lab. Technician) on 05.07.2022.
- Written Test for recruitment to the post of Surveyor on 05.07.2022.
- Written Test for recruitment to the posts of Jeep/ Car Drivers on 01.10.2022 for 1272 candidates.
- Written Test for recruitment to the posts of Clerks on 30.10.2022 for 2556 candidates. The typing test in English and Punjabi was conducted for the qualified candidates (190 candidates) for the post of Clerk from 14.12.2022 to 16.12.2022.
- Written Test for the post of Office Assistant/General Assistant at RRS Ballawal Saunkhri, FASC Jallowal, FASC Tarn Taran, FASC Barnala, FASC Ferozepur, Skill Development Centre and Dean, College of Basic Sciences & Humanities on 05.03.2023.
- Written Test for appointment to the post of Clerk on compassionate grounds on 05.03.2023.
- Written Test for the post of General Assistant at KVK Gurdaspur on 26.06.2023.

### Higher Standard Departmental Examination for PAU Employees

Six papers of Higher Standard Departmental Examination were conducted for PAU employees during February, 2023.



### Departmental Examination in Accounts for Teachers

The Examination Cell conducted the Departmental Examination in Accounts for teachers twice i.e. on 11.10.2022 and 12.06.2023.

The results of all the above tests were prepared and submitted to the Registrar, PAU / concerned quarters

for further necessary action.

### Training Classes for Departmental Examination in Accounts for Teachers

The Examination Cell arranged Training Classes for teachers who applied for Departmental Examination in Accounts twice i.e. from 3.10.2022 to 10.10.2022 and 29.05.2023 to 02.06.2023.

## NEW COURSES

### College of Agriculture

| Course No.                        | Course Title                                         | Credit Hours |
|-----------------------------------|------------------------------------------------------|--------------|
| <b>Agricultural Biotechnology</b> |                                                      |              |
| MBB-501                           | Principles of Biotechnology                          | 3+0          |
| MBB-502                           | Fundamentals of Molecular Biology                    | 3+0          |
| MBB-503                           | Molecular Cell Biology                               | 3+0          |
| MBB-504                           | Techniques in Molecular Biology I                    | 0+3          |
| MBB-505                           | Omics and Systems Biology                            | 2+1          |
| MBB-506                           | Plant Genetic Engineering                            | 3+0          |
| MBB-507                           | Techniques in Molecular Biology II                   | 0+3          |
| MBB 508                           | Introduction to Bioinformatics                       | 2+1          |
| MBB 509                           | Plant Tissue Culture                                 | 2+1          |
| MBB-510                           | Microbial/Industrial Biotechnology                   | 2+1          |
| MBB-511                           | Molecular Plant Breeding                             | 2+1          |
| MBB-512                           | IPR, Bio-safety & Bioethics                          | 2+0          |
| MBB-513                           | Immunology and Molecular Diagnostics                 | 3+0          |
| MBB-514                           | Nano Biotechnology                                   | 2+1          |
| MBB-515                           | Environmental Biotechnology                          | 3+0          |
| MBB-516                           | Bio-entrepreneurship                                 | 1+0          |
| MBB 517                           | Stress Biology and Genomics                          | 2+0          |
| MBB 518                           | Gene Regulation                                      | 2+0          |
| MBB 591                           | Master's Seminar                                     | 1+0          |
| MBB-601                           | Plant Molecular Biology                              | 3+0          |
| MBB-602                           | Plant Genome Engineering                             | 3+0          |
| MBB-603                           | Plant Omics and Molecular Breeding                   | 3+0          |
| MBB-604                           | Commercial Plant Tissue culture                      | 2+0          |
| MBB-605                           | Plant Microbe Interaction                            | 2+0          |
| MBB-606                           | RNA Biology                                          | 1+0          |
| MBB-607                           | Plant Hormones and Signalling                        | 2+0          |
| MBB-608                           | Computational and Statistical Tools in Biotechnology | 2+1          |
| MBB-610                           | Genome Editing in Plants                             | 2+0          |
| MBB-691                           | Seminar                                              | 1+0          |
| MBB-692                           | Seminar                                              | 1+0          |



| Course No.                                         | Course Title                                                          | Credit Hours |
|----------------------------------------------------|-----------------------------------------------------------------------|--------------|
| <b>Climate Change and Agricultural Meteorology</b> |                                                                       |              |
| AGM-501                                            | Fundamentals of Meteorology                                           | 2+1          |
| AGM-503                                            | Crop-Weather Relationships                                            | 2+0          |
| AGM-507                                            | Crop Weather Models                                                   | 1+2          |
| AGM-508                                            | Applied Agricultural Climatology                                      | 1+2          |
| AGM-509                                            | Weather Forecasting                                                   | 2+1          |
| AGM-510                                            | RS And GIS Applications in Agricultural Meteorology                   | 2+1          |
| AGM-513                                            | Aero bio meteorology                                                  | 2+1          |
| AGM-502                                            | Fundamentals of Agricultural Meteorology                              | 2+1          |
| AGM-504                                            | Agro-Meteorological Measurements and Instrumentation                  | 1+2          |
| AGM-505                                            | Crop Micrometeorology                                                 | 2+1          |
| AGM-506                                            | Evapotranspiration and Soil Water Balance                             | 2+1          |
| AGM-511                                            | Strategic Use of Climatic Information                                 | 2+1          |
| AGM-512                                            | Weather And Climate Risk Management                                   | 2+0          |
| AGM-591                                            | Master's Seminar                                                      | 1+0          |
| AGM-599                                            | Master's Research                                                     | 0+30         |
| AGM-601                                            | Climate Change And Sustainable Development                            | 2+1          |
| AGM-603                                            | Livestock and Fisheries Meteorology                                   | 2+2          |
| AGM-605                                            | Analytical Tools and Methods For Agro-Meteorology                     | 1+1          |
| AGM-607                                            | Environmental Physics for Agricultural Meteorology                    | 3+0          |
| AGM-602                                            | Meteorology of Air Pollution                                          | 2+2          |
| AGM-604                                            | Hydrometeorology                                                      | 2+1          |
| AGM-606                                            | Research And Publication Ethics                                       | 2+0          |
| AGM-608                                            | Computer Programs and Software for Agrometeorological Data Management | 1+1          |
| AGM-691                                            | Doctor's Seminar                                                      | 1+0          |
| AGM-692                                            | Doctor's Seminar                                                      | 1+0          |
| AGM-699                                            | Doctor's Research                                                     | 0+75         |
| <b>Agronomy</b>                                    |                                                                       |              |
| Agron-107                                          | Basic Agronomy and Production Technology for Kharif Crops             | 1+1          |
| Agron-306                                          | Sustainable Farming System and Precision Agriculture                  | 2+1          |
| Agron-307                                          | Medicinal, Spices and Aromatic Crops                                  | 2+1          |
| Agron-501                                          | Modern Concepts in Crop Production                                    | 3+0          |
| Agron-502                                          | Principles and Practices of Soil Fertility and Nutrient Management    | 2+1          |
| Agron-503                                          | Principles and Practices of Weed Management                           | 2+1          |
| Agron-504                                          | Principles and Practices of Water Management                          | 2+1          |
| Agron-505                                          | Conservation Agriculture                                              | 1+1          |
| Agron-506                                          | Agronomy of Major Cereals and Pulses                                  | 1+1          |
| Agron-507                                          | Agronomy of Oilseed, Fibre and Sugar Crops                            | 2+1          |
| Agron-508                                          | Agronomy of Medicinal, Aromatic & Underutilized Crops                 | 2+1          |
| Agron-509                                          | Agronomy of Fodder and Forage Crops                                   | 2+1          |
| Agron-510                                          | Agrostology and Agro-Forestry                                         | 2+1          |



| Course No.        | Course Title                                           | Credit Hours |
|-------------------|--------------------------------------------------------|--------------|
| Agron-511         | Cropping Systems and Sustainable Agriculture           | 2+0          |
| Agron-512         | Dryland Farming and Watershed Management               | 2+1          |
| Agron-513         | Principles and Practices of Organic Farming            | 2+1          |
| Agron-514         | Field Plot Techniques                                  | 1+1          |
| Agron-591         | Master's Seminar                                       | 1+0          |
| Agron-599         | Master's Research                                      | 0+30         |
| Agron-601         | Current Trends in Agronomy                             | 3+0          |
| Agron-602         | Recent Trends in Crop Growth and Productivity          | 2+1          |
| Agron-603         | Irrigation Management                                  | 2+1          |
| Agron-604         | Recent Trends in Weed Management                       | 2+0          |
| Agron-605         | Integrated Farming Systems for Sustainable Agriculture | 2+0          |
| Agron-606         | Soil Conservation and Watershed Management             | 2+1          |
| Agron-607         | Stress Crop Production                                 | 2+1          |
| Agron-691         | Doctor's Seminar                                       | 1+0          |
| Agron-692         | Doctor's Seminar                                       | 1+0          |
| Agron-699         | Doctor's Research                                      | 0+75         |
| <b>Entomology</b> |                                                        |              |
| Ent-501           | Insect Morphology                                      | 2+1          |
| Ent-502           | Insect Anatomy and Physiology                          | 2+1          |
| Ent-503           | Insect Taxonomy                                        | 1+2          |
| Ent-505           | Biological Control of Insect Pests and Weeds           | 2+1          |
| Ent-506           | Toxicology of Insecticides                             | 2+1          |
| Ent-509           | Pests of Field Crops                                   | 2+1          |
| Ent-510           | Pests of Horticultural and Plantation Crops            | 2+1          |
| Ent-516           | Apiculture                                             | 2+1          |
| Ent-517           | Sericulture                                            | 2+1          |
| Ent-518           | Lac Culture                                            | 2+1          |
| Ent-521           | Edible and Therapeutic Insects                         | 1+1          |
| Ent-522           | Medical and Veterinary Entomology                      | 1+1          |
| Ent-523           | Forest Entomology                                      | 1+1          |
| Ent-504           | Insect Ecology                                         | 2+1          |
| Ent-507           | Host Plant Resistance                                  | 2+1          |
| Ent-508           | Concepts of Integrated Pest Management                 | 2+0          |
| Ent-511           | Post-Harvest Entomology                                | 1+1          |
| Ent-512           | Insect Vectors of Plant Pathogens                      | 1+1          |
| Ent-513           | Principles of Acarology                                | 1+1          |
| Ent-514           | Vertebrate Pest Management                             | 1+1          |
| Ent-515           | Techniques in Plant Protection                         | 0+1          |
| Ent-519           | Bio-technological Approaches in Entomology             | 2+1          |
| Ent-520           | Plant Quarantine, Biosafety and Biosecurity            | 2+0          |
| Ent-591           | Master's Seminar                                       | 1+0          |



| Course No.                 | Course Title                                                 | Credit Hours |
|----------------------------|--------------------------------------------------------------|--------------|
| Ent-599                    | Master's Research                                            | 0+30         |
| Ent-603                    | Insect Ecology and Diversity                                 | 2+1          |
| Ent-608                    | Insect Behaviour                                             | 1+1          |
| Ent- 609                   | Acarology                                                    | 1+1          |
| Ent-604                    | Molecular Entomology                                         | 1+1          |
| Ent-601                    | Insect Phylogeny and Systematics 1+2                         | 1+2          |
| Ent- 602                   | Insect Physiology and Nutrition                              | 2+1          |
| Ent- 605                   | Bio-inputs for Pest Management                               | 2+1          |
| Ent- 606                   | Insect Toxicology and Residues                               | 2+1          |
| Ent-607                    | Plant Resistance to Insects                                  | 1+1          |
| Ent- 610                   | Integrated Pest Management                                   | 2+0          |
| Ent- 611                   | Melittology and Its Applications                             | 2+0          |
| Ent-691                    | Doctoral Seminar-I                                           | 0+1          |
| Ent- 692                   | Doctoral Seminar –II                                         | 0+1          |
| Ent-699                    | Doctor's Research                                            | 0+75         |
| <b>Extension Education</b> |                                                              |              |
| Ext-202                    | Fundamentals of Agricultural Extension and Rural Development | 2+1          |
| Ext-302                    | Communication and Diffusion of Agricultural Innovation       | 1+1          |
| Ext-501                    | Extension Landscape                                          | 2+0          |
| Ex-502                     | Applied Behaviour Change                                     | 2+1          |
| Ext-503                    | Organisational Behavior and Development                      | 2+1          |
| Ext-504                    | Research Methodology in Extension                            | 2+1          |
| Ext-505                    | Capacity Development                                         | 2+1          |
| Ext-506                    | ICTs for Agricultural Extension and Advisory Services        | 2+1          |
| Ext-507                    | Evaluation and Impact Assessment                             | 2+1          |
| Ext-508                    | Managing Extension Organisations                             | 2+1          |
| Ext-509                    | Enabling Innovation                                          | 1+1          |
| Ext-510                    | Gender Mainstreaming                                         | 2+1          |
| Ext-591                    | Master's Seminar                                             | 0+1          |
| Ext-599                    | Master's Research                                            | 0+30         |
| Ext-601                    | Policy Engagement and Extension                              | 2+1          |
| Ext-602                    | Methodologies for Social and Behavioural Research            | 2+1          |
| Ext-603                    | Technology Commercialization and Incubation                  | 2+1          |
| Ext-604                    | Educational Technology and Instructional Design              | 2+1          |
| Ext-605                    | Risk Management and Climate change Adaptation                | 2+1          |
| Ext-606                    | Livelihood Development                                       | 1+1          |
| Ext-607                    | Facilitation for People centric development                  | 2+1          |
| Ext-691                    | Doctor's Seminar                                             | 0+1          |
| Ext-692                    | Doctor's Seminar                                             | 0+1          |
| Ext-699                    | Doctor's Research                                            | 0+75         |



| Course No.                         | Course Title                                                            | Credit Hours |
|------------------------------------|-------------------------------------------------------------------------|--------------|
| <b>Food Science and Technology</b> |                                                                         |              |
| FPT-501                            | Emerging Technologies in Food Processing                                | 2+1          |
| FPT-502                            | Emerging Technologies in Food Packaging                                 | 2+1          |
| FPT-503                            | Industrial Manufacturing of Food and Beverages                          | 2+1          |
| FPT-514                            | Food Ingredients and Additives                                          | 2+1          |
| FPT-517                            | Enzymes in Food Processing                                              | 2+1          |
| FPT-520                            | Summer Internship                                                       | 0+2          |
| FPT-521                            | Technology of Fruits and Vegetable Processing                           | 2+1          |
| FPT-522                            | Technology of Cereals Pulses and Oilseeds                               | 2+1          |
| FPT-523                            | Technology of Milk and Milk Products                                    | 2+1          |
| FPT-524                            | Food Quality System and Management                                      | 2+0          |
| FPT-601                            | Novel Technologies for Food Processing and Shelf-Life Extension         | 3+0          |
| FPT-603                            | Food Manufacturing Technology                                           | 3+0          |
| FPT-608                            | Carbohydrate Technology                                                 | 2+1          |
| FPT-609                            | Protein Technology                                                      | 2+1          |
| FPT-610                            | Advanced Food Analysis                                                  | 0+2          |
| <b>Plant Breeding and Genetics</b> |                                                                         |              |
| GPB-501                            | Principles of Genetics                                                  | 2+1          |
| GPB-502                            | Principles of Plant Breeding                                            | 2+1          |
| GPB-504                            | Varietal Development and Maintenance Breeding                           | 1+1          |
| GPB-508                            | Mutagenesis and Mutation Breeding                                       | 2+1          |
| GPB-509                            | Hybrid Breeding                                                         | 2+1          |
| GPB-510                            | Seed Production and Certification                                       | 1+1          |
| GPB-511                            | Crop Breeding –I (Kharif Crops)                                         | 2+1          |
| PGS-503                            | Intellectual Property and its Management in Agriculture                 | 1+0          |
| PGS-505                            | Agricultural Research, Research Ethics and Rural Development Programmes | 1+0          |
| GPB-503                            | Fundamentals of Quantitative Genetics                                   | 2+1          |
| GPB-504                            | Varietal Development and Maintenance Breeding                           | 1+1          |
| GPB-506                            | Molecular Breeding and Biotechnology                                    | 2+1          |
| GPB-512                            | Crop Breeding- II (Rabi crops)                                          | 2+1          |
| GPB-516                            | Breeding for Stress Resistance and Climate Change                       | 2+1          |
| GPB-518                            | Genetic enhancement for PGR utilization                                 | 1+1          |
| GPB-604                            | Plant Genetic Resources, conservation and utilization                   | 2+0          |
| GPB-605                            | Genomics in Plant Breeding                                              | 2+1          |
| GPB-608                            | Breeding Designer Crops                                                 | 1+1          |
| GPB-609                            | IPR and Regulatory Mechanism                                            | 1+0          |
| <b>Plant Pathology</b>             |                                                                         |              |
| Pl. Path-501                       | Mycology                                                                | 2+1          |
| Pl. Path-502                       | Plant Virology                                                          | 2+1          |
| Pl. Path-505                       | Principles of Plant Pathology                                           | 2+1          |
| Pl. Path-507                       | Principles of Plant Disease Management                                  | 2+1          |



| Course No.          | Course Title                                                             | Credit Hours |
|---------------------|--------------------------------------------------------------------------|--------------|
| Pl. Path-510        | Ecology of Soil Borne Plant Pathogens                                    | 1+1          |
| Pl. Path-513        | Biological Control of Plant Pathogens                                    | 1+1          |
| Pl. Path-516        | Diseases of Fruits, Plantation and Ornamental Crops                      | 2+1          |
| Pl. Path-518        | Post-Harvest Diseases                                                    | 2+1          |
| Pl. Path-519        | Plant Quarantine and Regulations                                         | 1+0          |
| Pl. Path-503        | Plant Pathogenic Prokaryotes                                             | 2+1          |
| Pl. Path-504        | Plant Nematology                                                         | 2+1          |
| Pl. Path-506        | Techniques for Detection and Diagnosis of Plant Diseases                 | 0+2          |
| Pl. Path-508        | Epidemiology and Forecasting of Plant Diseases                           | 1+0          |
| Pl. Path-509        | Disease Resistance in Plants                                             | 2+0          |
| Pl. Path-511        | Chemicals and Botanicals in Plant Disease Management                     | 2+1          |
| Pl. Path-512        | Detection and Management of Seed Borne Pathogens                         | 2+1          |
| Pl. Path-514        | Integrated Disease Management                                            | 2+1          |
| Pl. Path-515        | Diseases of Field and Medicinal Crops                                    | 2+1          |
| Pl. Path-517        | Diseases of Vegetable and Spices Crops                                   | 2+1          |
| Pl. Path-591        | Master's Seminar                                                         | 1+0          |
| Pl. Path-599        | Master's Research                                                        | 0+ 30        |
| Pl. Path-601        | Advances in Mycology                                                     | 2+1          |
| Pl. Path-602        | Advances in Virology                                                     | 2+1          |
| Pl. Path-605        | Principles and Procedures of Certification                               | 1+0          |
| Pl. Path-603        | Advances in Plant Pathogenic Prokaryotes                                 | 2+1          |
| Pl. Path-604        | Molecular Basis of Host-Pathogen Interaction                             | 2+1          |
| Pl. Path-606        | Plant Biosecurity and Biosafety                                          | 2+0          |
| Pl. Path-691        | Doctoral Seminar- I                                                      | 1+0          |
| Pl. Path-692        | Doctoral Seminar- II                                                     | 1+0          |
| Pl. Path-699        | Doctoral Research                                                        | 0+ 75        |
| <b>Soil Science</b> |                                                                          |              |
| Soil-501            | Soil Physics                                                             | 2+1          |
| Soil-502            | Soil Fertility and Fertilizer Use                                        | 2+1          |
| Soil-503            | Soil Chemistry                                                           | 2+1          |
| Soil-504            | Soil Mineralogy, Genesis and Classification                              | 2+1          |
| Soil-507            | Radioisotopes in Soil and Plant Studies                                  | 2+0          |
| Soil-509            | Remote Sensing and GIS Technique for Soil, Water and Crop Studies        | 2+1          |
| Soil-510            | Analytical Technique and Instrumental Methods in Soil and Plant Analysis | 0+2          |
| Soil-511            | Management of Problem Soils and Water                                    | 2+1          |
| Soil-515            | System Approaches in Soil and Crop Studies                               | 2+0          |
| Soil-505            | Soil Erosion and Conservation                                            | 2+1          |
| Soil-506            | Soil Biology and Biochemistry                                            | 2+1          |
| Soil-508            | Soil, Water and Air Pollution                                            | 2+1          |
| Soil-512            | Land Degradation and Restoration                                         | 1+0          |
| Soil-513            | Soil Survey and Land Use Planning                                        | 2+0          |



| Course No. | Course Title                                 | Credit Hours |
|------------|----------------------------------------------|--------------|
| Soil-514   | Introduction to Nanotechnology               | 2+1          |
| Soil-591   | Master's Seminar                             | 1+0          |
| Soil-599   | Master's Research                            | 0+ 30        |
| Soil-605   | Biochemistry of Soil Organic Matter          | 2+0          |
| Soil- 606  | Soil Resource Management                     | 3+0          |
| Soil-607   | Modelling of Soil Plant System               | 2+0          |
| Soil-608   | Clay Mineralogy                              | 2+1          |
| Soil-609   | Recent Trends in Soil Microbial Biodiversity | 2+1          |
| Soil-601   | Recent Trends in Soil Physics                | 2+0          |
| Soil-602   | Modern Concept in Soil Fertility             | 2+0          |
| Soil-603   | Physical Chemistry of Soil                   | 2+0          |
| Soil-604   | Soil Genesis and Micromorphology             | 2+0          |
| Soil-691   | Doctoral Seminar                             | 1+0          |
| Soil-692   | Doctoral Seminar                             | 1+0          |
| Soil-699   | Doctoral Research                            | 0+75         |
| Soil-691   | Doctoral Seminar- I                          | 1+0          |
| Soil-692   | Doctoral Seminar- II                         | 1+0          |
| Soil-699   | Doctoral Research                            | 0+ 75        |

### College of Agricultural Engineering and Technology

| Course No.               | Course Title                                        | Credit Hours |
|--------------------------|-----------------------------------------------------|--------------|
| <b>Civil Engineering</b> |                                                     |              |
| CE-501                   | Dimensional Analysis and Similitude                 | 2+0          |
| CE-502                   | Water Quality and Pollution Control                 | 2+1          |
| CE-503                   | Earthquake Resistant Design of Structures           | 3+0          |
| CE-504                   | Advanced Construction Practices and Steel Detailing | 2+1          |
| CE-505                   | Repair and Retrofitting of Structures               | 3+0          |
| CE-506                   | Dams and Reservoir Operations                       | 2+1          |
| CE-507                   | Open Channel Flow                                   | 3+0          |
| CE-508                   | Agro Industrial Pollution Control                   | 3+0          |
| CE-509                   | Control of Pollution from Solid Waste               | 2+0          |
| CE-510                   | Experimental Stress Analysis                        | 3+0          |
| CE-511                   | Landfills and Ash ponds                             | 3+0          |
| CE-512                   | Mechanics of Sediment Transport                     | 3+0          |
| CE-513                   | Geotechnical Investigations and Ground Improvement  | 3+0          |
| CE-514                   | Environmental System Analysis                       | 2+0          |
| CE-515                   | Solid and Hazardous Waste Management                | 3+0          |
| CE-516                   | Construction Management and Equipment               | 3+0          |
| CE-517                   | Concrete Technology and Pre-stressed Concrete       | 3+0          |
| CE-518                   | Advanced Foundation Design                          | 3+0          |



| Course No.                                               | Course Title                                          | Credit Hours |
|----------------------------------------------------------|-------------------------------------------------------|--------------|
| CE-519                                                   | Advanced Solid Mechanics                              | 3+0          |
| CE-520                                                   | Design of R. C. C. Bridges                            | 2+1          |
| CE-521                                                   | Inelastic Design in Structures                        | 3+0          |
| CE-522                                                   | Advanced Structural Analysis                          | 3+0          |
| CE-601                                                   | Advanced Reinforced Concrete Design                   | 3+0          |
| CE-602                                                   | Dynamic Response of Structures                        | 3+0          |
| CE-603                                                   | Finite Element Applications in Structural Engineering | 3+0          |
| CE-604                                                   | Design of Tall Structures                             | 3+0          |
| CE-605                                                   | Design of Industrial Structures                       | 3+0          |
| CE-606                                                   | Optimization Techniques in Structural Engineering     | 3+0          |
| <b>Electrical Engineering and Information Technology</b> |                                                       |              |
| CSE-501                                                  | Big Data Analytics                                    | 2+1          |
| CSE-502                                                  | Artificial Intelligence                               | 2+1          |
| CSE-503                                                  | Neuro-Fuzzy Applications in Engineering               | 2+1          |
| CSE-504/MCA-516                                          | Soft Computing Techniques in Engineering              | 2+1          |
| CSE-505/MCA-506                                          | Database Management Systems                           | 2+1          |
| CSE-506                                                  | Digital Image Processing                              | 2+1          |
| CSE-507/EE-504                                           | Process Control System                                | 2+1          |
| CSE-508                                                  | Computer Engineering                                  | 2+1          |
| CSE-509                                                  | Parallel Programming                                  | 1+2          |
| CSE-510                                                  | Software Engineering                                  | 2+1          |
| CSE-511                                                  | Computer Networks                                     | 2+1          |
| CSE-512                                                  | System Programming                                    | 3+0          |
| CSE-513/EE-512                                           | Internet of Things                                    | 2+1          |
| CSE-514/MCA-515                                          | Cryptography and Computer Security                    | 2+1          |
| CSE-515                                                  | Computer Methods in Engineering                       | 0+3          |
| CSE-516                                                  | Machine Learning in Agriculture                       | 2+1          |
| CSE-517                                                  | Cloud and Mobile Computing                            | 2+1          |
| CSE-518/EE-507                                           | Microcontroller and Embedded Systems                  | 2+1          |
| CSE-519/EE-513                                           | Wireless Sensor Networks                              | 1+1          |
| CSE-591                                                  | Seminar                                               | 1+0          |
| CSE-599                                                  | Master's Research                                     | 0+30         |
| EE-501                                                   | Programmable Logic Devices and Controllers            | 2+1          |
| EE-502                                                   | Design and Application of Transducers                 | 2+1          |
| EE-503                                                   | Instrumentation Engineering                           | 2+1          |
| EE-504/CSE-507                                           | Process Control System                                | 2+1          |
| EE-505                                                   | Applied Instrumentation                               | 2+1          |
| EE-506                                                   | Drone Technology                                      | 2+1          |
| EE-507/CSE-518                                           | Microcontroller and Embedded Systems                  | 2+1          |
| EE-508                                                   | Linear System Analysis                                | 2+0          |
| EE-509                                                   | Methods of Optimization                               | 2+1          |



| Course No.       | Course Title                             | Credit Hours |
|------------------|------------------------------------------|--------------|
| EE-510           | Optimal Control                          | 2+1          |
| EE-511           | Maintenance Management                   | 2+0          |
| EE-512/CSE-513   | Internet of Things                       | 2+1          |
| EE-513/CSE-519   | Wireless Sensor networks                 | 1+1          |
| EE-601           | Analysis and Design of Instrumentation   | 2+1          |
| EE-602           | Non-linear and Time Varying Systems      | 3+0          |
| EE-603           | Large Scale Systems                      | 3+0          |
| EE-604           | Optimization of Engineering Systems      | 3+0          |
| EE-591           | Seminar                                  | 1+0          |
| EE-599           | Master's Research                        | 0+30         |
| ee-699           | Doctoral Research                        | 0+75         |
| MCA-501          | Computer Fundamentals and Programming    | 2+1          |
| MCA-502          | Computer Organization and Architecture   | 2+0          |
| MCA-503          | Internet and Web Technologies            | 3+1          |
| MCA-504          | Dynamic Web Development                  | 3+1          |
| MCA-505          | Multimedia and Applications              | 2+1          |
| MCA-506/ CSE-505 | Database Management Systems              | 2+1          |
| MCA-507          | Visual Programming                       | 1+2          |
| MCA-508          | Programming in C++                       | 2+2          |
| MCA-509          | Data Structures and Algorithms           | 2+2          |
| MCA-510          | Core Java                                | 2+2          |
| MCA-511          | Data Communication and Networks          | 2+0          |
| MCA-512          | Linux System Administration              | 1+2          |
| MCA-513          | Concepts of Object-Oriented Programming  | 2+2          |
| MCA-514          | Design and Analysis of Algorithms        | 3+0          |
| MCA-515/ CSE-514 | Cryptography and Computer Security       | 2+1          |
| MCA-516/CSE-504  | Soft Computing Techniques in Engineering | 2+1          |
| MCA-517          | System Software                          | 3+0          |
| MCA-518          | Operating System                         | 3+1          |
| MCA-519          | Cyber Law in India                       | 1+0          |
| MCA-520          | Network Programming                      | 2+1          |
| MCA-521          | Design and Management of Web Portals     | 2+1          |
| MCA-522          | Content Management                       | 1+2          |
| MCA-523          | Data warehouse and Data Mining           | 2+1          |
| MCA-524          | System Analysis and Design               | 2+0          |
| MCA-525          | Object Oriented Software Engineering     | 3+0          |
| MCA-526          | Network Management                       | 1+2          |
| MCA-527          | Parallel and Distributed Computing       | 2+1          |
| MCA-528          | Server Programming with Java             | 2+1          |
| MCA-529          | Next Generation Technologies             | 2+1          |
| MCA-591          | Seminar                                  | 1+0          |



| Course No.      | Course Title                               | Credit Hours |
|-----------------|--------------------------------------------|--------------|
| MCA-599         | Master's Research                          | 0+30         |
| PGS-508         | Data Analysis for Researchers              | 0+1          |
| CSE-501         | Big Data Analytics                         | 2+1          |
| CSE-502         | Artificial Intelligence                    | 2+1          |
| CSE-503         | Neuro-Fuzzy Applications in Engineering    | 2+1          |
| CSE-504/MCA-516 | Soft Computing Techniques in Engineering   | 2+1          |
| CSE-505/MCA-506 | Database Management Systems                | 2+1          |
| CSE-506         | Digital Image Processing                   | 2+1          |
| CSE-507/EE-504  | Process Control System                     | 2+1          |
| CSE-508         | Computer Engineering                       | 2+1          |
| CSE-509         | Parallel Programming                       | 1+2          |
| CSE-510         | Software Engineering                       | 2+1          |
| CSE-511         | Computer Networks                          | 2+1          |
| CSE-512         | System Programming                         | 3+0          |
| CSE-513/EE-512  | Internet of Things                         | 2+1          |
| CSE-514/MCA-515 | Cryptography and Computer Security         | 2+1          |
| CSE-515         | Computer Methods in Engineering            | 0+3          |
| CSE-516         | Machine Learning in Agriculture            | 2+1          |
| CSE-517         | Cloud and Mobile Computing                 | 2+1          |
| CSE-518/EE-507  | Microcontroller and Embedded Systems       | 2+1          |
| CSE-519/EE-513  | Wireless Sensor Networks                   | 1+1          |
| CSE-591         | Seminar                                    | 1+0          |
| CSE-599         | Master's Research                          | 0+30         |
| EE-501          | Programmable Logic Devices and Controllers | 2+1          |
| EE-502          | Design and Application of Transducers      | 2+1          |
| EE-503          | Instrumentation Engineering                | 2+1          |
| EE-504/CSE-507  | Process Control System                     | 2+1          |
| EE-505          | Applied Instrumentation                    | 2+1          |
| EE-506          | Drone Technology                           | 2+1          |
| EE-507/CSE-518  | Microcontroller and Embedded Systems       | 2+1          |
| EE-508          | Linear System Analysis                     | 2+0          |
| EE-509          | Methods of Optimization                    | 2+1          |
| EE-510          | Optimal Control                            | 2+1          |
| EE-511          | Maintenance Management                     | 2+0          |
| EE-512/CSE-513  | Internet of Things                         | 2+1          |
| EE-513/CSE-519  | Wireless Sensor networks                   | 1+1          |
| EE-601          | Analysis and Design of Instrumentation     | 2+1          |
| EE-602          | Non-linear and Time Varying Systems        | 3+0          |
| EE-603          | Large Scale Systems                        | 3+0          |
| EE-604          | Optimization of Engineering Systems        | 3+0          |
| EE-591          | Seminar                                    | 1+0          |



| Course No.                                  | Course Title                                     | Credit Hours |
|---------------------------------------------|--------------------------------------------------|--------------|
| EE-599                                      | Master's Research                                | 0+30         |
| MCA-501                                     | Computer Fundamentals and Programming            | 2+1          |
| MCA-502                                     | Computer Organization and Architecture           | 2+0          |
| MCA-503                                     | Internet and Web Technologies                    | 3+1          |
| MCA-504                                     | Dynamic Web Development                          | 3+1          |
| MCA-505                                     | Multimedia and Applications                      | 2+1          |
| MCA-506                                     | Database Management Systems                      | 2+1          |
| MCA-507                                     | Visual Programming                               | 1+2          |
| MCA-508                                     | Programming in C++                               | 2+2          |
| MCA-509                                     | Data Structures and Algorithms                   | 2+2          |
| MCA-510                                     | Core Java                                        | 2+2          |
| MCA-511                                     | Data Communication and Networks                  | 2+0          |
| MCA-512                                     | Linux System Administration                      | 1+2          |
| MCA-513                                     | Concepts of Object-Oriented Programming          | 2+2          |
| MCA-514                                     | Design and Analysis of Algorithms                | 3+0          |
| MCA-515                                     | Cryptography and Computer Security               | 2+1          |
| MCA-516                                     | Soft Computing Techniques in Engineering         | 2+1          |
| MCA-517                                     | System Software                                  | 3+0          |
| MCA-518                                     | Operating System                                 | 3+1          |
| MCA-519                                     | Cyber Law in India                               | 1+0          |
| MCA-520                                     | Network Programming                              | 2+1          |
| MCA-521                                     | Design and Management of Web Portals             | 2+1          |
| MCA-522                                     | Content Management                               | 1+2          |
| MCA-523                                     | Data warehouse and Data Mining                   | 2+1          |
| MCA-524                                     | System Analysis and Design                       | 2+0          |
| MCA-525                                     | Object Oriented Software Engineering             | 3+0          |
| MCA-526                                     | Network Management                               | 1+2          |
| MCA-527                                     | Parallel and Distributed Computing               | 2+1          |
| MCA-528                                     | Server Programming with Java                     | 2+1          |
| MCA-529                                     | Next Generation Technologies                     | 2+1          |
| MCA-591                                     | Seminar                                          | 1+0          |
| MCA-599                                     | Master's Research                                | 0+30         |
| PGS-508                                     | Data Analysis for Researchers                    | 0+1          |
| <b>Farm Machinery and Power Engineering</b> |                                                  |              |
| FMPE-501                                    | Soil Dynamics in Tillage and Traction            | 2+1          |
| FMPE-502                                    | Testing and Evaluation of Agricultural Equipment | 2+1          |
| FMPE-503                                    | Ergonomics and Safety in Farm Operations         | 2+1          |
| FMPE-504                                    | Design of Tractor systems                        | 2+1          |
| FMPE-505                                    | Design of Farm Machinery-I                       | 2+1          |
| FMPE-506                                    | Design of Farm Machinery-II                      | 1+1          |
| FMPE-507                                    | Management of Farm Power and Machinery System    | 2+1          |



| Course No.                    | Course Title                                                         | Credit Hours |
|-------------------------------|----------------------------------------------------------------------|--------------|
| FMPE-511                      | Principles of Automation and Control                                 | 2+1          |
| FMPE-512                      | Principles of Hydraulic and Pneumatic Systems                        | 2+1          |
| FMPE-513                      | Applied Instrumentation in Farm Machinery                            | 2+1          |
| FMPE-514                      | Systems Simulation and Computer Aided Problem Solving in Engineering | 1+1          |
| FMPE-515                      | Computer Aided Design of Machinery                                   | 0+2          |
| FMPE-516                      | Advance Manufacturing Technologies                                   | 2+1          |
| FMPE-517                      | Machinery for Precision Agriculture                                  | 2+1          |
| FMPE-518                      | Machinery for Horticulture and Protected Agriculture                 | 2+0          |
| FMPE-601                      | Advances in Farm Machinery and Power Engineering                     | 2+1          |
| FMPE-602                      | Advances in Machinery for Precision Agriculture                      | 2+1          |
| FMPE-603                      | Energy Conservation and Management in Production Agriculture         | 3+0          |
| FMPE-604                      | Mechanics of Tillage in Relation to Soil and Crop                    | 2+1          |
| FMPE-611                      | Mechanics of Traction and its Application                            | 2+1          |
| FMPE-612                      | Farm Machinery Management and Systems Engineering                    | 2+1          |
| FMPE-613                      | Machinery for Special Farm Operations                                | 2+0          |
| FMPE-614                      | Ergonomics in Working Environment                                    | 2+1          |
| <b>Mechanical Engineering</b> |                                                                      |              |
| ME-501                        | Mechatronics and Robotics in Agriculture                             | 2+0          |
| ME-502                        | Refrigeration Systems                                                | 2+1          |
| ME-503                        | Mechanism Analysis and Synthesis                                     | 2+1          |
| ME-504                        | Vibrations                                                           | 3+0          |
| ME-505                        | Thermal Environmental Engineering                                    | 3+0          |
| ME-506                        | Thermodynamics                                                       | 3+0          |
| ME-507                        | Fatigue Design                                                       | 2+1          |
| ME-508                        | Vibration and Noise Control                                          | 3+0          |
| ME-509                        | Bearings and Lubrication                                             | 2+0          |
| ME-510                        | Industrial Heat Transfer                                             | 3+0          |
| ME-511                        | Conduction and Radiation Heat Transfer                               | 3+0          |
| ME-512                        | Ideal Fluid Flow                                                     | 3+0          |
| ME-513                        | Solar Energy Utilization                                             | 3+0          |
| ME-514                        | Steam Power Engineering                                              | 3+0          |
| ME-515                        | Computer Aided Design                                                | 2+1          |
| ME-516                        | Analysis of Robot Manipulators                                       | 3+0          |
| ME-517                        | Viscous Flow and Convective Heat Transfer                            | 3+0          |
| ME-518                        | Computer Integrated Manufacturing                                    | 3+0          |
| ME-519                        | Automation, CNC Machines and Robotics                                | 3+0          |
| ME-601                        | Advanced Conductive Heat Transfer                                    | 3+0          |
| ME-602                        | Advanced Convective Heat Transfer                                    | 3+0          |
| ME-603                        | Design of Solar Energy Systems                                       | 3+0          |
| ME-604                        | Advanced Combustion                                                  | 3+0          |
| ME-605                        | Computational Heat Transfer and Fluid Flow                           | 3+0          |



| Course No.                             | Course Title                                                  | Credit Hours |
|----------------------------------------|---------------------------------------------------------------|--------------|
| <b>Processing and Food Engineering</b> |                                                               |              |
| PFE-501                                | Transport Phenomena in Food Processing                        | 2+1          |
| PFE-502                                | Unit Operations in Food Process Engineering                   | 2+1          |
| PFE-503                                | Field Crops Process Engineering                               | 2+1          |
| PFE-504                                | Horticultural Crops Process Engineering                       | 2+1          |
| PFE-505                                | Storage Engineering and Handling of Agricultural Produce      | 2+1          |
| PFE-506                                | Food Package Engineering                                      | 1+1          |
| PFE-507                                | Instrumentation and Sensors in Food Processing                | 2+1          |
| PFE-508                                | Application of Engineering Properties in Food Processing      | 2+1          |
| PFE-509                                | Food Quality and Safety                                       | 2+1          |
| PFE-510                                | Food Processing Technologies                                  | 2+1          |
| PFE-511                                | Food Processing Equipment and Plant Design                    | 1+1          |
| PFE-512                                | Seed Process Engineering                                      | 1+1          |
| PFE-513                                | Agri-Project Planning and Management                          | 2+1          |
| PFE-514                                | Farm Structures and Environmental Control                     | 2+1          |
| PFE-515                                | Dairy Product Processing                                      | 2+1          |
| PFE-516                                | Processing of Meat, Poultry and Fish                          | 2+1          |
| PFE-517                                | Design of Aquacultural Structures                             | 2+1          |
| PFE-518                                | Thermal Environmental Engineering for Agricultural Processing | 3+0          |
| PFE-519                                | Bioprocess Engineering                                        | 2+1          |
| PFE-601                                | Advances in Food Process Engineering                          | 2+1          |
| PFE-602                                | Drying and Dehydration of Food Materials                      | 2+1          |
| PFE-603                                | Textural and Rheological Characteristics of Food Materials    | 2+1          |
| PFE-604                                | Agricultural Waste and By-Products Utilization                | 2+1          |
| PFE-605                                | Mathematical Modeling in Food Processing                      | 3+0          |
| PFE-606                                | Advance Bioprocess Engineering                                | 2+1          |
| <b>Renewable Energy Engineering</b>    |                                                               |              |
| REE-501                                | Renewable Energy Technologies                                 | 2+1          |
| REE-502                                | Solar Thermal Energy Conversion Technologies                  | 2+1          |
| REE-503                                | Biomass Energy Conversion Technologies                        | 2+1          |
| REE-504                                | Energy Auditing, Conservation and Management                  | 2+1          |
| REE-505                                | Wind Energy Conversion and Utilization                        | 2+1          |
| REE-506                                | Solar Photovoltaic System Design and Analysis                 | 1+1          |
| REE-507                                | Renewable Energy Policy, Planning and Economics               | 3+0          |
| REE-508                                | Alternate Fuels and Applications                              | 2+1          |
| REE-509                                | Biogas Technology and Mechanism                               | 1+1          |
| REE-510                                | Energy, Ecology and Environment                               | 3+0          |
| REE-511                                | Design and Analysis of Renewable Energy Conversion Systems    | 2+1          |
| REE-512                                | Energy Generation from Agricultural Waste and Byproducts      | 2+1          |
| REE-513                                | Agro Energy Audit and Management                              | 2+1          |
| REE-514                                | Green House Energetic and Passive Architecture                | 1+1          |



| Course No.                        | Course Title                                                  | Credit Hours |
|-----------------------------------|---------------------------------------------------------------|--------------|
| REE-515                           | Energy Management in Food Processing Industries               | 1+1          |
| REE-601                           | Biochemical Conversion of Biomass                             | 2+1          |
| REE-602                           | Thermo-Chemical Conversion of Biomass                         | 2+1          |
| REE-603                           | Advances in Renewable Energy Systems                          | 2+1          |
| REE-604                           | New Alternate Energy Systems                                  | 2+1          |
| REE-605                           | Fuels and Combustion                                          | 2+1          |
| REE-606                           | Advances in Biogas Technology                                 | 2+1          |
| REE-607                           | Solid Waste and Waste Water Management                        | 2+1          |
| REE-608                           | Advanced Photovoltaic Power Generation                        | 1+1          |
| REE-609                           | Energy Planning, Management and Economics                     | 3+0          |
| REE-610                           | Renewable Energy for Industrial Application                   | 2+1          |
| REE-611                           | Biofuel Technologies and Applications                         | 1+1          |
| REE-612                           | Energy Modelling and Simulation                               | 1+1          |
| <b>Soil and Water Engineering</b> |                                                               |              |
| IDE-501                           | Design of Surface Irrigation Systems                          | 1+1          |
| IDE-502                           | Design of Farm Drainage Systems                               | 2+1          |
| IDE-503                           | Command Area Management                                       | 2+1          |
| IDE-504                           | Water and Nutrient Management under Protected Cultivation     | 2+1          |
| IDE-505                           | Design of Drip and Sprinkler Irrigation Systems               | 2+1          |
| IDE-506                           | Ground Water Engineering                                      | 2+1          |
| IDE-507/SWCE-507                  | Remote Sensing and GIS for Land and Water Resource Management | 2+1          |
| IDE-508                           | Waste Water Management and Utilization in Agriculture         | 2+1          |
| IDE-509                           | Water Conveyance and Distribution                             | 2+1          |
| IDE-510                           | Minor Irrigation                                              | 2+1          |
| IDE-511                           | Design of Pumps for Irrigation and Drainage                   | 2+0          |
| IDE-512                           | Crop Environmental Engineering                                | 2+0          |
| IDE-513                           | Water Resources Systems Engineering                           | 2+1          |
| IDE-514                           | Irrigation Economics Planning and Management                  | 2+0          |
| IDE-515                           | Sensing and Automation in Irrigation Systems                  | 3+0          |
| IDE-601                           | Recent Developments in Irrigation Engineering                 | 2+1          |
| IDE-602                           | Advances in Drainage Engineering                              | 2+1          |
| IDE-603                           | Hydro-Mechanics and Groundwater Modeling                      | 3+0          |
| IDE-604                           | Soil-Water-Plant-Atmospheric Modeling                         | 2+1          |
| IDE-605                           | Plant Growth Modeling and Simulation                          | 2+0          |
| IDE-606                           | Multi Criteria Decision Making System                         | 2+0          |
| SWCE-501                          | Advanced Soil and Water Conservation Engineering              | 2+1          |
| SWCE-502                          | Applied Watershed Hydrology                                   | 2+1          |
| SWCE-503                          | Soil and Water Conservation Structures                        | 2+1          |
| SWCE-504                          | Stochastic Hydrology                                          | 2+1          |
| SWCE-505                          | Watershed Management and Modeling                             | 2+1          |
| SWCE-506                          | Flow Through Porous Media                                     | 2+0          |



| Course No. | Course Title                                             | Credit Hours |
|------------|----------------------------------------------------------|--------------|
| SWCE-508   | Climate Change and Water Resources                       | 3+0          |
| SWCE-509   | Numerical Methods in Hydrology                           | 2+0          |
| SWCE-510   | Dryland Water Management Technologies                    | 2+0          |
| SWCE-601   | Advances in Hydrology                                    | 2+1          |
| SWCE-602   | Soil and Water Systems Simulation and Modeling           | 2+1          |
| SWCE-603   | Reservoir Operation and River Basin Modeling             | 2+1          |
| SWCE-604   | Modeling Soil Erosion Processes and Sedimentation        | 2+1          |
| SWCE-605   | Waste Water Treatment and Utilization                    | 3+0          |
| SWCE-606   | Hydro-Chemical Modeling                                  | 2+0          |
| RSGIS-501  | Principles of Remote Sensing                             | 2+1          |
| RSGIS-502  | Geomatics, Geodesy and GPS                               | 2+1          |
| RSGIS-503  | Digital Image Processing                                 | 2+1          |
| RSGIS-504  | Introduction to Photogrammetry and Cartography           | 2+1          |
| RSGIS-505  | Agri-Informatics                                         | 2+1          |
| RSGIS-506  | Application of RS and GIS for Soil Resources Management  | 2+1          |
| RSGIS-507  | Application of RS and GIS for Water Resources Management | 2+1          |
| RSGIS-508  | Application of RS and GIS for Land Resources Management  | 2+1          |

### College of Basic Sciences and Humanities

| Course No.                                            | Course Title                                                                                                                          | Credit Hours |
|-------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------|--------------|
| <b>Agricultural Journalism, Languages and Culture</b> |                                                                                                                                       |              |
| PGS-506                                               | English with Critical Analysis and Verbal Reasoning Skills                                                                            | 0+1          |
| PGS-501 revised as PGS-502                            | Technical Writing, Communication Skills & Library and Information Services revised as BSMA Technical Writing and Communication Skills | 0+1          |
| <b>Biochemistry</b>                                   |                                                                                                                                       |              |
| Biochem-101                                           | Introduction to Biochemistry                                                                                                          | 2+1          |
| Biochem-102                                           | Nutritional Biochemistry-I                                                                                                            | 2+1          |
| Biochem-103                                           | Nutritional Biochemistry-II                                                                                                           | 3+0          |
| Biochem-104                                           | Principles of Biochemistry                                                                                                            | 2+0          |
| Biochem-203                                           | Structure and Function of Biomolecules                                                                                                | 3+0          |
| Biochem-206                                           | General Enzymology                                                                                                                    | 2+0          |
| Biochem-207                                           | Basic Biochemistry                                                                                                                    | 3+1          |
| Biochem-208                                           | Food Biochemistry and Nutrition                                                                                                       | 2+1          |
| Biochem-209                                           | Introduction to Intermediary Metabolism                                                                                               | 3+0          |
| Biochem-301                                           | Introduction to Molecular Biochemistry                                                                                                | 3+0          |
| Biochem-302                                           | Basic Experiments in Biochemistry                                                                                                     | 0+3          |
| Biochem-303                                           | Introduction to Membrane Biochemistry                                                                                                 | 3+0          |
| Biochem-304                                           | Enzymology and Enzyme Technologies                                                                                                    | 2+1          |
| Biochem-421                                           | Fundamentals of Biochemistry                                                                                                          | 3+0          |
| Biochem-423                                           | Fundamentals of Molecular Biochemistry                                                                                                | 2+0          |
| Biochem-424                                           | Experiments in Biochemistry                                                                                                           | 0+3          |



| Course No.       | Course Title                                                     | Credit Hours |
|------------------|------------------------------------------------------------------|--------------|
| Biochem-425      | Fundamentals of Plant Biochemistry                               | 2+0          |
| Biochem-426      | Fundamentals of Animal Biochemistry                              | 3+0          |
| Biochem-429      | Biochemical and Biophysical Techniques                           | 3+0          |
| Biochem-430      | Fundamentals of Enzymology                                       | 3+0          |
| Biochem-431      | Fundamentals of Membrane Biochemistry                            | 2+0          |
| Biochem-432      | Clinical Biochemistry                                            | 2+1          |
| Biochem-501      | Basic Biochemistry                                               | 3+1          |
| Biochem-502      | Intermediary Metabolism                                          | 3+0          |
| Biochem-503      | Enzymology                                                       | 2+1          |
| Biochem-504      | Molecular Biology                                                | 2+1          |
| Biochem-505      | Techniques in Biochemistry                                       | 2+2          |
| Biochem-506      | Immunochemistry                                                  | 2+1          |
| Biochem-507      | Plant Biochemistry                                               | 2+1          |
| Biochem-508      | Animal Biochemistry                                              | 3+0          |
| Biochem-509      | Nutritional Biochemistry                                         | 2+1          |
| Biochem-510      | Nitrogen and Sulphur Metabolism                                  | 2+1          |
| Biochem-511      | Biochemistry on Xenobiotics                                      | 2+0          |
| Biochem-591      | Seminar                                                          | 1+0          |
| Biochem-599      | Master's Research                                                | 30           |
| Biochem-601      | Advanced Enzymology                                              | 2+1          |
| Biochem-602      | Advanced Molecular Biology                                       | 3+0          |
| Biochem-603      | Biochemistry of Biotic and Abiotic Stresses                      | 3+0          |
| Biochem-604      | Frontier Topics in Biochemistry                                  | 2+0          |
| Biochem-605      | Concepts and Applications of Omics in Biological Science         | 3+0          |
| Biochem-606      | Bio membranes                                                    | 2+0          |
| Biochem-607      | Application of Techniques in Biochemistry                        | 1+2          |
| Biochem-691      | Seminar I                                                        | 1+0          |
| Biochem-692      | Seminar II                                                       | 1+0          |
| <b>Chemistry</b> |                                                                  |              |
| Chem-501         | Thermodynamics and Electrochemistry                              | 3+0          |
| Chem-502/ AC 509 | Chromatographic and Spectroscopic Techniques                     | 2+1          |
| Chem- 503        | Basic Concepts of Inorganic Chemistry                            | 2+0          |
| Chem-504         | Physical Organic Chemistry                                       | 2+0          |
| Chem-505/AC- 504 | Natural Product Chemistry                                        | 2+1          |
| Chem-506         | Experiments in Physical Chemistry                                | 0+2          |
| Chem-507         | Quantum Chemistry-Statistical Mechanics                          | 3+0          |
| Chem-508         | Chemical Kinetics and Surface Chemistry                          | 2+0          |
| Chem-509         | Co-ordinate Chemistry, Reaction Mechanism and Inorganic Polymers | 2+1          |
| Chem-510         | Synthesis and Characterization of Organic Compounds              | 0+2          |
| Chem-511/AC 501  | Introduction to Agrochemicals                                    | 2+1          |
| Chem-512         | Reaction, Reagents and Photochemistry                            | 3+0          |



| Course No.                                   | Course Title                                                            | Credit Hours |
|----------------------------------------------|-------------------------------------------------------------------------|--------------|
| Chem-513                                     | Chemistry of Transition Metals                                          | 2+0          |
| Chem-514                                     | General Physical and Colloidal Chemistry                                | 3+0          |
| Chem-515/AC 505                              | Agrochemical regulation, quality control and management                 | 2+0          |
| Chem-601                                     | Special Topics in Chemistry                                             | 3+0          |
| Chem-602                                     | Advanced Physical Chemistry                                             | 3+0          |
| Chem-603                                     | Organometallic Chemistry                                                | 3+0          |
| Chem-604                                     | Bio-inorganic Chemistry                                                 | 3+0          |
| Chem-605                                     | Organic Synthesis and Spectroscopy                                      | 2+1          |
| Chem-606                                     | Constitution of Inorganic Compounds and Dynamics of Inorganic Reactions | 3+0          |
| Chem-607                                     | Green Chemistry                                                         | 2+1          |
| Chem-608/AC 601                              | Agrochemical Formulation Technology                                     | 2+2          |
| <b>Economics &amp; Sociology</b>             |                                                                         |              |
| Econ-208                                     | International Trade and Policy in Agriculture                           | 2+0          |
| Econ-209                                     | Agricultural Price and Policy Analysis                                  | 2+1          |
| Econ-210                                     | Theory and Practices of Banking                                         | 2+0          |
| <b>Mathematics, Statistics &amp; Physics</b> |                                                                         |              |
| Math-521                                     | Algebra-I                                                               | 3+0          |
| Math-522                                     | Complex Analysis                                                        | 3+0          |
| Math-523                                     | Algebra-II                                                              | 3+0          |
| Math-524                                     | Ordinary and Partial Differential Equations                             | 3+0          |
| Math-525                                     | Elements of functional Analysis                                         | 2+0          |
| Math-526                                     | Numerical Methods                                                       | 2+1          |
| Math-527                                     | Calculus of Variation and Operations                                    | 2+0          |
| Math-528                                     | Real Analysis                                                           | 2+0          |
| Math-529                                     | Principles of Topology                                                  | 2+0          |
| Math-530                                     | Transformation Theory                                                   | 2+0          |
| Math-531                                     | Measure Theory                                                          | 2+0          |
| Math-532                                     | Classical Mechanics                                                     | 2+0          |
| Math-535                                     | Operational Methods                                                     | 2+1          |
| Stat-501                                     | Mathematics For Applied Sciences                                        | 2+0          |
| Stat-502                                     | Statistical Methods for Applied Sciences                                | 2+1          |
| Stat-511                                     | Experimental Designs                                                    | 2+1          |
| Stat-512                                     | Basic Sampling Techniques                                               | 2+1          |
| Stat-521                                     | Applied Regression Analysis                                             | 2+1          |
| Stat-522                                     | Data Analysis Using Statistical Packages                                | 2+1          |
| Stat-526                                     | Non-Parametric Statistics                                               | 2+1          |
| Stat-551                                     | Mathematics-I                                                           | 3+0          |
| Stat-552                                     | Probability Theory                                                      | 2+0          |
| Stat-553                                     | Statistical Methods                                                     | 2+1          |
| Stat-554                                     | Actuarial Statistics                                                    | 2+0          |
| Stat-555                                     | Bioinformatics                                                          | 2+0          |



| Course No.                        | Course Title                                                     | Credit Hours |
|-----------------------------------|------------------------------------------------------------------|--------------|
| Stat-556                          | Econometrics                                                     | 2+0          |
| Stat-561                          | Mathematics-II                                                   | 2+0          |
| Stat-562                          | Statistical Inference                                            | 2+1          |
| Stat-563                          | Design Of Experiments                                            | 2+1          |
| Stat-564                          | Sampling Techniques                                              | 2+0          |
| Stat-565                          | Statistical Genetics                                             | 2+1          |
| Stat-566                          | Statistical Quality Control                                      | 2+0          |
| Stat-567                          | Optimization Techniques                                          | 1+1          |
| Stat-571                          | Multivariate Analysis                                            | 2+1          |
| Stat-572                          | Regression Analysis                                              | 1+1          |
| Stat-573                          | Statistical Computing                                            | 1+1          |
| Stat-574                          | Time Series Analysis                                             | 1+1          |
| Stat-575                          | Demography                                                       | 2+0          |
| Stat-576                          | Statistical Methods For Life Sciences                            | 2+0          |
| Phys-501                          | Classical and Statistical Mechanics                              | 4+0          |
| Phys-515                          | Modern Physics                                                   | 2+1          |
| Phys-516                          | Atomic and Molecular Spectroscopy                                | 2+0          |
| Phys-517/Math-533                 | Mathematical Physics-I                                           | 3+0          |
| Phys-518/Math-534                 | Mathematical Physics-II                                          | 2+1          |
| <b>Microbiology</b>               |                                                                  |              |
| Mushroom Cultivation              | Choice based Skill Development Course                            | 0+2          |
| Micro-501                         | Techniques in Microbiology                                       | 0+2          |
| Micro-502                         | Principles of Microbiology                                       | 3+1          |
| Micro-503                         | Microbial Physiology and Metabolism                              | 3+1          |
| Micro-504                         | Microbial genetics                                               | 2+1          |
| Micro-507                         | Food Microbiology                                                | 2+1          |
| Micro-510                         | Industrial microbiology                                          | 2+1          |
| Micro-601                         | Improvement in Fermentation Technology                           | 2+1          |
| <b>Zoology</b>                    |                                                                  |              |
| Zoo-601                           | Advances in Cell and Developmental Biology                       | 2+1          |
| Zoo-602                           | Advances in Animal Ecology, Behaviour and Bioresource Management | 2+1          |
| <b>School of Business Studies</b> |                                                                  |              |
| Mgt-101                           | Introduction to Management and Organizational Behavior           | 3+0          |
| Mgt-102                           | Introduction to Financial Accounting                             | 2+1          |
| Mgt-105                           | Entrepreneurship Development                                     | 1+1          |
| Mgt-205                           | Marketing Management                                             | 2+0          |
| Mgt-103                           | Business Environment and Ethics                                  | 2+0          |
| Mgt-104                           | Financial Management                                             | 2+1          |
| Mgt-501/ABM-501                   | Principles of Management and Organizational Behaviour            | 3+0          |
| Mgt-502/ABM-502                   | Managerial Accounting and Control                                | 2+1          |



| Course No.      | Course Title                                                                          | Credit Hours |
|-----------------|---------------------------------------------------------------------------------------|--------------|
| Mgt-503/ABM-503 | Applied Managerial Economics/Applied Agribusiness Economics                           | 2+0          |
| Mgt-506/ABM-506 | Marketing Management-I/ Agricultural and Food Marketing Management-I                  | 2+0          |
| Mgt-539/ABM-539 | Communication for Management/Communication for Management and Agribusiness            | 2+1          |
| Mgt-541/ABM-541 | Computer Applications for Business/Computer Applications for Agribusiness             | 2+1          |
| Mgt-504/ABM-504 | Human Resource Management/ Human Resource Management for Agricultural Organizations   | 2+0          |
| Mgt-505/ABM-505 | Production and Operations Management                                                  | 2+0          |
| Mgt-507/ABM-507 | Marketing Management-II/ Agricultural and Food Marketing Management-II                | 2+0          |
| Mgt-509/ABM-509 | International Trade/ International Trade for Agricultural Products                    | 2+0          |
| Mgt-540/ABM-540 | Research Methodology for Management/ Research Methodology for Agribusiness Management | 2+1          |
| Mgt-543/ABM-543 | Business Environment/ Agribusiness Environment and Policy                             | 2+0          |
| Mgt-537/ABM-537 | Operations Research                                                                   | 2+0          |
| Mgt-538/ABM-538 | Financial Management/ Financial Management in Agribusiness                            | 2+0          |
| Mgt-601         | Econometrics for Business                                                             | 2+1          |
| Mgt-602         | Research Methods –I                                                                   | 2+1          |
| Mgt-603         | Management Thoughts and Comparative Management                                        | 2+1          |

### College of Community Sciences

| Course No.                         | Course Title                                   | Credit Hours |
|------------------------------------|------------------------------------------------|--------------|
| <b>Apparel and Textile Science</b> |                                                |              |
| ATS-501                            | Textile Chemistry                              | 2+1          |
| ATS-502                            | Textile and Apparel Quality Analysis           | 2+1          |
| ATS-503                            | Pattern Making and Draping                     | 1+2          |
| ATS-504                            | Woven Textile Design                           | 2+1          |
| ATS-505                            | Wet Processing of Textiles                     | 2+1          |
| ATS-506                            | Computer Aided Textile and Apparel Designing   | 0+2          |
| ATS-507                            | Textile and Apparel Industrial Management      | 3+0          |
| ATS-508                            | Historic Textiles and Costumes                 | 1+1          |
| ATS-509                            | Textile Auxiliaries                            | 2+1          |
| ATS-510                            | Socio Psychological Aspects of Clothing        | 2+0          |
| ATS-511                            | Sustainability in Textile and Apparel Industry | 2+0          |
| ATS-512                            | Textile and Apparel Product Development        | 1+1          |
| ATS-513                            | Laboratory Techniques in Textile Research      | 0+2          |
| ATS-514                            | Special Project                                | 0+1          |
| ATS-591                            | Seminar                                        | 1+0          |
| ATS-599                            | Thesis/ Research                               | 0+30         |
| ATS-601                            | Textile Ecology                                | 2+0          |



| Course No.                                                | Course Title                                                | Credit Hours |
|-----------------------------------------------------------|-------------------------------------------------------------|--------------|
| ATS-602                                                   | Technical Textiles                                          | 2+1          |
| ATS-603                                                   | Technological Developments in Textiles and Apparel          | 2+0          |
| ATS-604                                                   | Colour Application in Textiles                              | 1+1          |
| ATS-605                                                   | Functional Clothing                                         | 2+1          |
| ATS-606                                                   | Textile Conservation                                        | 1+1          |
| ATS-607                                                   | Operational Management in Textiles and Apparel              | 2+0          |
| ATS-608                                                   | Technology of Nonwovens                                     | 2+0          |
| ATS-609                                                   | Special Project                                             | 0+2          |
| ATS-691                                                   | Seminar I                                                   | 1+0          |
| ATS-692                                                   | Seminar II                                                  | 1+0          |
| ATS-699                                                   | Research                                                    | 0+75         |
| <b>Extension Education &amp; Communication Management</b> |                                                             |              |
| EECM-501                                                  | Global Extension Systems                                    | 3+0          |
| EECM-502                                                  | Development Communication                                   | 2+1          |
| EECM-503                                                  | ICT and New Media                                           | 1+3          |
| EECM-504                                                  | Technology Transfer and Management                          | 2+1          |
| EECM-505                                                  | Dynamic Communication skills                                | 1+2          |
| EECM-506                                                  | Participatory Programme Management                          | 1+2          |
| EECM-507                                                  | Organizational Development and HRD                          | 1+1          |
| EECM-508                                                  | Educational Technology                                      | 2+1          |
| EECM-509                                                  | Group Dynamics                                              | 2+0          |
| EECM-510                                                  | Community Development and Outreach                          | 2+1          |
| EECM-511                                                  | Climate Change Management                                   | 1+1          |
| EECM-512                                                  | Gender Sensitization for Empowerment                        | 1+1          |
| EECM-513                                                  | Special Project- Out sourcing for Media product development | 0+2          |
| EECM-591                                                  | Seminar                                                     | 1+0          |
| EECM-599                                                  | Thesis/ Research                                            | 0+30         |
| EECM-601                                                  | Managerial Skills for Extension Professionals               | 2+1          |
| EECM-602                                                  | Impact Assessment of Development Programmes                 | 1+2          |
| EECM-603                                                  | Scaling Techniques for Behaviour Research                   | 1+2          |
| EECM-604                                                  | Design and Development of e-Extension Project               | 0+3          |
| EECM-605                                                  | Sustainable Livelihood Systems                              | 1+1          |
| EECM-606                                                  | Extension Research Project Management                       | 1+2          |
| EECM-607                                                  | Media Application and Product Promotion                     | 2+2          |
| EECM-608                                                  | Advocacy and Behavior Change Management                     | 1+2          |
| EECM-691                                                  | Seminar I                                                   | 1+0          |
| EECM-692                                                  | Seminar II                                                  | 1+0          |
| EECM-699                                                  | Research                                                    | 0+75         |



| Course No.                                    | Course Title                                                       | Credit Hours |
|-----------------------------------------------|--------------------------------------------------------------------|--------------|
| <b>Food and Nutrition</b>                     |                                                                    |              |
| FN-501                                        | Macro and Micro Nutrients in Human Nutrition                       | 3+0          |
| FN-502                                        | Public Health and Nutrition                                        | 2+1          |
| FN-503                                        | Techniques in Food Analysis                                        | 1+2          |
| FN-504                                        | Diet Therapy                                                       | 2+1          |
| FN-505                                        | Nutrition and Physical Fitness                                     | 2+1          |
| FN-506                                        | Developments in Nutrition and Immunity                             | 2+0          |
| FN-507                                        | Clinical Nutrition                                                 | 2+1          |
| FN-508                                        | Nutrition Counselling                                              | 0+2          |
| FN-509                                        | Food Safety and Standards                                          | 2+1          |
| FN-510                                        | Nutritional Challenges in Life Cycle                               | 3+0          |
| FN-511                                        | Food Science                                                       | 2+1          |
| FN-512                                        | Food Processing Technology                                         | 2+1          |
| FN-513                                        | Human Physiology                                                   | 3+0          |
| FN-514                                        | Institutional Food Service Management                              | 1+1          |
| FN-591                                        | Seminar                                                            | 1+0          |
| FN-599                                        | Thesis/ Research                                                   | 0+30         |
| FN-601                                        | Macronutrient Metabolism                                           | 3+0          |
| FN-602                                        | Micronutrient Metabolism                                           | 2+0          |
| FN-603                                        | Nutrition and Agricultural Interface                               | 3+0          |
| FN-604                                        | Global Nutritional Problems                                        | 2+0          |
| FN-605                                        | Nutrition in Calamities                                            | 2+0          |
| FN-606                                        | Maternal and Child Nutrition                                       | 2+0          |
| FN-607                                        | Hormones and Enzymes                                               | 2+0          |
| FN-608                                        | Energy Metabolism                                                  | 2+0          |
| FN-609                                        | Application of Biotechnology in Food Science and Nutrition         | 3+0          |
| FN-610                                        | Recent Trends in Food Science and Technology                       | 3+0          |
| FN-691                                        | Seminar I                                                          | 1+0          |
| FN-692                                        | Seminar II                                                         | 1+0          |
| FN-699                                        | Research                                                           | 0+75         |
| <b>Human Development &amp; Family Studies</b> |                                                                    |              |
| HDFS- 501                                     | Theories of Human Development                                      | 3+0          |
| HDFS-502                                      | Dynamics of Human Development                                      | 3+0          |
| HDFS-503                                      | Methods and Techniques of Assessment in Human Development          | 2+1          |
| HDFS-504                                      | Innovative Programmes in Early Childhood Development and Education | 2+1          |
| HDFS-505                                      | Gender Issues in Human Development and Relationships               | 2+1          |
| HDFS-506                                      | Adult Development                                                  | 2+0          |
| HDFS-507                                      | Management of Differently Abled                                    | 2+1          |



| Course No.                                      | Course Title                                                                                   | Credit Hours |
|-------------------------------------------------|------------------------------------------------------------------------------------------------|--------------|
| HDFS-508                                        | Adolescent Development and Challenges                                                          | 2+1          |
| HDFS-509                                        | Guidance and Counselling                                                                       | 2+1          |
| HDFS-510                                        | Interventions for Differently Abled Children                                                   | 1+1          |
| HDFS-511                                        | Family Ecology                                                                                 | 2+0          |
| HDFS-512                                        | Family and Cultural Diversities                                                                | 2+0          |
| HDFS-513                                        | Family Therapy                                                                                 | 2+1          |
| HDFS-591                                        | Seminar                                                                                        | 1+0          |
| HDFS-599                                        | Thesis/ Research                                                                               | 0+30         |
| HDFS-601                                        | Advanced Human Development                                                                     | 3+0          |
| HDFS-602                                        | Ecology and Human Development                                                                  | 3+0          |
| HDFS -603                                       | Programme Development for Vulnerable Families                                                  | 2+1          |
| HDFS -604                                       | Strategic Developmental Intervention                                                           | 2+1          |
| HDFS-605                                        | Family Studies                                                                                 | 3+0          |
| HDFS-606                                        | Adulthood and Aging                                                                            | 3+0          |
| HDFS-607                                        | Mental Health                                                                                  | 3+0          |
| HDFS-608                                        | Qualitative Research Methods                                                                   | 1+1          |
| HDFS-691                                        | Seminar I                                                                                      | 1+0          |
| HDFS-692                                        | Seminar II                                                                                     | 1+0          |
| HDFS-699                                        | Research                                                                                       | 0+75         |
| <b>Resource Management and Consumer Science</b> |                                                                                                |              |
| RMCS-501                                        | Resource Management: Principles and Practices                                                  | 3+0          |
| RMCS-502                                        | Human Factors and Ergonomics                                                                   | 2+1          |
| RMCS-503                                        | Interior Space Planning                                                                        | 1+2          |
| RMCS-504                                        | Consumer Economics                                                                             | 2+1          |
| RMCS-505                                        | Work and Work Station Design                                                                   | 2+1          |
| RMCS-506                                        | Colour and Lighting in Interiors                                                               | 2+1          |
| RMCS-507                                        | Consumer Issues and Legislations                                                               | 2+0          |
| RMCS-508                                        | Product Design                                                                                 | 1+2          |
| RMCS-509                                        | Ergonomic Research Techniques                                                                  | 1+2          |
| RMCS-510                                        | Housing and Energy Efficient Building Design (in collaboration with Dept of Civil Engineering) | 2+1          |
| RMCS-511                                        | Technical Drawings                                                                             | 1+2          |
| RMCS-512                                        | Interior Design Business Management                                                            | 1+2          |
| RMCS-513                                        | Environmental Resource Management                                                              | 1+1          |
| RMCS-514                                        | Special Project                                                                                | 0+2          |
| RMCS-591                                        | Seminar                                                                                        | 1+0          |
| RMCS-599                                        | Thesis/ Research                                                                               | 0+30         |
| RMCS-601                                        | Trends in Resource Management                                                                  | 3+0          |
| RMCS-602                                        | Occupational Biomechanics                                                                      | 2+1          |
| RMCS-603                                        | Globalization and Consumer Economics                                                           | 2+1          |
| RMCS-604                                        | Space Designing and Managerial Dimensions for Special needs                                    | 1+2          |



| Course No. | Course Title                        | Credit Hours |
|------------|-------------------------------------|--------------|
| RMCS-605   | Physical Ergonomics                 | 1+2          |
| RMCS-606   | Environmental Issues and Challenges | 2+0          |
| RMCS-607   | Family Dynamics and Women Power     | 2+1          |
| RMCS-608   | Special Project                     | 0+2          |
| RMCS-691   | Seminar I                           | 1+0          |
| RMCS-692   | Seminar II                          | 1+0          |
| RMCS-699   | Research                            | 0+75         |

### College of Horticulture and Forestry

| Course No.                              | Course Title                                                        | Credit Hours |
|-----------------------------------------|---------------------------------------------------------------------|--------------|
| <b>Floriculture and Landscaping</b>     |                                                                     |              |
| FLS-501                                 | Systematics of Ornamental Plants                                    | 2+1          |
| FLS-502                                 | Breeding of Ornamental Plants                                       | 2+1          |
| FLS-503                                 | Commercial Production of Cut Flowers                                | 2+1          |
| FLS-504                                 | Commercial Production of Loose Flowers                              | 2+1          |
| FLS-505                                 | Ornamental Gardening and Landscaping                                | 2+1          |
| FLS-506                                 | Indoor Plants and Interior scaping                                  | 1+1          |
| FLS-507                                 | Nursery Management in Ornamental Plants                             | 2+1          |
| FLS-508                                 | Turf Grass Management                                               | 1+1          |
| FLS-509                                 | Value Addition in Floriculture                                      | 2+1          |
| FLS-510                                 | Protected Cultivation of Flower Crops                               | 2+1          |
| FLS-511                                 | CAD for Landscaping                                                 | 1+2          |
| FLS-512                                 | Seed Production in Flower Crops                                     | 1+1          |
| FLS-591                                 | Seminar                                                             | 2+1          |
| FLS-599                                 | Research                                                            | 2+1          |
| FLS-601                                 | Crop Regulation in Ornamental Crops                                 | 1+1          |
| FLS-602                                 | Postharvest Biology of Floricultural Crop                           | 2+1          |
| FLS-603                                 | Specialty Flowers, Fillers and Cut Greens                           | 1+2          |
| FLS-604                                 | Biotechnological Approaches in Floricultural Crops                  | 1+1          |
| FLS-605                                 | Advances in Landscape Gardening                                     | 2+1          |
| FLS-606                                 | Vertical Gardening                                                  | 2+1          |
| FLS-607                                 | Modern Approaches in Breeding of Floricultural crops                | 0+1          |
| FLS-608                                 | Current Trends in Production Technology of Floricultural Crops      | 0+1          |
| FLS-609                                 | Recent Developments in Protected Cultivation of Floricultural Crops | 2+1          |
| FLS-691                                 | Seminar                                                             | 0+75         |
| FLS- 692                                | Seminar                                                             | 0+1          |
| <b>Forestry &amp; Natural Resources</b> |                                                                     |              |
| SAF-501                                 | Silviculture                                                        | 2+1=3        |
| SAF-502                                 | Forest Biometry                                                     | 1+1=2        |
| SAF-503                                 | Silvicultural Practices                                             | 1+1=2        |
| SAF-504                                 | Agroforestry Systems                                                | 2+1=3        |



| Course No.           | Course Title                                             | Credit Hours |
|----------------------|----------------------------------------------------------|--------------|
| SAF-505              | Interactions in Agroforestry Systems                     | 1+1=2        |
| SAF-506              | Modern Nursery Technologies                              | 1+1=2        |
| SAF-507              | Plantation Forestry                                      | 2+1=3        |
| SAF-508              | Industrial Agroforestry                                  | 1+1=2        |
| SAF-509              | Climate Change and Conservation Silviculture             | 2+0=2        |
| SAF-510              | Trees and Shrubs for Agroforestry                        | 1+1=2        |
| SAF-511              | Economics of Agroforestry Systems                        | 2+1=3        |
| SAF-512              | Tree Seed Technology                                     | 2+1=3        |
| SAF-513              | Nutrient and Weed Management in Production               | 1+1=2        |
| SAF-514              | Crop and Live Stock Management in Agroforestry           | 2+0=2        |
| FBT-501              | Applied Forest Tree Improvement                          | 2+1=3        |
| FBT-502              | Forest Ecology and Biodiversity Management               | 2+1=3        |
| FBT-503              | Breeding Methods in Forest Trees                         | 2+1=3        |
| FBT-504              | Reproductive Biology of Forest Trees                     | 2+1=3        |
| FBT-505              | Tree Seed Orchards                                       | 2+1=3        |
| FBT-506              | Quantitative Genetics in Forest Tree Breeding            | 2+1=3        |
| FBT-507              | Forest Genetic Diversity and Conservation                | 3+0=3        |
| FBT-508              | Biotechnology in Forestry                                | 2+1=3        |
| FBT-509              | Clonal Forestry                                          | 2+0=2        |
| FBT-510              | Forest Ecophysiology                                     | 2+1=3        |
| FBT-511              | Physiology of Woody Plants                               | 2+1=3        |
| FBT-512              | Breeding for Insect Pest and Disease Resistance in Trees | 2+1=3        |
| FBT-513              | Tree Seed Technology                                     | 2+1=3        |
| SAF-591              | Seminar                                                  | 1+0          |
| SAF-599              | Master's Research                                        | 0+30         |
| <b>Fruit Science</b> |                                                          |              |
| FSC-501              | Tropical Fruit Production                                | 2+1          |
| FSC-502              | Sub-Tropical and Temperate Fruit Production              | 2+1          |
| FSC-503              | Propagation and Nursery Management of Fruit Crops        | 2+1          |
| FSC-504              | Breeding of Fruit Crops                                  | 2+1          |
| FSC-505              | Systematics of Fruit Crops                               | 2+1          |
| FSC-506              | Canopy Management in Fruit Crops                         | 1+1          |
| FSC-507              | Growth and Development of Fruit Crops                    | 2+1          |
| FSC-508              | Nutrition of Fruit Crops                                 | 2+1          |
| FSC-509              | Biotechnology of Fruit Crops                             | 2+1          |
| FSC-510              | Organic Fruit Culture                                    | 2+1          |
| FSC-511              | Export Oriented Fruit Production                         | 2+1          |
| FSC-512              | Climate Change and Fruit Crops                           | 1+0          |
| FSC-513              | Minor Fruit Production                                   | 2+1          |
| FSC-591              | Seminar                                                  | 1+0          |



| Course No.               | Course Title                                                  | Credit Hours |
|--------------------------|---------------------------------------------------------------|--------------|
| FSC-599                  | Research                                                      | 0+30         |
| FSC-601                  | Innovative Approaches in Fruit Breeding                       | 3+0          |
| FSC-602                  | Modern Trending Fruit Production                              | 3+0          |
| FSC-603                  | Recent Developments in Growth Regulation                      | 3+0          |
| FSC-604                  | Advanced Laboratory Techniques                                | 1+2          |
| FSC-605                  | Arid and Dry Land Fruit Production                            | 2+0          |
| FSC-606                  | Abiotic Stress Management in Fruit Crops                      | 2+1          |
| FSC-607                  | Biodiversity and Conservation of Fruit Crops                  | 2+1          |
| FSC-608                  | Smart Fruit Production                                        | 2+0          |
| FSC-691                  | Seminar I                                                     | 1+0          |
| FSC-692                  | Seminar II                                                    | 1+0          |
| FSC-699                  | Doctoral Research                                             | 0+75         |
| <b>Vegetable Science</b> |                                                               |              |
| VSC-501                  | Production of Cool Season Vegetable Crops                     | 2+1          |
| VSC-502                  | Production of Warm Season Vegetable Crops                     | 2+1          |
| VSC-503                  | Growth and Development of Vegetable Crops                     | 2+1          |
| VSC-504                  | Principles of Vegetable Breeding                              | 2+1          |
| VSC-505                  | Breeding of Self-Pollinated Vegetable Crops                   | 2+1          |
| VSC-506                  | Breeding of Cross- Pollinated Vegetable Crops                 | 2+1          |
| VSC-507                  | Protected Cultivation of Vegetable Crops                      | 2+1          |
| VSC-508                  | Seed Production of Vegetable Crops                            | 2+1          |
| VSC-509                  | Production of Underutilized Vegetable Crops                   | 2+1          |
| VSC-510                  | Systematics of Vegetable Crops                                | 1+1          |
| VSC-511                  | Organic Vegetable Production                                  | 1+1          |
| VSC-512                  | Production of Spice Crops                                     | 2+1          |
| VSC-513                  | Processing of Vegetable Crops                                 | 1+1          |
| VSC-514                  | Postharvest Management of Vegetable Crops                     | 2+1          |
| VSC-591                  | Seminar                                                       | 1+0          |
| VSC-599                  | Research                                                      | 0+30         |
| VSC-601                  | Recent Trends in Vegetable Production                         | 3+0          |
| VSC-602                  | Advances in Breeding of Vegetable Crops                       | 3+0          |
| VSC-603                  | Abiotic Stress Management in Vegetable Crops                  | 2+1          |
| VSC-604                  | Seed Certification, Processing and Storage of Vegetable Crops | 2+1          |
| VSC-605                  | Breeding for Special Traits in Vegetable Crops                | 2+0          |
| VSC-606                  | Biodiversity and Conservation of Vegetable Crops              | 2+1          |
| VSC-607                  | Biotechnological Approaches in Vegetable Crops                | 2+1          |
| VSC-608                  | Advanced Laboratory Techniques for Vegetable Crops            | 1+2          |
| VSC-691                  | Seminar                                                       | 0+1          |
| VSC-692                  | Seminar                                                       | 0+1          |
| VSC-699                  | Research                                                      | 0+75         |

## Patents Granted/Applications Filed

| Patents granted under Indian Patent Act, 1970 |               |                                                                                                                                                            |                                           |                                                |
|-----------------------------------------------|---------------|------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------|------------------------------------------------|
| 1                                             | 201711032209  | Bacteriological food testing kit (BFTK) for rapid and efficient detection of presence/absence of recurrent indicator and emerging pathogens in food sample | Department of Microbiology                | Patent number 446897 granted on 24/08/2023.    |
| 2                                             | 914/DEL/2015  | A gluten free whole grain flour composition and food product                                                                                               | Department of Food Science and Technology | Patent granted on 30/06/2023 and number 436517 |
| 3                                             | 1514/DEL/2015 | A fungal consortium for degradation of lignin and or silica, process and application thereof                                                               | Department of Microbiology                | Patent granted on 20/04/2023 and number 429474 |
| 4                                             | 201811039891  | Molasses based microbial fertilizer and method thereof                                                                                                     | Department of Microbiology                | Patent granted on 01/03/2023 and number 423627 |
| 5                                             | 768/DEL/2015  | Flour composition of gluten-free food grain                                                                                                                | Department of Food Science and Technology | Patent granted on 10/02/2023 and number 421209 |
| 6                                             | 710/DEL/2015  | A mutant yeast strain for producing low alcoholic debittered beverage                                                                                      | Department of Microbiology                | Patent granted on 16/02/2023 and number 421977 |
| 7                                             | 1567/DEL/2015 | Improved water and nutrient perforation and re-circulation system for pot based substrate hydroponics                                                      | Department of Mechanical Engineering      | Patent granted on 28/10/2022 and number 410204 |

| Applications filed under Indian Patent Act, 1970 |              |                                                                                                                   |                                                        |                              |
|--------------------------------------------------|--------------|-------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------|------------------------------|
| 1                                                | 202211069184 | Straw size reduction machine                                                                                      | Department of Farm Machinery & Power Engineering       | Complete specification filed |
| 2                                                | 202311006571 | Liquid endophytic bacterial inoculant of <i>Bacillus thuringiensis</i> PAU_43RN for enhancing the yield of cotton | Department of Microbiology (School of Organic Farming) | Complete specification filed |
| 3                                                | 202311028033 | A process for modifying whey for preparing leavened food products                                                 | Department of Microbiology                             | Complete specification filed |
| 4                                                | 202311031339 | A one pot synthesis method for preparation of xanthine derivatives                                                | Department of Chemistry                                | Complete specification filed |
| 5                                                | 202311031340 | A one pot synthesis method for preparation of xanthine derivatives                                                | Department of Chemistry                                | Complete specification filed |
| 6                                                | 202311049990 | A polymeric antimicrobial nano-composite and method of making thereof                                             | Department of Microbiology                             | Complete specification filed |



## STUDENTS' ACADEMIC ACCOMPLISHMENTS

### Academic Awards

| Best Oral/Poster Presentation Awards/Thesis Awards                                             |                                          |                                                                                                                                     |                                                                                                                                                                                                                                          |
|------------------------------------------------------------------------------------------------|------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Student                                                                                        | Admission No.                            | Award/Prize                                                                                                                         | Awarding Agency                                                                                                                                                                                                                          |
| <b>College of Agriculture</b>                                                                  |                                          |                                                                                                                                     |                                                                                                                                                                                                                                          |
| Sharanjeet Kaur Brar                                                                           | L-2020-A-151-M                           | Best Poster Presentation                                                                                                            | CSK HPKV, Palampur, June 2023                                                                                                                                                                                                            |
| Rozy Rasool                                                                                    | L-2017-A-17-D                            | Best Poster Presentation                                                                                                            | International Web Conference on 'Global Research Initiatives for Sustainable Agriculture & Allied Sciences', December 13-15, 2021                                                                                                        |
|                                                                                                |                                          |                                                                                                                                     | Society for Scientific Development in Agriculture and Technology during 'International Conference on Innovative and Current advances in Agriculture and Allied Sciences', July 19, 2021                                                  |
| Sathya T                                                                                       | L-2019-A-3-D                             | Best Poster Presentation                                                                                                            | IOBC (International Organization of Biological Control)-WPRS Working Group Meeting on 'Integrated Control in Oilseed Crops', May 17-18, 2022, Rennes, France (Online)                                                                    |
| <b>College of Agricultural Engineering &amp; Technology</b>                                    |                                          |                                                                                                                                     |                                                                                                                                                                                                                                          |
| COAETian Innovators, a team of 25 B.Tech. (Agril. Engg.) student members and 3 faculty mentors | B.Tech. (Agril. Engg.) students of COAET | All-India Rank-1 in the National Level Competition- 'TIFAN 2023'.                                                                   | SAE India (Society of Automotive Engineers - India) and John Deere Limited, Pune                                                                                                                                                         |
| Baldev Singh Kalsi                                                                             | L-2019-AE-160-D                          | Best Poster Presentation                                                                                                            | In the category 'Food Processing, Value Addition, and Post-harvest Technology' at the VII International Conference on 'Global Research Initiatives for Sustainable Agriculture & Allied Sciences' by Astha Foundation, Meerut (UP) India |
| Sukhmanjot Kaur                                                                                | L-2021-AE-238-M                          | Best Poster Presentation                                                                                                            | Sri Guru Granth Sahib World University, Fatehgarh Sahib                                                                                                                                                                                  |
| Navneet Sharma                                                                                 | L-2019-AE-165-D                          | Best Oral Presentation                                                                                                              | Academy of Natural Resource Conservation and Management, Lucknow, India                                                                                                                                                                  |
| Raouf Aslam                                                                                    | L-2019-AE-08-D                           | Young Scientist Award                                                                                                               | IAAHAS, Gurugram, India                                                                                                                                                                                                                  |
|                                                                                                |                                          | Second Best Paper Presentation                                                                                                      | SGT University, Gurugram                                                                                                                                                                                                                 |
|                                                                                                |                                          | Won Stage-1 of the Grand Challenge for the 'Development of Technologies for Primary Processing, Storage and Valorization of Onions' | Department of Consumer Affairs (DoCA), Ministry of Consumer Affairs, Food and Public Distribution (MoCAFPD)                                                                                                                              |



|                                        |                  |                                                                                                                                                                                                                                                                                              |                                                                                           |
|----------------------------------------|------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------|
| Mahima Sharma                          | L-2019-AE-235-M  | Best M. Tech. Thesis Award in Agricultural Engineering                                                                                                                                                                                                                                       | ISTE, New Delhi                                                                           |
| Mudasir Ali                            | -                | Best PG Thesis Award (2022) titled 'Design, development and evaluation of a dust separation system for wheat straw combine' during International Conference on 'Advances in agricultural, veterinary and allied sciences for improving livelihood and environmental security'                | ICAR-IGFR<br>BAU, Ranchi, Jharkhand                                                       |
| Chandan Solanki                        | -                | Best Ph.D. Thesis Award (2022) titled 'Design and Development of continuous pre-milling treater for improved recovery from selected pulses'                                                                                                                                                  | Green Planet Agrotech Foundation                                                          |
|                                        |                  | Third prize for Best Oral Presentation for the paper 'Impact of continuous microwave pre-milling treatments on chickpea for enhanced recovery' at International Conference on 'Advances in Agricultural, Veterinary and Allied Sciences for Improving Livelihood and Environmental Security' | ICAR and NAHEP at University of Kashmir                                                   |
| College of Basic Sciences & Humanities |                  |                                                                                                                                                                                                                                                                                              |                                                                                           |
| Rashmi                                 | L-2020-BS-135-D  | Second Best Poster Presentation at National Conference on 'Natural & Organic Farming For Ecological, Economical & Nutritional Security'                                                                                                                                                      | Palampur, June 7-9, 2023                                                                  |
| Harjinder Kaur                         | L-2021- BS-142-D | Best Poster Presentation at International Conference on 'Animal Behaviour and Trends in Zoological Studies'                                                                                                                                                                                  | REVA University, Bangalore, from April 04-05, 2023                                        |
| Meenu Verma                            | L-2021- BS-143-D | Best Poster Presentation at 6th International Conference on 'Strategies and Challenges in Agriculture and Life Science for Food Security and Sustainable Environment'                                                                                                                        | Himachal Pradesh University, Shimla, April 28-30, 2023.                                   |
| Navneet Kaur                           | L-2017-BS-25-IM  | Second Prize in Oral Presentation on the theme 'Plant- microbes interactions' during National Conference on 'Emerging Paradigm in Agricultural Microbiology'                                                                                                                                 | Atmiya University, Gujarat, February 11, 2023                                             |
|                                        |                  | Joined as Technical Assistant in Pharmaceutical Company, Ludhiana on 22/3/2023 @ 2.4 lacs package.                                                                                                                                                                                           |                                                                                           |
| Diksha Singla                          | L-2017-BS-57-D   | Postdoctoral Research Associate Position                                                                                                                                                                                                                                                     | Lethbridge College, Alberta, from April 2023 to March 2024                                |
| Heena Rani                             | L-2018-BS-75-D   | Postdoctoral Research Associate Position                                                                                                                                                                                                                                                     | US Department of Agriculture, Cereal Crops Research Unit, Madison, Wisconsin, April, 2023 |



| <b>College of Community Science</b>           |                 |                                                                                                                                                                                                                                      |                                                                                                     |
|-----------------------------------------------|-----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------|
| Satinder Kaur                                 | L-2019-CS-157-D | First Prize in Paper Presentation during 34th Biennial National Conference of Home Science Association of India on 'Incubation Opportunities in Home Science for Self-reliant India'                                                 | St. Teresa's College, Kochi, Kerala, December 15-17, 2022                                           |
| Pavan M                                       | L-2020-CS-158-D | Second Prize in Poster Presentation on 'Green Composites: Sustainable Materials for Future Era' during the 4 <sup>th</sup> International Conference on Global Efforts on Agriculture, Forestry, Environment and Food Security        | Institute of Forestry, Tribhuvan University, Pokhara Campus, Nepal, September 17-19, 2022           |
| Lagima Arora                                  | L-2020-CS-351-M | Third Prize in Poster Presentation during National Symposium on Millets                                                                                                                                                              | PGIMR, Chandigarh, September 2, 2022                                                                |
|                                               |                 | Best Paper Award during the 5 <sup>th</sup> International Conference held through virtual mode                                                                                                                                       | USFN, Malaysia, November 16-17, 2022                                                                |
| Manisha Patil                                 | L-2020-CS-352-M | Best Oral Presentation during the 54 <sup>th</sup> Annual Conference of the Nutrition Society of India                                                                                                                               | ICMR-National Institute of Nutrition, Hyderabad, Telangana, December 22-23, 2022                    |
| Prabhjot Kaur                                 | L-2020-CS-354-M | Young Scientist Award during the 54 <sup>th</sup> Annual Conference of the Nutrition Society of India                                                                                                                                | ICMR-National Institute of Nutrition, Hyderabad, Telangana, December 22-23, 2022                    |
| <b>College of Horticulture &amp; Forestry</b> |                 |                                                                                                                                                                                                                                      |                                                                                                     |
| Garima                                        | L-2019-H-82-D   | Best Poster Award in 3 <sup>rd</sup> National Symposium on 'Emerging Technologies and Trends in Sustainable Production and Value Chain Management of Onion, Garlic and other Allium Species', held at Jain Hill Jalgaon, Maharashtra | ICAR-Directorate of Onion and Garlic Research and Jain Irrigation System Ltd., February 11-14, 2023 |
| Kritika Pant                                  | L-2021-H-94-D   | First Prize in Poster Presentation at 'Progressive Horticulture Conclave', held at GB Pant Agricultural University, Pantnagar, Uttarakhand                                                                                           | Indian Society of Horticultural Research and development (ISHRD), February 3-5, 2023                |
| Ulli Murali Krishna                           | L-2019-H-80-D   | First Prize in Poster Presentation at 'Progressive Horticulture Conclave', held at GB Pant Agricultural University, Pantnagar, Uttarakhand                                                                                           |                                                                                                     |
| Dixit Chaudhary                               | L-2020-H-78-D   | Third Prize in Oral Presentation at 'Progressive Horticulture Conclave', held at GB Pant Agricultural University, Pantnagar, Uttarakhand                                                                                             |                                                                                                     |
| Vamsi Maddirala                               | L-2021-H-181-M  | Best Poster Presentation at 'Progressive Horticulture Conclave', held at GB Pant Agricultural University, Pantnagar, Uttarakhand                                                                                                     |                                                                                                     |

## SCHOLARSHIPS AND FINANCIAL ASSISTANCE

### Fellowships, Scholarships and Financial Aids

| Prime Minister's Fellowship for Doctoral Research |                 |                                           |                                       |                                                                                                                                                                                      |
|---------------------------------------------------|-----------------|-------------------------------------------|---------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Student                                           | Admission No.   | Department                                | Industry Partner                      | Title of Thesis                                                                                                                                                                      |
| <b>College of Agriculture</b>                     |                 |                                           |                                       |                                                                                                                                                                                      |
| Om Prakash Raigar                                 | L-2021-A-51-D   | Department of Plant Breeding and Genetics | NGB diagnostics Private Limited       | Harnessing the allelic variations for improving nutrient deficiency tolerance in rice ( <i>Oryza sativa</i> L.) under direct seeded cultivation conditions. (2023)                   |
| Bikkasani Mythri                                  | L-2021-A-49-D   | Department of Plant Breeding and Genetics | Corteva Agriscience                   | Genome wide association and genomic prediction for silage component traits in tropical maize ( <i>Zea mays</i> L.). (2023)                                                           |
| Ruchi Goyal                                       | L-2020-A-76-D   | Soil Science                              | DST-GOI                               | Water and nitrogen movement in <i>basmati</i> rice-wheat system under surface and sub-surface fertigation. (2022)                                                                    |
| Arpana Sharma                                     | L-2020-A-61-D   | Plant Pathology                           | Agricare Organic Farms                | Race profiling in <i>Ascochyta blight</i> (Pass.) Labr. and its gene expression in chickpea ( <i>Cicer arietinum</i> L.). (2022)                                                     |
| Krishna Sai Karnatam                              | L-2020-A-21-D   | School of Agricultural Biotechnology      | Nutranta Seeds, Pvt. Ltd., Hyderabad  | Genome wide association studies for banded leaf & sheath blight and shoot fly resistance in maize. (2022)                                                                            |
| Anurang Saharan                                   | L-2020-A-19-D   | School of Agricultural Biotechnology      | NGB Diagnostics, Pvt. Ltd., New Delhi | Development of whole genome sequence assembly, genome annotation and prediction of virulence gene of <i>Puccinia f. sp. Triticae</i> pathotypes prevalent in India. (2022)           |
| Jatin Sharma                                      | L-2020-A-55-D   | Plant Breeding & Genetics                 | Signet Crop Sciences India Pvt. Ltd.  | Studies on genetic variability in maize germplasm and molecular tagging of genomic regions for kernel methionine content in maize. (2022)                                            |
| <b>College of Basic Sciences &amp; Humanities</b> |                 |                                           |                                       |                                                                                                                                                                                      |
| Manpreet Kaur                                     | L-2020-BS-116-D | Botany                                    | Beauscape Farms                       | Physiological and biochemical alterations in chilli induced by <i>Colletotrichum</i> spp. and its management with seed treatment for overcoming phytosanitary trade barriers. (2022) |
| Riya Bansal                                       | L-2020-BS-141-D | Microbiology                              | Crop Chemicals India Ltd.             | Assessment of liquid formulation of phosphate - solubilizing rhizobacteria on phosphorus acquisition and yield of potato. (2022)                                                     |
| <b>College of Horticulture &amp; Forestry</b>     |                 |                                           |                                       |                                                                                                                                                                                      |
| Dixit Chaudhary                                   | L-2020-H-78-D   | Floriculture & Landscaping                | RTS Flowers                           | Effect of growing media, growth regulators, storage temperature and duration on bulblet formation from scales in Lillium ( <i>Lilium hybrida</i> L.). (2022)                         |



| INSPIRE Fellowship/SERB Fellowship/DBT |               |             |            |                                            |
|----------------------------------------|---------------|-------------|------------|--------------------------------------------|
| Name                                   | Admission No. | Fellowship  | Amount     | Awarding Agency                            |
| <b>College of Agriculture</b>          |               |             |            |                                            |
| Rozy Rasool                            | L-2017-A-17-D | DST/INSPIRE | 30,000/-   | Department of Science and Technology (DST) |
| Kavita Thakur                          | L-2020-A-43-D | DST/INSPIRE | 31,000/-   | DST INSPIRE                                |
| Dinesh Kumar Saini                     | L-2017-A-43-D | DST/INSPIRE | 1,56,172/- | DST INSPIRE                                |
| Pavneet Kaur                           | L-2019-A-30-D | DST/INSPIRE | 3,72,000/- | DST INSPIRE                                |
| Sony Bora                              | L-2020-A-17-D | DST/INSPIRE | 3,72,000/- | DST INSPIRE                                |
| Masrat Siraj                           | L-2019-A-36-D | DST/INSPIRE | 3,72,000/- | DST INSPIRE                                |
| Karthick Babu S                        | L-2020-A-57-D | DST/INSPIRE | 3,72,000/- | DST INSPIRE                                |
| Vaddula Yamini                         | L-2019-A-23-D | DST/INSPIRE | 3,72,000/- | DST INSPIRE                                |
| Arushi Arora                           | L-2018-A-45-D | SERB        | 1,99,200/- | DST-Science and Engineering Board          |

| ICAR/UGC/CSIR/ICMR:JRF/SRF/GATE/NET/NTS Fellowships/Scholarships                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>College of Agriculture</b> <ul style="list-style-type: none"> <li>Bindhya BN and Amanjot Kaur were awarded University Grants Commission- NET- Junior Research Fellowship for Rs. 31,000/- each</li> <li>Iqbal Kaur and Ayushi Pal were awarded the ICSSR Fellowship for Rs. 2,60,000/- and Rs. 90,000/- respectively</li> <li>Prabhdeep Kaur was awarded the Department of Biotechnology-Graduate Aptitude Test – Biotechnology Fellowship for Rs. 60,000/-</li> <li>Ahmad Mubasher Wahab Zada and Nooriali Noori were awarded the ICAR Fellowship (Foreign Student) worth Rs. 2,16,000/- each</li> <li>Navaneetha Krishanan J was awarded the DBT-JRF by DBT Delhi worth Rs. 4,20,000/-</li> <li>Kamalpreet Singh Mandahal was awarded the CSIR-JRF worth Rs. 4,20,000/-</li> <li>Thirty five students were awarded ICAR-JRF by the ICAR, New Delhi</li> <li>Fifty three students were awarded the ICAR-NTS UG Scholarships</li> <li>One student was awarded the ICAR-NTS PG Scholarship worth Rs. 5,000/-</li> </ul> |
| <b>College of Agricultural Engineering &amp; Technology</b> <ul style="list-style-type: none"> <li>Akshay Mahadik , Aamir Ishaq Shah and Raouf Aslam were awarded ICAR-SRF worth Rs. 35,000/- each by the ICAR, New Delhi</li> <li>Twenty two Ph.D. scholars were awarded ICAR-SRF by the ICAR, New Delhi</li> <li>Five students, Lalremmawii, Kritanjal Goswami, Wagh Muktabai, Pratibha Jain and Zeenat Mujeeb were awarded ICAR-JRF worth Rs. 12,640/- each by the ICAR, New Delhi</li> <li>Thirty one students were awarded the ICAR-NTS UG Scholarships</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| <b>College of Basic Sciences &amp; Humanities</b> <ul style="list-style-type: none"> <li>Three students, Mona Sharma, Ishamjeet and Gurkirat Singh Sekhon were awarded NET-JRF worth Rs. 31,000/- each by CSIR-UGC</li> <li>Three students, Anuj Choudhary, Manisha and Taranpreet Kaur were awarded CSIR Fellowship by CSIR-HRDG Five students were awarded the ICAR Fellowship for M.Sc. worth Rs. 5,000/- each by ICAR</li> <li>Eleven students were awarded the ICSSR Doctoral Fellowship worth Rs. 20,000/- each by ICSSR</li> <li>Twenty two students were awarded the ICAR-NTS UG Scholarships</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                          |
| <b>College of Horticulture &amp; Forestry</b> <ul style="list-style-type: none"> <li>Six students, Eshanee, Anusha K R, Pooja Devi, Ulli Murali Krishna, Aiswarya V Dev K P and Saurabh Yadav were awarded ICAR-SRF by the ICAR, New Delhi</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |



- Five students, Rinchin Lhamu Dirkipa, Madiha Qadiri, Vamsi Maddirala, Aadil Basheer and Akshita Jalota were awarded ICAR-SRF by the ICAR, New Delhi
- Fifteen students were awarded the ICAR-NTS UG Scholarships

**College of Community Science**

- Four students, Ekta, Karnika, Saloni Chauhan and Pavan M were awarded the ICAR-SRF for Rs. 31,000/- each by ICAR, New Delhi
- Nine students were awarded the ICAR-SRF for Rs. 12,640/- each by ICAR, New Delhi
- Fifteen students were awarded the ICAR-NTS UG Scholarships

**PAU Merit Scholarship / Fellowship / Student READY****College of Agriculture**

- Two hundred thirteen students were awarded the PAU Merit Scholarships
- Four hundred twenty six students were awarded PAU Student READY Scholarships worth Rs. 3,000/- each

**College of Agricultural Engineering & Technology**

- Twenty four students were awarded the PAU Merit Scholarships
- Seventy one were awarded PAU Student READY Scholarships worth Rs. 3,000/- each

**College of Basic Sciences & Humanities**

- Seventy four students were awarded the PAU Merit Scholarships

**College of Horticulture & Forestry**

- Sixty students were awarded the PAU Merit Scholarships

**College of Community Science**

- Sixty one students were awarded the PAU Merit Scholarships
- One hundred one students were awarded PAU Student READY scholarships worth Rs. 3,000/- each

**Miscellaneous Awards/Fellowships/Scholarships****College of Agriculture**

- Medha, was awarded the Bayers Fellowship worth Rs. 4,80,000/- by the Bayer Crop Science Limited and BCKIC
- Two students, Jashleen Kaur Sidhu and Shivani Jha were awarded the Dr. A.P.J. Abdul Kalam Scholarship worth Rs. 3,00,000/- each by the Cooperative and Rural Development by National Cooperative of India (NCUI), under Cooperative Education Fund (CEF)
- Thirty three students were awarded the Dr. G. S. Khush Merit Scholarship worth Rs. 14,400/- each by the Dr. G. S. Khush Foundation
- Thirteen students were awarded the Piara Singh Parmar Memorial Student Aid Fund worth Rs. 20,000/- each by the Piara Singh Parmar Memorial Society
- Pankaj Ghodke, was awarded the CSMNR Fellowship worth Rs. 31,000/- each by the State Govt. of Maharashtra
- Two students, Jashanpreet Kaur and Manpreet Kaur were awarded the Dr Ambedkar Fellowship worth Rs. 62000/- each by PAU
- Ayana Mohan, was awarded the Savitribai Jyotirao Phule Fellowship for Single Girl Child (SJS GC) worth Rs. 31,000/- by the University Grants Commission (UGC), Department of Higher Education
- Gurpreet Singh, was awarded the Maulana Azad National Fellowship worth Rs. 35,000/- by the NMDFC (National Minorities Development and Finance Corporation)
- Four students, Nitika Sharma, Kamaljit Singh, Ravneet Kaur and Shabnam were awarded the Shri Bal Krishan Vaid Scholarship worth Rs. 12000/- each by the Mr AK Vaid, Navi Mumbai
- Three students, Akanksha Attri, Prabhsimran Singh and Vani were awarded the FMC Science Leadership Scholarship worth Rs. 2,40,000/- each by FMC
- Pooja Ankush Ade was awarded the Maharashtra State ST Scholarship worth Rs. 92,640/- by the State Govt. of Maharashtra
- Two students, Jaspreet Kaur and Mohitpreet Kaur were awarded the Dhanuka Agritech Ltd. Fellowship worth Rs. 1,20,000/- by Dhanuka Agritech. Ltd.
- Sanyam was awarded the J.S. Basi Scholarship worth Rs. 18,000/- each
- Five students were awarded the J.K. Bindra Scholarship worth Rs. 48,000/- each
- Two students were awarded the S.K. Vasal Scholarship worth Rs. 18,000/- each
- Smeeksha Koundal was awarded Rs. 50,000/- under the Grameen Chintan Scheme by NABARD


**College of Agricultural Engineering & Technology**

- Pooja Goyal was awarded the AWaDH Project (IIT, Ropar) worth Rs. 20,000/- by the Department of Science & Technology
- Merenungla Ozukum was awarded the National Fellowship & Scholarship for Higher Education of ST students worth Rs. 28,000/- by the Ministry of Tribal Affairs, GOI
- Potdar Pratik Pandit was awarded the ICMR Fellowship worth Rs. 35,000/- by the ICMR, New Delhi
- Two students, Tajpreet Singh and Shivangi Thakur were awarded Rs. 20,000/- each under the Mera Swaraj Support Education Program by the Manav Vikas Sanstha" NGO of M/s Mahindra & Mahindra Ltd. (Swaraj Division)
- Four students, Ashu Shailinder Singh Kainth, Karan, Suman Rani and Harwinder Kaur were awarded the Piara Singh Parmar Memorial Student Aid Fund worth Rs. 20,000/- each by the Piara Singh Parmar Memorial Society
- Three students, Harmanpreet Kaur, Inderpreet Singh Sran and Arshdeip Singh were awarded the Dr. G. S. Khush Merit Scholarship worth Rs. 12,00/- each by the Gurdev Singh Khush Foundation for Advancement of Agricultural Sciences
- Samiksha was awarded the Prof. R. N. Kaul Scholarship worth Rs. 2400/-
- Simranjeet Kaur was awarded Post Matric Scholarship, with total fee reimbursement by the Central Government + State Government

**College of Basic Sciences & Humanities**

- Forty eight students were awarded Post Matric Scholarship, with total fee reimbursement by the Central Government + State Government
- Three students, YuvrajGagandeep, Isha and Radhika Dhawan were awarded the Dr GS Khush Scholarship worth Rs. 14,000/-; and one student, Diya Sagar was awarded Dr GS Khush Scholarship worth Rs. 1,200/- by the Gurdev Singh Khush Foundation for Advancement of Agricultural Sciences
- Two students, Gurpreet Singh and Simarjot Kaur were awarded under the Gramin Chinntan Scheme, NABARD
- Two students, Puneet Kaur and Ayushi Arora were awarded the Alumni Gold Medal for Excellence in Academics in Chemistry/ Biochemistry for the year 2020-21 and Award of Dr Bhupinder Singh Sekhon Medal-2020-21 and 2021-22 respectively
- Simranpreet Kaur Natt was awarded the Best Ph.D. Student Award by the Microbiologists Society, India
- Priyanka was awarded the MBSI Ph.D. Award by the Microbiologists Society, India
- Two students, Swati Pandey and Riya Bansal were awarded by the National Biotech Youth Award by the Microbiologists Society, India
- Preetiman Kaur was awarded by the National Biotech Youth Award by the Microbiologists Society, India; and the First Prize in Inter-College cooking competition on Healthy Millet Recipes by the Dept. of Food and Nutrition, PAU

**College of Horticulture & Forestry**

- Four students, Lovepreet Singh, Gazal Rani, Chetna Devi and Kavita were awarded the Dr. G. S. Khush Merit Scholarship worth Rs. 1,200/- each by the Dr. G. S. Khush Foundation

**College of Community Science**

- Kunika was awarded the Sardarni Gurbachan Kaur Scholarship worth Rs. 300/-
- Sonali was awarded the Vidya Wati Saini Scholarship worth Rs. 200/-
- Four students, Manpreet Kaur Sidhu, Navneet Kaur, Jagjit Kaur and Sana were awarded the Dr. G.S. Khush Scholarship worth Rs. 1,200/- each
- Two students, Jasmine Sooch and Mani Jain were awarded the Charanjit Kaur Hira Memorial Merit Scholarship worth Rs. 1,300/- each

## STUDENTS' WELFARE ACTIVITIES

### Outstanding Sports Achievements of Students/Teams

#### National Level

- Ms. Nehmat Sidhu, (CoA) won the Bronze Medal in the 51<sup>st</sup> Senior National Handball (W) Championship held at Nadyal (Andhra Pradesh) on from November 26-30, 2022.
- Mr. Jagtreshwarjot Singh, (CoA) participated in the 65<sup>th</sup> National Shooting Championship held at Bhopal and Trivandrum from November 24 to December 04, 2022.
- Mr. Rajvir Singh, (CoA) participated in the 65<sup>th</sup> National Shooting Championship held at Bhopal and Trivandrum from November 24 to November 30, 2022.
- Ms. Sehajpreet Kaur, (CoA) participated in the 65<sup>th</sup> National Shooting Championship held at Bhopal and Trivandrum from December 03- 09, 2022.
- Mr. Gurmanjeet Singh, (CoA) participated in the 65<sup>th</sup> National Shooting Championship held at Bhopal and Trivandrum from November 27 to December 02, 2022.
- Mr. Shivdeep Singh Grewal, (CoA) participated in the 51<sup>st</sup> Senior Men's National Handball Championship held at Ahmedabad (Gujarat) from December 24-29, 2022.
- Mr. Harshaan Singh Mashiana, (CoA) participated in the 37<sup>th</sup> National Junior Athletics Championship-2022 held at Assam from November 11-15, 2022.
- **Athletics (Men):** Harshaan Singh Mashiana (CoH&F) clinched the 1<sup>st</sup> position in 400M & 2<sup>nd</sup> position in 200M; while Jobanjit Singh (CoA) bagged the 2<sup>nd</sup> position in 100M.
- **Athletics (Women):** Harleen Kaur (CoCS) won the 1<sup>st</sup> position in 100M, 200M and Long Jump; while Harmeet Kaur (CoBS&H) secured the 2<sup>nd</sup> position in 800M, 1500m and 5000M

#### Inter-University Tournament

- The PAU teams participated in the North Zone Inter-Varsity Tournaments in the games of Lawn Tennis (M), Cricket (M), Football (M), Table Tennis (M&W), Basketball (M&W), Swimming (M&W), Kabaddi (M), Cycling (M&W), Handball (M&W), Badminton (M&W), Volleyball (W), Hockey (M), Athletics (M), Shooting (M&W) & Weight Lifting (M).

#### State level Tournament

- Mr. Jagtreshwarjot Singh, (CoA) won three Gold Medals in the Punjab State Shooting Championship held at Mohali from September 19-24, 2022.
- Mr. Rajvir Singh, Mr. Gursagar, Mr. Udeydeep Singh, Mr. Preet Singh, Ms. Sehajpreet Kaur, Mr. Jaskanwar Partap Singh, and Mr. Hunnerdeep Singh, (all from CoA), participated in the Punjab State Shooting Championship held at Mohali, from September 19-24, 2022.

### Tournaments/Events

#### Inter-College Tournament

#### All-India Inter-Agricultural University Sports and Games Meet

- The PAU contingent consisting of 33 students (21 Men and 12 Women students) from the constituent colleges of the university and 03 officials participated in Basketball (M&W), Badminton (W), Table Tennis (W), Athletic (M&W) and Volleyball (M). In Team Games, PAU won the Gold Medal in Table Tennis (W). The PAU contingent was declared Overall Runners' Up in Team Games (W). PAU sportspersons also bagged distinction in different games/events:
- **Table Tennis (Women):** The PAU Table Tennis (W) Team won Gold Medal in Table Tennis. The team comprised of Aadisha Saini (CoA), Ashna (CoCS) and Guntaas (CoA).
- As per the sports calendar of the University duly approved by the PAU Sports & Youth Activities Council for the session 2022-23, an Inter-College Tournament was organized in the game of PAU Handball (M&W), Basketball (M&W), Table Tennis (M&W), Volleyball (M), Football (M), Swimming (M&W), Badminton (M&W), Cricket (M), Hockey (M), Lawn Tennis (M), Kabaddi (M), Cycling (M&W), Shooting (M&W) & Weight lifting (M).
- Mr. Jashanpreet Singh (CoA) and Ms. Jasleen Kaur (CoCS) were declared the Best Cyclists (M&W) respectively.
- Mr. Mahavir Singh (CoA) was declared the Best Hockey Player.
- Mr. Taranjit Singh and Ms. Ekamjot Kaur (both from CoA) were declared the Best Swimmers (M&W), respectively.



### Annual Athletic Meet

- The 56<sup>th</sup> Annual Athletic Meet of PAU for the session 2022-23 was held at PAU Athletic Track on 20<sup>th</sup> April, 2023. Mr. Harshaan Singh (CoH&F), Mr. Arshdeep Singh (COA), and Mr. Jasandeep Singh Sandhu (CoAE&T) were declared the Best, second Best and third Best Athletes respectively, in the Men Category.
- Ms. Harleen Kaur (CoCS), Ms. Harmeet Kaur (CoBS&H), and Ms. Haritha M (CoH&F) were declared the Best, second Best and third Best Athletes in Women Category.

### International Day of Yoga

- The PAU organized International Day of Yoga on June 21, 2023. Experts from Unique Yoga Tutors, Ludhiana, were invited to conduct the Training Session. About 300 delegates including faculty and students participated in the event. A Practical Session on demonstration of various yogic *asanas* and *pranayam* was also conducted.

### Special Sports Coaching Camps

- Before participation of the PAU Teams in the North Zone/All-India Inter-Varsity/Inter-Agricultural University Tournaments, a Coaching Camp of 15-20 days duration in the games of Volleyball (M&W), Basketball (M&W), Football (M), Swimming (M&W), Lawn Tennis (M), Handball (M&W), Hockey (M), Badminton (M&W), Weight Lifting (M), Kabaddi (M), Table Tennis (M&W) & Cycling (M&W) was organized.

### NSO Activities

- As many as 302 students from different colleges were registered in NSO programme in various games i.e. Athletics, Swimming, Handball, Cricket, Basketball, Badminton, Volleyball, Kabaddi, Shooting, Table Tennis, Hockey, Football, Cycling, Lawn Tennis etc. during Semester I, 2022-23, from which about 60 NSO trainees participated in Inter-College, Inter-Varsity and Inter-Agri Tournaments.

- A Special NSO Coaching camp of 15 days duration was organized by the Directorate of Students' Welfare from May 02-20, 2023 in the University Campus. A total 137 NSO trainees (Boys & Girls) attended this camp.
- The Annual NSO Coaching Camp of 15 days duration was organized by the Directorate of Students' Welfare from August 23 to September 06, 2022 in the University Campus. This camp is compulsory for every undergraduate student who has opted for NSO programme. As many as 382 NSO trainees attended the camp. The camp was conducted in various games viz. Athletic, Badminton, Basketball, Cricket, Football, Hockey, Volleyball, Shooting, Kabaddi, Handball, Table Tennis, Lawn Tennis, Swimming and Weightlifting.

### Sports Scholarships

- To motivate the students towards sports participation, Sports Scholarships were awarded to outstanding sportspersons on the basis of their achievements and proficiency in sports. The Sports Scholarship Committee in its meeting held on March 21, 2023 approved ten Sports Scholarships worth Rs. 500/- each per month, one Scholarship was awarded in major and seven Scholarships were awarded in minor games for the academic session 2022-23.

### University Merit/University Colour/Roll of Honour

- The PAU Sports & Youth Activities Council in its 58<sup>th</sup> meeting held on February 16, 2023 awarded ten Merit Certificates, one University Colour and two Rolls of Honour for the session 2020-21 and awarded nine Merit Certificates, one University Colour and one Roll of Honour for the session 2021-22 to outstanding sportspersons/artists of PAU for their proficiency in sports, game, cultural and literary events. The University Merit/University Colour/ Roll of Honour were awarded to the students during the 55<sup>th</sup> Annual Athletic Meet of the University held on April 06, 2022.

# Extension

The University has a strong mechanism of transfer of improved agricultural technologies, and capacity building of farmers and extension functionaries. It includes 18 *Krishi Vigyan Kendras* (KVKs) and 15 Farm Advisory Service Centres (FASCs) at district level, different departments, Agricultural Technology Information Centre (ATIC) and Advanced Training Unit at main campus, Ludhiana. The Directorate of Extension Education has a strong linkage with the line departments. The knowledge relating to technologies and practices, developed by the University, is disseminated to the stakeholders through various extension activities such as *Kisan Melas*, field days, workshops, adaptive research trials (ARTs), specialized trainings (short, vocational and in-service), exhibitions, demonstrations, campaigns, trainings camps, technical guidance through personnel contact or on telephone. In addition to farm literature, various electronic media tools including e-news paper, TV/radio talks, *Kisan Mobile Advisory Service* (KMAS), WhatsApp groups, video capsules, farmer portal etc. are also being used for the quick dissemination of agricultural technologies to the farmers. PAU has also formed *kisan club/committees* of the farmers of different interest groups and regular meetings are arranged for in this regard.

## KISAN MELAS

*Kisan Melas* play a key role in the dissemination of improved agricultural knowledge among the masses. In these events, the farmers are acquainted with

new technologies through live field demonstrations, exhibitions and technical sessions. The question-answer session during the *Kisan Melas* update the farmers about their queries. Seven *Kisan Melas* (one each at main campus Ludhiana; KVK, Amritsar; Patiala; Regional Research Stations, Ballawal Saunkhri, Faridkot and Gurdaspur and Regional Research Station, Bathinda) were organized during the months of September, 2022 and March, 2023. The theme of March 2023 *Kisan Mela* was “*Aao kheti kharch ghatayiye, wadhu pani khaad na payiye*”; and the theme of September 2022 *Kisan Mela* was “*Kisani, jawani ate paon paani bachayiye, aao rangla Punjab bnanyiye*”. During September 2022 *Kisan Mela*, Sh Bhagwant Mann Hon’ble Chief Minister of Punjab was the Chief Guest and during March 2023, Dr Bikram Singh Gill, KSU, USA and Dr Ashwani Kumar, IFS, Former DG, ICFRE, Dehradun were the Chief Guests, at main campus Ludhiana. A large number of farmers participated in these *Melas*. Live demonstrations of field crops with improved varieties, production and protection technologies, straw management techniques, bee-keeping, mushroom cultivation, nutritional gardening, protected cultivation etc. were arranged in PAU experimental areas for farmers in these *Kisan Melas*. Seed of improved field and vegetable crop varieties, planting materials of vegetables/fruit/forest/ornamentals and bio-fertilizers were made available for farmers in these *Kisan Melas*.

### *Kisan Melas* organized during the year 2022-23:

| Sr. No. | Place                                              | September, 2022          | March, 2023                |
|---------|----------------------------------------------------|--------------------------|----------------------------|
| 1       | Ballawal Saunkhri                                  | 6-9-2022                 | 07-03-2023                 |
| 2       | Gurdaspur                                          | 9-9-2022                 | 10-03-2023                 |
| 3       | Nagkalan Jahangir, Amritsar                        | 2-9-2022                 | 02-03-2023                 |
| 4       | Faridkot                                           | 13-9-2022                | 14-03-2023                 |
| 5       | Rauni, Patiala                                     | 16-9-2022                | 16-03-2023                 |
| 6       | PAU, Ludhiana                                      | 23-9-2022 &<br>24-9-2022 | 24-03-2023 &<br>25-03-2023 |
| 7       | Bathinda                                           | 29-9-2022                | 21-03-2023                 |
| 8       | Food Industry and Craft <i>Mela</i> , PAU Ludhiana | 11-10-2022               |                            |

## Glimpses of *Kisan Mela* at PAU Ludhiana



## ADAPTIVE RESEARCH TRIALS (ARTs)

Adaptive research trials (ARTs) are conducted to test the new technologies/varieties at the farmers' fields under different agro-climatic conditions of the State. A total of 342 ARTs were conducted during the period under report to evaluate new crop varieties, crop production and protection technologies. In these adaptive trials, 20 new varieties (6 field crops, 14 vegetables) were tested. The details of the varieties tested in ARTs are given below:

| Field Crops Varieties    |                                  |
|--------------------------|----------------------------------|
| Wheat                    | PBW 823                          |
| Chickpea                 | GL-17020                         |
| Fennel                   | Ajmer Fennel 2                   |
| Millet                   | Foxtail Millet 1, Proso Millet 1 |
| Maize                    | PFM-12                           |
| Vegetable Crop Varieties |                                  |
| Brinjal                  | PBHL-56                          |
| Pea                      | IPFD12-2                         |
| Okra                     | PROL-1                           |
| Cauliflower              | PGAC 25-17                       |
| Carrot                   | PCO-4, Arka Suraj                |
| Cucumber                 | PBRK-11                          |
| Watermelon               | PWM-3                            |
| Tarwanga                 | PTW- 201-52                      |
| Coriander                | PD-5824                          |
| Muskmelon                | CNTB-668                         |
| French Bean              | FBK 1 , WY & FBK 2               |

## ON FARM TRIALS (OFTs)

On Farm Trials (OFTs) are conducted to test a new technology/idea at farmer's field along with PAU recommended practice and farmer's own practice as control. A total of 135 OFTs were conducted by different KVKs and FASCs. Some salient findings of important OFTs are given below:

### Crop Production

- **Effect of potassium application on productivity of paddy:** The three treatments were T1-No use of potassium (Farmer's practice - FP); T2 - one spray of potassium nitrate @ 1.5% at Boot stage (Recommended practice - RP) and T3- Two sprays of potassium nitrate @ 1.5% at Boot stage and week after (Technology Assessed). The results

showed the highest yield of 72.25 q/ha with recommended technology in comparison to 72.0q/ha under Technology Assessed and 67.5 q/ha under farmer practice.

- **Seed priming to ameliorate Mn deficiency in wheat:** Treatments were as follows: T1-Spray on appearance of Mn deficiency (Farmer's practice); T2 -Spray of  $\text{MnSO}_4 \cdot 7\text{H}_2\text{O}$ , 2 -4 days before 1st irrigation and 3 sprays at weekly interval (Recommended practice) and T3-Seed treatment with 1 kg  $\text{MnSO}_4 \cdot 7\text{H}_2\text{O}$  +3 sprays at weekly interval after first irrigation (Technology Assessed). Technology assessed (T3-54.8 q/ha) was at par with the recommended technology (T2-55.0 q/ha).
- **Cost-and-resource effective method of paddy cultivation:** T1- Manual transplanting in puddled field (Farmers' practice), T2- Direct sowing using Lucky seed drill, T3- Direct sowing using modified ZTD and T4-Direct sowing using normal DSR. Direct seeding was beneficial in terms of duration (took 7-8 days less for maturity) and water productivity (saved 10-15% irrigation water). In addition, there was labour saving of Rs 4000/ha.
- **Comparative evaluation of different resource conservation techniques of wheat sowing:** T1-Conventional Sowing (Farmers' practice), T2- Sowing with Happy Seeder (Recommended practice) and T3- Sowing with Super seeder (Recommended practice & Technology assessed). Sowing wheat with HS after harvesting paddy with combine fitted with SMS give highest yield in comparison to other sowing methods. Sowing directly with Happy Seeder after harvesting resulted in saving Rs. 3000/- per ha.
- **Productivity of wheat as influenced by application of water soluble fertilizer:** T<sub>1</sub> - (RP) 2 %  $\text{KNO}_3$  at boot and anthesis, T<sub>2</sub> - 2% Monopotassium Phosphate (0:52:34) at 70 DAS, T<sub>3</sub> - 2 % Mono Potassium Phosphate (0:52:34) at 70 DAS and : 2 %  $\text{KNO}_3$  at anthesis and T<sub>4</sub> -(FP) Without any foliar spray (FP). Highest grain yield of wheat was recorded in T1 (19.3 q/a) and T3 (19.2 q/a) treatments.
- **Effect of pre-emergence herbicide on productivity of DSR:** T<sub>1</sub> - (RP) Stomp 30 EC (Pendimethalin) @ 2.5 L per ha, T<sub>2</sub> - Stomp 30 EC (Pendimethalin) @ 2.5 L per acre + Sathi 10 WP @ 150 g (Pyrazosulfuron

ethyl), T<sub>3</sub> - Stomp 30 EC (Pendimethalin) @ 3.75 L per acre + Sathi 10 WP @ 150g (Pyrazosulfuron ethyl) and T<sub>4</sub> - (FP) weed free. Combination of Stomp 30 EC (Pendimethalin) @ 2.5 L per acre + Sathi 10 WP @ 150 g (Pyrazosulfuron ethyl) recorded better control of weeds in DSR.

- **Evaluation of performance of organic sugarcane production:** T<sub>1</sub>- Soil test based recommended fertilizers (Recommended practice), T<sub>2</sub>- 300 kg urea + 100 kg DAP (Farmer practice) and T<sub>3</sub>- FYM @ 8 tonne/acre (Intervention). Cane yields were: T<sub>1</sub>-388 q/acre, T<sub>2</sub>-327 q/acre and T<sub>3</sub>-344 q/acre.
- **Evaluation of method of urea application on yield of wheat :** T1- soil test based recommended urea (90 kg urea/acre) (Recommended practice), T2- 135 kg urea/acre (Farmer practice) and T3- 72 kg urea/acre (45 kg urea/acre at sowing+ Spray of 9 kg urea/acre at 20, 35 and 50 days after sowing) (Intervention). Grain yields under different treatments were: T<sub>1</sub> - 20.30 q/acre, T<sub>2</sub> - 20.16 q/acre and T<sub>3</sub> - 20.04 q/acre.
- **Evaluation of performance of DSR (PR 126) under different dates of sowing:** T1: Sowing in first fortnight of June (15 June), T2: End of May (25 May) and T3: Sowing in second fortnight of June (25 June). No significant difference was observed in yield; whereas, there was a water saving of 30 % between T2 and T3. Total 114 mm of rainfall was observed in the month of June. Maximum yield of 56.5 q/ha was observed in T1.
- **Effect of sowing methods on quality and yield of wheat:** T<sub>1</sub>: Wheat sown with super seeder after partial burning (FP), T<sub>2</sub>: Wheat sown with Happy Seeder (RP) and T<sub>3</sub>: Wheat sown with mulching practice (surface seeding) (I). T<sub>1</sub>: 46.34 q/ha, T<sub>2</sub>: 53.79 q/ha and T<sub>3</sub>: 52.80 q/ha.
- **Comparison of different rice residue management technologies for sowing of wheat:** T<sub>1</sub>: Physical removal of loose straw + Zero till (FP), T<sub>2</sub>: Use of SMS combine + Happy Seeder (RP) and T<sub>3</sub>: Use of combine without SMS + Sowing of wheat with Super Seeder (To be assessed). Use of SMS combine + Happy Seeder gave the highest B-C ratio.
- **Performance of Bt- cotton through different sowing methods:** T1- Cotton sowing Drill (Three tynes) (FP), T2- Ridge sowing (RP), T3- Cotton

sowing Drill (RP) and T4- Bed maker Bt cotton sowing machine (To be assessed). Bed maker Bt-cotton sowing machine results in higher number of monopodial, sympodial branches and number of bolls per plant.

- **Comparative performance of wheat in differently managed paddy straw fields:** T<sub>1</sub>: Partial burning + Conventional (disc harrow -2, cultivator-2, planking- 2, sowing) (FP), T<sub>2</sub>: SMS + PAU Happy seeder (RP) and T<sub>3</sub>: SMS + Super Seeder. The yield was comparable in all the treatments. The cost of sowing was highest in T1 (Rs. 34538 /ha). The Net returns and BC ratio was higher in T2 as compared to other treatments.
- **Nitrogen Management in Basmati (Pusa Basmati 1121):** T<sub>1</sub>: Application of 225 kg urea per ha (FP), T<sub>2</sub>: Application of 90 kg urea per ha (RP) and T<sub>3</sub>: Application of 135 kg urea per ha. Results showed that grain yield was slightly increased with increase in urea dose up to 225 kg urea per ha; however, the difference in yield at T1 and T3 was very less.
- **Effect of Seed Rate of Kharif Mash on Yield (Mash 114 & Mash 883):** T<sub>1</sub> 10 Kg/ha (FP), T<sub>2</sub> -15 Kg/ha and T<sub>3</sub> - 20 Kg/ha (RP). Grain yield was comparable in T2 and T3 in both the varieties; however, increase in grain yield was observed with increase in seed rate.
- **Effect of mustard oil and mineral mixture supplementation on production performance of dairy cows after calving:** T<sub>1</sub>- Normal / Routine feeding (F.P.), T<sub>2</sub>- Normal / Routine feeding+ 50 g mineral mixture daily (RP) and T<sub>3</sub>- Normal / Routine feeding+ 50 g mineral mixture daily+ 100ml mustard oil supplementation (Assessed). The increase in average milk yield and fat % was from 0.5 to 0.86 litre (4.6 to 7.9%) and 0.3 to 0.6% respectively after dietary supplementation of mineral mixture and mustard oil.
- **Performance of rainy season groundnut under different planting methods:** T<sub>1</sub>: Paired row planting (15x55cm) (Farmer's practice), T<sub>2</sub>: Flat sowing (30x 15 cm) (Recommended practice) and T<sub>3</sub>: Bed sowing (22.5 x 20 cm) (Intervention). Pod yield with flat sowing was at par with bed sowing but better than paired row planting.
- **Effect of PSB bio-fertilizer in potato crop:** T<sub>1</sub>: No use of PSB (Farmer practice), T<sub>2</sub>: 100% of recommended P (Recommended practice) and T<sub>3</sub>: 100% of recommended P + PSB (Intervention).

The application of PSB bio-fertilizer increased the availability of phosphorus and hence increased the tuber yield.

- **Comparison of different methods of wheat sowing:** T<sub>1</sub>: Conventional method of wheat sowing (Farmers practice), T<sub>2</sub>: Sowing of wheat with PAU Smart Seeder in paddy residue (Recommended practice), T<sub>3</sub>: Sowing of wheat with Super Seeder in paddy residue (Recommended practice) and T<sub>4</sub>: Sowing with roto till drill in paddy residue (Practice under test). The wheat crop exhibited maximum lodging in Super Seeder sown wheat fields (40-70%) followed by roto till drill sown fields (30-65%), conventional sowing (30-55%) and PAU Smart Seeder sown fields (5-10%).
- **Effect of variety selection and early sowing date on potato yield:** T<sub>1</sub>: Cultivation of Potato cv. *Kufri Jyoti* in the first week of September (Farmer practice), T<sub>2</sub>: Cultivation of Potato cv. *Kufri Pukhraj* in the first week of September as per PAU recommendation (Control) and T<sub>3</sub>: Cultivation of Potato cv. *Kufri Surya* in the first week of September (Practice under test). Average yield of T<sub>3</sub> was slightly higher. T<sub>3</sub> also showed lesser splitting of tubers compared with the T<sub>1</sub> and T<sub>2</sub>.
- **Effect of foliar application of Cytokinins on pea yield:** T<sub>1</sub>: Application of commercial product, Mahaphal (Multiplex), 250 ml/acre (Farmer practice), T<sub>2</sub>: No foliar application of any growth promoter/PGR (Control) and T<sub>3</sub>: Application of Cytokinins (100ppm) at flowering and pod formation stage (Practice under test). Average yield of T<sub>3</sub> was higher. T<sub>3</sub> also had lesser whitening of pods compared with the T<sub>1</sub> and T<sub>2</sub>.
- **Comparative analysis of different sowing techniques of wheat:** T1 –Sowing of wheat using Zero till drill @100kg/ha (Recommended practice), T2-Broadcasting of wheat seed @100kg/ha in standing stubbles followed by use of stubble shaver and irrigation. (Farmer's practice) and T3 - Sowing of wheat using Happy seeder @ 100kg/ha (Intervention). T1: Yield (q/ha) 52q ;Net Return (Rs./ha) Rs. 78,983 and BC Ratio 2.90, T2: Yield (q/ha) 51.6 q; Net Return (Rs./ha) 74,285 and BC Ratio 2.50 and T3: Yield (q/ha) 53q; Net Return (Rs./ha) 82,893 and BC Ratio 3.19.
- **Effect of planting method and spacing on bulb yield in *rabi* onion:** T<sub>1</sub> Flat planting (15 cm × 7.5 cm) (Recommended practice), T<sub>2</sub> Flat planting (10 cm × 10 cm) (Farmer's practice) and T<sub>3</sub> – Bed planting:

Bed size 67.5 cm (12 cm × 7.5 cm) (Intervention). To obtain higher bulb yield in onion, planting should be done as per T<sub>1</sub>.

- **Effect of sowing time on growth and yield of rainy season tomato var. Pb Varkha Bahar-4:** T<sub>1</sub>: Sowing from 15<sup>th</sup> July onwards (Recommended practice), T<sub>2</sub>: Sowing of tomato from 10 August onwards (Farmer practice), T<sub>3</sub>: Sowing from 25<sup>th</sup> July onwards (Intervention) and T<sub>4</sub>: Sowing from 5<sup>th</sup> August onwards (Intervention). T<sub>3</sub> and T<sub>4</sub> were found to have higher yields than Treatment T<sub>1</sub> and T<sub>2</sub>. Heavy rains in mid July led to lower plant survival, thus lower yields.
- **Comparison of different methods for sowing of wheat:** T<sub>1</sub>: Happy Seeder (Recommended practice), T<sub>2</sub>: Super Seeder (Recommended practice), T<sub>3</sub>: Conventional tillage (Farmer practice) and T<sub>4</sub>: Surface seeding (Intervention). Wheat crop sown using surface seeding technology had higher B:C ratio due to low cost of cultivation.
- **Effect of crop establishment practices on productivity of wheat crop:** T<sub>1</sub>: Sowing of wheat crop @ 45 kg/acre with Happy seeder technology (Recommendation practices), T<sub>2</sub>: Conventional sowing of wheat crop @ 45 kg/acre (Farmer practice) and T<sub>3</sub>: Broadcasting of wheat seed @ 45 kg/acre in standing stubbles followed by (fb) mulcher fb irrigation of field (Intervention). The respective yields were: T<sub>1</sub>: 19.69 q/acre, T<sub>2</sub>: 20.29 q/acre and T<sub>3</sub>: 20.37 q/acre.
- **Seed priming of late sown wheat with Potassium nitrate:** T<sub>1</sub>: (Farmer's practice)- No priming, T<sub>2</sub>: (Recommended practice)- Hydropriming and T<sub>3</sub>: (New intervention)- Seed priming with Potassium nitrate. The treatment (T3) in which seed priming was done with potassium nitrate gave higher grain yield and net returns than farmer's practice and recommended practices.

### Crop Protection

- **Evaluation of different seed treatment measures against black scurf disease:** T1- Tuber spray with Systiva (Fluxapyroxad 333g/l) FS @ 80 ml/100 L water for one-acre seed (Farmers' practice), T2- Tuber dip for 10 minutes with Emesto Prime (Penflufen 22.43%) @ 83 ml/100 Lt water per acre (Recommended practice) and T3- Tuber dip for 10 minutes with Systiva (Fluxapyroxad 333g/l) FS @ 80 ml/100L water per acre (Technology assessed). Tuber dip for 10 minutes with Emesto



Prime recorded the lowest disease % to the tune of 4.0 followed by tuber dip with Systiva (4.8 %). On the contrary, tuber spray with Systiva recorded the highest black scurf to the tune of 8.0 %. The highest tuber yield was obtained in T2 followed by T3 .

- **Control of aphid population on wheat:** T1: Thiomethaxam @ 80-100 g/acre (Farmer practice), T2: Thiomethaxam @ 20g/acre (Recommended practice) and T3: Neem based formulation @0.5 l/acre (To be assessed). Results of the on farm testing demonstrated that neem based insecticides provided good control only at initial population whereas, maximum reduction in aphid population and maximum yield/acre were recorded in recommended practice.
- **Management of mustard aphid with cultural methods:** T1: Confidor@40ml/acre (FP), T2: Actara 25 WG@40g/acre (RP) and T3: Intercropping of mustard with two rows of garlic (NI). T2 showed the highest yield of 19.5 q/ha.
- **Evaluation of fermented butter milk solution for the management of yellow rust in wheat:** T1 - Spray of Tilt 25 EC @ 200 ml/ acre in 200 litres of water (RP), T2- Spray of 10 days old fermented buttermilk @ 100 ml per litre of water (Use of 100 litre spray solution per acre) (FP) and T3- Spray of Tilt 25EC @ 100 ml/ acre + 10 days old fermented buttermilk @ 50 ml per litre of water (Use of 200 litre spray solution/ acre) (I). T1 gave the highest yield. Buttermilk can be used as a preventive measure.
- **Management of sheath blight in rice (PR-128):** T1: Tilt 25 EC 200 ml/100 lit of water per acre at 15 days interval (Two sprays) (FP), T2: Tilt 25 EC 200 ml/200 lit of water per acre at 15 days interval (Two sprays) (RP) and T3: Salicylic acid (500 ppm) Prophylactic spraying followed by one spray of Tilt 25 EC in 200 lit of water per acre (I). T1 showed disease incidence of 7.2 per cent with B: C ratio of 2.31. T2 showed disease incidence in traces only with B: C ratio of 2.75. T3 showed disease incidence of 2.1 per cent with B: C ratio of 2.74.
- **Management of wheat aphid:** T1: Confidor 100 ml/100lt of water per acre (One spray) (FP), T2: Confidor 40 ml/100 lit of water per acre at 15 days interval (RP) and T3: Salicylic acid (500 ppm) Prophylactic spraying followed by one spray of

Confidor 40 ml/100 lit of water per acre (I). In T1 5.0 % aphid resurgence was noted with B:C ratio of 1.8. Aphid infestation in T2 was in traces with B:C ratio of 1.91. In T3 aphid attack was only 1.0 % which was at par with chemical control.

- **Management of plant hoppers (BPS &WBPH) in paddy using 'Home Made Neem' extract:** T1: Use of recommended insecticides- Dinotefuron 20 SG @ 80 g/acre (Recommended practice), T2: Use of un-recommended insecticides-Thiamethoxam 25 WG (Farmer's practice) and T3: Spray of 'Home Made Neem extract' @ 4 litre/acre(Intervention). Spray of 'Home Made Neem extract' (@4 litres/acre) maintained plant hopper population below ETL (4.11/hill) with good net return (Rs. 72875/ha) and B:C ratio (1.53).
- **Management of brinjal shoot & fruit borer using PAU neem extract:** T1: Use of recommended insecticides (Coragen 18.5 SC @ 80 ml/acre) (Recommended practice), T2: Use of un-recommended insecticides (Lamdacyhalothrin 5 EC) (Farmer's practices) and T3: Spray of neem extract on plants and on inter row soil at 10 days interval @ 1 litre/acre with spray of recommended insecticide if ETL crossed. (Intervention). Spray of neem extract at 10 days interval on plants and inter row soil resulted in less shoot infestation (4.4% ), less fruit infestation (4.4%), better net return (270000), and B:C ratio (2.53).

### Animal Science

- **Supplementation of vitamin E and herbal teat dipping method (GADVASU) in cross bred lactating cows:** T1-No use of Vitamin E and teat dipping solution (Farmers' practice), T2- Teat dipping after milking (Iodine 0.5%+ glycerol) (recommended practice) and T3- Herbal teat dip (GADVASU) along with supplementation of Vitamin E @ 1000 units / day / animal (technology assessed). Daily supplementation with vitamin E @1000 unit along with herbal teat dip practice in milch animals daily yielded best results in terms of less prevalence of mastitis and more milk production.
- **Supplementation of Taramira (*Eruca Sativa*) in grounded form to dairy animals during monsoon season as anti ecto-parasitic agent:** T1- No use of Taramira supplement and anti ecto-parasitic agent (Farmers' practice), T2- Use of ivermectin

injection ( Anti ecto-parasitic agent) @0.2mg per kg of body weight per animal (Recommended practice T3- Supplementation of taramira @ 75 g/day per animal (Technology to be assessed). Supplementation with Taramira @ 75 gm per day yielded good results in term of average daily yield i.e. 12.63 litres per animal, but BC ratio analysis showed that T2 was more profitable as compared to T3.

- **Assessment of suitable backyard poultry breeds for egg production:** T<sub>1</sub> : Local breeds of poultry (FP), T<sub>2</sub> :RIR breed recommended by GADVASU/PAU (RP) and T3 : Chabro breed of backyard poultry (To be assessed). Egg production was almost double in case of Chabro breed as compared to local breeds.
- **Low body weight gain in goat kids and reduced mortality:** T - Green fodder + dry fodder + milk (Farmer's practice), T Green fodder + Dry fodder + milk + concentrate (Recommended practice) and T Milk+ concentrate (Intervention). T<sub>3</sub> performed better amongst all the interventions.

### Community Science

- **Cost effective and safe storage of woolens:** T<sub>1</sub>- Use of naphthalene balls (RP ), T<sub>2</sub>-Use of newspaper (FP ) and T<sub>3</sub>- Use of *neem* leaves (I). T<sub>1</sub> was found more effective than T<sub>2</sub> and T<sub>3</sub>.
- **Evaluation of shelf life of jaggery using different storage methods at household level:** T<sub>1</sub>: Storage in steel container (RP), T<sub>2</sub>: Storage in plastic container (FP) and T<sub>3</sub>: Storage in glass container (I). T<sub>3</sub> was found more effective than other treatments.
- **Assessment of various techniques of wari preparation:** T<sub>1</sub>: Urad Dal paste + spices (FP), T<sub>2</sub>: Urad dal paste 50 % + Potato paste 50 % + spices (RP) and T<sub>3</sub>: Urad dal Paste 70 %+ Ash Gourd 30 % + Spices (I). T<sub>3</sub> gave the best results in terms of nutritive value, taste and shelf life.
- **Evaluation of different cake baking techniques at household level:** T<sub>1</sub> : Baking a cake in electric oven (RP), T<sub>2</sub>: Baking a cake in pressure cooker/ *kadhai* (FWP) and T<sub>3</sub>: Baking a cake in solar cooker (To be assessed). Taste and appearance of cake prepared by Treatment T3 were not invariably acceptable due to inability to regulate temperature. Use of treatment T3 is possible only during the hot summer days.

- **Different techniques of honey processing:** T1: Packaging of raw honey (Farmer Practice), T2: Boiling of honey in double vessels, filtration and packing in bottles (Recommended Practice) and T3: Using honey processing machine for processing and packing in bottle (Intervention). T1 treatment showed highest moisture content. T2 treatment reduced the moisture level to 18.2 % and T3 reduced to 14.1%. T3 showed better organoleptic characteristics such as sweet taste, yellow color and sweet smell. The dark brown color, pungent smell and acrid taste indicated the fermentation in T1 and T2.

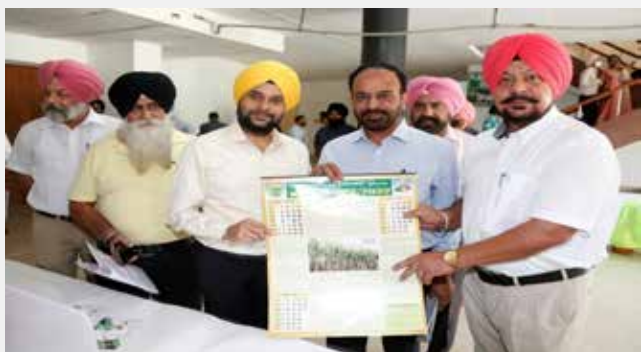
## TRAININGS, CAMPS AND EXHIBITIONS

### Trainings

PAU *Krishi Vigyan Kendras* (KVKs) and Centre for Advance Training at PAU Campus, Ludhiana organized 1155 trainings (999 short, 207 vocational, 104 in-service and 52 sponsored) for the farmers, farm women and extension functionaries of the state developments departments to enhance their knowledge and skill for increasing agricultural productivity and farm income. Vocational trainings were given on precision farming, hybrid seed production, protected cultivation of vegetables, pruning of fruit plants, mushroom cultivation, apiculture, poultry, dairy, piggery, goatery, value addition of agricultural produce (preparation of pickle/*murabba*/ketchup and other recipes), tie and dye, stitching and embroidery, etc. In these trainings 24653 farmers, 7042 farm women and 1982 extension personnel participated.

### Camps

The extension scientists from *Krishi Vigyan Kendras*, Farm Advisory Service Centres (FASCs) and various departments of PAU participated in village, block and district level camps to disseminate the latest technologies among the farmers. Extension scientists acted as resource persons in these training camps organized by the line departments including State Departments of Agriculture and Farmers Welfare, Horticulture, Soil Conservation, IFFCO, KRIBHCO, NFL, etc. The experts acquainted the farmers with the latest technologies developed by PAU and specific focus was given on resource management and integrated INM and IPM technologies. A total of 410 such training camps were addressed by scientists of Punjab Agricultural University.



## Exhibitions

Exhibitions were arranged during *Kisan Melas*, training camps, field days, scientific advisory committee meetings, technology week celebrations and special days to create awareness among farmers about new and improved technologies and practices. A total of 204 exhibitions were arranged during this year, wherein important production, protection and resource conservation technologies were exhibited through charts, live and preserved plant specimens, farm machinery, models of various important technologies including drip irrigation, processing equipments, and farm literature. In these exhibitions, the farmers were also enrolled for the monthly magazines of PAU i.e. *Progressive Farming* and *Changi Kheti*.

## DEMONSTRATIONS

Working on the principle of “Seeing is believing” the demonstrations on improved varieties, crop production, protection and other improved agricultural technologies were conducted at farmers’ fields and KVK farms. A total of 18907 cluster front line demonstrations (CFLDs) were conducted on improved varieties of oilseeds (groundnut, sesame, *gobhi sarson*, raya and sunflower), pulses (pea, summer moong, main season moong, mash, soybean, gram and lentil), wheat, *parmal* rice, *basmati* rice, cotton (American and *desi*), maize and maize fodder, Punjab Celery 1 and winter vegetables. The field demonstrations were also conducted on resource conservation technologies such as nitrogen management in paddy using leaf colour chart, skipping of P application in rice, cotton and maize after wheat grown with recommended dose of P; seed

and nursery treatment for management of foot rot in basmati; irrigation of paddy after drainage of ponded water; green manuring before rice cultivation; fruit fly trap; paddy straw management by using baler, straw management system, chopper and Happy Seeder for wheat sowing; use of rice transplanter; management of maize borer using *Trichoderma harzianum*; use of biofertilizers, use of fertilizers on soil test basis; weed control in direct seeded rice; weed control in maize; management of stem borer/leaf folder in *parmal* rice and *basmati* rice etc.

Besides, demonstrations were carried out on the use of cobalt chloride for control of parawilt in cotton; control of jassid in cotton; mixed cropping of sarson and toria; and intercropping of gobhi sarson in sugarcane. Demonstrations on nutrition gardening of summer and winter vegetable crops; use of paddy straw chopper; use of baler-cum-knotter; seed treatment of wheat; low tunnel technology for vegetable crops; bulb set technique in *kharif* onion production; cultivation of rainy season tomato and broccoli; and fungicidal management of foot rot/gummosis in citrus.

In addition to the field demonstrations, method demonstrations on different important practices were also conducted. A total of 3484 method demonstrations on the collection of soil and water samples; seed treatment; *Rhizobium* inoculation in different crops; spray techniques of agro-chemicals; computing economic threshold levels for plant protection; nursery raising of vegetables, and on different aspects of cooking and home management practices were conducted.

## WORKSHOPS

During the period under report, four workshops were organized by the Directorate of Extension Education to share the newly developed varieties/hybrids of different fields and horticultural crops and other recommendations on production and protection technologies. A total of 2041 scientists and extension functionaries from the State Departments of Agriculture and Horticulture participated in these workshops.

| Sr. No. | Programme                                                                    | Date          |
|---------|------------------------------------------------------------------------------|---------------|
| 1.      | Research & Extension Specialists' for Workshop for Rabi Crops for Rabi Crops | 23-24.08.2022 |
| 2.      | Research and Extension Specialists' Workshop of Fruits and Vegetables Crops  | 19-20.01.2023 |
| 3.      | Workshop on Paddy Straw Management                                           | 09.06.2023    |
| 4.      | State Level Training Planning Workshop                                       | 27.01.2023    |

## FARMERS' ORGANIZATIONS

| No. of Camps Organized                        | Farmers Benefited |
|-----------------------------------------------|-------------------|
| PAU Kisan Club Ladies Wing (Regd.) : 10       | 625               |
| PAU Aromatic and Spice Growers Association: 2 | 95                |

## FIELD DAYS AND TECHNICAL GUIDANCE

The university also holds field days at the site of demonstration in order to popularize specific recommendation. A total of 345 field days at different villages were organized to promote the cultivation of pulses (lentil, soybean, gram), sunflower, gobhi sarson (canola day), maize, nutrition garden, DSR, straw management techniques, IPM in *rabi* and *kharif* crops, PAU fruit fly traps, mechanical transplanting of paddy, etc.

The scientists of KVKs, FASCs of different districts and ATIC at PAU provided technical guidance to 72736 farmers. These included 37818 office visits, 22816 field visits and 72736 telephone contacts.

## Special Campaigns

Farmers were advised about the clean cultivation, cultivation of recommended Bt cotton hybrids, timely sowing, proper nutrient management, use of non chemical (yellow sticky traps) and chemical approaches

based on the economic threshold level through the training camps, advertisements in the newspaper, WhatsApp, TV/ radio talks etc. Meetings of Interstate Consultative Monitoring Committee for whitefly on cotton were also held under the chairmanship of the Vice-Chancellor.

## PLANT CLINIC

The Plant Clinic at ATIC, PAU, Ludhiana, KVKs and FASCs, advised 72736 farmers, diagnosed 9723 samples suffering from various problems like insect-pests, diseases, nutritional deficiencies and other disorders. Various other services provided were as under:

| Activity                                                | ATIC | KVKs  | FASCs | Total |
|---------------------------------------------------------|------|-------|-------|-------|
| Farmers' visits                                         | 367  | 24623 | 12828 | 37818 |
| Telephone queries                                       | 786  | 41200 | 30750 | 72736 |
| Field visits                                            | 4    | 5790  | 17022 | 22816 |
| Advisory services to farmers                            | 642  | 29701 | 46668 | 77011 |
| Diagnostic service                                      | 604  | 4947  | 4172  | 9723  |
| Referred samples by the extension functionary diagnosed | 13   | 200   | 200   | 413   |
| Lectures delivered/ attended                            | 8    | 3238  | 1025  | 4271  |
| Radio/TV talks                                          | 4    | 35    | 24    | 63    |
| Exhibitions                                             | 2    | 255   | 202   | 459   |
| Exposure visit                                          | 2    | 134   | 14    | 150   |
| Soil health Card                                        | 3754 |       |       |       |
| Bio-fertilizers (acres) pkts                            | 4676 |       |       |       |
| Bioagents (acres)                                       | -    |       |       |       |

## KRISHI VIGYAN KENDRA ACTIVITIES AND FARM ADVISORY SERVICE SCHEME

### KVK Activities

Presently, 18 KVKs are working in Amritsar, Bathinda, Faridkot, Fatehgarh Sahib, Ferozepur, Gurdaspur, Hoshiarpur, Jalandhar, Kapurthala, Ludhiana, Mansa, Moga, Sri. Muktsar Sahib, Pathankot, Patiala, Ropar, SBS Nagar and Sangrur districts. These KVKs impart



practical trainings to the farmers as well as farm women and extension functionaries of state department, demonstrate latest field technology in technology park, conduct the front line demonstrations and on farm research trials (OFTs). In addition, the field days, special days, exhibition and campaigns are also organized by these *Kendras*. During the period under report, the KVKs conducted 1746 training courses on different aspects. These included 1285 short term, 283 vocational and 133 in-service courses and 45 sponsored training courses. In these courses, 24653 males and 7042 females from general category, 5336 males and 3304 females from reserve category (SC/BC) participated. The scientists also conducted 146 OFTs and 15370 demonstrations (8385 FLDs, 3484 method demonstrations and 3501 others). The scientists of these *Kendras* organized 139 field days to create awareness amongst the farmers about the latest improved agricultural technologies. The scientists from KVKs participated as resource persons in 496 training camps. During training camps, training courses and on special occasions, a total of 255 exhibitions were also arranged. A total of 4090 soil samples and 1606 water samples were analysed by the KVKs. Besides, 35 TV Talks and 79 Radio Talks on production and protection technologies, subsidiary occupations and home science were also delivered. In addition, the experts from these *Kendras* delivered 3238 lectures in specialized training programmes and special days. The scientists at KVKs undertook various extension activities (1283) in the cluster of selected villages. They also organized *Kisan Gosthis* (134), ex-trainee sammalen (15) and exposure visits of farmers (134) to various places and at PAU. All the KVKs hold SAC meetings every year and a total of 18 such meetings were organized. The scientists sent 46496 messages to farmers through KMAS.

### FASC Activities

Presently, 15 FASCs are working in Amritsar, Bathinda, Barnala, Faridkot, Fazilka, Ferozepur, Gurdaspur, Hoshiarpur, Jalandhar, Kapurthala, Patiala, Ropar, Mohali, Sangrur and Tarn Taran districts. These FASCs conduct adaptive research trials (ARTs) at farmers' fields to test the latest technologies developed by researchers in farmers' participatory mode. In addition, demonstrations, field days, farmers' group discussion,

exhibitions and campaigns were also organized by the FASCs. These centres conducted ARTs (147) on different crops. The FASCs played an important role in transfer of technology by providing the technical guidance to 12828 farmers at office, 30750 farmers during field visits and 17022 farmers on telephone. The scientists of these centers acted as resource persons and delivered lectures in 399 training camps. Besides, they organized 67 field days, 233 surveillances and 61 crop surveys. During various training camps, *Kisan Melas* and on special occasions, a total of 202 exhibitions were also laid down. The experts diagnosed 4172 plant samples for various disorders. The centres published 153 publications (research papers and popular articles) in various journals and monthly magazines, delivered 8 T.V. / Radio Talks and provided 23 feedbacks. The scientists also participated in 108 State and National Level Seminars/Conferences /Workshops/Symposia etc.

### PAU DOOTS

The PAU *doots* are being sent 2-3 messages per week regarding various agricultural practices through e-mail. They further spread that message through public address system of *Gurdwaras /Mandirs* to fellow farmers for faster spread of technologies. During the current year, 1276 doots were enrolled and 370 messages related to recent advances in technologies were sent.

### COMMUNICATION THROUGH MASS MEDIA

The Communication Centre maintains a constant liaison with the print and electronic media including Doordarshan and All India Radio (AIR), Jalandhar to publicize the activities of PAU. It issues press releases to different newspapers and news channels on regular basis. During the period under report, the Centre issued 1450 press releases (730 in English and 720 in Punjabi). The Centre also sent several articles in English and Punjabi, authored by PAU scientists, for publication in vernacular newspapers and magazines. Besides, the Centre provided TV coverage to different events and also produced *Kisan Mela* reports for telecast from Doordarshan. It coordinated with Doordarshan Kendra, Jalandhar for 71 TV talks and AIR, Jalandhar for 70 radio talks by PAU scientists. It also prepared six documentaries and procured advertisements worth Rs 3,14,460/-. In addition, it organised 54 episodes of PAU Live Programme (Facebook and YouTube).

## TRAININGS TO FARMERS



## FARM PUBLICATIONS

The Centre publishes two monthly farm magazines *Changi Kheti* (in Punjabi) and *Progressive Farming* (in English). Both the farm magazines are printed in four colours on offset machines to maintain top quality. The combined circulation of these magazines was for Rs. 1,66,100/- during 2022-23. The Centre also publishes Package of Practices for Crops of Punjab, twice a year, both in English and Punjabi. Besides, technical farm bulletins are published regularly on various crops and technologies. During the period under report, the Centre brought out 12 farm bulletins in English and 34 in Punjabi.

New and revised editions of *Rabi*, *Kharif*, Package of Practices for Floriculture, Orchard Management, Rodent Pest, Lifestyle Diseases, Citrus Cultivation,

Kinnow, Home Preservation of Fruits and Vegetables, Statistics, Field Problems of Important Crops, Canola-Rapeseed Mustard, *Jhone te Basmati*, *Guldaudi*, *Naujawan Awastha*, *Sabziyan di Kasht*, *Herbal Boote*, *Karoge Gall Milega Hall*, *Gharelu Padhar te Kudarti Somey*, *Falan di Kasht*, *Madumakhi Palan- Ik Sahayak Kitta*, *Sade Viah Sade Bhog*, *Haadhi*, *Baghbaani de Mittar Keede*, *Kheti Farm te Bahi Khata*, *Ghar Bagichi te Pakwaan*, *PAU vich sthapit Kala Kritiyan*, *Parali di Saambh Sambhal*, *Bhojan Surakheya*, *Sajawati Booteyan di Landscape vich Varton*, *Gharelu Padhar te Anaaj te Beej di Sambhaal*, *Khumbaan di Kasht*, *Seunk Trap*, *Ghar vich Falan te Sabziyan di Sambhal*, *Sabziyam di Kasht*, *Mukh Samasyavan*, *Faldar Booteyan di Samasyavan*, *Agro-Processing*, *Pauda Rog*, *Sabziyan di Kasht - 2023*, *Falan di Kasht*, *Canola Saron di Kasht*, *Jaivik Kheti* and *Chiku* were brought out by the Centre.

## INFORMATION AND COMMUNICATION TOOLS (ICTs)

| ICT Technology                                                                                                                         | Total Number                           |
|----------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------|
| PAU <i>Kisan</i> App (Subscribers)                                                                                                     | 1,02,303                               |
| PAU Farm Inputs App (Subscribers)                                                                                                      | 4,730                                  |
| PAU Farm Machinery App (Subscribers)                                                                                                   | 2,988                                  |
| PAU Facebook (Followers)                                                                                                               | 56,436                                 |
| PAU Facebook Live/year (Programmes)                                                                                                    | 259 (reach 5 lakh in weekly programme) |
| PAU YouTube (Subscribers)                                                                                                              | 24,350                                 |
| PAU YouTube Live/Year (Programmes)                                                                                                     | 259 (reach 5 lakh in weekly programme) |
| PAU Twitter (Followers)                                                                                                                | 2,123                                  |
| Documentaries/Jingles                                                                                                                  | 773                                    |
| Farmers Portal on PAU Website (Views)                                                                                                  | 9,82,290                               |
| Digital Newspaper (Weekly) – <i>Kheti Sandesh</i>                                                                                      | 9,66,000 farmers                       |
| Weather Agro-advisory                                                                                                                  | About 9 lakh farmers                   |
| WhatsApp Groups by Communication Centre/all KVKs/FASCs (Farming Communities, Mushroom, Bee keeping, Dairy Farming, Home Science, etc.) | 900 (6592 messages sent)               |
| Toll Free / Missed Call Number<br>1800 180 5100                                                                                        | 5,200 farmers<br>(152 messages sent)   |
| PAU <i>Kisan Doots</i>                                                                                                                 | 7,295 (370 messages sent)              |
| KMASS                                                                                                                                  | 46496 farmers (143 messages sent)      |

# Human Resource, Finance and Infrastructure Development

## NEW APPOINTMENTS, PROMOTIONS AND RETIREMENTS

### New appointments

During the period under report, one Assistant Professor (and equivalent) was directly recruited.

### Promotions and retirements

During the period under report, 24 Assistant Professor level teachers having grade pay of Rs. 6000/- were placed in the grade pay of Rs. 7000/-, 38 Assistant Professor level teachers having grade pay of Rs. 7000/- were placed in the grade pay of Rs. 8000/- in the pay scale of Rs. 15600-39100; 17 Assistant Professors having grade pay of Rs. 8000/- in the pay scale of Rs. 15600-39100 were promoted to the posts of Associate

Professor & equivalent in the grade pay of Rs. 9000/- in the pay scale of Rs. 37400-67000 and 29 Associate Professors having grade pay of Rs. 9000/- were promoted to the post of Professor & equivalent in the grade pay of Rs. 10,000/- in the pay scale of Rs. 37400-67000. Eighteen teachers retired/resigned/expired from the University service.

### Faculty strength (as per budget estimate 2023-2024)

| Category | Sanctioned posts | Posts in position |
|----------|------------------|-------------------|
| State    | 1062             | 524               |
| ICAR     | 151              | 150               |
| KVK      | 126              | 111               |
| Others   | 22               | 19                |
| Total    | 1361             | 804               |

## NATIONAL AND INTERNATIONAL LINKAGES

During the period under report, PAU signed nine MoUs with various national and international institutions and organizations:

| Name of the Institution                                                 | Field                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Date of Expiry |
|-------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|
| CSK Himachal Pradesh Krishi Vishvavidyalaya, Palampur, Himachal Pradesh | To promote and enhance scientific and academic interaction in mutually beneficial areas.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | 25.08.2027     |
| Agricultural Research Organization, Volcani Centre, Israel              | Exchange of scientists, scientific literature, information and methodology; exchange of scientific equipment as available and required in the programme of common interest as may be mutually agreed upon; development and implementation of collaborative research projects in the identified areas and methodology to be used as mutually agreed upon, subject to IPR (Intellectual Property Rights) clause in Article IV.                                                                                                                                                               | 04.09.2025     |
| ICAR-Central Institute for Cotton Research, Nagpur                      | Promotion of inter-institutional research collaboration, staff and students' training/postgraduate research.                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | 16.09.2027     |
| Nature Conservancy India Solutions Pvt. Ltd., New Delhi                 | TNC India is providing technical and scientific support to the project Promoting Regenerative and No-burn Agriculture (PRANA) which is a three-year project focused on the state of Punjab in Northwest India that aims to deliver the following outcomes with their implementation partners RGR Cell of Sir Rattan Tata Trust and Syngenta Foundation India: Eliminating burning of straw in one million hectares of cropland; and getting around 250,000 farmers to adopt a no-burn cropping system; piloting financial instruments that incentivize farmers to adopt no-burn practices. | 15.12.2025     |



| Name of the Institution                                                                  | Field                                                                                                                                                                                                                          | Date of Expiry |
|------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|
| Indian Institute of Maize Research, Ludhiana                                             | To use expertise and scientific manpower of PAU, Ludhiana and land and other resources of irrigation, fertilizers and other necessary machinery available in ICAR-IIMR, Ludhiana, for seed production of field crops.          | 06.02.2028     |
| Punjab Remote Sensing Centre, Ludhiana                                                   | To continue a collaborative M.Tech. programme in Remote Sensing & GIS.                                                                                                                                                         | 16.05.2027     |
| Indian Council for Cultural Relations, Ministry of External Affairs, Government of India | Providing scholarship to international students through ICCR.                                                                                                                                                                  | 05.03.2026     |
| Mrs. Bector's Food Specialists Ltd., Phillaur                                            | Improving and renovating water conservation infrastructure under Corporate Social Responsibility.                                                                                                                              | 31.12.2023     |
| ICICI Foundation for Inclusive Growth, Chennai                                           | In the areas of Sustainable Agricultural Practices; Technology and Global Best Practices on Agriculture and Horticulture; Crop Residue Management; Waste Management; Natural Resources Management; and Agricultural Education. | 24.05.2028     |

## FACULTY AWARDS AND HONOURS

### University Accomplishments

Punjab Agricultural University was adjudged the Best State Agricultural University and Third Best amongst Agricultural Universities and Institutes, under NIRF-2023 by National Board of Accreditation (NBA), Ministry of Education (MOE), GOI.

| Faculty Member                          | Department                           | Award                                                             | Year | Awarding Institution                                      |
|-----------------------------------------|--------------------------------------|-------------------------------------------------------------------|------|-----------------------------------------------------------|
| <b>College of Agriculture</b>           |                                      |                                                                   |      |                                                           |
| Dr PS Shera                             | Entomology                           | Fellow, Society for Biocontrol Advancement, ICAR-NBAIR, Bengaluru | 2022 | Society for Biocontrol Advancement, ICAR-NBAIR, Bengaluru |
| Dr Vikas Jindal                         | -                                    | Best Poster Presentation                                          | 2022 | Indian Ecological Society                                 |
|                                         |                                      | Best Oral Presentation                                            | 2022 | Conference at Hyderabad                                   |
| Drs Davinder Singh, Lopamudra Mohapatra | Extension Education                  | Best Oral Paper Presentation                                      | 2022 | Indian Society of Extension Education                     |
| Dr Savita Sharma                        | Food Science and Technology          | Fellow, NADSI                                                     | 2022 | National Academy of Dairy Sciences (India)                |
| Dr Parveen Chhuneja                     | School of Agricultural Biotechnology | Jeanie Borlaug Laube Women in Triticum (WIT) Mentor award         | 2022 | Borlaug Global Rust Initiative (BGRI)                     |
|                                         |                                      | Fellowship of National Academy of Agricultural Sciences (NAAS)    | 2022 | National Academy of Agricultural Sciences (NAAS)          |
|                                         |                                      | Fellowship of National Academy of Sciences, India (NASI)          | 2022 | National Academy of Sciences, India (NASI)                |
| Dr. Nitika Sandhu                       | School of Agricultural Biotechnology | SERB Women Excellence Award                                       | 2022 | Science and Engineering Research Board, New Delhi         |



| Faculty Member                                                                                                             | Department                  | Award                                                                                                       | Year | Awarding Institution                                         |
|----------------------------------------------------------------------------------------------------------------------------|-----------------------------|-------------------------------------------------------------------------------------------------------------|------|--------------------------------------------------------------|
| Dr Sohan Singh Walia                                                                                                       | School of Organic Farming   | Best Centre Award (on-station)                                                                              | 2022 | ICAR- IIFSR, Modipuram, Meerut                               |
|                                                                                                                            |                             | Best Centre Award (on-Farm)                                                                                 | 2022 | ICAR- IIFSR, Modipuram, Meerut                               |
| Dr OP Choudhary                                                                                                            | Soil Science                | Indian Society of Soil Salinity and Water Quality Fellow                                                    | 2022 | Indian Society of Soil Salinity and Water Quality            |
|                                                                                                                            |                             | Dr GS Khush Distinguished Professor Chair Award                                                             | 2022 | Dr GS Khush Foundation                                       |
| Dr SS Dhaliwal                                                                                                             | Soil Science                | Dr J. A. P. Yadav Memorial Award for Excellence in Soil Science                                             | 2022 | Indian Society of Soil Science                               |
| Dr Manpreet Singh Mavi                                                                                                     | Soil Science                | Dr Darshan Singh Brar Young Scientist Award                                                                 | 2022 | Dr GS Khush Foundation                                       |
| Dr Hari Mohan Meena                                                                                                        | Soil Science                | Certificate of Appreciation                                                                                 | 2022 | College of Agriculture, PAU                                  |
| Dr Virender Singh Sohu                                                                                                     | Plant Breeding and Genetics | Dr MV Rao Memorial Award                                                                                    | 2022 | SAWBAR                                                       |
| Dr Hari Ram                                                                                                                | Plant Breeding and Genetics | Dr S Nagarajan Memorial Award                                                                               | 2022 | SAWBAR                                                       |
| Dr Buta Singh Dhillon                                                                                                      | Plant Breeding and Genetics | Best Poster Award                                                                                           | 2022 | PAU, Ludhiana                                                |
|                                                                                                                            |                             | Best Oral Presentation Award during International Conference on System of Crop Intensification (ICSCI-2022) | 2022 | IIRR, Hyderabad                                              |
| Dr Ravi Prakash Pal                                                                                                        |                             | SK Ranjhan Best Ph.D. Thesis Award                                                                          | 2022 | Animal Nutrition Society of India                            |
| Dr Ravi Prakash Pal                                                                                                        |                             | Best Poster Presentation                                                                                    | 2022 | Indian Society of Sheep and Goat Utilization and Production  |
| Drs Ruchika Bhardwaj, R S Sohu, Devinderpal Singh, Maninder Kaur, Harpreet Kaur Cheema, Meenakshi Goel and Ashlesha Singla |                             | Certificate of Appreciation                                                                                 | 2022 | AICRP (FCU), IGFR, Jhansi under the aegis of ICAR, New Delhi |
| Dr Usha Nara                                                                                                               |                             | Certificate of Appreciation                                                                                 | 2022 | Controller General of Patents, Designs and Trademarks        |
| Dr Inderjit Singh                                                                                                          |                             | Prof. MS Chhinan Distinguished Professor Chair                                                              | 2023 | PAU, Ludhiana                                                |
| Dr Poonam Sharma                                                                                                           |                             | ISPRD Excellence Award (Crop Production)                                                                    | 2023 | Indian Society of Pulses Research and Development, Kanpur    |
| Dr Gaurav Kumar Taggar                                                                                                     |                             | ISPRD Excellence Award 2023 (Crop Protection)                                                               | 2023 | Indian Society of Pulses Research and Development, Kanpur    |



| Faculty Member                                                                                                                            | Department                      | Award                                                                                                                                                                                                                                    | Year | Awarding Institution                                                     |
|-------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|--------------------------------------------------------------------------|
| Dr Shayla Bindra                                                                                                                          |                                 | ISPRD Fellow Award 2023                                                                                                                                                                                                                  | 2023 | Indian Society of Pulses Research and Development, Kanpur                |
| Dr Harleen Kaur                                                                                                                           |                                 | MJ Narasimhan Medal Award for Best Research Paper during Platinum Jubilee Conference on "Plant and Soil Health Management: Issues and Challenges held at University of Mysore, Mysuru, Karnataka                                         | 2023 | Indian Phytopathological Society, ICAR-IARI, New Delhi, India            |
| Drs Rahul Kapoor, Meenakshi Goyal, Maninder Kaur and Ashlesha Singla                                                                      | Plant Breeding and Genetics     | Certificate of Appreciation                                                                                                                                                                                                              | 2023 | AICRP(FCU), IGFR, Jhansi under the aegis of ICAR, New Delhi              |
| <b>College of Agricultural Engineering &amp; Technology</b>                                                                               |                                 |                                                                                                                                                                                                                                          |      |                                                                          |
| Dr Satish Kumar Gupta<br>Drs Rohinish Khurana and Anoop Dixit as faculty mentors along with team of 25 students of B.Tech. (Agril. Engg.) | O/o Dean FMPE                   | All India Winners (AIR-1) and cash prize of Rs. 1.5 lakh in the National Level Competition 'SAE INDIA TIFAN 2023: Technology innovation forum for agricultural nurturing' for development of an 'Automated multi-vegetable transplanter' | 2023 | Society of Automotive Engineers – India and John Deere Limited, Pune     |
| Dr Satish Kumar Gupta, Er Tarandeep Singh as faculty mentors along with team of 20 students of B.Tech. (Agril. Engg.)                     | O/o Dean, CoAET FMPE            | Future Award in the National Level Competition-SIEP-Hero e-bike Challenge                                                                                                                                                                | 2023 | Imperial Society of Automotive Engineers                                 |
| Dr Gagandeep Kaur                                                                                                                         | Processing and Food Engineering | Certificate of Appreciation for Excellence in Teaching                                                                                                                                                                                   | 2022 | College of Agriculture, PAU                                              |
| Dr Gurveer Kaur                                                                                                                           | Processing and Food Engineering | 2 <sup>nd</sup> position in Poster Presentation during International Conference on "Development and Promotion of Millets and Seed Spices for Livelihood Security"                                                                        | 2023 | Agriculture University, Jodhpur, Rajasthan                               |
|                                                                                                                                           |                                 | Young Scientist Award                                                                                                                                                                                                                    | 2023 | The International Research Awards on Science, Technology, and Management |
| Dr Gurveer Kaur as faculty mentor of students team for ISAE Calendar Conceptathon                                                         | Processing and Food Engineering | 1 <sup>st</sup> and 3 <sup>rd</sup> Prize in Calendar Conceptathon                                                                                                                                                                       | 2022 | Indian Society of Agricultural Engineering                               |



| Faculty Member                                    | Department                                   | Award                                                                                                                                                                         | Year          | Awarding Institution                                                                                                                                                                                     |
|---------------------------------------------------|----------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Dr Preeti                                         | Processing and Food Engineering              | Young Researcher Award                                                                                                                                                        | 2023          | Institute of Scholar, ISO 9001:2015 certified and registered under Ministry of MSME and Corporate Affairs, Govt. of India                                                                                |
| Dr Sandhya                                        | Processing and Food Engineering              | Young Scientist Award                                                                                                                                                         | 2022          | Society for World Environment, Food and Technology, New Delhi                                                                                                                                            |
|                                                   |                                              | Best Oral Paper Presentation Award during International Conference on 'Contribution of Agriculture for challenges and opportunities of food security till 2030' (hybrid mode) | 2022          | Mangalayatan University, Jabalpur (MP)                                                                                                                                                                   |
| Dr Rakesh Sharda                                  | Soil and Water Engineering                   | Best Centre Award-AICRP-PEASUM                                                                                                                                                | 2022          | ICAR                                                                                                                                                                                                     |
| <b>College of Basic Sciences &amp; Humanities</b> |                                              |                                                                                                                                                                               |               |                                                                                                                                                                                                          |
| Dr Ashoo Toor                                     | Agricultural Journalism, Languages & Culture | Certificate of Appreciation for Teaching Services                                                                                                                             | 2022          | College of Agriculture, PAU, Ludhiana                                                                                                                                                                    |
| Dr Jaspreet Kaur                                  | Microbiology                                 | Certificate of Appreciation for Teaching Services                                                                                                                             | 2022          | College of Agriculture, PAU, Ludhiana                                                                                                                                                                    |
| Dr Shiwani Guleria Sharma                         | Microbiology                                 | Young Scientist Award (State level, Punjab)                                                                                                                                   | 2022          | Microbiologists Society, India                                                                                                                                                                           |
|                                                   |                                              | Young Scientist Award (National level)                                                                                                                                        | 2022          | Microbiologists Society, India                                                                                                                                                                           |
| Dr GS Kocher                                      | Microbiology                                 | State President of Microbiologists Society, India                                                                                                                             | 2022 and 2023 | FSSAI, India                                                                                                                                                                                             |
|                                                   |                                              | Selected on expert Panel of Alcoholic Beverages                                                                                                                               | 2023          | FSSAI, India                                                                                                                                                                                             |
| Dr Param Pal Sahota                               | Microbiology                                 | Indian Patent No. 421977                                                                                                                                                      | 2023          | Govt. of India                                                                                                                                                                                           |
| Dr Seema Garcha                                   | Microbiology                                 | Indian Patent No. 423627                                                                                                                                                      | 2023          | Govt. of India                                                                                                                                                                                           |
| Dr Neena Singla                                   | Zoology                                      | International Travel Grant for attending '7 <sup>th</sup> International conference on Rodent Biology and Management (ICRBM7)' in Arusha, Tanzania, Africa                     | 2023          | DST, New Delhi                                                                                                                                                                                           |
| Dr Rajwinder Singh                                |                                              | Best Zoologist Award                                                                                                                                                          | 2023          | 6 <sup>th</sup> International Conference on Strategies and Challenges in Agricultural and Life Sciences for Food security and Sustainable Environment (SCALFE-2023), Himachal Pradesh University, Shimla |



| Faculty Member                           | Department            | Award                                                                                                                                                                                                                                                   | Year | Awarding Institution                                                                                     |
|------------------------------------------|-----------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|----------------------------------------------------------------------------------------------------------|
| Dr Preeti Goyal                          | Biochemistry          | Young Researcher in Biochemistry                                                                                                                                                                                                                        | 2023 | Venus International Foundation, Adambakkam, Chennai,                                                     |
|                                          |                       | International Young Scientist Award                                                                                                                                                                                                                     | 2022 | International Institute of Organized Research- I2OR and Green ThinkerZ, Ministry of MSME, Govt. of India |
|                                          |                       | Universal Best Young Faculty award                                                                                                                                                                                                                      | 2022 | International American Council for Research and Development, Tamil Nadu                                  |
| Dr Kamal Vatta                           | Economics & Sociology | Letter of Appreciation for supporting research work on Paddy Stubble Management in India                                                                                                                                                                | 2022 | Research Institute for Humanity and Nature, Kyoto, Japan                                                 |
| Drs Kamal Vatta, Parminder Kaur          | Economics & Sociology | Third Prize for Poster Presentation on 'Direct Seeding of Rice in Indian Punjab: Insights from a Primary Survey'                                                                                                                                        | 2022 | Indian Ecological Society, SKUAST, Jammu                                                                 |
| Dr Kamal Vatta                           | Economics & Sociology | President's Award for co-chairing a session                                                                                                                                                                                                             | 2022 | Indian Ecological Society, SKUAST, Jammu                                                                 |
| Dr Narinderpal Singh                     | Economics & Sociology | Team Award for Reviving Historical Trees                                                                                                                                                                                                                | 2022 | Punjab Agricultural University, Ludhiana                                                                 |
| Dr Harsimranjeet Kaur Mavi               | Economics & Sociology | Certificate of Appreciation for Teaching Services                                                                                                                                                                                                       | 2022 | College of Agriculture, PAU, Ludhiana                                                                    |
| Dr Shaikh Mohd Mouzam                    | Economics & Sociology | Dr RT Doshi Second Prize in Paper Presentation                                                                                                                                                                                                          | 2022 | Agricultural Economics Research Association, New Delhi                                                   |
| Drs Baljinder Kaur Sidana, Arjinder Kaur | Economics & Sociology | Second Prize in Oral Presentation in Regional Conference of ISAE, 2022                                                                                                                                                                                  | 2022 | Indian Society of Agricultural Economics in SKUAST, Jammu                                                |
| Dr Laishram Priscilla                    | Economics & Sociology | Dr Anamitra Saha Prize for Best Paper published in Indian Journal of Agricultural Economics                                                                                                                                                             | 2023 | Indian Society of Agricultural Economics                                                                 |
| <b>College of Community Science</b>      |                       |                                                                                                                                                                                                                                                         |      |                                                                                                          |
| Dr Renuka Aggarwal                       | Food and Nutrition    | Third prize in Poster Presentation shared with M.Sc. student Laghima Arora for the paper entitled "Sensory characteristics and proximate composition of value-added products prepared from minor millets" in 3 <sup>rd</sup> National Millets Symposium | 2022 | PGI and MGSIPA held at PGIMER, Chandigarh                                                                |
|                                          |                       | Best Paper Award shared with M.Sc. student Laghima Arora for the paper entitled "Minor millet based food products: A step towards healthy diet" in 5 <sup>th</sup> International Conference on Food and Nutrition (USFN)                                | 2022 | Food and Nutrition (USFN) Malaysia                                                                       |

| Faculty Member                                      | Department                                       | Award                                                                                                                                                                                                                                                                                                | Year | Awarding Institution                                                                    |
|-----------------------------------------------------|--------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-----------------------------------------------------------------------------------------|
| Drs Monika Choudhary,<br>Amarjeet Kaur              | Food and Nutrition                               | Young Scientist Award shared with M.Sc. student Prabhjot Kaur for research paper 'Evaluation of prebiotic potential of selected fruit peels' during the 54 <sup>th</sup> Annual Conference of the Nutrition Society of India                                                                         | 2022 | Nutrition Society of India held at the ICMR-National Institute of Nutrition, Hyderabad  |
| Drs Sonika Sharma,<br>Kiran Grover                  | Food and Nutrition                               | Best Oral Presentation Award shared with M.Sc. student Manisha Patil for the paper entitled 'Effect of post-harvest treatments on nutritional composition, physiological quality and shelf life of broccoli microgreens' during the 54 <sup>th</sup> Annual Conference of Nutrition Society of India | 2022 | Nutrition Society of India held at the ICMR-National Institute of Nutrition, Hyderabad  |
| Dr Surbhi Mahajan                                   | Apparel and Textile Science                      | Second position for Best Poster Presentation in an International Conference on 'Global Efforts on Agriculture, Forestry, Environment and Food Security'                                                                                                                                              | 2022 | Institute of Forestry, Tribhuvan University, Pokhara Campus, Nepal                      |
| Mrs Manisha Sethi                                   | Apparel and Textile Science                      | First prize in Poster Presentation in an International Conference on 'Emerging Trends in Traditional and Technical Textiles'                                                                                                                                                                         | 2023 | Dr B R Ambedkar National Institute of Technology, Jalandhar                             |
| Dr Mandeep Sharma                                   | Extension Education and Communication Management | Best KVK Scientist Award                                                                                                                                                                                                                                                                             | 2023 | Indian Society of Extension Education, New Delhi                                        |
| Dr Rashmi Upreti                                    | Human Development & Family Studies               | Young Researcher Award                                                                                                                                                                                                                                                                               | 2023 | Institute of Scholars (InSc), Registered under MSME & Corporate Affairs, Govt. of India |
| <b>College of Horticulture &amp; Forestry</b>       |                                                  |                                                                                                                                                                                                                                                                                                      |      |                                                                                         |
| Drs Jaswinder Singh Brar,<br>KS Gill, Sandeep Singh | Fruit Science                                    | University Team Award for rejuvenation of historical trees                                                                                                                                                                                                                                           | 2022 | PAU, Ludhiana                                                                           |
| Dr Sandeep Singh                                    | Fruit Science                                    | Member, Editorial Committee of Tephritid Workers of Asia, Australia and Oceania (TAAO) Newsletter, Australia.                                                                                                                                                                                        | 2022 | Tephritid Workers of Asia, Australia and Oceania (TAAO), Australia.                     |
|                                                     |                                                  | Farm Literature Popularization Award                                                                                                                                                                                                                                                                 | 2022 | PAU, Ludhiana                                                                           |



| Faculty Member                            | Department        | Award                                                                                                                                                                                                                               | Year | Awarding Institution                                                                                                                                              |
|-------------------------------------------|-------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Dr Sandeep Singh                          | Fruit Science     | Appreciation Award for sale of PAU literature                                                                                                                                                                                       | 2022 | PAU, Ludhiana                                                                                                                                                     |
|                                           |                   | Award of Honour from Alumni Association                                                                                                                                                                                             | 2023 | PAU, Ludhiana                                                                                                                                                     |
| Dr Hira Singh                             | Vegetable Science | Awarded DST-AWSAR-2022 Award                                                                                                                                                                                                        | 2023 | Department of Science and Technology, Ministry of Science and Technology, Government of India.                                                                    |
| Dr R K Dhall                              | Vegetable Science | Fellow of Indian Society of Vegetable Science                                                                                                                                                                                       | 2023 | IIVR, Varanasi                                                                                                                                                    |
| Drs SAH Patel, SK Jindal, Rupeet Gill     | Vegetable Science | Third Prize in Poster for 'Screening of cherry tomato ( <i>Solanum lycopersicum</i> L varcerasiforme Mill.) germplasm against late blight ( <i>Phytophthora infestans</i> ) using detached leaf assay and whole plant assay method' | 2023 | National Symposium on 'Confluencing indigenous and modern strategies for plant health management' organized by Himalayan Phytopathological Society and UHF, Nauni |
| Dr RIS Gill                               | Forestry & NR     | Indian Society of Agroforestry Fellow                                                                                                                                                                                               | 2022 | Central Agroforestry Research Institute (CAFRI) Jhansi                                                                                                            |
| <b>Directorate of Extension Education</b> |                   |                                                                                                                                                                                                                                     |      |                                                                                                                                                                   |
| Dr Gurlal Singh Gill                      | KVK Faridkot      | Young Scientist Award and Best Oral Presentation Award                                                                                                                                                                              | 2022 | Krishi Vigyan Kendra, Ujjain                                                                                                                                      |
| Dr G S Aulakh                             | KVK               | Lifetime Achievement Award                                                                                                                                                                                                          | 2022 | Society of Krishi Vigyan                                                                                                                                          |
| Dr Gurdeep Singh                          | KVK Bathinda      | Best Presentation Award                                                                                                                                                                                                             | 2023 | Zonal Project Directorate, ICAR Ludhiana                                                                                                                          |
| Drs Ajaib Singh, Maninder Singh Bons      | KVK Hoshiarpur    | Appreciation Certificate                                                                                                                                                                                                            | 2023 | ICAR-ATARI, Zone-I, PAU Campus, Ludhiana                                                                                                                          |
| Dr Tejbeer Singh                          | SBS Nagar         | Best Scientist Award                                                                                                                                                                                                                | 2022 | The Society of Krishi Vigyan                                                                                                                                      |
| Dr Narinder Deep Singh                    | KVK Pathankot     | Appreciation Certificate                                                                                                                                                                                                            | 2023 | ICAR- ATARI Zone I                                                                                                                                                |
| Dr Satbir Singh                           | KVK Ropar         | Appreciation letter                                                                                                                                                                                                                 | 2023 | The Director, ICAR ATARI Zone I                                                                                                                                   |
| KVK Ropar                                 | KVK Ropar         | Appreciation letter                                                                                                                                                                                                                 | 2023 | The Director, ICAR ATARI Zone I                                                                                                                                   |
| Dr Aparna,                                | KVK Ropar         | Appreciation Certificate                                                                                                                                                                                                            | 2023 | ICAR ATARI Zone I, RVSKVV Gwalior and NADCL, Baramulla.                                                                                                           |
| Dr Ashok Kumar                            | KVK Sangrur       | Best Extension Scientist Award and Best Poster Presentation Award                                                                                                                                                                   | 2022 | Society of Krishi Vigyan                                                                                                                                          |
| Dr Pritpal Singh                          | FASC, Bathinda    | PAWEES (2022) Paper Award                                                                                                                                                                                                           | 2022 | International Society of Paddy and Water Environment Engineering (PAWEES)                                                                                         |

## TRAININGS AND VISITS ABROAD

| Faculty Member and Department                     | Institution visited                                                                                                                                              | Period of visit                         | Purpose of visit                                                                                                                                                                                       |
|---------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>College of Agriculture</b>                     |                                                                                                                                                                  |                                         |                                                                                                                                                                                                        |
| Dr Surinder K Sandhu                              | Tribhuvan University, Pokhara Campus, Pokhara, Nepal                                                                                                             | September 07-19, 2022                   | Chairman (Technical Session-Innovations in Agriculture) in 4 <sup>th</sup> International Conference on Global Efforts on Agriculture, Forestry, Environment and Food Security in Institute of Forestry |
| Dr Renu Khanna<br>(Plant Breeding and Genetics)   | International Rice Research Institute (IRRI), Philippines                                                                                                        | September 21 to October 07, 2022        | To attend HRDC Annual Meeting, from September 21-23, 2022 and interaction with Dr Shalabh Dixit team on DSR phenotyping, RGA facility and other breeding program activities                            |
| Dr Makhan Singh Bhullar<br>(Agronomy)             | Bangkok, Thailand                                                                                                                                                | December 04-09, 2022                    | 8 <sup>th</sup> International Weed Science Congress                                                                                                                                                    |
| Dr Priti Sharma<br>(Biotechnology)                | University of Missouri, USA                                                                                                                                      | September 2022 to February 2023         | Six months training on "Development of haploid inducer stock through gene-editing of PLA1 and DMP genes in maize" under SERB International Research Experience Award supported by DST, Govt. of India  |
| Dr O P Choudhary<br>(Soil Science)                | University of California, USA                                                                                                                                    | July 04, 2022 to August 21, 2022        | To attend International training under ICAR-NAHEP-CAAST SNRM project                                                                                                                                   |
| Dr Manpreet Singh Mavi<br>(Soil Science)          | IOWA State University, Ames, USA                                                                                                                                 | June 15, 2022 to September 14, 2022     | To attend International training under ICAR-NAHEP-CAAST SNRM project                                                                                                                                   |
| Dr Sandeep Sharma<br>(Soil Science)               | University of Nebraska-Lincoln, Lincoln NE, USA                                                                                                                  | September 12, 2022 to November 13, 2022 | Training on Micro plate method for nitrification and soil enzyme assay.                                                                                                                                |
| Dr Varinderpal Singh<br>(Soil Science)            | International Centre for Biosaline Agriculture, Dubai, UAE                                                                                                       | March 13-14, 2023                       | To participate in Workshop on 'Agriculture Environment, Social and Governance (ESG) nexus with Agriculture under climate change'                                                                       |
| <b>College of Basic Sciences &amp; Humanities</b> |                                                                                                                                                                  |                                         |                                                                                                                                                                                                        |
| Dr Neena Singla,<br>(Zoology)                     | Africa Centre of Excellence for Innovative Rodent Pest Management and Biosensor Technology Development (ACE II- IRPM & BTM) and the Institute of Pest Management | July 05-08, 2022-                       | To attend 7 <sup>th</sup> International Conference on Rodent Biology and Management (ICRBM7) in Arusha, Tanzania, Africa                                                                               |



| Faculty Member and Department                     | Institution visited                                                                                                                       | Period of visit      | Purpose of visit                                                                                                                            |
|---------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------|----------------------|---------------------------------------------------------------------------------------------------------------------------------------------|
| Dr Kamal Vatta,<br>(Economics and Sociology)      | Research Institute for Humanity and Nature (RIHN), Kyoto, Japan                                                                           | July 30, 2022        | To deliver a Lecture                                                                                                                        |
|                                                   | Research Institute for Humanity and Nature (RIHN), Kyoto, Japan                                                                           | September 06, 2022   | To participate as a Panelist                                                                                                                |
|                                                   | Research Institute for Humanity and Nature (RIHN), Japan and Research Institute for Business and Economics (RIEB), Kobe University, Japan | November 02-09, 2022 | To attend Seminars and Meetings                                                                                                             |
|                                                   | University of Economics, Ho Chi Minh City, Vietnam                                                                                        | August 19-20, 2022   | To chair a Session                                                                                                                          |
|                                                   | University of Cambridge, UK                                                                                                               | March 10-16, 2023    | To deliver a Lecture                                                                                                                        |
| Dr Narinderpal Singh<br>(Economics and Sociology) | Langkawi, Malaysia                                                                                                                        | July 07-08, 2022     | To attend and present a paper in International Conference on Science, Computing, Chemistry and Management                                   |
| <b>College of Community Science</b>               |                                                                                                                                           |                      |                                                                                                                                             |
| Dr Kiran Bains<br>(Food and Nutrition)            | International Union of Nutritional Sciences (IUNS), International Life Sciences Institute (ILSI), Tokyo                                   | December 06-11, 2022 | To attend and deliver talk on "Digestibility of amino acids in foods of India" at 22 <sup>nd</sup> IUNS—International Congress of Nutrition |
| <b>College of Horticulture &amp; Forestry</b>     |                                                                                                                                           |                      |                                                                                                                                             |
| Dr Sandeep Singh                                  | Macquarie University, Sydney, Australia                                                                                                   | November 22, 2022    | Training on Australian National Action Plan of Exotic Fruit Flies (as an expert)                                                            |

### EMINENT VISITORS

| Name and designation                                                                 | Date of visit | Purpose of visit                                                                                                                                 |
|--------------------------------------------------------------------------------------|---------------|--------------------------------------------------------------------------------------------------------------------------------------------------|
| Dr Maninder Ahluwalia, Biomedical Science, Cardiff Metropolitan University Wales, UK | 10.8.2022     | To deliver talk on 'Eat to fit your Genes' in the Department of Food and Nutrition                                                               |
| Dr SK Kaushik                                                                        | 30.1.2023     | Monitoring of DUS Project of Fababean in the Department of Plant Breeding and Genetics                                                           |
| Dr HL Raiger                                                                         | 21.2.2023     | Monitoring of breeding work of potential crops in the Department of Plant Breeding and Genetics                                                  |
| Dr Shalabh Dixit, IRRI, Philippines                                                  | 03.3.2023     | To launch India-BMGF-PAU collaborative project on the DSR system for the Indo Gangetic Plains in the Department of Plant Breeding and Genetics   |
| Dr Jauhar Ali Hybrid Rice Breeder, Senior Scientist-II, IRRI, Philippines            | 03.3.2023     | To launch India-BMGF-PAU collaborative project on the DSR system for the Indo Gangetic Plains in the Department of Plant Breeding and Genetics   |
| Dr Van Schepler Luu, Plant Pathologist, IRRI, Philippines                            | 09.4.2023     | To visit Rice Pathology Lab in the Department of Plant Breeding and Genetics                                                                     |
| Dr Bidyut Sarmah, Director, DBT –NECAB, AAU, Jorhat                                  | 15.5.2023     | To discuss collaborative project of DBT- NECAB –Phase III in the Department of Plant Breeding and Genetics                                       |
| Dr Bikram Singh Gill, Distinguished Professor Emeritus, Kansas State University, USA | 30.05.2023    | To discuss sustainable and profitable wheat production and future of wheat research/cultivation in the Department of Plant Breeding and Genetics |
| Dr Amelia Henry, Drought Physiologist, IRRI, Philippines                             | 26.6.2023     | To collect soil samples for IRRI trials and interact with the PAU rice team in the Department of Plant Breeding and Genetics                     |

## IMPORTANT EVENTS ORGANIZED AT PAU

### College of Agriculture

| Programme                                                                                                                                        | Organizing/Sponsoring Agency                                                                             |
|--------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------|
| Online Workshop on Improving Research Writing using Grammarly (November 11, 2022)                                                                | PAU, Ludhiana                                                                                            |
| Research and Extension Specialists' Workshop for Rabi Crops, 2020 (August 24, 2022)                                                              | PAU, Ludhiana                                                                                            |
| Research and Extension Specialists' Workshop for Horticultural Crops (Winter) (January 20-21, 2023)                                              | PAU, Ludhiana                                                                                            |
| All-India Coordinated Research Project on Cotton April 06-07, 2023)                                                                              | PAU, Ludhiana                                                                                            |
| GBS Data Analysis, Linkage Map Construction and QTL Analysis (March 19-28, 2023)                                                                 | PAU, Ludhiana in collaboration with Washington State University, Pullman, USA funded by BIRAC, New Delhi |
| Brain Storming Meeting: Enhancing Production and Value Addition of Millets (May 16, 2023)                                                        | Forage, Millets and Nutrition Section, PAU, Ludhiana                                                     |
| FOSTAC Training (Food Safety and Supervisor & Basic Manufacturing) (March 18, 2023)                                                              | FSSAI                                                                                                    |
| Industry- Academia Interaction Workshop (April 12, 2023)                                                                                         | Department of Food Science and Technology, PAU, Ludhiana                                                 |
| Inter-class Quiz Competition on the theme 'Inspiring Health and Well being: Environment, Food Safety & Yoga (June 21, 2023)                      | Department of Food Science and Technology, PAU, Ludhiana                                                 |
| Symposium on "Transforming the Green Revolution Hub of India: Innovations in Crop Breeding, Resource Management and Policy" (August 17-18, 2022) | PAU, Ludhiana                                                                                            |
| CAFT Programme "Soil and Water Management for Sustaining Intensive Agriculture" (December 1-21 2022)                                             | ICAR                                                                                                     |

### College of Agricultural Engineering & Technology

| Programme                                                                                                                                                                                                                                            | Organizing/Sponsoring Agency                                                  |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------|
| "Entrepreneurship Development in Food processing for Livelihood" for SC/ST under SCSP (November 11, 2022 December 09, 2022, December 16, 2022, May 11, 2023, June 01, 2023)                                                                          | Department of Processing and Food Engineering, PAU, Ludhiana.                 |
| Training Course on "Entrepreneurship Development in Food Processing for Livelihood for SC/ST under SCSP Training" (November 30, 2022, December 07, 2022, December 13, 2022, December 21, 2022, January 04, 2023, January 10, 2023, January 17, 2023) | Department of Processing and Food Engineering, PAU, Ludhiana. (AICRP on PHET) |
| PAU Food Industry and Craft Mela 2022(October 11, 2022)                                                                                                                                                                                              | PAU Ludhiana                                                                  |
| Fifth Workshop on "Food Supply Chain Advancement Network" (February 14, 2023)                                                                                                                                                                        | PAU and Monash University, Australia                                          |
| Research and Extension Specialists' Workshop on "Rabi Crops" (August 23-24, 2022)                                                                                                                                                                    | DEE, PAU, Ludhiana                                                            |
| Meeting of AICRP on ESA regarding new projects proposed (September 16, 2022)                                                                                                                                                                         | PAU, Ludhiana                                                                 |
| "End-user Training of Grammarly Tool" (November 11, 2022)                                                                                                                                                                                            | MSR Library, PAU, Ludhiana                                                    |
| Research and Extension Specialists' Workshop on "Horticultural Crops" (January 19-20, 2023)                                                                                                                                                          | DEE, PAU, Ludhiana                                                            |
| World Earth Day (April 24, 2023)                                                                                                                                                                                                                     | Department of Soil and Water Engineering and Sponsored by PPCB, Punjab        |
| Workshop on "Paddy Straw Management Strategies and Action Plan" (June 9, 2023)                                                                                                                                                                       | Department of Agriculture and Farmers Welfare, Punjab                         |



### College of Basic Sciences & Humanities

| Programme                                                                                                                                          | Organizing/Sponsoring Agency                                                                                |
|----------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------|
| Training of the field staff working in the Comprehensive Scheme for “Studying the Cost of Cultivation of Principal Crops in Punjab” (May 24, 2023) | Department of Economics and Sociology, Punjab Agricultural University, Ludhiana                             |
| Slogan Writing Competition on “Sanitation and Hygiene” (August 25, 2022)                                                                           | Department of Microbiology, PAU, Ludhiana                                                                   |
| Workshop on “Biofuels from Lignocellulosic Waste” (January 11, 2023)                                                                               | Department of Microbiology, PAU, Ludhiana                                                                   |
| Lecture on “Primarily findings of Akash Project on Paddy Stubble Management” (June 07, 2023)                                                       | Under the Programme of Azadi ka Amrit Mahotsav                                                              |
| Guest lecture on “State violence and culture: Implications for future generations of Punjab” (June 08, 2023)                                       | SAASCA, PAU Ludhiana                                                                                        |
| Workshop on “Paddy Straw Management and Action Plans” (June 09, 2023)                                                                              | Ministry of Agriculture and Farmers’ Welfare, Government of India and state of Punjab                       |
| Guest lecture on “Political economy of economic development in India” (June 16, 2023)                                                              | Under the Programme of Azadi ka Amrit Mahotsav                                                              |
| Maat Bhasha Divas (April 28, 2023)                                                                                                                 | Department of Agricultural Journalism, Languages & Culture, PAU, Ludhiana                                   |
| Lecture on “Significance of Photosynthetic Pigments in Crop Production” (March 22, 2023)                                                           | Under ICAR scheme “Strengthening and Development of Higher Agricultural Education in India for SC students” |
| Lectures under SC cluster programme on “Proteomic approaches for identification of differentially expressed proteins” (March 27, 2023)             | Department of Biochemistry, PAU, Ludhiana                                                                   |

### College of Community Science

| Programme                                                                                                                         | Organizing/Sponsoring Agency                                                                               |
|-----------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------|
| Workshop on “Contemporary Challenges of Research and Extension in Human Development and Family Studies” (July 04, 2022)           | Department of Human Development & Family Studies, PAU, Ludhiana                                            |
| Online Collaborative Training Programme on “Mainstreaming Gender Concerns in Agriculture & Allied Sector” (September 20-22, 2022) | PAU, Ludhiana & MANAGE, Hyderabad                                                                          |
| Webinar on “How to be more effective in life” (August 16, 2022)                                                                   | Online                                                                                                     |
| Awareness programme on ‘Fast food eating ill practice’ (September 16, 2022)                                                       | Department of Human Development and Family Studies, PAU, Ludhiana                                          |
| Orientation course on “Teaching, Research and Extension” for newly recruited faculty of PAU (August 23-September 02, 2023)        | PAU, Ludhiana                                                                                              |
| Training under the project “Socio-emotional Empowerment of SC Adolescent Girls” (September 29-October 18, 2022)                   | Department of Human Development & Family Studies, PAU, & sponsored by RKVY (Rashtriya Krishi Vikas Yojana) |
| Workshop on “Web Designing” (March 20-21, 2023)                                                                                   | EECM, PAU, Ludhiana                                                                                        |
| Workshop on “Photography and Video Production” (March 27-28, 2023)                                                                | EECM, PAU, Ludhiana                                                                                        |
| World Health Day (April 06, 2023)                                                                                                 | Department of Food and Nutrition, PAU, Ludhiana                                                            |
| Workshop on “Nutrition Entrepreneurship and Motivational Counseling” (April 24, 2023)                                             | COAET, PAU, Ludhiana                                                                                       |
| Career Guidance lecture for UG students (April 25, 2023)                                                                          | Department of Human Development & Family Studies in collaboration with PANACEA BHARTI institute            |



| Programme                                                                                                       | Organizing/Sponsoring Agency                                                                                                                               |
|-----------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Workshop on “Dissemination of Importance and Use of Millets in Daily Diet” (May 05, 2023)                       | Department of Food and Nutrition                                                                                                                           |
| Workshop on “Effective Communication Skills” (June 02, 2023)                                                    | EECM , PAU, Ludhiana                                                                                                                                       |
| Three-days training workshop on “Cognitive Therapies and their Integration with Mindfulness” (June 05-07, 2023) | Department of Human Development and Family Studies, PAU, Ludhiana                                                                                          |
| World Food Safety Day- ‘Safe Food and Healthy Diets - A Way Forward to Tandrusat Punjab” (June 07, 2023)        | Department of Food and Nutrition, PAU, Ludhiana, in collaboration with Food and Drug Administration (FDA), Department of Health and Family Welfare, Punjab |
| International Year of Millets-2023 (June 09, 2023)                                                              | Department of Food and Nutrition, PAU, Ludhiana                                                                                                            |
| Inter-College Cooking Competition on Healthy Millet Recipes (June 09, 2023)                                     | Department of Food and Nutrition, PAU, Ludhiana                                                                                                            |
| International Yoga Day (June 20, 2023)                                                                          | College of Community Science                                                                                                                               |

### College of Horticulture & Forestry

| Programme                                                                                                                               | Organizing/Sponsoring Agency                                                         |
|-----------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|
| Tutorial classes for SC students on “Entrepreneurship Development through On-Farm Processing of Horticultural Produce” (March 16, 2023) | PAU Ludhiana/ICAR                                                                    |
| Tutorial classes for SC students on “Health Immunity and Sanitization” (March 20, 2023)                                                 | PAU Ludhiana/ICAR                                                                    |
| Tutorial classes for SC students on “Postharvest Management of Horticultural Crops” (March 21, 2023)                                    | PAU Ludhiana/ICAR                                                                    |
| Field Day on “Nutrient Management in Citrus” (May 25, 2023)                                                                             | Regional Research Station, Abohar/ Department of Fruit Science, ICAR-AICRP on Fruits |
| Training to SC students on “Propagation of Fruit Plants” (March 30-31, 2023)                                                            | PAU Ludhiana/ICAR                                                                    |
| Dr MS Randhawa Diamond Jubilee Annual Flower Show (March 01-02, 2023)                                                                   | Department of Floriculture & Landscaping, PAU, Ludhiana                              |
| Chrysanthemum Show (Exhibition-cum-Competition) (December 06-07, 2022)                                                                  | Department of Floriculture & Landscaping, PAU, Ludhiana                              |
| International Biodiversity Day (May 22, 2023)                                                                                           | Punjab Biodiversity Board                                                            |
| World Environment Day (June 5, 2023)                                                                                                    | College of Horticulture & Forestry                                                   |

### Directorate of Extension Education

| Programme                                                                                    | Organizing/ sponsoring agency                     |
|----------------------------------------------------------------------------------------------|---------------------------------------------------|
| Workshop on “Presentation for NICRA Action Plan” (July 13, 2022)                             | Directorate of Extension Education, PAU, Ludhiana |
| Workshop on “Preparedness for Crop Residue Management” (August 18, 2022)                     | ATARI Zone-I, Ludhiana                            |
| Research and Extension Specialists Workshop for <i>Rabi</i> Crops (August 23-24, 2022)       | Directorate of Extension Education, PAU, Ludhiana |
| Training on use of “Grammarly” (November 11, 2022)                                           | PAU, Ludhiana                                     |
| Training-cum-Workshop on “How to make Posters and write Research Papers” (November 13, 2022) | Society of Krishi Vigyan PAU, Ludhiana            |
| Horticulture Workshop (January 19-20, 2023)                                                  | PAU, Ludhiana                                     |



| Programme                                                                                                                                        | Organizing/ sponsoring agency                                                                                         |
|--------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------|
| State Level Training Planning Workshop (January 27, 2023)                                                                                        | PAU, Ludhiana                                                                                                         |
| State Level Action Plan Workshop (February 24, 2023)                                                                                             | PAU, Ludhiana                                                                                                         |
| Workshop on “Paddy Straw Management Strategies and Action Plans” (June 09, 2023)                                                                 | PAU, Ludhiana                                                                                                         |
| Workshop on “Contemporary Challenges of Research & Extension in HD & FS” (July 04, 2023)                                                         | College of Community Science, PAU, Ludhiana                                                                           |
| Symposium on “Transforming the Green Revolution Hub of India: Innovations In Crop Breeding, Resource Management and Policy” (August 17-18, 2022) | PAU, Ludhiana                                                                                                         |
| Research and Extension Specialists Workshop for Rabi Crops (August 23-14, 2022)                                                                  | PAU, Ludhiana                                                                                                         |
| Stakeholders Dialogue on “Mitigating the Severity of Heat Wave” (August 18, 2022)                                                                | ATARI, PAU, Ludhiana                                                                                                  |
| Workshop on State level Training and Planning (January 17, 2023)                                                                                 | PAU, Ludhiana                                                                                                         |
| Workshop on “Food Supply Chain” (February 14, 2023)                                                                                              | PAU, Ludhiana                                                                                                         |
| Zonal Workshop on “Annual Action Plan of KVKs” (February 24, 2023)                                                                               | ATARI, PAU, Ludhiana                                                                                                  |
| Training on “Cultivation of Rainy Season Vegetables” (April 09, 2023)                                                                            | PAU Ludhiana                                                                                                          |
| Workshop on “Dissemination of Knowledge on Importance and Use of Millets in Daily Diet” (May 05, 2023)                                           | PAU, Ludhiana                                                                                                         |
| Kisan Saarthi Workshop (every Friday)                                                                                                            | ATARI, PAU, Ludhiana                                                                                                  |
| “Present Status, Challenges and Prospects of Small Ruminants Pastoralists” (October 08-09, 2022)                                                 | ICAR-ATARI, Zone-1, PAU, Ludhiana in collaboration with Central Sheep and Wool Research Institute (CSWRI), Avikanagar |
| National Workshop on CRM (June 09, 2023)                                                                                                         | PAU, Ludhiana                                                                                                         |
| Effective Communication Skills for Transfer of Technology (July 14, 2022)                                                                        | PAU, Ludhiana                                                                                                         |
| Dr D S Brar Memorial Symposium (August 17, 2022)                                                                                                 | PAU, Ludhiana                                                                                                         |
| Workshop on Rabi Crops (August 23, 2022)                                                                                                         | PAU, Ludhiana                                                                                                         |
| Workshop on “Food Supply Chains” (August 31, 2022)                                                                                               | PAU, Ludhiana                                                                                                         |
| Kisan Samman Samelan (December 02, 2022)                                                                                                         | PAU, Ludhiana                                                                                                         |
| State Level Annual Training Planning Programme (January 27, 2023)                                                                                | PAU, Ludhiana                                                                                                         |
| First Kisan Sarkar-Milni, (February 12, 2023)                                                                                                    | PAU, Ludhiana                                                                                                         |
| Second Kisan Milni (May 11, 2023)                                                                                                                | PAU, Ludhiana                                                                                                         |
| Workshop on Paddy Straw Management (June 09, 2023)                                                                                               | PAU, Ludhiana                                                                                                         |
| Workshop on “Contemporary Challenges of Research and Extension in Human Development and Family Studies” (July 04, 2022)                          | PAU Ludhiana                                                                                                          |
| Workshop on Rabi Crops (August 23-24, 2022)                                                                                                      | PAU Ludhiana                                                                                                          |
| Orientation Course on “Effective Teaching, Training and Extension” (August 23 to September 02, 2022)                                             | Dept of Extension Education and Communication Management, College of Community Science, PAU Ludhiana                  |
| Online Workshop on “Improving Research Writing using Grammarly” (November 11, 2022)                                                              | PAU Ludhiana/ Online                                                                                                  |
| Training on “Quality Assurance in Seed Production and Grading” (March 27, 2023)                                                                  | Director Seed PAU, Ludhiana                                                                                           |

| Programme                                                                                                                                     | Organizing/ sponsoring agency                    |
|-----------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------|
| Capacity Building Training Programme for Extension Scientists (April 21, 2023)                                                                | Directorate of Extension Education, PAU Ludhiana |
| Transforming the Green Revolution Hub of India : Innovations in Crop Breeding, Resource Management and Policy (August 17-18, 2022)            | PAU, Ludhiana                                    |
| Research and Extension Specialist Workshop on Rabi Crops. (August 23-24, 2022)                                                                | PAU Ludhiana                                     |
| Capacity Building for Extension Scientists (April 21, 2023)                                                                                   | PAU Ludhiana                                     |
| Workshop on “Paddy Straw Management Strategies” (June 09, 2023)                                                                               | PAU Ludhiana                                     |
| Symposium on “Transforming The Green Revolution Hub of India: Innovations in Crop Breeding, Resource Management and Policy” (August 17, 2022) | PAU, Ludhiana                                    |
| Workshop on Paddy Straw Management Strategies (June 09, 2023)                                                                                 | PAU Ludhiana/ICAR                                |
| Research and Extension Specialists’ Workshop for Rabi Crops (August 23-24, 2022)                                                              | PAU, Ludhiana                                    |
| Research and Extension Specialists’ Workshop for Horticultural Crops (January 19, 2023)                                                       | PAU, Ludhiana                                    |
| Capacity Building Training Programme (April 21, 2023)                                                                                         | PAU, Ludhiana                                    |
| Programme Planning Workshop for Extension Scientists working under FASC (April 28, 2023)                                                      | PAU, Ludhiana                                    |
| Workshop on “Paddy Straw Management” (June 09, 2023)                                                                                          | PAU, Ludhiana                                    |

## FACULTY PARTICIPATION IN NATIONAL AND INTERNATIONAL EVENTS

The University faculty participated in various national and international seminars, conferences, symposia, workshops, etc. Details are given below:

### International Participation

#### College of Agriculture

| Faculty and Department                    | Programme                                                                                                                               |
|-------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------|
| Dr Makhan Singh Bhullar<br>Agronomy       | 8 <sup>th</sup> International Weed Science Congress, Bangkok, Thailand (December 04-09, 2022)                                           |
| Dr Manmeet Brar Bhullar<br>Entomology     | XVI International Congress of Acarology, University of Auckland, New Zealand (December 01-05, 2022)                                     |
| Dr Usha Nara<br>Plant Breeding & Genetics | 7 <sup>th</sup> International Conference on Human Genetics and Genetic Disorders, Pulses Group, United Kingdom (Online- March 21, 2023) |

#### College of Community Science

| Faculty and Department                                                              | Programme                                                                                                                                                                                                              |
|-------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Drs Sukhdeep Kaur, Manjot Kaur<br>Extension Education &<br>Communication Management | International Conference on Communication Research in the Pandemic Times, Global Communication Research Association (Online- November 11-12, 2022)                                                                     |
| Drs Neerja Singla, Renuka Aggarwal<br>Food & Nutrition                              | 5th International Conference on Food and Nutrition – A Novel Approach to the Innovation and Invention in Food and Nutrition Science (via virtual mode), Universal Society of Food and Nutrition (November 16-17, 2022) |
| Dr Kiran Bains<br>Food & Nutrition                                                  | Attended 22nd International Union of Nutritional Sciences (IUNS), International Life Sciences Institute (ILSI) IUNS—International Congress of Nutrition at Tokyo, Japan (December 06-11, 2022)                         |



### College of Agricultural Engineering & Technology

| Faculty and Department                                                                                  | Programme                                                                                                                                                                                                                                                                                    |
|---------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Dr Manjeet Singh<br>Farm Machinery & Power Engg.                                                        | Technical Meet, University of Prince Edward Island, Canada (July 24-27, 2022)                                                                                                                                                                                                                |
| Dr Derminder Singh, Dr. Saurabh Ratra<br>Electrical Engg. & Information Technology                      | 14 <sup>th</sup> International Conference on Applied Energy (Elsevier) (ICAE), Bochum, Germany (August 08-11 2022)                                                                                                                                                                           |
| All faculty<br>Processing & Food Engg.                                                                  | Fourth Workshop on Food Supply Chains FoodSCAN 2022 (Virtual mode), PAU, Ludhiana and Monash University, Australia (August 31, 2022)                                                                                                                                                         |
| Dr Manpreet Singh<br>Renewable Energy Engineering                                                       | Food SCAN (Food Supply Chain Advancement Network)<br>Fourth Workshop on Food Supply Chains, organized by FoodSCAN (Food Supply Chain Advancement Network) – led by Monash University (Australia), Punjab Agricultural University, and University of Lincoln (UK) (August 31, 2022 (Virtual)) |
| Dr Anoop Dixit,<br>Er Arshdeep Singh<br>Farm Machinery & Power Engg.                                    | Workshop on Advancing sub-regional cooperation for sustainable climate smart and integrated management of crop residues, ESCAP-South & South West Asia office of United Nations Economic & Social Commission for Asia and the Pacific (Sept 15, 2022 (Online))                               |
| All faculty<br>Processing & Food Engg.                                                                  | 5 <sup>th</sup> International Conference on Food and Nutrition (Hybrid Mode) organized by Bioleagues, United Innovators (Nov. 16-17, 2022)                                                                                                                                                   |
| All faculty<br>Processing & Food Engg.                                                                  | 2 <sup>nd</sup> International Webinar on Nutrition and Healthcare, Scientex conferences, Wyoming USA (November 24-25, 2022)                                                                                                                                                                  |
| All faculty<br>Processing & Food Engg.<br>Dr Satish K Gupta<br>Dr Iqbal Singh<br>Renewable Energy Engg. | 5 <sup>th</sup> Workshop on Food Supply Chains- Food SCAN 2023, PAU, Ludhiana and Monash University, Australia (February 14, 2023)                                                                                                                                                           |
| All faculty<br>Processing & Food Engg.                                                                  | International Hybrid Conference on Nano Structural Materials and Polymers (ICNP 2023), IIUCNN, Kerala, GUT Poland, Univ. of Johannesburg, South Africa, and Univ. of Lorraine, France (May 12-14, 2023)                                                                                      |

### College of Basic Sciences & Humanities

| Faculty and Department                             | Programme                                                                                                                                                                                                                                                               |
|----------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Drs Neena Singla, Bhupinder Kaur Babbar<br>Zoology | 7 <sup>th</sup> International Conference on Rodent Biology and Management, Africa Centre of Excellence for Innovative Rodent Pest Management and Biosensor Technology Development (ACE II- IRPM & BTD) and the Institute of Pest Management Tanzania (July 05-08, 2022) |
|                                                    | First International Symposium of Wildlife Diseases Research Network in hybrid mode, Haikou, Hainan, China (June 26-28, 2023)                                                                                                                                            |
| Dr Kamal Vatta<br>Economics                        | 15 <sup>th</sup> Indo-Japanese Dialogue, Kobe University, Japan (November 03, 2022)                                                                                                                                                                                     |
|                                                    | Aakash Seminar, Research Institute for Humanity and Nature (RIHN), Kyoto, Japan (November 07, 2022)                                                                                                                                                                     |
|                                                    | 11 <sup>th</sup> Conference of the Asian Association for Environmental and Resource Economics, University of Economics, Ho Chi Minh City, Vietnam (August 19-20, 2022)                                                                                                  |
| Dr Yadhu Suneja<br>Biochemistry                    | Online Summer School Workshop on “Genome Editing for Food Security and Environmental Sustainability”, Plant Science Department, McGill University, Canada (August 04-05, 2022)                                                                                          |

## College of Horticulture & Forestry

| Faculty and Department                   | Programme                                                                                                                                                                                                   |
|------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Dr Sandeep Singh<br>Fruit Science        | 11 <sup>th</sup> International Symposium on Fruit Flies of Economic Importance, Macquarie University, Sydney, Australia (November 13-18, 2022)                                                              |
| Dr Abhishek Sharma,<br>Vegetable Science | 5th Rencontres de Quy Nhon: International Biology conference, ICSE, Quy Nhon, Binh Dinh, Vietnam (August 17-19, 2022)                                                                                       |
| Dr Hira Singh<br>Vegetable Science       | Attended Seven-day 31st International Horticultural Congress (IHC2022) organized by International Society of Horticultural Sciences (ISHS), Belgium at Congress Center, Angers, France (August 14-20, 2022) |

## DEE

| Faculty and Department | Programme                                                                                                                                              |
|------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------|
| Dr Kirandeep,<br>KVK   | Fourth (virtual) workshop on food supply chains, Monash University of Lincoln in collaboration with Department of PFE, PAU, Ludhiana (August 31, 2022) |

## National Participation

| College                                          | Participation count |
|--------------------------------------------------|---------------------|
| College of Agriculture                           | 211                 |
| College of Agricultural Engineering & Technology | 57                  |
| College of Basic Sciences & Humanities           | 97                  |
| College of Community Science                     | 49                  |
| College of Horticulture & Forestry               | 13                  |
| Directorate of Extension Education               | 466                 |
| MS Randhawa Library                              | 05                  |

## NEW EQUIPMENT ACQUIRED

### College of Agriculture

| Equipment                                                           | Cost<br>(Rs. in lakhs) | Utility                         |
|---------------------------------------------------------------------|------------------------|---------------------------------|
| Lemon juice extraction machine                                      | 1.2                    | Postgraduate and other research |
| Hunter Color Lab                                                    | 15.0                   | -do-                            |
| Texture Analyzer                                                    | 25.0                   | -do-                            |
| Laminar air flow                                                    | 4.25                   | -do-                            |
| Speed Breeding Facility                                             | 500.00                 | -do-                            |
| SNP Line                                                            | 230.10                 | -do-                            |
| Thermocyclers (384 wells)-2                                         | 8.0                    | -do-                            |
| Thermocyclers (96 wells)-2                                          | 6.0                    | -do-                            |
| GenoGrinder                                                         | 23.57                  | -do-                            |
| Vertical ultra low deep freezers (-86o C)-2                         | 24.0                   | -do-                            |
| Deep freezers (-20o C) – 2                                          | 3.31                   | -do-                            |
| Refrigerated centrifuge-swing bucket rotor with multiple adaptors-1 | 7.98                   | -do-                            |
| Refrigerated micro centrifuge for 1.5/2ml tubes-2                   | 9.98                   | -do-                            |



|                                               |       |                                                                                                                                                                         |
|-----------------------------------------------|-------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Micro centrifuge                              | 6.98  | -do-                                                                                                                                                                    |
| Gel documentation system-1                    | 8.0   | -do-                                                                                                                                                                    |
| Microplate spectrophotometer-1                | 11.92 | -do-                                                                                                                                                                    |
| ColorFlex EZ Spectrophotometer (Hunter lab)-1 | 14.0  | -do-                                                                                                                                                                    |
| UV Spectrophotometer-1                        | 4.95  | -do-                                                                                                                                                                    |
| Water bath shaker-2                           | 1.70  | -do-                                                                                                                                                                    |
| Incubator shaker-2                            | 5.0   | -do-                                                                                                                                                                    |
| Safety hood-2                                 | 14.0  | -do-                                                                                                                                                                    |
| High throughput autoclaves-2                  | 8.0   | -do-                                                                                                                                                                    |
| Ultrapure water purification-1                | 9.0   | -do-                                                                                                                                                                    |
| Trinocular Microscope                         | 1.19  | Identification of various plant pathogens for the identification of different potent strains of bio-control agents disease management under the organic farming system. |

### College of Agricultural Engineering & Technology

| Equipment                                                                             | Cost<br>(Rs. in lakhs) | Utility                                                                    |
|---------------------------------------------------------------------------------------|------------------------|----------------------------------------------------------------------------|
| Interactive panel 75"                                                                 | 2.05                   | MCA Lab                                                                    |
| Video conferencing system with expansion mic                                          | 1.48                   | Video conference room                                                      |
| Internet lease line                                                                   | 4.94                   | At university level                                                        |
| FTIR Spectrometer                                                                     | 15.0                   | Spectral analysis for characterization of food samples                     |
| Cooling Centrifuge                                                                    | 3.5                    | Extraction of Metabolites                                                  |
| Ozone Treatment Chamber<br>(Developed & Fabricated)                                   | 1.25                   | Disinfestation of food grains for long term storage                        |
| Solar photovoltaic pump testing centre at<br>Department of Soil and Water Engineering | 54.0                   | To test solar photovoltaic pumps commercially                              |
| Interactive Panel                                                                     | 2.18                   | For conducting online/offline seminars in committee room                   |
| Video conferencing system                                                             | 2.0                    | Arranging various Trainings/seminars in online interactive mode            |
| Virtual Realty System with FPV camera                                                 | 1.0                    | For research and experimental purposes                                     |
| Drone sprayer with granular broadcaster                                               | 11.21                  | -do-                                                                       |
| Drone Sprayer                                                                         | 6.71                   | -do-                                                                       |
| Laser land leveller                                                                   | 2.50                   | -do-                                                                       |
| Hydraulic system discharge conveyor                                                   | 3.07                   | -do-                                                                       |
| Green pea crop harvesting head                                                        | 4.87                   | -do-                                                                       |
| Green pea crop feeding conveyor                                                       | 1.91                   | -do-                                                                       |
| Jetson Xavier NX developer kit with LED display                                       | 1.09                   | -do-                                                                       |
| Sugarcane cutter planter                                                              | 1.04                   | -do-                                                                       |
| Mixer                                                                                 | 2.26                   | For uniform mixing of biomass samples for production of briquettes/pellets |
| Rapid Moisture Analyzer                                                               | 1.90                   | Fast analysis of moisture of biomass samples                               |
| Torrefaction unit continuous type                                                     | 1.5                    | To produce charred biomass for easy densification in paddy straw           |

### College of Basic Sciences & Humanities

| Equipment                              | Cost<br>(Rs. in lakhs) | Utility       |
|----------------------------------------|------------------------|---------------|
| GC-MS                                  | 68.39                  | Research Work |
| Deep Freezer(-80C) (Two)               | 19.84                  | Research Work |
| Plant Growth Chamber (Two)             | 44.98                  | Research Work |
| Elisa Plate Reader                     | 1.98                   | Research Work |
| Microplate Reader                      | 19.82                  | Research Work |
| qRT-PCR                                | 19.95                  | Research Work |
| Phase Contrast Microscope              | 9.58                   | Research Work |
| Sonicator                              | 47.55                  | Research Work |
| Microbial Identification System        | 11.60                  | Research Work |
| Fluorescent qubit Spectrometer         | 2.97                   | Research Work |
| Orbital Shaking Incubator (Two)        | 2.0                    | Research Work |
| Ultra Pure Water Purification System   | 4.85                   | Research Work |
| Horizontal Laminar Flow                | 2.49                   | Research Work |
| Fully Automatic Autoclave Single Lever | 2.62                   | Research Work |
| SDS-PAGE unit                          | 2.47                   | Research Work |
| Double Beam UV-Vis spectrophotometer   | 2.92                   | Research Work |

### College of Community Science

| Name of the instrument / equipment     | Cost (Lakhs) | Utility                                                                              |
|----------------------------------------|--------------|--------------------------------------------------------------------------------------|
| Automatic Macro Block Digestion System | 1.5          | Analysis of protein                                                                  |
| Tray Dryer-Electric                    | 1.47         | Entrepreneurial Trainings in Preservation and Bakery for Food Service Establishments |
| Alpha Ilce-6400M (18-135MM Lens)       | 1.0          | For extension, research and HRD activities                                           |

### College of Horticulture & Forestry

| Name of the instrument/equipment                                                                                                     | Cost (Lakhs) | Utility                                                                              |
|--------------------------------------------------------------------------------------------------------------------------------------|--------------|--------------------------------------------------------------------------------------|
| Refrigerated centrifuge                                                                                                              | 4.0          | Preparation of samples for biochemical analysis of fruits, use in molecular studies. |
| Ultra Low Deep Freezer                                                                                                               | 7.0          | For longer storage of samples/chemicals                                              |
| Stereo microscope                                                                                                                    | 7.98         | For insect/nematode studies                                                          |
| Tissue Culture Unit Autoclave/Equitron<br>Laminar Air Flow/ ACCO<br>Tissue Culture Rack/<br>Local Fabrication/Ocean Scientific Store | 8.0          | For micropropagation of different vegetable crops                                    |
| Refrigerated Deep Freezer                                                                                                            | 11.85        | For longer storage of samples/chemicals                                              |

### Directorate of Extension Education

| Name of the instrument/equipment | Cost (Lakhs) | Utility                        |
|----------------------------------|--------------|--------------------------------|
| Multi Crop Raised Bed Planter    | 11.5         | Multiple use of same machinery |
| Oil mill machinery (Oil Press)   | 4.66         | Processing and value addition  |
| Multi crop thresher              | 1.74         | For KVK Farm use               |
| Implement Shed                   | 3.41         | For KVK Farm use               |



|                                                        |      |                                                                |
|--------------------------------------------------------|------|----------------------------------------------------------------|
| Photo Framing                                          | 1.14 | For KVK Farm use                                               |
| DSR Drill cum multi crop planter with sprayer +FCR     | 1.15 | For KVK Farm use                                               |
| Desktop I3                                             | 1.5  | For KVK office use                                             |
| Seed processing plant gravity separator 3 fan elevator | 3.20 | For KVK Farm use                                               |
| PAU smart seeder                                       | 2.25 | For KVK Farm use                                               |
| 4 row multicrop bed planter                            | 1.25 | Under NICRA project                                            |
| Solar Panel 5KW                                        | 2.97 | Office electricity                                             |
| Agri Drone                                             | 9.97 | For spray on crops                                             |
| Lucky seed drill with automatic spraying               | 1.24 | For conducting demonstrations on tar-wattar direct seeded tice |
| Agri-Drone                                             | 9.98 | For conducting demonstrations on pesticide and nutrient sprays |
| PAU Smart seeder                                       | 2.25 | Use on Farm as demonstration purpose                           |
| PTO operated power weeder                              | 1.35 | Use on Farm as demonstration purpose                           |
| Bolero Jeep                                            | 8.88 | Use for tour and travelling purpose                            |
| Desert Cooler (8)                                      | 1.0  | Office use                                                     |

## NEW LABORATORIES AND INFRASTRUCTURE CREATED AND UPDATED

### College of Agriculture

- Renovation of Herbicide Residue laboratory
- Developed Quality Analysis Lab under DST-FIST

### College of Agricultural Engineering & Technology

- Alumni Relations Centre and Pro-Gallery created by Alumni Association.
- Hermetic Grain Storage System of 5 and 1 ton capacity along with CO<sub>2</sub> and O<sub>2</sub> analyser worth 5 lakhs procured for Storage Engineering Laboratory by the Department of Processing and Food Engineering.
- Submersible Pump Testing Centre set up and updated in the Research Hall by the Department of Soil and Water Engineering.
- Plant Factory set up and updated by the Department of Soil and Water Engineering.

### College of Basic Sciences & Humanities

- Orbital shakers, qRT-PCR, Deep Freezers, spectrophotometer, HPTLC, ELISA Reader, Water purification system, 2D-gel electrophoresis created and updated in DBT Builder Lab I by the Department of Biochemistry.
- GCMS, Laminar flow, furnace, UV-visible spectrophotometer, Gel Documentation system, conductivity meter in DBT Builder Lab II by the

Department of Biochemistry.

### College of Community Science

- Oven Toaster Griller, Bakery Planetary Mixer, Electric Deep Fryer and Carrot Juicer were purchased.
- New AICRP Laboratory established in the Food & Nutrition Department
- New equipment purchased for up-gradation of Analytic Laboratories, installation of LED digital magnetic stirrer and hot plate with support and external temperature probe
- Installation of vortex shaker and Automatic Protein Digester
- Four Computers of Video Production Lab in the Department of Extension Education & Communication Management repaired and updated.

### College of Horticulture & Forestry

- Fabrication of Mist Chamber installed in the Floriculture Farm by the Department of Floriculture & Landscaping.

### Directorate of Extension Education

- Installation of Minimal Processing Unit, Shed and Grain Storage structure at KVK Fatehgarh Sahab
- Installation of IPM lab at KVK Bathinda
- Implement Shed at KVK Gurdaspur
- Installation of Vehicle Shed at KVK Ferozepur
- Installation of Shed and Mushroom Unit at KVK Muktsar

## FINANCES

The Board of Management in its 310<sup>th</sup> meeting held on March 27, 2023 approved the budget estimates of the Punjab Agricultural University for the year 2023-24 amounting to Rs. 87958.58 lakhs. The details of these schemes, budget allocation for research, teaching, extension and for the administrative and miscellaneous activities are as under:

| Sr. No. | Schemes                                                                                                                                                  | Estimates of Budget (2023-24)<br>(Rs in lakh) | Estimates of Budget (2022-23)<br>(Rs in lakh) | 2022-23                               |                |
|---------|----------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------|-----------------------------------------------|---------------------------------------|----------------|
|         |                                                                                                                                                          |                                               |                                               | Actual Grant received<br>(Rs in Lakh) | Allocation (%) |
| 1       | State Schemes                                                                                                                                            |                                               |                                               |                                       |                |
| i)      | Research & Education Schemes                                                                                                                             | 68402.27                                      | 68291.88                                      | 40000.00                              | 74.25          |
| ii)     | AMIRIC                                                                                                                                                   | 492.30                                        | 170.00                                        | 100.00                                | 0.18           |
| iii)    | New College at Ballawal Saunkhri                                                                                                                         | 1393.40                                       | 1779.00                                       | 292.95                                | 0.54           |
|         | Total                                                                                                                                                    | 70287.97                                      | 70240.88                                      | 40392.95                              | 74.97          |
| 2       | Rashtriya Krishi Vikas Yojana (RKVY)                                                                                                                     |                                               |                                               | 1260.48                               | 2.34           |
| 3       | ICAR Schemes<br>(AICRP/ KVK/Adhoc and Development Grant)                                                                                                 | 11806.50                                      | 11831.68                                      | 8381.20*                              | 15.56          |
| 4       | Central Govt. Funding<br>(University Grants Commission and Centrally Sponsored Schemes, Department of Biotechnology, Department of Science & Technology) | 1965.25                                       | 1364.46                                       | 2432.37                               | 4.52           |
| 5       | Other Schemes<br>{National Horticultural Mission/<br>Misc. Schemes (Private Companies)/<br>Misc. (Foreign Contribution)} etc.                            | 2926.06                                       | 2575.50                                       | 1405.99                               | 2.61           |
| 6       | Self- financing Schemes                                                                                                                                  | 972.80                                        | 587.36                                        | -                                     | -              |
| 7       | Revolving Fund Schemes                                                                                                                                   |                                               | 319.64                                        | -                                     | -              |
|         | Total                                                                                                                                                    | 87958.58                                      | 86919.52                                      | 53872.99                              | 100            |

\*includes Rs.459.24 lakh for strengthening and development of PAU.

As compared to the Budget Estimates amounting to Rs. 86919.52 lakh for the year 2022-23 approved by the Board of Management in its 306<sup>th</sup> meeting held on March 30<sup>th</sup>, 2022, the actual grants received during the financial year 2022-23 were Rs. 53872.99 lakh. The University raised Rs. 9346.65 lakh through tuition fee and other sources/ services.

## Allocation of funds for various activities

| Budget Allocation                 | 2023-24<br>As per Budget Estimates |                | 2022-23<br>As per Actual grant received |                |
|-----------------------------------|------------------------------------|----------------|-----------------------------------------|----------------|
|                                   | Amount (Rs in lakh)                | Allocation (%) | Amount (Rs in lakh)                     | Allocation (%) |
| Research                          | 45747.11                           | 52.01          | 34399.71                                | 51.78          |
| Teaching                          | 21532.09                           | 24.48          | 16987.27                                | 25.57          |
| Extension                         | 11725.90                           | 13.33          | 8596.61                                 | 12.94          |
| General administration and others | 8953.48                            | 10.18          | 6450.78                                 | 9.71           |
| Total                             | 87958.58                           | 100            | 66434.37                                | 100            |

During the year 2022-23, actual allocation was 51.78% on Research, 25.57% on Teaching, 12.94% on Extension and 9.71% on General Administration and others.



# Mohinder Singh Randhawa Library

Mohinder Singh Randhawa Library plays a pivotal role in supporting ongoing research, study, teaching and extension activities of the university. It caters to the informational needs of the academia by keeping pace with digital technologies; and renders uninterrupted automated services in order to facilitate expeditious, exhaustive, easy and efficient access to scientific literature. The Saxena 24x7 Reading Hall provides a congenial atmosphere to the users with the ready provision of comfortable reading tables and chairs, desert coolers, pedestal fans etc.

Dr. Kulbir Singh Gill 24x7 fully air-conditioned Reading Hall bearing paintings showcasing the history of agriculture and also hosting the Hall of Fame bearing pictures of eminent agricultural scientists, provides a very comfortable reading environment for the students.

**Membership and transactions:** The Library registered 4614 active members during this period as compared to 4563 members during the previous report period. Besides, 12978 books were issued to the library members.

**Documents procured and subscribed:** The Library procured 1883 books which include books purchased for MSR library, departmental libraries, Research Stations & books received as gratis. It also procured 530 theses in print form and 530 theses Compact Discs (CDs). At present, the Library is subscribing to 16 online journals and 04 print journals against life membership. The Library also provided access to 5 online databases and 385 e-books. Thus, the total collection of library as on 30-06-2023 stood at 421472.

**Library services:** The Library provided access to e-resources to faculty, researchers and students of the university. Remote access was also made available to all the electronic resources like CeRA, E-journals, E-books and statistical databases. Online webinars for effective utilization of the online resources were organized for faculty and students of the university. The Library also engaged in providing essential services like issue/return of the books, issue of no due certificates etc. to its members.

**Online databases:** The Library provided online

access to scholarly material through various online databases, namely, Consortium for e-Resources in Agriculture (CeRA) for journal articles, Krishikosh for theses submitted in PAU as well as of the other State Agricultural Universities and ICAR institutes. The Library also uploaded 530 theses in Krishikosh database for the period under report. All printed publications of PAU such as Agricultural Research Journal, Changi Kheti, Progressive farming, Package & Practices, Theses etc. available in the Library were made accessible online to PAU fraternity from library webpage through PAU institutional repository. Indiatat.com online statistical database subscribed by the Library provides statistical information pertaining to agriculture and allied areas. The Library also provides access to 385 e-books of various publishers whereas ISO standards provided access to various standards on Food Products.

In addition, two more online databases were added for providing online access to faculty and students- Business Source Elite was procured for a period of one year and was provided for the faculty, researchers and students of Management. Food Science Source was procured for a period of one year and was provided for the faculty, researchers and students of Food and Nutrition Science, providing accessibility to online journals and other aspects relating to food science and technology.

Presently, the Library is also subscribing to EPWRF India Time Series (EPWRFITS) for a period of one year for unlimited users and unlimited downloads and along with five Usernames with Passwords including Remote Login Access for the following databases : Price Indices, Agricultural Statistics, Agricultural Wages in India and Wage Rates in Rural India etc. These were subscribed on the recommendation of the Department of Economics for a period of one year.

**Library Webpage:** The Library Webpage provides complete information about library resources, its rules and regulations, services, e-resources, list of print journals, circulars and new additions added to the library collection from time to time. Additionally, digitized copies of rare handwritten documents of Dr. M. S. Randhawa and all PAU print publications as well

as old print theses are now accessible campus wide to all the users. All the subscribed e-resources of the library like e-journals, e-books, e-theses, e-standards etc. are also accessible campus wide from the web page.

**Library Usage:** The Library has a rich collection of books, theses, journals, textbooks, reference books, abstracts, etc. to support the ongoing research, teaching and extension activities at PAU. The usage data is as follows:

| Sr. No. | Documents             | Usage |
|---------|-----------------------|-------|
| 1       | Books                 | 51311 |
| 2       | Theses                | 14702 |
| 3       | Bound periodicals     | 7990  |
| 4       | Current periodicals   | 2166  |
| 5       | Abstracts and Indexes | 3726  |
| 6       | Newspapers            | 2862  |
| 7       | Reference books       | 2638  |
| 8       | Textbooks             | 15549 |
| 9       | Rare books            | 2568  |

**Online Databases/Services Usage:** The Library web OPAC and all the databases subscribed by the Library except for Indiatat.com; are accessible through library webpage to PAU community. Indiatat.com is accessible from computer section of the library. These online resources and internet were extensively used by the students and staff. The usage data of various online databases during the period of report is as follows:

| Sr. No. | Service                                                                   | No. of users |
|---------|---------------------------------------------------------------------------|--------------|
| 1       | Consortium for e-Resources in Agriculture                                 | 92677        |
| 2       | Indiatat.com                                                              | 3738         |
| 3       | CRCnetBASE                                                                | 27           |
| 4       | EBSCO NetLibrary                                                          | 4606         |
| 5.      | Business Source Elite (Subscribed from 1st April 2022 to 30th April 2023) | 7213         |
| 6.      | Food Science Source (Subscribed from 1st April 2022 to 30th April 2023)   | 6976         |
| 7.      | Internet                                                                  | 947          |

# Impact

## National Rankings

- Punjab Agricultural University secured the first rank in the maiden (with respect to the vertical of agriculture and allied sectors) and the largest ever ranking exercise undertaken by the prestigious National Institute Ranking Framework (NIRF) on June 5, 2023.

## Foodgrain Productivity

- During 2021-22, Punjab led the nation with the highest foodgrain productivity of 4233 kg/ha (against the national average of 2419 kg/ha). It contributed 8.94% of the total foodgrain production in the country.
- During Kharif 2021, the state reported the highest paddy productivity of 6478 kg/ha at the national level and contributed 21.8% rice to the central pool. During Kharif 2022, paddy productivity went slightly down to 6472 kg/ha due to aberrant weather and certain emerging disease challenges. However, the state continued to be the largest contributor (21.5%) to the central rice pool. As per surveys conducted by the PAU, 62.4% of the *parimal* rice area was under the varieties recommended by the university; short to medium duration varieties had 68% share. Short duration varieties have low water requirement and straw load, thereby proving advantageous with respect to the management of key challenges of groundwater depletion and crop residue burning.
- During 2021-22, though due to unusually high temperatures during later crop growth stages wheat productivity in Punjab (4206 kg/ha) lost its national lead to Haryana state, but it made the largest contribution (51.3%) to the central wheat pool. Amidst recurring weather anomalies during Rabi 2022-23, with an estimated wheat productivity of 4707 kg/ha, Punjab retained its leadership in contribution to the central wheat pool (46.2%). Almost entire wheat acreage (92.6%) was under recommended wheat varieties.
- The year 2021-22 recorded the highest maize yield (3930 kg/ha) of the decade, which was higher than the national record yield of 3349 kg/ha (2021-22).

## Diversification

- In order to redeem cotton acreage lost to rice in the traditional southwest region of Punjab, state government made concerted efforts during Kharif 2023 in wartime mode towards ensuring timely and adequate supply of canal water and availability of quality seeds through traceability and other enforcement measures. These efforts helped bring an estimated 1.75 lakh ha area under cotton cultivation. Though it fell far short off the target of 3 lakh ha, but the achievement is likely to provide a strong impetus to future efforts. Synergistic efforts made by the PAU and line departments, especially due to village level focus through *Kisan Mitras*, have thus far been largely successful in staving off insect-pests and disease related challenges.
- Area under Basmati rice continues to grow - from 4.06 lakh ha in 2020, 4.36 lakh ha in 2021, and 4.95 lakh ha in 2022, to an estimated 5.74 lakh ha in 2023.
- Area under fruit crops in the state continues to rise gradually (83.7 thousand ha in 2017-18, 86.8 in 2018-19, 90.5 in 2019-20, 93.6 in 2020-21, and 96.7 thousand ha in 2021-22). Guava, mango, litchi, and lemon have witnessed drastic uptick in their respective acreages.
- Area under vegetable crops has also been increasing (258.5 thousand ha in 2017-18, 273.6 in 2018-19, 289.4 in 2019-20, 305.4 in 2020-21, and 300.4 thousand ha in 2021-22).
- Notwithstanding a meagre 5% share in potato produce of the country, Punjab meets more than 60% seed potato requirements of other key potato states like West Bengal, Uttar Pradesh, Bihar, Gujarat, Andhra Pradesh, Karnataka, and Maharashtra. The university's recently launched in-house potato breeding programme has yielded two important varieties – Punjab Potato 101 and Punjab Potato 102, which are expected to sustain momentum in the potato productivity.
- In order to diversify within rice-wheat cycle and to harness premium market, breeding programmes

have been successfully steered towards special traits. The PBW 1 Chapati variety of wheat released during 2020 continues to be received well by the growers as evidenced by the seed sale proceeds.

### Micro-irrigation

- The university continues to devise micro-irrigation modules for increasing number of crops. Micro-irrigation coverage in the state is estimated at 54,190 ha.

### Eco-Friendly Pest and Disease Management

- Effectiveness of *neem*-based aqueous extract for control of pests continues to be validated for increasing number of crops.
- Economic threshold and Economic injury levels (ETL/EIL) continue to be identified for increasing number of crops.
- Pesticide consumption in the state has slid from 5376 metric tons in 2021-22 to 5130 metric tons in 2022-23.
- The use of biopesticides in the state has gone up from 165 tons in 2021-22 to 172 tons in 2022-23.
- Punjab Agricultural University regularly monitors pesticide residue dynamics of staples. Around 7.7% of vegetable samples were contaminated and 0.54% were contaminated with pesticides above prescribed maximum residue limit (MRL). About 11 percent of fruit samples and 3.9% of rice samples were contaminated. However, no pesticide contamination was detected in samples of water, pulses and wheat.

### Soil Health Management

- Soil organic carbon, a key diagnostic of soil health, has been increasing over time as evidenced by the analysis of samples drawn from different fields across the state (0.33% in 1981-90, 0.36% in 1991-

2000, 0.4% in 2001-10, 0.53% in 2011-22).

- Consumption of phosphatic fertilizer has generally been decreasing (from 53.1 kg/ha in 2015-16 through 52.7 kg/ha in 2016-17, 45.9 kg/ha in 2017-18, 42.7 kg/ha in 2018-19, 49.8 kg/ha in 2019-20, and 49.1 kg/ha in 2020-21 to 46.8 kg/ha in 2021-22). The trend signifies adoption of some key recommendations made from time to time by the university for economizing P use.
- The university prepared biofertilizers for 15 different crops (enough for 69 thousand acres) for distribution among farmers.

### Crop Residue Management

- During 2022, total paddy residue burning count plunged to 49, 922 from 71, 304 in 2021. Paddy straw was managed without burning on about 49% area. Continuously expanded and updated residue handling machinery stock, especially the latest addition of PAU Surface Seeder, will help in stemming burning quickfixes.
- Policy support on the Direct Seeded Rice (DSR) *Basmati* cultivation may make a dent in managing straw load.

### Agribusiness and Technology Commercialization

- The university provided technical handholding for establishing five new agro-processing complexes and for upgrading two complexes.
- A modern jaggery plant (10 quintal capacity) was established at village Nila Niloy in Hoshiarpur district and was subsequently handed over to Mother Teresa self help group for supporting local livelihoods.
- During 2022-23, 32 MoAs were signed to commercialize a host of varietal, farm machinery, processing and waste management technologies.

# Administration

## BOARD OF MANAGEMENT

| Sr. No. | Name and Designation                                                                                                                                                                              | Period     |            |
|---------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|------------|
|         |                                                                                                                                                                                                   | From       | To         |
|         | <b>Honorary Chairman</b>                                                                                                                                                                          |            |            |
|         | Shri Banwarilal Purohit<br>Hon'ble Governor, Punjab & Chancellor                                                                                                                                  | 01.07.2022 | 30.06.2023 |
|         | <b>Working Chairman</b>                                                                                                                                                                           |            |            |
|         | Sh. Sarvjit Singh, IAS (Additional Charge)<br>Additional Chief Secretary, Agriculture & Farmers Welfare,<br>Department of Agriculture & Farmers Welfare,<br>Govt. of Punjab, Chandigarh- 160 001. | 01.07.2022 | 18.08.2022 |
|         | Dr Satbir Singh Gosal<br>Vice-Chancellor<br>PAU, Ludhiana                                                                                                                                         | 19.08.2022 | 30.06.2023 |
|         | <b>Members</b>                                                                                                                                                                                    |            |            |
| 1.      | Sh. Anirudh Tewari, IAS<br>Chief Secretary to Govt. of Punjab<br>Department of Agriculture & Farmers Welfare,<br>Govt. of Punjab, Chandigarh- 160 001                                             | 01.07.2022 | 04.07.2022 |
|         | Sh. Vijay Kumar Janjua, IAS<br>Chief Secretary to Govt. of Punjab, Chandigarh- 160 001                                                                                                            | 05.07.2022 | 30.06.2023 |
| 2.      | Sh. Sarvjit Singh, IAS<br>Addl. Chief Secretary, Agriculture & Farmers Welfare,<br>Department of Agriculture & Farmers Welfare,<br>Govt. of Punjab, Chandigarh- 160 001.                          | 01.07.2022 | 27.12.2022 |
|         | Sh. Rahul Tewari, IAS<br>Secretary, Agriculture & Farmers Welfare<br>Govt. of Punjab, Chandigarh- 160 001                                                                                         | 28.12.2022 | 12.03.2023 |
|         | Sh. Sumer Singh Gurjar, IAS<br>Principal Secretary, Agriculture & Farmers Welfare<br>Govt. of Punjab, Chandigarh- 160 001                                                                         | 13.03.2023 | 21.05.2023 |
|         | Sh. K.A.P. Sinha, IAS<br>Principal Secretary<br>Department of Finance,<br>Govt. of Punjab, Chandigarh- 160 001                                                                                    | 22.05.2023 | 30.06.2023 |
| 3.      | Sh. K.A.P Sinha, IAS<br>Principal Secretary<br>Department of Finance,<br>Govt. of Punjab, Chandigarh- 160 001                                                                                     | 01.07.2022 | 04.07.2022 |
|         | Sh. Ajoy Sharma<br>Principal Secretary<br>Department of Finance,<br>Govt. of Punjab, Chandigarh- 160 001                                                                                          | 05.07.2022 | 17.07.2022 |



|    |                                                                                                                                      |            |            |
|----|--------------------------------------------------------------------------------------------------------------------------------------|------------|------------|
|    | Sh. Ajoy Kumar Sinha, IAS<br>Principal Secretary (Finance)<br>Department of Finance,<br>Govt. of Punjab, Chandigarh- 160 001         | 18.07.2022 | 30.06.2023 |
| 4. | Sh. Gurvinder Singh<br>Director of Agriculture, Punjab<br>Kheti Bhawan (Near Dara Studio)<br>Phase-VI, Mohali- 160 055               | 01.07.2022 | 30.06.2023 |
| 5. | Dr Sujay Rakshit,<br>Director, Indian Institute of Maize Research,<br>PAU Campus, Ludhiana                                           | 01.07.2022 | 05.01.2023 |
|    | Dr Nachiket Kotwaliwale, Director<br>ICAR-Central Institute of Post-Harvest Engineering and Technology<br>(CIPHET), Ludhiana- 141004 | 06.01.2023 | 30.06.2023 |
| 6. | Sh. Hardayal Singh<br>S/o Sh. Dilbag Singh, Village Gaznipur,<br>District Gurdaspur, Punjab- 143520                                  | 01.07.2022 | 30.06.2023 |
| 7. | Sh. Amanpreet Singh<br>S/o Sh. Mohinder Singh<br>House No.18, Street No.3<br>New Harindera Nagar, Faridkot- 151203                   | 01.07.2022 | 30.06.2023 |
| 8. | Dr Deepak Mittal<br>Managing Director Sonalika Group,<br>International Tractors Limited, Jalandhar Road,<br>Hoshiarpur- 146022       | 01.07.2022 | 30.06.2023 |
| 9. | Smt. Kiranjeet Kaur Gill<br>16, II Floor, Baba Isher Singh Apartments,<br>Pakhowal Road, Ludhiana-141002                             | 01.07.2022 | 30.06.2023 |
|    | <b>Secretary</b>                                                                                                                     |            |            |
|    | Dr Shammi Kapoor<br>Registrar (Addl. Charge)                                                                                         | 01.07.2022 | 23.02.2023 |
|    | Dr Manav Indra Singh Gill<br>Registrar (Addl. Charge)                                                                                | 24.02.2023 | 30.06.2023 |



# Academic Council

| Designation                                              | Name                                        | From       | To         |
|----------------------------------------------------------|---------------------------------------------|------------|------------|
| Vice-Chancellor                                          | Sh. Sarvjit Singh<br>(Addl. Charge)         | 01.07.2022 | 18.08.2022 |
|                                                          | Dr Satbir Singh Gosal                       | 19.08.2022 | 30.06.2023 |
| Dean, Postgraduate Studies                               | Dr (Mrs) Sandeep Bains<br>(Addl. Charge)    | 01.07.2022 | 31.01.2023 |
|                                                          | Dr Pardeep Kumar Chhuneja<br>(Addl. Charge) | 01.07.2023 | 30.06.2023 |
| Dean, College of Agricultural Engineering & Technology   | Dr Ashok Kumar                              | 01.07.2022 | 31.01.2023 |
|                                                          | Dr H S Sidhu<br>(Addl. Charge)              | 01.02.2023 | 30.06.2023 |
| Dean, College of Community Science                       | Dr (Mrs) Sandeep Bains                      | 01.07.2022 | 31.01.2023 |
|                                                          | Dr Kiranjot Kaur Sidhu<br>(Addl. Charge)    | 01.02.2023 | 30.06.2023 |
| Dean, College of Basic Sciences & Humanities             | Dr Shammi Kapoor                            | 01.07.2022 | 30.06.2023 |
| Dean, College of Horticulture & Forestry                 | Dr Manav Indra Singh Gill                   | 01.07.2022 | 30.06.2023 |
| Dean, College of Agriculture                             | Dr Manav Indra Singh Gill<br>(Addl. Charge) | 01.07.2022 | 22.02.2023 |
|                                                          | Dr (Mrs) R K Dhaliwal<br>(Addl. Charge)     | 23.02.2023 | 30.06.2023 |
| Director of Research                                     | Dr Ajmer Singh Dhatt<br>(Addl. Charge)      | 01.07.2022 | 30.06.2023 |
| Director of Extension Education                          | Dr Ashok Kumar<br>(Addl. Charge)            | 01.07.2022 | 31.01.2023 |
|                                                          | Dr G S Buttar<br>(Addl. Charge)             | 01.02.2023 | 30.06.2023 |
| Head, Department of Food & Nutrition                     | Dr (Mrs) Kiran Bains                        | 01.07.2022 | 12.10.2023 |
| Head, Department of Human Development and Family Studies | Dr (Mrs) Deepika Vig                        | 28.10.2022 | 30.06.2023 |
| Head, Department of Processing & Food Engineering        | Dr Mahesh Kumar                             | 01.07.2022 | 20.08.2022 |
| Head, Department of Renewable Energy Engineering         | Dr Rajan Aggarwal                           | 21.08.2022 | 30.06.2023 |
| Director, School of Biotechnology                        | Dr (Mrs) Parveen Chhuneja                   | 01.07.2022 | 30.06.2023 |



| Designation                                    | Name                                        | From       | To         |
|------------------------------------------------|---------------------------------------------|------------|------------|
| Head, Department of Economics & Sociology      | Dr Kamal Vatta                              | 01.07.2022 | 04.04.2023 |
| Head, Department of Zoology                    | Dr (Mrs) Neena Singla                       | 24.04.2023 | 30.06.2023 |
| Head, Department of Floriculture & Landscaping | Dr (Mrs) Kiranjit Kaur Dhatt                | 01.07.2022 | 23.01.2023 |
| Head, Department of Vegetable Science          | Dr Tarsem Singh Dhillon                     | 24.01.2023 | 30.06.2023 |
| Registrar, Secretary                           | Dr Shammi Kapoor<br>(Addl. Charge)          | 01.07.2022 | 22.02.2023 |
|                                                | Dr Manav Indra Singh Gill<br>(Addl. Charge) | 23.02.2023 | 30.06.2023 |



# Important Decisions of the Board of Management

During the period under report, the Board of Management held five meetings (307<sup>th</sup> to 311<sup>th</sup>). The important decisions taken by the Board in this period are as under:

## Concession to Staff

- The Board of Management approved the revision of rates of Dearness Allowance to the employees transferred from State Farm Corporation of India (SFCI)/Punjab Land Development & Reclamation Corporation (PLDRC) to PAU drawing pay in the IDA (Industrial Dearness Allowance) pay scale.

B-1/308<sup>th</sup>

- The Board of Management approved the revision of rates of Dearness Allowance to the employees transferred from State Farm Corporation of India (SFCI)/Punjab Land Development & Reclamation Corporation (PLDRC) to PAU drawing pay in the CDA (Central Dearness Allowance) pay scale.

B-2/308<sup>th</sup>

- The Board approved the enhancement in the ceiling of Perks & Allowances from 25% to 30% to the ex-cadre employees transferred from SFCI/PLD&RC to PAU as per IDA pattern w.e.f. 01.04.2020.

B-4/309<sup>th</sup>

- The Board of Management approved that the time period required for a teacher to become eligible for transfer from outstation to PAU Campus, Ludhiana should be reduced from 7 years to 5 years of service at outstation.

C-4/309<sup>th</sup>

## Budget

- The Board of Management noted the creation and inclusion of new Revolving Fund Scheme entitled,

“Sale of Agricultural Produce, RF-18 (PC-3117)” in the University Budget for the year 2022-23.

B-4/308<sup>th</sup>

- The Board noted the creation and inclusion of new Revolving Fund Scheme entitled, “Commercial Plant Tissue Culture, RF-19 (PC-3118)”.

B-1/309<sup>th</sup>

- The Board approved the implementation of the revised 7<sup>th</sup> UGC pay scales for teachers and equivalent cadres of Punjab Agricultural University, Ludhiana.

B-8/309<sup>th</sup>

- The Board of Management approved the Budget Estimates of the Punjab Agricultural University for the financial year, 2023-24.

B-1/310<sup>th</sup>

## Concession to Students

- The Board of Management has approved the freezing of fee of all the degree programmes for two years i.e. 2023-24 & 2024-25.

- The tuition fee of all the self-supporting programmes is reduced 10% for two years i.e. 2023-24 and 2024-25.

- The fee structure of MCA (self-supporting) programme is approved to put on par with M. Tech. Agril. Engineering (normal fee mode).

- The fee for B. Tech. (Agril. Engg.) is rationalized with B.Sc. (Hons.) Agriculture tuition fee.

- The cycle stand shed charges for hostel students from Rs. 2370/- per semester are fixed at Rs.1000/- per semester.

C-1/311<sup>th</sup>



### Other Decisions

- The Board of Management unanimously decided to appoint Dr Satbir Singh Gosal as Vice-Chancellor of PAU.  
Item No.1/307<sup>th</sup>
- The Board of Management nominated Ms. Kiranjeet Kaur Gill as non-official member of the Finance Committee.  
C-1/308<sup>th</sup>
- The Board approved the appointment of Dr Nirmal Singh Jaura as Director Students' Welfare, PAU.  
A-3/309<sup>th</sup>
- The Board of Management approved in principal the Annual Report of PAU for the year 2021-22.  
C-1/309<sup>th</sup>
- The Board ratified the action taken by the Vice Chancellor in engaging Dr Manjit Singh Kang, Quantitative Geneticist, Former Vice Chancellor, PAU as Honorary Visiting Professor at PAU.  
C-2/309<sup>th</sup>
- The Board of Management ratified the action taken by the Vice-Chancellor in engaging Dr Jiwan Singh Sidhu, Former Head, Department of Food Science & Technology, PAU as Honorary Adjunct Professor at PAU.  
C-3/309<sup>th</sup>
- The Board of Management approved to transfer the 20.8527 ha of land at USF Ladhowal to NHAI for Ludhiana – Rupnagar Greenfield Expressway starting from Delhi- Katra Expressway (NE-5).  
C-6/310<sup>th</sup>



# Important Decisions of the Academic Council

During the period under report, six meetings (421<sup>st</sup> to 424<sup>th</sup>) of the Academic Council were held. The Important decisions taken by the Academic Council during this period are as under:-

- The Academic Council approved the institution of 'Dr Dev Raj Bhumbla Merit Scholarship'.  
Item No.C-3/421<sup>st</sup>
- The Council approved the institution of 'Gurbacahan Singh Bajwa Cash Award' for Best Athlete (Men & Women) on alternative years.  
Item No.C-4/421<sup>st</sup>
- The Council approved the framing of the rules for the award of 'FMC Science Leaders Fellowship Program'.  
Item No.C-19/421<sup>st</sup>
- The Council approved the institution of 'Avtar Singh Viridi Cash Award' for the students of 5-year Integrated M.Sc. (Hons) in Biochemistry.  
Item No.C-2/423<sup>rd</sup>
- The Council approved the institution of Medal in the name of 'Sardarni Sujana Kaur Memorial Medal for Excellence in Academics in M.Sc. Agricultural Economics/Sociology-Rules & Regulations/legend of certificate thereof.  
Item No. C-3/423<sup>rd</sup>
- The Council approved the award of 'S. Kashmir Singh Dhillon Memorial Medal' for Excellence in Academics in Ph.D. Horticulture (Vegetable Science)-Approval of rules and regulations/legend of certificate thereof.  
Item No. C-4/423<sup>rd</sup>
- The Council approved one year certificate course of French in Online Mode.  
Item No.C-2/424<sup>th</sup>
- The Council approved the institution of medal in the name of 'Sardarni Manjit Kaur W/o Dr Surjit Singh' to Doctorate student in Agronomy.  
Item No.C-5/424<sup>th</sup>
- The Council approved the institution of Fellowship in the name of 'Dr S S Parihar Memorial Fellowship' to the students of M.Sc. (Soil Science).  
Item No.C-9/424<sup>th</sup>
- The Council approved the institution of 'Devinder Singh Bansal Distinguished Scientist Award for Engineering Faculty of the College of Agricultural Engineering & Technology.'  
Item No.C-12/424<sup>th</sup>
- The Council approved the Devinder Singh Bansal Memorial Cash Award for M. Tech students of the college of Agricultural Engineering & Technology.  
Item No.C-13/424<sup>th</sup>
- The Council approved the change in nomenclature of Department of Family Resource Management to Department of Resource Management and Consumer Science as per the recommendations of BSMA.  
Item No.C-15/424<sup>th</sup>
- The Council approved the institution of award in the name of 'Dr A P S Gill Medal' for Excellence in Academics in M.Sc. Horticulture (Floriculture & Landscaping).  
Item No.C-18/424<sup>th</sup>
- The Council approved the scholarship in the name of 'Sardar Gajjan Singh and Mata Sant Kaur Dhillon Memorial Scholarship' to the students of B.Sc. (Hons.) Agriculture 2+4 year Programme.  
Item No.C-19/424<sup>th</sup>
- The Council approved the duration of MCA Programme from 3 years to 2 years from Academic Session 2023-24.  
Item No.C-21/424<sup>th</sup>
- The Council approved the institution of 'Best Ph.D. Thesis Award' for Doctoral research in the field of Agronomy in the memory of late Dr Harcharan Singh Sandhu.  
Item No.C-28/424<sup>th</sup>

# Annexure-I

## Important Projects Undertaken by the Estate Organization

### Projects Accomplished

| Sr. No. | Project                                                                                                                                                         | Amount in Rs. |
|---------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|
| 1       | Reconstruction of boundary wall of PAU along Ferozepur Road, Ludhiana                                                                                           | 2.51 Crore    |
| 2       | Construction of remaining part of the first floor of Dr GS Kalkat Laboratories, PAU, Ludhiana                                                                   | 80.00 Lakh    |
| 3       | Repair and Renovation of 14 type houses at Regional Research Station, Ballawal Saunkhri, Balachaur                                                              | 38.00 Lakh    |
| 4       | Construction of three rooms and one washroom at FRS, Jallowal                                                                                                   | 13.83 Lakh    |
| 5       | Fabrication of steps for ease of movement in Dr Manmohan Singh Auditorium, PAU, Ludhiana                                                                        | 7.71 Lakh     |
| 6       | Construction of two Research Laboratories and two offices over the existing building of experiential learning unit, College of Community Science, PAU, Ludhiana | 35.88 Lakh    |
| 7       | Construction of parking near PAU Health Centre, PAU, Ludhiana                                                                                                   | 18.52 Lakh    |
| 8       | Construction of chain linked boundary fence at RRS, Abohar                                                                                                      | 9.30 Lakh     |
| 9       | Construction of additional rooms on 2nd floor for Punjab Remote Sensing Centre, Ludhiana                                                                        | 72.12 Lakh    |

### Projects Initiated

| Sr. No. | Project                                                                                                                    | Amount in Rs. |
|---------|----------------------------------------------------------------------------------------------------------------------------|---------------|
| 1       | Chain link fencing around the Parker House at PAU, Ludhiana                                                                | 11.64 Lakh    |
| 2       | Construction of Demonstration Unit (Farm Machinery bank) at KVK, Jalandhar                                                 | 9.15 Lakh     |
| 3       | Construction of Poultry Demonstration Unit at KVK, Goneana (Muktsar)                                                       | 10.00 Lakh    |
| 4       | Construction of Incubation Centre at KVK, Patiala                                                                          | 85,74,480/-   |
| 5       | Construction of First phase of Boys Hostel at Ballawal Saunkhri                                                            | 79,82,755/-   |
| 6       | Fencing with iron pillars at H-Block of Regional Research Station, Gurdaspur                                               | 11.94 Lakh    |
| 7       | Laying of interlocking tiles for the path leading of office building, farmer hostel and demonstration unit at KVK, Bahawal | 6.00 Lakh     |
| 8       | Construction of Poultry Unit at KVK, Gurdaspur                                                                             | 7.02 Lakh     |
| 9       | Construction of three Green Houses, Department of Plant Breeding & Genetics at PAU, Ludhiana                               | 75.00 Lakh    |
| 10      | White wash and Exterior Paint in Hostel No. 6 at PAU, Ludhiana                                                             | 18,63,200/-   |
| 11      | Construction of boundary wall around Hostel No. 12 at PAU, Ludhiana                                                        | 12,77,200/-   |
| 12      | Painting of Hostel No. 1 at PAU, Ludhiana                                                                                  | 13.49 Lakh    |
| 13      | Installation of naturally Ventilated Polyhouse at KVK, Amritsar                                                            | 9.98 Lakh     |



## Important Projects Undertaken by the Engineering Unit

### Projects Accomplished

| Sr. No. | Project                                                                                                                                                                              | Amount in Rs. |
|---------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|
| 1       | Providing/Electricity installation for generator supply to Parker House at PAU, Ludhiana                                                                                             | 2,16,666/-    |
| 2       | Electrical work of various buildings at Ballawal Saunkhri                                                                                                                            | 13,60,600/-   |
| 3       | Providing E.I. work for the construction of remaining part of 1 <sup>st</sup> floor of Dr GS Kalkat Laboratories at PAU, Ludhiana                                                    | 8,50,564/-    |
| 4       | Providing E.I. for construction of two Research Laboratories and two offices over the existing building of Experiential Learning Unit, College of Community Science at PAU, Ludhiana | 2,96,456/-    |
| 5       | Providing E.I. in 1 <sup>st</sup> floor Bio Lab at Regional Research Station, Gurdaspur                                                                                              | 6,53,063/-    |
| 6       | Repair of electrical work in Bio-Control Lab at Regional Research Station, Kapurthala                                                                                                | 1,70,765/-    |
| 7       | Replacement LT Transmission Line Old Communication Chowk to Entomology Farm at PAU, Ludhiana                                                                                         | 1,93,862/-    |
| 8       | Repair/Replacement of electrical work on 3 <sup>rd</sup> floor in MS Randhawa Library at PAU, Ludhiana                                                                               | 2,62,545/-    |
| 9       | Replacement of Tube Lights with LED Lights in the Culture Racks of Commercial Plant Tissue Culture Unit, School of Agricultural Biotechnology at PAU, Ludhiana                       | 3,90,952/-    |
| 10      | Electrical works in Main Building and Quarters at Regional Research Station, Ballawal Saunkhri                                                                                       | 18,86,666/-   |

### Projects Under Progress

| Sr. No. | Project                                                                                                                                                                                      | Amount in Rs. |
|---------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|
| 1       | Repair/Renovation of electrical work of Food and Nutrition Lab near Skill Development Hostel at PAU, Ludhiana                                                                                | 2,88,119/-    |
| 2       | Repair E.I. in Old Pilot Plant in the Department of Food Science & Technology at PAU, Ludhiana                                                                                               | 6,56,802/-    |
| 3       | Providing E.I. work for the Agro-Processing Complex Unit, Department of Processing & Food Engineering, College of Agricultural Engineering & Technology at PAU, Ludhiana                     | 7,74,708/-    |
| 4       | Providing E.I. work in the construction of Main Building of New College of Agriculture at Regional Research Station, Ballawal Saunkhri                                                       | 1,16,50,021/- |
| 5       | Repair/Replacement of electrical work in School of Agricultural Biotechnology at PAU, Ludhiana                                                                                               | 24,23,391/-   |
| 6       | Providing E.I. work in partial construction of Girls' Hostel at Regional Research Station, Ballawal Saunkhri                                                                                 | 34,17,409/-   |
| 7       | Laying of network for CCTV at PAU, Ludhiana                                                                                                                                                  | 21,71,845/-   |
| 8       | (A) Replacement of street lights with LED lights (Gate No. 7 to 8 type Maintenance Chowk) at PAU, Ludhiana<br>(B) Replacement of street lights with LED lights at PAU campus & JLH, Ludhiana | 22,39,372/-   |
| 9       | Providing and installation of Boom Barriers & RFID Integration on main entry gates (1, 2 and 4) at PAU, Ludhiana                                                                             | 10,16,666/-   |
| 10      | Providing and installation of 35 KVA Generator Set for Dr KS Aulakh Examination Hall at PAU, Ludhiana                                                                                        | 7,04,702/-    |
| 11      | Providing and installation of ANPR System with IP CCTV on main entry gates (1, 2 and 4) at PAU, Ludhiana                                                                                     | 5,42,065/-    |

# Annexure-II

## PUBLICATIONS

### College of Agriculture

#### Research Papers in National and International Journals#:

1. Adhikary, A., Saini, R., Kumar, R., Singh, I., Ramakrishna, W. and Kumar, S. (2022). *Pseudomonas citronellolis* alleviates arsenic toxicity and maintains cellular homeostasis in chickpea (*Cicer arietinum* L.). *Plant Physiology and Biochemistry*, 184: 26-39 **(10.27)**
2. Aggarwal, S.K., Malik, P. Neelam, K. Kumar, K. Kaur, R. Lore, J.S. Singh, K. (2022). Genome-wide association mapping for identification of sheath blight resistance loci from wild rice *Oryza rufipogon*. *Euphytica*, 218, DOI: 10.1007/s10681-022-03091-z. **(7.90)**
3. Aggarwal, P., Singh, R., Kaur, S. and Kaur, N. (2022). Sugarcane juice kheer: a sweet meal for lactose intolerant people. *Agric Res J*, 59(4): 771-776. **(5.44)**
4. Aggarwal, S.K., Hooda, K.S., Bagaria, P.K., Kaur, H., Gogoi, R., Chauhan, P. and Singh, R.P. (2022). Multiple modules for the management of banded leaf and sheath blight of maize in India. *Indian Phytopathology*, 75:1065-1073, DOI: 10.1007/s42360-022-00543-3 **(5.95)**
5. Ahuja, R., Kalia, A., Sikka, R. and Chaitra, P. (2022) Nano modifications of BNHs for enhanced adsorption of HMs from wastewaters: *A Review ACS Omega*, 7(50): 45825- 45836. **(9.51)**
6. Amandeep and Kapoor, R. (2022). Exploitation and utilization of exotic germplasm accessions through variability and association studies in oat (*Avena sativa* L.). *Range Manag Agroforestry*, 43(2): 231-236 **(6.37)**
7. Anjali, Jindal, V. and Prakash, S. (2022). DNA barcoding of some pre-dominant spiders of semi-arid habitat of Agra, Uttar Pradesh India. *J. Exp. Zool. India* 25: 1581-85. **(5.25)**
8. Anupam, Dhillion, N.K., Kaur, S. and Buttar, H.S. (2023). Integrated Management of *Meloidogyne graminicolain* nursery beds of rice. *Indian Phytopathology*, 76:183-190. **(5.95)**
9. Arora, J.K., Kaur, S., Yadav, I., Kaur, S., Garg, M. Chhuneja, P. (2022). Investigation of differential expression of alpha-gliadin genes with variable immunogenic epitopes in hexa-and tetraploid wheat cultivars suggests some have lower immunogenicity. *Plant Molecular Biology Reporter*, 41, 134-144. **(7.60)**
10. Arora V., Pandove, G., Oberoi, H., Kaur, S. and Kalia, A. (2022). Amelioration in the quality traits of forage pearl millet (*Pennisetum glaucum*) by application of liquid microbial inoculants. *Indian J of Animal Sciences*, 92 (5): 599-603 **(6.32)**
11. Aulakh, C. S., Sandhu, A. S., Singh, M. and Thakur, M. (2022). Planting geometry affects potato (*Solanum tuberosum* L.) productivity and economics in north-west India. *Agricultural Research J*, 59(5): 876-80. **(5.44)**
12. Aulakh, C. S, Sharma, S., Thakur, M. and Kaur, P. (2022). A review of the influences of organic farming on soil quality, crop productivity and produce quality. *J of Plant Nutrition*. 45(12): 1884-1905 DOI: 10.1080/01904167.2022.2027976 **(7.13)**
13. Aulakh, C. S., Sidhu, A. S., Bhullar, M. S. and Singh, S. (2022). Non-chemical integrated weed management in organic wheat (*Triticum aestivum* L.) in north-west India. *Agricultural Research J*, 59(3): 423-28 **(5.44)**
14. Aulakh, C. S., Sidhu, A. S., Nara, U., Singh, S. and Singh, S. (2022). Evaluation of bread wheat (*Triticum aestivum*) genotypes under organic farming in north-west India. *Indian J of Agricultural Sciences*, 92(9): 1139-42 **(6.37)**
15. Aulakh, C. S., Sidhu, A. S., Singh, S. and Singh, D. (2022). Organic and natural farming in north-west India: Farmers' perspective. *Agricultural Research J*, 59 (6): 1078-1085. **(5.44)**
16. Bal, K. and Rani, N. (2022). Evaluation of integrated nutrient management on soil health, maize productivity and grain quality. *Journal of Soil, Plant and Environment*, 1(2): 44-60. DOI: 10.56946/jspae.v1i2.71 **(2.32)\***
17. Barsalia, R.K., Brar, K.S., Singh, P. and Sandhu, S. (2022). Estimation of combining ability for yield traits in Groundnut using genetic variance-covariance among relatives. *Leg Research*, 55(3): 310-316, DOI:10.18805/LR-4980 **(6.67)**
18. Basati, J.K., Kaur, Y., Hunjan, M.S., Lore, J.S., Kaur, H., Pannu, P.P.S. and Bal, R.S. (2022). Phenotypic diversity in phytopathogenic *Dickeya* associated with rice and maize in Punjab. *Plant Dis Research*, 37(2):178-186. **(4.76)**
19. Bassi, P., Kumar, V., Kaur, R., Kumar, S., Saini, R. K. and Janghu, S. (2023). Valorisation of kinnow peel for development of phytochemical enriched tea infusion: standardisation of tea bag loading, dipping temperature and dips per minute for the better extraction of bioactive compounds. *Int J Food Sci Technol*, 58: 2715-21. **( 9.71)**
20. Bons, H.K. and Pal, R. K. (2022). Survival of loquat under the subtropical conditions of Punjab, *J of Agrometeorology*, 24(3): 321-324. **(6.55)**

# National Academy of Agricultural Sciences (NAAS) Score in parenthesis.

Some papers may have been listed more than once depending on the affiliation of the author.

\* Impact Factor (IF)



21. Bhagat, M. A., Kaur, N. and Kaur, S. (2023). Effect of sowing dates on the phenology, grain yield and stress tolerance indices of barley (*Hordeum vulgare* L.) genotypes under subtropical conditions of Punjab. *J of Agrometeorol*, 25: 113-119 **(6.00)**
22. Bharadwaj, C., Jorben, J., Rao, A., Roorkiwal, M., Patil, B. S., Jayalakshmi, Khayum, A. S., Saxena, D. R., Yasin, M., Jahagirdar, J. E., Sontakke, P. L., Pithia, M. S., Chudasama, M. K., Swarup, I., Singh, R. K., Nitesh, S. D., Chitikineni, A., Singh, S., Singh, I., Pratap, A., Dixit, G. P., Srivastava, A. K. and Varshney, R. K. (2022). Development of high yielding fusarium wilt resistant cultivar by pyramiding of genes through Marker-Assisted Backcrossing in chickpea (*Cicer arietinum* L.). *Frontiers in Genetics*, 13: 924287, DOI: 10.3389/fgene.2022.924287. **(10.60)**
23. Bharti, K., Joshi, N., Khosla, S. and Kaur, R. (2022). Compatibility of entomopathogenic fungus *Metarhizium rileyi* with biorationals. *Indian J Ent*, 85: 225-228, DOI: 10.55446/IJE.2022.801 **(5.08)**
24. Bhinder, G., Sharma, S., Kaur, H., Akhtar, J., Mittal, M. and Sandhu, S. (2022). Genomic regions associated with seed meal quality *brassica napus* germplasm. *Front in Pl Science*, 13: 1-15. DOI: 10.3389/fpls.2022.882766 **(12.63)**
25. Bhullar, M.B., Kaur P. and Dhall R.K. (2022). Efficacy of biorationals against the two-spotted spider mite infesting cucumber cultivated under nethouse. *Zoosymposia*, 22: 003-019, DOI: 10.11646/Zoosymposia.22.1.2. **(0.5) \***
26. Biswas, S., Bhullar, M.B. and Kaur, P. (2023). Five new records and distribution of predatory mite fauna (Arachnida: Acari) associated with crop ecosystems of Northern India. *International J of tropical Insect Science*, 43(3), DOI: 10.1007/s42690-023-01040-4 **(6.85)**
27. Bobade, H., Singh, A., Sharma, S., Gupta, A. and Singh, B. (2022). Effect of extrusion processing on techno-functional, textural and bioactive properties of whole-grain corn flour-based breakfast cereals sweetened with honey. *J Texture Stud*, 53: 672-83. **(9.22)**
28. Bobade, H., Singh, A., Sharma, S., Gupta, A. and Singh, B. (2022). Effect of extrusion conditions and honey on functionality and bioactive composition of whole wheat flour-based expanded snacks. *J Food Process Preserv*, 46:1-11, e16132. **(8.19)**
29. Bobade, H., Singh, A., Sharma, S., Gupta, A. and Singh, B. (2022). Whole grain cereal flours and honey-based extruded breakfast cereals: Effect of extrusion processing on functional characteristics, antioxidant properties and hydroxymethylfurfural generation. *J Food Proc Preserv*, 46: e17166. **(8.19)**
30. Bopche, U., Kingra, P. K., Setia, R. and Singh, S.P. (2022). Spatio-temporal analysis of meteorological drought in Punjab under past, present and future climate change scenarios. *Arabian J of Geosciences*, 15, 756 DOI: 10.1007/s12517-022-10025-5 **(7.83)**
31. Brar, L.K., Sharma, P., Chugh, P., Kaur, P., Sharma, R. and Banga, S.S. (2022). Effect of elevated temperature on phenology, growth, yield components and seed yield of Brassica juncea grown in temperature gradient tunnels (TGT). *J of Agrometeorology* 24(4): 359-366. **(6.55)**
32. Brar, S., Kumar, P. and Kaur, P. (2018). Problems Faced by Farmers in Direct Seeded Rice- A Case Study. *Indian Journal of Economics and Development*, 14: 497-501. **(4.82)**
33. Buttar, H.S., Dhillon, N.K., Kaur, S. and Anupam. (2022). Integrated Application of Amendments and Chemicals for the Management of Root-Knot Nematode (*Meloidogyne incognita*) on Cucumber. *Indian J of Agricultural Sciences*, 92(11):1331-1335. **(6.37)**
34. Buttar, H. S., Singh, A., Sirari, A., and Kashyap, S. (2022). Occurrence of pod rot in Punjab: An emerging disease of mungbean. *Plant Disease Research*, 37(2): 143-148. **(4.76)**
35. Buttar, H.S., Dhillon, N.K., Kaur, S. and Anupam. (2023). Effects of root-knot nematode (*Meloidogyne incognita*) population densities on the growth of cucumber. *Indian Phytopathology*, 76: 303-307. **(5.95)**
36. Buttar, H. S., Singh, A., Sirari, A., and Sharma, S. (2023). Pod rot of mungbean in Punjab, India: First record of association of *Fusarium equiseti* and *Fusarium chlamydosporum*. *Crop Protection*, 168, 106230. **(9.04)**
37. Buttar, H. S., Singh, A., Sirari, A., Kaur, K., Kumar, A., Lal, M. K. and Kumar, R. (2023). Investigating the impact of fungicides and mungbean genotypes on the management of pod rot disease caused by *Fusarium equiseti* and *Fusarium chlamydosporum*. *Frontiers in Plant Science*, 14:1-15. **(12.62)**
38. Chandel, R., Kumar, V., Kaur, R., Kumar, S., Gill, M. S., Sharma, R. and Kumar, D. (2023). Functionality enhancement of osmo-dried sand pear cubes using different sweeteners: quality, bioactive, textural, molecular, and structural characterization. *J Food Meas Charact*, 17(4): 1-13. DOI: 10.1007/s11694-023-01894-9 **(8.43)**
39. Cherotich, C. and Kaur, M. (2023). Determinants of Awareness of Good Agricultural Practices (GAP) among Vegetable Growers in Nakuru, Kenya. *Asian J of Agril Ext, Econ and Soc*, 41(5): 111-120 **(4.86)**
40. Chandi, A. K., Kaur, A. and Chandi, R. S. (2022). Effect of insecticides on food consumption and utilization behaviour of different populations of *Spodoptera litura*. *Pesticide Research J*, 34(2): 115-21. **(5.49)**
41. Chandi, A. K., Kaur, A. and Chandi, R. S. (2023) Effect of insecticides on locomotory behaviour and enzyme activity of *Spodoptera litura* (Fabricius) populations from Punjab. *J of Environmental Biology*, 44: 214-19. **(5.57)**.
42. Chandi, A. K., Kaur, A. and Chandi, R. S. (2023). Oviposition behaviour of *Spodoptera litura* (Fabricius) and *Leucinodes orbonalis* Guenee populations from Punjab. *J of Experimental Zoology*, 26 (2): 2269-2272. **(5.25)**.
43. Chandi, R.S., Kaur, A., Sharma, R.K., Kumar, R. and Chhuneja, P. (2022). Efficacy of PAU Homemade Neem (*Azadirachta indica*) extract against *Bemisia tabaci* on brinjal. *Agric Res J*, 59 (4): 690-98 **(5.44)**
44. Chandi, R. S., Kaur, A., Sharma, R. K., Kumar, R. and Chhuneja, P. K. (2022) Efficacy of PAU homemade neem extract (*Azadirachta indica*) against *Bemisia tabaci* on brinjal. *Agricultural Research Journal*, 59(4): 690-98. **(5.44)**

45. Chaudhary, S., Jha, U. C., Paul, P. J., Prasad, P. V. V., Sharma, K. D., Kumar, S., Gupta, D. S., Sharma, P., Singh, S., Siddique, K. H. M. and Nayyar, H. (2022). Assessing the heat sensitivity of Urdbean (*Vigna mungo* L. Hepper) genotypes involving physiological, reproductive and yield traits under field and controlled environment. *Frontiers in Plant Science*, 13: 1-18. DOI: 10.3389/fpls.2022.1042999 **(12.63)**
46. Chawla, J.S., Gill, G. K., Garg, T., Singh G. and Sandhu, S.K. (2023). Notification of crop varieties and registration of germplasm, Maize Hybrid-PMH 13. *Indian J Genet Plant Breeding*, 83 (1): 148. **(7.34)**.
47. Chhabra, R., Sharma, R., Hunjan, M.S., Sharma, V.K., Thakur, S., and Chauhan, S. (2022). Physio-biochemical and histological alterations in response to sheath blight disease of rice (*Oryza sativa* L.). *Journal of Phytopathology*, 170, 778-790 DOI: 10.1111/jph.13141. **(7.79)**
48. Chhabra, R., Sharma, R., Hunjan, M. S., Sharma, V.K., Thakur, S. and Chauhan, S.K. (2023). Efficacy of botanical extracts on imparting systemic acquired resistance against rice sheath blight incited by *Rhizoctonia solani*. *J Plant Dis Prot*, 130, 551–569 DOI: 10.1007/s41348-023-00722-y **(7.85)**
49. Chhabra, R., Sharma, R., Hunjan, M.S., Sharma, V.K., Sharma, P. and Chauhan, S.K. (2023). Microstructural and metabolic variations induced by *Bipolaris oryzae* inciting brown spot disease of rice. *Cereal Research Communications*. 51, 953–968 DOI: 10.1007/s42976-023-00351-z **(7.24)**
50. Choudhary, A. K., Singh, N. and Singh, D. (2022). Management of foot rot of citrus (*Citrus jambhiri* spp.) using biocontrol agents. *Indian J of Agricultural Sciences* 92 (9): 1148–1152. **(6.37)**
51. Choudhary, A. K., Singh, N. and Singh, D. (2023). Mass multiplication and shelf life of *Trichoderma asperellum* in talc based bioformulation. *Agricultural Research J*, (Accepted). **(5.44)**
52. Choudhary, A., Mohindru, B., Kaur R., Singh, J. and Chhuneja, P.K. (2022). Partial solar eclipse affects *Apis mellifera* Linnaeus foraging activity. *Ind J Entomol*, (Accepted) **(5.08)**
53. Das D.T., Sharma, P., Tevatiya, S., Chauhan, C., Kumari, S., Yadav, P., Singla, D., Srivastava, V., Rani, J., Hasija, Y. (2022). Bidirectional microbiome-gut-brain-axis communication influences metabolic switch-associated responses in the mosquito *Anopheles culicifacies*. *Cells* 11,1-24 **(12.60)**
54. Deol, J.K., Sharma, S.P., Rani, R., Kalia, A., Chhuneja, P., Sarao, N.K. (2022). Inheritance analysis and identification of SSR markers associated with fusarium wilt resistance in melon. *The Journal of Horticultural Science and Biotechnology*, 97, 66-74 **(7.64)**
55. Devgan, M., Gill, G.K., Praba, U.P., Singh, G., Garg, T., Karnatam, K.S., Kaur, A. Vikal, Y. (2022). Biochemical and molecular characterization of sub-tropical maize germplasm for tocopherols. *J of Food Composition and Analysis*, 114, DOI: 10.1016/j.jfca.2022.104842 **(10.56)**
56. Dhaliwal, S.K., Gill, R.K., Sharma, A., Kaur, A., Bhatia, S., Kaur, S. (2022). A large-effect QTL introgressed from ricebean imparts resistance to Mungbean yellow mosaic India virus in blackgram (*Vigna mungo* (L.) Hepper). *Theoretical and Applied Genetics*, 135:4495-4506. **(11.70)**
57. Dhall, R.K., Kaur, H., Manchanda, P., Eshanee. (2023). Genetics and marker assisted breeding for sex expression in cucumber. *Frontiers in Genetics*, 14, DOI: 10.3389/fgene.2023.1180083 **(10.60)**
58. Devi, K.S., Banta, G. and Jindal, V. (2023) Technique to deliver dsRNA in *Bemisia tabaci* nymphs and its validation through silencing of juvenile hormone esterase gene. *J. Appl. Ent*, 147, 611-621. DOI: 10.1111/jen.13147 **(8.18)**
59. Devi, R., Singh, P., Mamta, Jeet, K. and Kumar, V., (2022). Temperature-dependent Dielectric Properties of Adulterated Honey – A Quality Assessment Measure for Fraud Detectio. *Indian J of Pure and Applied Physics*, 60, 209-217 **(6.92)**
60. Dhakad, A.K., Oberoi, H. and Lamba, J.S. (2022). Screening of *Moringa oleifera* seed sources for forage nutritional values and mineral profiling- A potential tree fodder in north-western India. *Forage Res*, 48 (3): 294-303. **(4.48)**
61. Dhakal, M., Tak, P. S., Kaur, J. and Pannu, P.P.S. (2022). Management of yellow rust of wheat under organic farming system. *Plant Disease Research*, 37 (2): 93-98. **(4.76)**.
62. Dhaliwal, L. K., Kaur, J. and Singh, J. (2022). Weather variability during wheat growing season in central plain region of Punjab. *International J of Plant and Soil Science*. 34(6): 34-48. **(5.07)**
63. Dhaliwal, S.S., Sharma, V., Shukla, A.K., Kaur, J., Gupta, R.K., Verma, V., Kaur, M., Singh, V.K. and Singh, P. (2023). Interactive effect of land use systems on depth-wise soil properties and micronutrients minerals in North-Western, India. *Heliyon*, 9(2): 1-10. e13591. **(9.78)**
64. Dhami, D. S., Kaur, S., Sharma, A., Dhillon, N. K. and Jain, S. (2022). Relative consequences of interaction among *Meloidogyne incognita*, *Fusarium oxysporum* and tomato leaf curl Palampur virus on disease severity and growth of muskmelon. *Indian Phytopathology*, 75: 767-779. **(5.95)**
65. Dhanda S., Kaur, S., Chaudhary, A., Jugulam, M., Hunjan, M.S., Sangha, M.K. and Bhullar, M.S. (2022). Characterization and management of metsulfuron-resistant *Rumex dentatus* biotypes in Northwest India. *Agronomy J*, 114: 366-378. **(8.24)**
66. Dhanda, S., Kaur, S., Chaudhary, A. and Bhullar, M.S. (2022). Confirmation of metsulfuron-resistant *Rumex dentatus* in Punjab and Haryana and its management. *Agric Res J*, 59 (3) : 429-437 **(5.44)**
67. Dharmateja, P., Yadav, R., Kumar, M., Babu, P., Jain, N., Mandal, P.K., Pandey, R., Shrivastava, M., Gaikwad, K.B., Bainsla, N.K. and Tomar, V. (2022). Genome-wide association studies reveal putative QTLs for physiological traits under contrasting phosphorous conditions in wheat (*Triticum aestivum* L.). *Front in Genetics*, 13: 1-23 **(10.77)**



68. Dhayal, D., Lal, K., Khanna, M., Sudhishri, S., Brar, A.S., Sindhu, V.K., Singh, M., Bhattacharyya, R., Rajath, E., Rosin, K.G. and Chakraborty, D. (2023). Performance of surface and subsurface drip fertigated wheat-moongbean-maize cropping system under different irrigation schedules and nutrient doses. *Agric Water Manag*, 284:1-13. 108338. **(10.52)**
69. Dhayal, D., Lal, K., Sindhu, V.K., Khanna, M., Sudhishri, S., Singh, M., Bhattacharyya, R., Rosin, K.G. and Chakraborty, D. (2023). Productivity and profitability of drip fertigated wheat (*Triticum aestivum*) – mungbean (*Vigna radiata*) – maize (*Zea mays*) cropping system. *Indian J of Agril Science*, 93: 284-289. **(6.37)**
70. Dhillon, B.S. and Ram, H. (2022). Growth indices, photosynthetic parameters and productivity of barley (*Hordeum vulgare*) as influenced by sowing dates and cutting management. *Indian J Agron*, 67 (4): 374-379. **(5.55)**
71. Dhillon, N.K., Kaur, S., Anupam, Buttar, H.S., Singh, K., Singh, P., Khapte, S. and Kumar, P. (2023). Management of Root-Knot Nematode with Non-Chemical Methods for Sustainable Production of Cucumber under Protected Cultivation. *Agronomy*, 13, 124. **(9.42)**
72. Dhiman, A., Kaur, R., Chandel, R., Kumar, S., Singh, B., Kumar, D. and Suhag, R. (2023). Effect of blanching and dehydration on rheological, structural, functional and physicochemical properties of okra. *J Food Meas Charact*, 17:4236-4248. DOI: 10.1007/s11694-023-01952-2 **(8.43)**
73. Dikhsa, Riari, T.S., Walia, S.S. and Garg, L. (2022). A Comparative Study of Economic Profitability of Various Integrated Farming Systems in Punjab. *Jof Community Mobilization and Sustainable Dev*, 17: 1235-1241 **(5.65)**
74. Dubey, S., Sikka, R., & Dhalwal, J. (2022). Bioavailability of cd and pb to indian mustard (brassica juncea (L.) czern.) as influenced by biochar. *Agric Res J*, 59(5): 864-869 **(5.44)**.
75. Dulazi, A.A., Kukal, S.S., Sharma, S. and Dhalwal, J. (2023). Soil organic carbon and its labile pools as modulated by soil microbes under different land use practices in Typic Ustochrepts. *Trop Ecol*, 64: 276-286. **(7.33)**
76. Ekhe, B.D., Aggarwal, R., Bains, K. and Sidhu, A. S. (2023). Comparison of bioactive compounds and antioxidant potential of varieties of different cereal grasses for potential therapeutic use. *Indian J of Ecology*, 50(4): 1220-1224. **(5.79)**
77. Gandhi, H., Toor, B.S., Kaur, A. and Kaur, J. (2022). Effect of processing treatments on physicochemical, functional and thermal characteristics of lentils (*Lens culinaris*). *J Food Measure Character*, 16(6): 4603-4614. **(8.43)**
78. Garima and Sandhu S S (2023) Phenology, growth and productivity of rice (*Oryza sativa* L.) under reduced sunlight intensity and foliar nitrogen application. *J of Agrometeorology*, 25(1): 98-104. **(6.00)**
79. Gaurav, K., Arora, S., Silva, P., Sanchez-Martin, J., Horsnell, R., Gao, L., Brar, G.S., Widrig, V., Raupp, W.J., Singh, N., Wu, S., Kale, S.M., Chinoy, C., Nicholson, P., Quiroz-Chavez, J., Simmonds, J., Hayta, S., Smedley, M.A., Harwood, W., Pearce, S., Gilbert, D., Kangara, N., Gardener, C., Forner, M.M., Liu, J., Yu, G., Boden, S.A., Pascucci, P., Ghosh, S., Hafeez, A.N., Hara, T.O., Waites, J., Cheema, J., Steuernagel, B., Patpour, M., Justesen, A.F., Liu, S., Rudd, J.C., Avni, A., Sharon, A., Steiner, B., Kirana, R.P., Buerstmayr, H., Mehrabi, A.A., Nasyrova, F.Y., Chayut, N., Matny, O., Steffenson, B.J., Sandhu, N., Chhuneja, P., Lagudah, E., Elkot, A.F., Tyrrell, S., Bian, X., Davey, R.P., Simonsen, M., Schauser, L., Tiwari, V.K., Kutcher, H.R., Hucl, P., Li, A., Liu, D., Mao, L., Xu, S., Guedira, G.B., Faris, J., Dvorak, J., Luo, M.C., Krasileva, K., Lux, T., Artmeier, S., Mayer, K.F.X., Uauy, C., Mascher, M., Bentley, A.R., Keller, B., Poland, J., Wulff, B.B.H. (2022). Population genomic analysis of *Aegilops tauschii* identifies targets for bread wheat improvement. *Nature Biotechnology*, 40, 422-431 **(20.00)**
80. Ghongade, D. S., Sangha, K. S., Dhall, R. K. and Bhullar, M. B. (2022). Field evaluation of *Blaptostethus pallens* Poppius (Hemiptera: Anthocoridae) in controlling *Tetranychus urticae* Koch on parthenocarpic cucumber under protected environments. *Int J Acarology*, 48 (2): 139-144. **(7.06)**
81. Gill, J., Jindal, V. and Sangha, K.S. (2023) Molecular characterization of *Trichogramma* spp. in sugarcane ecosystem in Punjab. *Indian J. Agric. Sci*, 93 (6): 659-663. **(6.37)**
82. Gill, J. K., Sangha, K. S., Shera, P. S. and Sharma, S. (2022). Insecticidal toxicity to *Trichogramma chilonis* Ishii (Hymenoptera: Trichogrammatidae) and subsequent effects on parasitic efficiency and adult emergence rate of descendant generation. *Int J Trop Insect Sci*, 42(5): 3489-3498. **(7.02)**
83. Gill, M. S., Gill, P. P. S., Pal, R. K. and Singh, N. (2022). Mulching effects on soil temperature and yield of pear [*Pyrus pyrifolia* (Burm.) Nakai] in humid subtropical climate of Punjab. *MAUSAM*, 73(4), 951-958 **(6.64)**
84. Goyal, A., Rani, N., Hundal, S. S. and Dhillon, N. (2023). Impact of Iron Oxide Nanoparticles on the Growth, Vermicomposting Efficiency and Nutritional Status of Vermicompost through *Eisenia fetida*. *Environmental Science Archives*, 2(1):75–85. DOI: 10.5281/zenodo.7691979 **(4.00)\***
85. Goyal, A., Rani, N., Hundal, S.S. and Dhillon, N. (2023). Impact of Zinc Oxide Nanoparticles on the Growth and Vermicomposting Efficiency of Vermicompost through *Eisenia fetida*. *National Journal of Environment and Scientific Research* 5 (5): 45-61 **(0.24)\***
86. Goyal, M., Kaur, H. and Singh, D.P. (2022). Biochemical profiling of geographically diverse cowpea (*Vigna unguiculata* L.) genotypes for nutritional quality and photochemical and antioxidant potential. *Agric Res J*, 59 (6):1010-19. **(5.44)**
87. Goyal P, Gupta N , Kaur S (2022) Screening of Barely (*Hordeum vulgare* L.) genotypes for tolerance to salt stress. *Agric Res J*, 59 (4): 616-624.6 **(5.44)**
88. Goyal, R., Sidhu, A. and Sharma, A. B. (2022). 1, 2, 4-Triazolyl functionalized allyl sulfide with antifungal potential for the control of *Fusarium fujikuroi* causing foot rot of rice. *Eur J Plant Pathol*, 163: 61-69. DOI: 10.1007/s10658-021-02457-8 **(7.91)**
89. Grover, K., Jeet, K. (2023). Preparation and Characterization of Nanohybrids Made of Graphene Oxide as Super Adsorbent. *Mat. Sci. Res. India*, 20(1):60-74. **(4.57)**

90. Gudi S, Saini, D.K., Halladakeri, P., Singh, G., Singh, S., Kaur, S., Goyal, P., Srivastava, P., Mavi, G.S. and Sharma, A. (2023). Genome-wide association study unravels genomic regions associated with chlorophyll fluorescence parameters in wheat (*Triticum aestivum* L.) under different sowing conditions. *Plant Cell Rep*, 42(9): 1453-1472. DOI: 10.1007/s00299-023-03041-6 **(10.96)**
91. Gupta, M., Choudhary, M., Singh, A., Sheoran, S., Singla, D., Rakshit, S. (2022). Meta-QTL analysis for mining of candidate genes and constitutive gene network development for fungal disease resistance in maize (*Zea mays* L.). *The Crop Journal*, 11, 511-522 **(10.41)**
92. Gupta, R.K., Kaur, J., Kang, J.S., Singh, H., Kaur, S., Sayed, S., Gaber, A. and Hossain, A. (2022). Tillage in combination with rice straw retention in a rice–wheat system improves the productivity and quality of wheat grain through improving the soil physio-chemical properties. *Land*, 11:1693-1710. DOI: 10.3390/land11101693 **(9.40)**
93. Gupta, R.K., Hans, H., Kalia, A., Kang, J.S., Kaur, J., Sraw, P.K., Singh, A., Alataway, A., Dewidar, A.Z. and Mattar, M.A. (2022). Long-term impact of different straw management practices on carbon fractions and biological properties under rice–wheat system. *Agriculture* 12: 1733-1748. DOI: 10.3390/agriculture12101733 **(3.04)\***
94. Gupta, V., Gupta, M., Sandhu, S. S., Singh, M., Kour, S., Bharat, R., Singh, A. P., Singh, P. and Singh, B. (2022). Evaluation of wheat varieties and their validation through CERES-Wheat model under lower foothills of Shivalik range of N-W Himalayas. *Agricultural Mechanization in Asia, Africa and Latin America*, 53(02): 6051-6065. **(6.14)**
95. Haider, M.W., Kaur, J., Bala, R., Singh, S., Srivastava, P., Sharma, A., Singh, R. and Kumari, J. (2023). Stripe rust resistance gene(s) postulation in wheat germplasm with the help of differentials and tagged molecular markers. *Scientific Rep*, 13:9007-9020. DOI: 10.1038/s41598-023-37367-8. **(11.00)**
96. Hari, R., Kaur, H., and Sikka, R. (2022). Need-based nitrogen management of wheat through use of green seeker and leaf color chart for enhancing grain yield and quality. *J Plant Nutrition*, 45: 2655-2671. DOI: 10.1080/01904167.2022.2035757 **(6.57)**
97. Harish, G. N., Singh, R., Sharma, S., Taggar, G. K. (2022). Changes in defense-related antioxidative enzymes amongst the resistant and susceptible soybean genotypes under whitefly, *Bemisia tabaci* (Hemiptera: Aleyrodidae) stress. *Phytoparasitica*, 51: 63-75. **(7.81)**
98. Harish, G. N., Singh, R. and Taggar, G. K. (2023). Screening technique to evaluate soybean resistance to whitefly, *Bemisia tabaci* (Gennadius) under screen-house conditions. *Journal of Entomological Research*, 47(2): 309-316 **(5.89)**
99. Harish, G. N., Singh, R., Sharma, S. and Taggar, G. K. (2023). Characterisation of resistance in soybean genotypes to whitefly, *Bemisia tabaci* (Gennadius) (Hemiptera: Aleyrodidae). *Indian J of Entomology* (Accepted) **(5.08)**
100. Hilli, H.J. and Kapoor, R. (2023). An overview of breeding objectives to improve the economically important traits in oat. *Current Agri Res J*, 11(1): 18-27. **(4.36)**
101. Hilli, H.J., Kapoor, R., Singla, A., Sharma, P. and Srivastava, P. (2023). Towards mapping of *Helminthosporium* leaf blight / *Pyrenophora* leaf spot resistance genes/QTLs in oats. *Cereal Research Commun*, 51:471–481 **(7.24)**
102. Hima, D., Sonia, K. and Hunjan, M.S. (2022). Chemical composition and antibacterial potential of *Terminalia arjuna* (Roxb. ex DC.) Wight Arn. leaves essential oil against phytopathogenic bacteria of rice and potato. *J of Essential Oil Bearing Plants* 25:468-481, DOI: 10.1080/0972060X.2022.2105661 **(7.70)**
103. Hunjan, M. S., Dhakal, M., Katoch, S., Suri, K. S., Jindal, V., Kaur, Y., Kooner, R., Lore, J. S., Pannu, P.P.S. and Mangat, G.S. (2022). First report of southern rice black streaked dwarf virus associated with rice dwarf symptoms in Indian Punjab. *Plant Disease Research*, 37 (2): 198-202. **(4.76)**
104. Hunjan, M.S., Dhakal, M., Katoch, S., Suri, K.S., Jindal, V., Kaur, Y., Kooner, R., Lore, J.S., Pannu P.P.S. and Mangat, G.S. (2022). First report of southern rice black streaked dwarf virus associated with rice dwarf symptoms in Indian Punjab. *Plant Disease Research*, 37 (2): 198-202, DOI No. 10.5958/2249-8788.2022.00033.6 **(4.76)**
105. Jagtap, A.B., Yadav, I.S., Vikal, Y., Praba, U.P., Kaur, N., Gill, A.S. and Johal, G.S. (2023). Transcriptional dynamics of maize leaves, pollens, and ovules to gain insights into heat stress-related responses. *Front. Plant Sci*, 14:1117136 **(11.75)**
106. Jain, S. and Rani, R. (2022). Dose optimization of combination product of tebuconazole + trifloxystrobin WG against powdery mildew of green pea incited by *Erysiphe polygoni*. *Pesticide Research J*, 34(2):195-200. **(5.49)**
107. Jhans, B., Kaur, G., Gupta, A., Singh, A., Sharma, S. and Sharma, R. (2023). Functional, bioactive and morphological properties of purple wheat bran enriched pasta. *Int J Food Sci Technol*, 58(3):1241-49. **(9.71)**
108. Jindal, S., Pathak, D., Pandher, S., Rathore, P., Vikal, Y. (2022). Inheritance and molecular tagging of genes introgressed from *Gossypium arboreum* to *G. hirsutum* for leafhopper tolerance. *Journal of Genetics*, 101, DOI: 10.1007/s12041-022-01379-6. **(7.17)**
109. Jindal, V., Li, D., Rault, L.C., Fatehi, S., Singh, R., Mating, M., Zou, Y., Ng, H.L., Kaczmarek, K., Zabrocki, J., Gui, S., Smagghe, G., Anderson, T.D., Nachman, R.J. and Park, Y. (2022) Bee-safe peptidomimetic acaricides achieved by comparative genomics. *Sci Rep* 12, 17263-17275. DOI: 10.1038/s41598-022-20110-0 **(10.38)**
110. Joshi, D., Dhaliwal, R.K. and Singh, D. (2022). A Measurement Tool to Assess Attitude of Rural Youth towards Agriculture as an Occupation. *Indian J of Extension Education*, 22: 97-100 **(5.22)**
111. Joshi, S., Sharma, S., Sharma, R., Gupta, A. and Kumar, R. (2023). Influence of pre-gelatinization in conjunction with guar gum addition on texture functionality, bioactive profile, in vitro nutrient digestibility, morphology and secondary structure of protein of quality protein maize pasta. *Int. J. Food Sci. Technol*, 58(6): 3448-57. **(9.71)**



112. Kapoor, R. and Singh, T.P. (2022). Notification of crop varieties and registration of germplasm, oat variety-OL 1874-1. *Indian J Genet Pl Breed*, 82 (4): 533. **(6.51)**
113. Kapoor, R., Amandeep and Hilli H.J. (2022). OL 15: A high yielding, single cut variety of fodder oat developed for Punjab state. *Electronic J Plant Breed*, 13 (1): 125-131. **(5.14)**
114. Kapoor, S., Kaur, A., Kaur, R., Kumar, V. and Choudhary, M. (2022). Euryale ferox, a prominent superfood: Nutritional, pharmaceutical, and its economical importance. *J Food Biochem*, 46: 1-15. DOI: 10.1111/jfbc.14435 **(8.72)**
115. Karedla, A.K., Choudhary, A., Singh, J. and Chhuneja, P.K. (2023). Effect of sub-lethal doses of thiamethoxam on the memory of *Apis mellifera* Linnaeus. *Curr Sci*, 124(4): 451-456 **(7.17)**
116. Karnatam, K.S., Chhabra, G., Saini, D.K., Singh, R., Kaur, G., Praba, U.P., Kumar, P., Goyal, S., Sharma, P., Ranjan, R., Sandhu, S.K., Kumar, R. and Vikal, Y. (2023). Genome-wide meta-analysis of QTLs associated with root traits and implications for maize breeding. *Int J Mol Science*, 24(7): 6135. **(12.21)**
117. Karnatam, K.S., Mythri, B., Un Nisa W., Sharma, H., Meena, T.K., Rana, P., Vikal, Y., Gowda, M., Dhillon, B.S. and Sandhu, S. (2023). Silage maize as a potent candidate for sustainable animal husbandry development—perspectives and strategies for genetic enhancement. *Front Genetics*, 14:1150132. DOI: 10.3389/fgene.2023.1150132 **(10.77)**
118. Karnatam, K.S., Chhabra, G. Saini, D.K., Singh, R., Kaur, G., Praba, U.P., Kumar, P., Goyal, S., Sharma, P., Ranjan, R. et al. (2023). Genome-Wide Meta-Analysis of QTLs Associated with Root Traits and Implications for Maize Breeding. *International J of Molecular Sciences*, 24, DOI: 10.3390/ijms24076135 **(11.92)**
119. Karnatam, K.S., Mythri, B., Un Nisa, W., Sharma, H., Meena, T.K., Rana, P., Vikal, Y., Gowda, M., Dhillon, B.S. and Sandhu, S. (2023). Silage maize as a potent candidate for sustainable animal husbandry development- Perspectives and strategies for genetic enhancement. *Front. Gene*, 14:1150132. **(10.60)**
120. Kataria, D., Mandal, K., Sharma, S. and Kang, B. K. (2022). Dissipation and persistence of imidacloprid used as seed treatment in peas. *Indian J Entomol*, 84: 1–5. DOI: 10.55446/IJE.2022.657 **(5.08)**
121. Katoch, S., Arora, A., Kaur, A., Singh, H. and Hunjan, M.S. (2022). Graft transmission and confirmation of *Candidatus Liberibacter asiaticus* using PCR with species specific primers. *Plant Disease Research*, 37(2): 187-191. **(4.76)**
122. Katyal, P., Bhardwaj, R., Sharma, S., Sekhon, J.K., Pathania, N., Vyas, P., Kapoor, S. and Kocher, G.S. (2022). Microbial decomposer assisted in situ degradation of surface retained paddy straw. *International J Recycling Organic Waste in Agriculture*, 12(3): 467-475. DOI: 10.30486/ijrowa.2022.1935169.1292 **(2.92)\***
123. Kaul, S. Kaur, K., Kaur, J., Mehta, N. and Kennedy, J. F. (2023). Properties of potato starch as influenced by microwave, ultrasonication, alcoholic-alkali and pre-gelatinization treatments. *Int Journal Biol Macromol*, 226, 1341-51. **(12.95)**
124. Kaul, S., Kaur, K., Kaur, P. and Kaur, J. (2022). Development and shelf-life assessment of ready-to-bake frozen potato paranthas fortified with iron and zinc. *Int J Food Sci Technol*, 57(11), 7214-21. **(9.71)**
125. Kaur, A., Grewal, S.K., Kaur, S., Sharma, A., Srivastava, P., Garg, M., Wani, S.H., Chhuneja, P., Singh, K., Kaur, S. (2022). Juvenile heat stress tolerance in *Triticum durum*—*Aegilops tauschii* derived synthetics: A way forward for wheat improvement. *Molecular Biology Reports*, 49, 5669-5683 **(8.32)**
126. Kaur, A. and Singh, G. (2022). Zinc and iron application in conjunction with nitrogen for agronomic biofortification of field crops- A review. *Crop and Pasture Science*, 73(7-8), 769-780. **(8.25)**
127. Kaur, A., Sharma, U., Singh, S., Singh, R., Vikal, Y., Singh, S., Malik, P., Kaur, K., Singh, I., Bindra, S., Sarmah, B. K. and Sandhu, J. S. (2022). Introgressing cry1Ac for pod borer resistance in chickpea through Marker-Assisted Backcross breeding. *Frontiers in Genetics*, 13:1-15. DOI: 10.3389/fgene.2022.847647. **(9.26)**
128. Kaur, A., Saini, M.K., Sharma, S. and Kooner, R. (2022). Novel Molecules targeted control of brinjal shoot and fruit Borer, *Leucinodes orbonalis* in subtropical conditions of Punjab (India). *Pesticide Research Journal* 34 (1): 41-45 **(5.49)**
129. Kaur, A., Sharma, V.K., Rani, R. and Hunjan, M.S. (2023). Morpho-molecular characterization based diversity analysis of *Bipolaris* isolates infecting graminaceous hosts. *Cereal Research Communications*, 51: 1-15. DOI: 10.1007/s42976-023-00409-y **(7.24)**
130. Kaur, A., Singh, K. B., Brar, A. S., Gupta, R. K. and Kingra, P. K. (2023). Interactive effect of nitrogen and irrigation on evapotranspiration, growth, yield and water productivity of subsurface drip-irrigated spring maize: Field and simulation studies. *Irrigation and Drainage* 72(2): 1-20. DOI: 10.1002/ird.2812. **(7.42)**
131. Kaur, A., Aggarwal, P., Kaur, N. and Kaur, S. (2022). Enhancement of biofunctional properties, sensory attributes, and shelf life of flatbread by incorporating red bell pepper (*Capsicum annuum* L.). *J Food Proc and Preserv*, 46(12): 1-16. DOI: 10.1111/jfpp.17220. **(8.19)**
132. Kaur, A., Sidhu, A. S., Aulakh, R. K., Kaur, J. and Singh, A. (2023). Evaluation of physico-chemical parameters of soil in different cropping systems and their co-relation with earthworm diversity. *International J of Plant and Soil Science* 35: 121-28. DOI: 10.9734/IJPSS/2023/v35i112953. **(5.07)**
133. Kaur, A., Grewal, S.K., Kaur, S., Sharma, A., Puja Srivastava, et al (2022) Juvenile heat stress tolerance in *Triticum durum*—*Aegilops tauschii* derived synthetics: a way forward for wheat improvement. *Mol Biol Rep*, 49:5669-5683 **(8.74)**
134. Kaur, G., Yadav, I.S., Bhatia, D., Vikal, Y., Neelam, K., Dhillon, N.K., Praba, U.P., Mangat, G.S. and Singh, K. (2022). BSAseq Identifies a Major Locus on Chromosome 6 for Root-Knot Nematode (*Meloidogyne graminicola*) resistance from *Oryzagla berrima*. *Frontiers in Genetics*, 13: 1-15. **(10.60)**

135. Kaur, H., Sidhu, G.S., Mittal, A., Yadav, I.S., Mittal, M., Singla, D., Singh, N., Chhuneja, P. (2022). Comparative transcriptomics in alternate bearing cultivar Dashehari reveals the genetic model of flowering in mango. *Frontiers in Genetics*, 13, DOI: 10.3389/fgene.2022.1061168 **(10.60)**
136. Kaur, H., Kalia, A., Sandhu, J.S., Dheri, G.S., Kaur, G., Pathania, S. (2022). Interaction of TiO<sub>2</sub> nanoparticles with soil: Effect on microbiological and chemical traits. *Chemosphere*, DOI: 10.1016/j.chemosphere.2022.134629 **(13.09)**
137. Kaur, H., Kyum, M., Sandhu, S., Singh, G., Sharma, P. (2023). Protocol optimization and assessment of genotypic response for inbred line development through doubled haploid production in maize. *BMC Plant Biology*, 23, DOI: 10.1186/s12870-023-04228-5 **(10.22)**
138. Kaur, H., Dhall, R.K., Sharma, P. (2023). Association studies in pea for yield and yield attributing traits. *Genetika*, 55, 373-385. **(6.76)**
139. Kaur, H., Manchanda, P., Kumar, P., Dhall, R.K., Chhuneja, P., Weng, Y. (2023). Genome-wide identification and characterization of parthenocarpic fruit set-related gene homologs in cucumber (*Cucumis sativus* L.). *Scientific Reports*, 13, DOI: 10.1038/s41598-023-29660-3 **(10.38)**
140. Kaur, H., Kingra, P. K., Singh, R., Kaur, S. and Singh, S.P. (2022). Simulation of climate change impact on water productivity of maize in central Punjab. *Mausam* 73 (3): 673-682 **(6.37)**
141. Kaur, H., Kingra, P.K. and Singh, S.P. (2022). Managing Climate Change Impacts on Growth and Yield of Maize by Adjusting Sowing Time. *Mausam* 73(3): 673-82 **(6.64)**
142. Kaur, H., Kyum, M., Sandhu, S., Bjwa, G. S., and Sharma, P. (2023). Protocol optimization and assessment of genotypic response for inbred line development through doubled haploid production in maize. *BMC Plant Biology*, 23:219 DOI: 10.1186/s12870-023-04228-5 **(11.26)**
143. Kaur, H., Ahmadi, K., Kumar, S. and Kumar, M. (2022). Associations between charcoal rot disease and grain yield in different sowing dates in spring maize (*Zeamays* L.). *Indian Phytopathology*, 75: 741–747. h DOI: 10.1007/s42360-022-00493-w **(5.95)**
144. Kaur, H., Singh, I., Sethi, S., Bhatia, D., Gill, B. S. and Singh, S. (2022). Genetic Divergence for Seed Yield Enhancing and Quality Traits in Pigeonpea [*Cajanus cajan* (L.) Millsp.]. *Legume Research*, 46(6): 684-689. DOI: 10.18805/LR-4739. **(6.59)**
145. Kaur, H., Oberoi, H.K., Ganapathy, K.N. and Bhardwaj, R. (2023). Effect of popping and malting processing techniques on physiochemical, antinutrients and antioxidant properties of millets flour. *J Food Sci Tech*, 60: 2370-2384. DOI:10.1007/s13197-023-05758-4 **(8.70)**
146. Kaur, H., Kaur, J., Bala, R., Srivastava, P., Raheja, S. and Biswas, B. (2023). Evaluation of monogenic lines with known *Lr* genes and commercial wheat cultivars for leaf rust (*Puccinia triticina*) resistance across different environments in Punjab, India. *Cereal Res Commun*, DOI: 10.1007/s42976-023-00405-2. **(7.24)**
147. Kaur, J., Goyal, M., Lamba, J.S. and Agarwal, R.K. (2022). Sugarcane tops and additives influence nutritional quality and fermentation characteristics of mixed silage prepared with rice straw. *Range Mgmt. and Agroforestry*, 43 (2): 309-316. **(6.37)**
148. Kaur, J., Kaur, Y., Hunjan, M.S., Lore, J.S., Kaur, H., Pannu, P.P.S. and Bal, R.S. (2022). Phenotypic diversity in phytopathogenic *Dickeya zeae* associated with rice and maize in Punjab. *Plant Disease Research*, 37(2): 178-186. **(4.76)**
149. Kaur, J., Singh, B., Singh, A., Sharma, S. and Kidwai, M. K. (2023). Effect of extrusion processing on techno-functional properties, textural properties, antioxidant activities, in vitro nutrient digestibility and glycemic index of sorghum–chickpea-based extruded snacks. *J Texture Stud.* (Accepted). **(9.22)**
150. Kaur, J., Kaur, P. and Kothiyal, S. (2022). Futuristic changes in monthly meteorological parameters as simulated by four GCMs under four emission based scenarios at Ludhiana, Punjab. *Arabian J of Geosciences*, 15: 906 **(7.83)**
151. Kaur, J. and Kaur, P. (2022). A critical assessment of changes in climate predicted by four GCMs under different RCP scenarios in Punjab (India). *Mausam* 73(4): 749-762. **(6.64)**
152. Kaur, K., Sharma, A., Mavi, G. S., Srivastava, P., Kaur, H., Sharma, H., Singh, S., Kushwah, A., Sohu, V.S. (2022). Biofortified wheat: harnessing genetic diversity for improved nutritional quality to eradicate hidden hunger. *Crop Science*, 62, 802-819. **(8.32)**
153. Kaur, K., Utreja, D., Dhillion, N.K., Anupam and Buttar, H.S. (2022). Heterocyclic Moieties as Prospective Nematicides: An Overview. *Current Organic Chemistry*, 26(18):1-22 **(2.18)\***
154. Kaur, K. and Kumar, P. (2022). Impact analysis of KVK activities in different adopted villages of Punjab. *J of Community Mobilization and Sustainable Development*. 17: 362-68 **(5.3)**
155. Kaur, K., Kaur Kler, T. and Sandhu, S. (2023). T-Perches Determining Avian Feeding Guilds in Maize. *Indian J Entomology*, 85: 1–6. DOI: 10.55446/IJE.2023.700 **(5.08)**
156. Kaur, K. and Kaur, P. (2022). Evaluating the impact of intra-seasonal change in temperature and solar radiation on phenology and yield of rice using CERES-rice model in Punjab. *Mausam* 73(2): 423-432. **(6.64)**
157. Kaur, K. and Kaur, P. (2022). Simulation of yield of rice cultivars under variable agronomic management options using CERES-Rice and INFOCROP-Rice models in irrigated plains of Punjab. *Agric Res J*, 59 (3): 438-446. **(5.44)**
158. Kaur, K., Mavi, G.S., Bhagat, I., Sharma, A., Srivastava, P., Kaur, H. and Sohu, V.S. (2023). Phenotypic Evaluation of Grain Zinc Enhanced Wheat Lines for Agronomic and Quality Traits. *Indian J Agric Res*, 57:1 30-34 **(5.27)**
159. Kaur, M., Singh, D., Anand, A. and Singh, T. (2023). Do attributes of happy seeder technology influence its adoption speed? An investigation using duration analysis in Northern India. *Int J of Agril Sustainability*, 21(1): 1-17. (3.506)\*

160. Kaur, M., Joshi, N., Sharma, S. and Kalia, A. (2022). Pathogenicity of Nucleopolyhedrovirus (NPV) against *Spodoptera litura* (Fabricius). *J Biol Control*, 35 (4): 218-226 **(4.99)**
161. Kaur, M., Choudhary A., Mohindru B., Kaur M., Singh J. and Chhuneja P.K. (2022) How long can bee specimen be left in pan trap under sub-tropical conditions without compromising its extractable genomic DNA quality and quantity? *J Entomol Res*, (Accepted) **(5.89)**
162. Kaur, M. and Oberoi, H.K. (2022). Production potential of a bio-energy crop (sweet sorghum) for biomass, grain yield and bio-fuel under variable nutrient environment in North-West India. *Indian J of Agronomy*, 67 (4): 412-416. **(5.55)**
163. Kaur, M., Ram, H. and Kaur, S. (2022). Performance of food barley (*Hordeum vulgare* L.) varieties under different sowing windows and seeding rates. *Agric Res J*, 59: 625-630 DOI: 10.5958/2395-146X.2022.00091.6 **(5.44)**
164. Kaur, N., Sohu, R.S., Bhardwaj, R., Sharma, S. and Kaur, M. (2022). Effect of salinity on growth traits in sorghum (*Sorghum bicolor*). *Agric Res J*, 59 (5): 844-855. **(5.44)**
165. Kaur, N. and Kaur, P.(2022).Calibration and validation of CERES-Maize model under different environments for Ludhiana, Punjab. *J. of Agril Physics* 22(1): 99-106. (5.10)
166. Kaur, N., Aggarwal, P. and Kaur, S. (2023). Phytochemical profile and techno-functional properties of black carrot (*Daucus carota*) pomace powder for the formulation of nutraceutical tablets: an impact of drying methods. *Biomass Convers Biorefin*, 13: 1-11. DOI: 10.1007/s13399-023-04511-3. **(10.99)**
167. Kaur, N., Aggarwal, P., Kaur, N. and Kaur, S. (2023). Phytonutritional profile, cooking quality, in vitro digestibility, organoleptic attributes and storage stability of variety bell pepper incorporated pasta. *J Food Meas Charc*, 17(2), 1371-1381. **(8.43)**
168. Kaur, N., Aggarwal, P., Kumar, V. and Kaur, S. (2023). Ultrasound-Assisted Extraction of Phytochemicals from Java Plum (*Syzygiumcumini* L.) Pomace: Process Optimization, Phytochemical Characterization Using HPLC, FTIR, SEM and Mineral Profiling. *Waste, Biomass Valori*, 14: 949-61. **(9.70)**
169. Kaur, N., Singh, M. J. and Kaur, S. (2022). Long term monthly and inter-seasonal weather variability analysis for lower Shivalik foothills of Punjab. *Mausam*, 73(1): 173-80. **(6.64)**
170. Kaur, P., Kaur, G., Kyum, M., Kaur, S., Bains, S., Sharma, P., Kaur, H., Sandhu, S.K., Vikal, Y. (2022). Marker-assisted pyramiding of southern leaf blight resistance QTLs *qSLB3.1* and *qSLB8.1* in maize (*Zea mays*). *Indian J of Agricultural Sciences* 92,1437-1442 **(6.33)**
171. Kaur, P., Saini, K. S., Kaur, K., Singh, T. and Walia, S. S. (2022). Production potential, economics and energetics of rice (*Oryza sativa*)- wheat (*Triticum aestivum*) cropping system influenced by organic amendments and different levels of nitrogen. *Indian J of Agronomy*, ISA/2021(07)/121. (Accepted) **(5.55)**
172. Kaur, P., Sandhu, S.S., Kothiyal, S. and Kaur, J. (2022). Determination of sowing window for wheat in Punjab, India using sensitized, calibrated and validated CERES-Wheat model *J of Agril Physics*, 22(2):215-227. **(5.10)**
173. Kaur, P., Kaur, G., Kyum, M., Kaur, S., Bains, S., Sharma, P., Kaur, H., Sandhu, S.K. and Vikal, Y. (2022). Marker-assisted pyramiding of southern leaf blight resistance QTLs *qSLB3.1* and *qSLB8.1* in maize (*Zea mays*). *Indian J Agril Science*, 92: 1437–1442. **(6.37)**
174. Kaur, R., Bedi, S. and Kaur, P. (2022). Evaluation of growth and yield in wheat (*Triticum aestivum* L.) under heat stress conditions. *Agric Res J*, 59 (4): 609-615. **(5.44)**
175. Kaur, R., Kumar, A., Kumar, V., Kumar, S., Saini, R. K., Nayi, P. and Gehlot, R. (2022). Recent advancements and applications of explosion puffing. *Food Chem*, 403: 1-11. **(13.51)**
176. Kaur, R, Kumar, P, Kumar, A, Praba, UP, Birdi, R, Singh, R, Kaur, G, Lore, JS, Neelam, K, Vikal, Y (2022) *OsMATE6* gene putatively involved in host defense response toward susceptibility against *Rhizoctonia solani* in rice. *J of Plant Interactions* 17, 744-755 **(10.21)**
177. Kaur, R., Kaur, R., Sharma, N., Kumari, N. et al. (2022). Protein profiling in a set of wild rice species and rice cultivars: A stepping stone to protein quality improvement. *Cereal Research Communications*, 51, 163–177. **(6.85)**
178. Kaur, S., Sharma, S. P, Sarao, N. K., Deol, J. K., Gill, R., Abd-Elsalam, K. A., Alghuthaymi, M. A., Hassan, M. M. and Chawla, N. (2022). Heterosis and combining ability for fruit yield, sweetness,  $\beta$ -carotene, ascorbic acid, firmness and fusarium wilt resistance in muskmelon (*cucumis melo* L.) involving genetic male sterile lines. *Horticulturae*, 8(1):82, DOI:10.3390/horticulturae8010082 **(8.33)**
179. Kaur, S., Kang, B.K., Sharma, S. and Sahoo, S.K. (2022). Dissipation of Fenazaquin in Brinjal Fruits and its cultivated soil. *Pestic Res J*, 34(2): 201-08. **(5.49)**
180. Kaur, S., Aggarwal, P. and Babbar, N. (2022). Evaluating Progress of Indian Potato Processing Industry: An Updated Review. *Potato Res*, 66: 945-964. DOI:10.1007/s11540-022-09605-5 **(8.07)**
181. Kaur, S., Aggarwal, P. and Kaur, N. (2022). Enhanced functionality and shelf stability of burfi by incorporating kinnow (mandarin) fruit juice. *J Food Sci Technol*, 59(12):4956-68. **(8.70)**
182. Kaur, S., Kaur, P. and Kaur, H. (2022). The role of meteorological parameters in determining yield of rice cultivated under flooded transplanted conditions in Ludhiana district- A case study. *J of Agrometeorology*, 24 (3): 299-304. **(6.55)**
183. Kaur, S., Kocher, D.K., Kaur, A. and Kumar, R.(2023).Larvicidal potential and retention efficacy period of citronella leaf oil against *Aedes aegypti* L. *Indian Journal of Entomology*, 85: 1-7 **(5.08)**.

184. Kaur, S. and Dhillon, N.K.(2022). Ecofriendly Management of Root Knot Nematode, *M. Incognita*, in Cucumber under Protected Cultivation. *Agricultural Research J*, 59(2): 285-92. **(5.44)**
185. Kaur, S., Dhillon, N. K., Devi, R. and Buttar, H. S. (2022). Assessment of root-knot nematode, *M. incognita* and identification of the source of resistance in cauliflower, *Brassica oleracea*. *J of Applied Horticulture*, 24(2):235-239. **(5.13)**
186. Kaur, Y., Arora, A. and Thind, S.K. (2023). Management of *Phytophthora nicotianae*, the incitant of citrus foot rot, with new generation fungicides. *Agriculture Research J*, 60(1): 66-73. **(5.44)**
187. Kaura, V., Malhotra, P.K., Mittal, A., Sanghera, G.S., Kaur, N., Bhardwaj, R.D., Cheema, R.S., Kaur, G. (2022). Physiological, biochemical, and gene expression responses of sugarcane under cold, drought and salt stresses. *J of Plant Growth Regulation* 41, DOI: 10.1007/s00344-022-10850-8. **(10.17)**
188. Khan, H., Krishnappa, G.R., Kumar, S., Mishra, C.N., Krishna, H., Devate, N.B., Parkash, O., Yadav, S.S., Srivastava, P. et al. (2022). Genome-wide association study for grain yield and component traits in wheat (*Triticum aestivum* L.). *Front Genet*13: 1-17, DOI: 10.3389/fgene.2022.982589 **(10.77)**
189. Khan, H., Krishnappa G, Kumar, S., Mishra, C.N., Parkash, O., Rathore, A., Das, R.R., Yadav, R., Krishna, H., Bishnoi, O.P. and Sohu, V.S. (2023). Genetic gains in grain yield in wheat (*Triticum aestivum* L.) cultivars developed from 1965 to 2020 for irrigated production conditions of northwestern plains zone of India. *Cereal Research Commun*, 51:437-446.**(7.24)**
190. Khanna, N., Bhullar, M.S., Jaidka, M. and Kaur, T. (2022). Maize weed control and yield using different applications of tembotrione. *Intl J Pest Mgt*, DOI: 10.1080/09670874.2022.2050833 **(7.91)**
191. Khanna, N., Jaidka, M. and Bhullar, M.S.(2022). Quantification of intra- and inter-row weed competition in maize. *Maydica*, 66 (3): 5 **(6.54)**
192. Kharub, A.S., Ram, H., Khippal, A., Singh, B., Kumar, S., Berkesia, N., Yadav, M., Singh, B.P., Kaur, M., Kumar, D., Verma, R.P.S. and Singh, G.P. (2022). Use of growth regulators for lodging tolerance and increasing productivity of barley (*Hordeum vulgare*): An empirical study. *Indian J Agric Sci*, 92 (11): 1306–1310. **(6.37)**
193. Khedwal, R.S., Chaudhary, A., Sindhu, V.K., Yadav, D.B., Kumar, N., Chhokar, R.S., Poonia, T.M., Kumar, Y. and Dahiya, S. (2023). Challenges and technological interventions in rice–wheat system for resilient food–water–energy–environment nexus in North-western Indo-Gangetic Plains: A review. *Cereal Res Comm*, 51: 785-807. DOI: 10.1007/s42976-023-00355-9. **(6.85)**
194. Khepar, V., Sidhu, A., and Sharma, A. B. (2023). Topologically Zn 2+ hybridized ZnS nanospheres (Zn 2+/nZnS) efficiently restrained the infection of *Fusarium verticillioides* in rice seeds by hyphal disorganization and nutritional modulation. *Environmental Science: Nano*, 10(4): 1138-1151. **(9.47)\***
195. Khepar, V., Sidhu, A., Sharma, A. B., and Sharma, P. (2023). Zinc sulfide nano aqua formulation as antifungal nanoprimer agent against phytopathogens of paddy seeds: in silico, in vitro and seed treatment studies. *European J of Plant Pathology*, 165(3):509-524. **(7.91)**
196. Khepar V, Sidhu, A. and Sharma, A. B. (2022). Nanomaterized zinc sulfide-meerscham biomatrix (nZnS-MR) efficiently suppressed *Fusarium verticilloides* with augmented rice seed quality benefits during storage. *Pest Management Sci*, 79(1): 244-256. DOI: 10.1002/ps.7194 **(10.85)**
197. Khokhar, S., Taggar, G. K. and Grewal, S. K. (2023). Alteration in the developmental physiology of *Maruca vitrata* (Fabricius) on jasmonic acid and salicylic acid treated pigeonpea. *Arthropod-Plant Interactions*, 17: 389-400. **(8.41)**
198. Kooner, R. and Suri, K.S. (2022). Biological activity of benzpyrimoxan insecticide against plant hoppers in rice. *Curr Adv in Agric Sci*, 14: 180-185. **(5.12)**
199. Kooner, R., Sharma, D.K. and Suri K.S. (2023). Efficacy of two-in-one model traps and sun drying against *Callosobruchus maculatus* (F.) in mungbean. *Indian J of Ent*, 85: 129-133. **(5.08)**
200. Kothiyal, S., Kaur, P., Sandhu, S. S. and Kaur, J. (2023). Modelling viable adaptive options under climate change scenarios to increase maize productivity in Indian Punjab. *Arabian J of Geosciences*, 16: 403 DOI: 10.1007/s12517-023-11516-9. **(6.00)**
201. Kothiyal, S., Kaur, P., Sandhu, S. S. and Kaur, J. (2023). Modelling the climate change impact of mitigation (RCP 2.6) and high emission (RCP 8.5) scenario on maize yield and possible adaptation measures in different agroclimatic zones of Punjab, India. *J of the Science of Food and Agriculture*, 103(14): 6984-6994. DOI: 10.1002/jsfa.12779 **(10.13)**
202. Kothiyal, S., Kaur, P. and Kaur, J. (2022). Simulation and analysis of maize (*Zea mays* L.) yield trend under different emission scenarios in Ludhiana district of Punjab. *Agric Res J*, 59 (4): 639-652. **(5.44)**
203. Kothiyal, S., Kaur, P. and Kaur, J. (2023). A critical analysis of effect of projected temperature and rainfall for differential sowing of maize cultivars under RCP4.5 and RCP6.0 scenarios for Punjab. *Theoretical and Applied Climatology*, 151: 329–354 **(9.41)**
204. Kothiyal, S., Kaur, P., Sandhu, S.S. and Kaur, J. (2023). Modelling viable adaptive options under climate change scenarios to increase maize productivity in Indian Punjab. *Arabian J of Geosciences* 16: 1-17. **(6.00)**
205. Krishnappa, G., Khan, H., Krishna, H., Kumar, S., Mishra, C. N., Parkash, O., Devate, N.R., Nepolean, T., Rathana, N.D., Mamrutha, H.M. and Srivastava, P. et al (2022). Genetic dissection of grain iron and zinc, and thousand kernel weight in wheat (*Triticum aestivum* L.) using genome-wide association study. *Scientific Rep*, 12(1): 1-23. DOI:10.1038/s41598-022-15992-z **(10.00)**
206. Kumar, A., Sandhu, N., Kumar, P., Pruthi, G., Singh, J., Kaur, S., Chhuneja, P. (2022). Genome-wide identification and in silico analysis of NPF, NRT2, CLC and SLAC1/SLAH nitrate transporters in hexaploid wheat (*Triticum aestivum*). *Scientific Reports*, 12, 1-20. **(10.38)**



207. Kumar, A., Kaur, R., Kumar, V., Kumar, S., Gehlot, R. and Aggarwal, P. (2022). New insights into water-in-oil-in-water (W/O/W) double emulsions: Properties, fabrication, instability mechanism, and food applications. *Trend Food Sci Technol*, 128(1): 1-25. DOI: 10.1016/j.tifs.2022.07.016 **(18.56)**
208. Kumar, A., Sharma, S., Toor, A. K., Sharma, P. and Dhaliwal, S. S. (2023). Variability in Iron and Zinc as Well as Protein Concentration in Blackgram (*Vigna mungo* (L.) Hepper) Genotypes for Improved Nutritional Quality. *Legume Research*. (Accepted). **(6.67)**
209. Kumar, A., Gill, R. K., Sandhu, J. S., Singh, I. and Singh, S. (2022). Notification and germplasm registration: Urdbean variety-Mash 1137. *Indian J of Genetics and Plant Breeding*, 82: 377 **(6.51)**
210. Kumar, K., Kaur, A., Kishore, A., Kaur, P., Babbar, A., Kaur, G., Kamboj, I., Lore, J.S., Vikal, Y., Mangat, G.S. (2022). High-resolution mapping of the quantitative trait locus (QTLs) conferring resistance to false smut disease in rice. *J of Applied Genetics*, 63, 35-45. **(9.24)**
211. Kumar, K., Mandal, S.N., Neelam, K., De L.R., Benildo, G. (2022). MicroRNA-mediated host defense mechanisms against pathogens and herbivores in rice: Balancing gains from genetic resistance with trade-offs to productivity potential. *BMC Plant Biology*, 22, 1-16. **(10.22)**
212. Kumar, K., Mandal, S.N., Pradhan, B., Kaur, P., Kaur, K., Neelam, K. (2022). From evolution to revolution: Accelerating crop domestication through genome editing. *Plant and Cell Physiology*, 63, 1607-1623 **(10.93)**
213. Kumar, R., Bhatt, R., Kashyap, L. and Shera, P.S. (2023). Silicon retention in soil and sugarcane cultivar and its impact on stalk borer (*Chiloauricilius* Dudgeon), yield and quality indices in Northwest India. *Silicon*, 15(15): 1-16. DOI: 10.1007/s12633-023-02508-1 **(8.94)**
214. Kumar, R., Kaur, N., Singh, A.D., Shobha, Chaudhary, D., Singh, B., Das, A., Kumar, P., Sharma, P., and Kaur, Y. (2022). Improvement in nutritional quality of traditional unleavened flat bread using quality protein maize. *Frontiers in Nutrition*, 9, 1-12. **(12.58)**
215. Kumar, S., Sharma, S., Kumar, V., Sharma, A., Kaur, R. and Saini, R. (2023). Jamun (*Syzygiumcumini* (L.) Skeels): The conventional underutilized multifunctional plant-an exotic gleam into its food and functional significance. *Ind Crop Prod*, 191:115873. **(11.65)**
216. Kumar, S., Kaur, H., Hunjan, M.S. and Kaur, K. (2022). Biochemical changes induced in the maize leaf sheath upon inoculation with *Rhizoctonia solani* incitant of banded leaf and sheath blight. *Cereal Research Communications*. 51, 413–423 DOI: 10.1007/s42976-022-00310-0. **(6.85)**
217. Kumar, S., Singh, M., Singh, S.K. and Bhullar, M.S. (2022). Droplet size distribution and weed control efficacy of unmanned aerial vehicle sprayer in wheat crop. *J AgrilEngg*, 59 (2):126-136. **(4.79)**
218. Kumar, S., Pradhan, A.K., Kumar, U., Dhillon, G.S., Kaur, S., Budhlakoti, N., Mishra, D.C., Singh, A.K., Singh, R., Kumari, J., Kumaran, V.V., Mishra, V.K., Bhati, P.K., Das, S., Chand, R., Singh, K., Kumar, S. (2022). Validation of Novel spot blotch disease resistance alleles identified in unexplored wheat (*Triticum aestivum* L.) germplasm lines through KASP markers. *BMC Plant Biology*, 22, DOI: 10.1186/s12870-022-04013-w. **(10.22)**
219. Kumar, S., Jacob, S.R., Mir, R.R., Vikas, V.K., Kulwal, P., Chandra, T., Kaur, S., Kumar, U., Kumar, S., Sharma, S. (2022). Indian wheat genomics initiative for harnessing the potential of wheat germplasm resources for breeding disease-resistant, nutrient-dense, and climate-resilient cultivars. *Frontiers in Genetics*, 13, 1-19. **(10.60)**
220. Kumar, T., Tiwari, N., Bharadwaj, C., Roorkiwal, M., Reddy, S. P. P., Patil, B. S., Kumar, S., Hamwieh, A., Vinutha, T., Bindra, S., Singh, I., Alam, A., Chaturvedi, S. K., Kumar, Y., Nimmy, M. S., Siddique, K. H. M. and Varshney, R. K. (2022). A comprehensive analysis of Trehalose 6-phosphate synthase (TPS) gene for salinity tolerance in chickpea (*Cicer arietinum* L.) *Scientific Reports*, 12:16315 DOI: 10.1038/s41598-022-20771-x. **(10.38)**
221. Kumar, V. and Grewal, G. K. (2023). Influence of temperature on survival and development of *Helicoverpa armigera* (Hubner). *Ecology, Environment and Conservation*, 29(3): 342-47. **(5.41)**
222. Kumar, V., Kaur, J. and Kaur, J. (2023). Effectiveness of new generation insecticides against mealybug, *Phenacoccus solenopsis* in Bt cotton. *Indian J of Entomology*, 35, 28-32 **(5.08)**
223. Kumar, V., Kumar, A. and Jindal, V. (2023). Effect of Bt and non-Bt cotton on biology of *Thrips tabaci* and its management using insecticides. *Indian J of Entomology*, 85: 1-13. DOI: 10.55446/IJE.2023.508 **(5.08)**
224. Kumari, M., Radha, Kumar, M., Zhang, B., Amarowicz, R., Puri, S., Pundir, A., Rathour, S., Kumari, N., Chandran, D. and Dey, A. (2022). *Acacia catechu* (L.f.) Willd: A Review on Bioactive Compounds and their Health Promoting Functionalities. *Plants* (Basel), 11(22): 3091. DOI: 10.3390/plants11223091. PMID: 36432824, PMCID: PMC9697042 **(10.66)**
225. Kundra, V., Aulakh, C. S. and Bhullar, M. S. (2023). Integration of allelopathic water extracts with cultural practices for weed management in organic wheat. *Indian J of Weed Science*, 55(1): 24–31 **(5.84)**
226. Kushwah, A., Bhatia, D., Barmukh, R., Singh, I., Singh, G., Bindra, S., Vij, S., Chellapilla, B., Pratap, A., Roorkiwal, M., Kumar, S., Varshney, R.K. and Singh, S. (2022). Genetic mapping of QTLs for drought tolerance in chickpea (*Cicer arietinum* L.). *Front Genet*, 13: 953898. DOI: 10.3389/fgene.2022.953898. **(10.60)**
227. Kushwah, A., Bhatia, D., Singh, G., Singh, I., Vij, S., Bindra, S., Siddique, K.H.M., Nayyar, H. and Singh, S. (2022). Phenotypic evaluation of agronomic and root related traits for drought tolerance in recombinant inbred line population derived from a chickpea cultivar (*C. arietinum* L.) and its wild relative (*C. reticulatum*). *Physiol Mole Biol Plants*, 28: 1437–1452. **(8.39)**

228. Kushwah, A., Bhatia, D., Barmukh, R., Singh, I., Singh, G., Bindra, S., Vij, S., Bhardwaj, C., Pratap, A., Roorkiwal, M., Kumar, S., Varshney, R. K. and Singh, S. (2022). Genetic mapping of QTLs for drought tolerance in chickpea (*Cicer arietinum* L.). *Frontiers in Genetics*, 13:953898. DOI: 10.3389/fgene.2022.953898. **(10.60)**
229. Lekhi, D., Kaur, A., Rani, U., Soi, S., Singh, I., Bindra, S., Pratap, A., Singh, S. and Bharadwaj, C. (2022). Inheritance and mapping of QTLs for Ascochyta blight resistance in chickpea (*Cicer arietinum*). *Indian J of Agricultural Sciences*, 92: 316-19 **(6.37)**
230. Mahar, J.B., Sharma, S., Kaur, R., Grover, K., Dharni, K. and Nara, U. (2023). Nephroprotective effect of lemongrass (*Cymbopogon flexuosus*) and celery (*Apium graveolens*) based detoxifying drinks against carbon tetrachloride-induced nephrotoxicity in albino rats. *J. Anim. Plant Sci.*, 33(4), 765-775 **(6.57)**
231. Malhotra, N., Sharma, S., Sahni, P., Singh, B. and Sharma, S. P. (2022). Nutritional composition, techno-functionality, in-vitro starch digestibility, structural characteristics and storage stability of sweet potato flour and mash supplemented specialty pasta. *LWT – Food Sci Technol*, 168: e113886. DOI : 10.1016/j.lwt.2022.113886 **(6.00)\***
232. Malhotra, P.K., Sanghera, G.S., Kaur, M., Kapoor, M. (2022). Optimization of selective agents for *in vitro* regeneration of sugarcane transformants using NPTII gene. *Agricultural Research Journal*, 59, 631-638 **(5.44)**
233. Manchanda, P., Kaur, M., Sharma, S., Sidhu, G.S. (2023). Biotechnological interventions for reducing the juvenility in perennials. *Horticulturae* 9, DOI: 10.3390/horticulturae9010033. **(8.33)**
234. Manchanda, P., Kaur, H., Mankoo, R.K., Kaur, A., Kaur, J., Kaur, S., Sidhu, G.S. (2022). Optimization of extraction of bioactive phenolics and their antioxidant potential from callus and leaf extracts of *Citrus sinensis* (L.) Osbeck, c. *Reticulata* blanco and *C. maxima* (Burm.) Merr. *J of Food Measurement and Characterization* 17, 1343-1353. **(8.43)**
235. Mandal, A., Majumder, A., Dhaliwal, S.S., Toor, A.S., Mani, P.K., Naresh, R.K., Gupta, R.K., and Mitran, T. (2022). Impact of agricultural management practices on soil carbon sequestration and its monitoring through simulation models and remote sensing techniques: A review. *Critical Rev Environ Science Technol*, 52:1-49. DOI: 10.1080/10643389.2020.1811590 **(18.56)**
236. Mandal, A., Toor, A.S., Dhaliwal, S.S., Singh, Pritpal, Singh, V.K., Sharma, Vivek., Gupta, R.K., Naresh, R.K., Kumar, Y., Pramanick, B., Nanda, G., Gaber, A., Alkhedaide, A., Mohd. Soliman, M., and Hossain, A. (2022). Long-Term Field and Horticultural Crops Intensification in Semiarid Regions Influence the Soil Physiobiochemical Properties and Nutrients Status. *Agronomy*, 12: 1010. DOI:10.3390/agronomy12051010 **(9.42)**
237. Mandal, K., Joshi, S., Bansal, T., Sharma, S. and Kang, B. K. (2022). Residual determination of spirotetrament and imidacloprid in onion and tomato crop by mass spectrometry. *Int J Environ Anal Chem*, DOI: 10.1080/03067319.2022.2103690. **(8.83)**
238. Mandal, K., Kaur, A., Sharma, S. and Sahoo, S. K. (2022). Persistence of trifloxystrobin and tebuconazole in cowpea following application of combination formulation. *Pestic Res J*, 34(1)15-19. **(5.49)**
239. Mandal, K., Singh, R., Sharma, S. and Kataria, D. (2023). Dissipation and kinetic studies of fluopyram and trifloxystrobin in chilli. *J Food Compost Anal*, 115: 105008. **(10.56)**
240. Mangat, H.K., Rani, M., Pathak, R.K., Yadav, I.S., Utreja, D., Chhuneja, P.K., Chhuneja, P. (2022). Virtual screening, molecular dynamics and binding energy MM-PBSA studies of natural compounds to identify potential ECR inhibitors against *Bemisia tabaci* gennadius. *Plos one*, 17, 1-13 **(9.24)**
241. Manhas, U., Singh, S.P., Kingra, P. K., Setia, R. K. and Sharma, R. (2022). Delineation of thermal requirements of Rice (*Oryza sativa* L) using Geospatial Technology in Punjab. *J of Agrometeorology* 24(1): 90-94. **(6.55)**
242. Mavi, M.S., Singh, G., Choudhary, O.P., Singh, A., Vashisht, B.B., Sekhon, K.S., Pathania, N., Singh, BP. (2023). Successive addition of rice straw biochar enhances carbon accumulation in soil irrigated with saline or non-saline water. *Environmental Research* 217: 114733. **(14.43)**
243. Mehta, P. and Dhaliwal, L. K. (2023). Agromet wheat app for estimation of phenology and yield of wheat under Punjab conditions. *International J of Biometeorology*. 67, 439–445 DOI: 10.1007/s000484-022-02423-x. **(9.74)**
244. Mittal, S., Saini, S.P., Meena, H.M. and Singh, P. (2023). Soil Manganese Dynamics and Performance of Wheat Cultivars in Relation to Soil and Foliar Manganese Application with and Without Manures in North-western, India. *J Soil Sci Plant Nutr*, 23:1967–1980, DOI: 10.1007/s42729-023-01151-4. **(9.61)**
245. Mohindru, B. and Chhuneja, P. K. (2023). Differential expression of hygienic trait characteristics between hygienic and non-hygienic *Apis mellifera* Linnaeus colonies. *J Entomol Res*, 47 (1): 195-199. **(5.89)**
246. Murria, S., Gupta, N., Kingra, P. K., Sharma, A.B., Bhardwaj, R. and Kaur, N. (2022) Influence of agro-meteorological variables on downy mildew development in pearl millet (*Pennisetum glaucum* (L.) R. Br.). *J of Agrometeorology*, 24 (1): 113-116. **(6.55)**
247. Neelam, K., Kumar, K., Kaur, A., Kishore, A., Kaur, P., Babbar, A., Kaur, G., Kamboj, I., Lore, J.S., Vikal, Y. (2022). High-resolution mapping of the quantitative trait locus (QTLs) conferring resistance to false smut disease in rice. *J of Applied Genetics*, 63, 35-45 **(9.24)**
248. Negi, P., Rani, R. and Jain, S. (2023). Survival and infectivity of oospores of *Pseudoperonosporacubensis* causing downy mildew of cucurbits in the alluvial plains of Northwestern India. *Indian Phytopathology*, 76:347-354. **(5.95)**
249. Negi, P., Rani, R. and Jain, S. (2023). Distribution and prevalence of downy mildew disease on cucurbits in Punjab. *Indian J of Ecology*, 50(1): 146-50. **(5.79)**
250. Nisar, S., Mavi, MS., Singh, J., Dey, P. (2022). Integrated nutrient management in spring-maize improves yield, nutrient use efficiency and minimizes greenhouse gas intensity. *Archives of Agronomy and Soil Science* 69, 2522-2536 **(8.24)**



251. Oberoi, H.K., Singh, J. and Tiwana, U.S. (2022). Response of hybrid fodder sorghum in relation to sulfur fertilization and irrigation regimes in semi-arid region of North West India. *J Plant Nutrition*, 46(1): 1-21. **(7.71)**
252. Padhy, A.K., Sharma, A., Sharma, H., Srivastava, P., Singh, S., Kaur, P., Kaur, J., Kaur, S., Chhuneja, P. and Bains, N.S. (2023). Combining high carotenoid, grain protein content and rust resistance in wheat for food and nutritional security. *Front Genet*, 14DOI:10.3389/fgene.2023.1075767 **(10.77)**
253. Padhy, A.K., Kaur, P., Singh, S., Kashyap, L. and Sharma, A. (2022). Colored wheat and derived products: Key to global nutritional security. *Crit Rev Food SciNutr*, DOI:10.1080/10408398.2022.2119366 **(17.18)**
254. Padhy, A.K., Sharma, A., Sharma, H., Rajput, R., Pandey, A., Srivastava, P., Kaur, S., Kaur, H., Singh, S., Kashyap, L., Mavi, G.S., Kaur, J., Sohu, V.S., Chhuneja, P. and Bains, N.S. (2022). Bread wheat with enhanced grain carotenoid content: a novel option for wheat biofortification. *Mol Breeding*, 42:67. DOI:10.1007/s11032-022-01338-0 **(9.30)**
255. Padhy, A.K., Sharma, A., Sharma, H., Srivastava, P., Singh, S., Kaur, P., Kaur, J., Kaur, S., Chhuneja, P., Bains, N.S. (2023). Combining high carotenoid, grain protein content and rust resistance in wheat for food and nutritional security. *Frontiers in Genetics*, 14, DOI: 10.3389/fgene.2023.1075767 **(10.60)**
256. Padhy, A.K., Sharma, A., Sharma, H. R., Ruchika, Pandey, A., Srivastava, P., Kaur, S., Kaur, H., Singh, S., Kashyap, L. (2022). Bread wheat with enhanced grain carotenoid content: a novel option for wheat biofortification. *Molecular Breeding*, 42, DOI: 10.1007/s11032-022-01338-0 **(8.59)**
257. Pal, R.K., Kumar, V., Kaur, A. and Singh, P. (2022). Optimizing Sowing Window for Cotton using CROPGRO-Cotton Model for South-Western Region of Punjab. *J of Agricultural Physics*, 22: 107-115. **(5.10)**
258. Pal, V., Singh, G. and Dhaliwal, S.S. (2023). Effects of sequential and tank mix applications of zinc, iron and nitrogen on symbiotic parameters, productivity and economics of chickpea (*Cicer arietinum* L.) under field conditions. *J of Soil Science and Plant Nutrition*, 23(2): 2673-2686. **(9.61)**
259. Pankaj, Sharma, S., Singh, V., Angmo, P. (2023). Changes in soil biological and chemical environment during wheat growth stages under nitrogen and straw management practices in rice-wheat system, *J of Plant Nutrition*, 46, 3599-3616 DOI: 10.1080/01904167.2023.2209112 **(7.71)**
260. Panwar, A.S., Ansari, M.A., Ravisankar, N., Babu, S., Prusty A.K., Ghasal, P.C., Choudhary, J., Shamim, M., Singh, R., Raghavendra, K.J., Dutta, D., Meena, A.L., Chauhan, G.V., Ansari, M.H., Singh, R., Aulakh, C.S., Singh, D.K. and Sharma, P.B. (2022). Effect of organic farming on the restoration of soil quality, ecosystem services, and productivity in rice-wheat agro-ecosystems. *Front Environ Sci* 10. DOI: 10.3389/fenvs.2022.972394 **(11.41)**
261. Patel, E., Kalia, A., Gill, B.S., Kaur, A., Sandhu, J.S. (2023). Direct organogenesis from cortical cells of hypocotyl segments in soybean. *In vitro Cell Developmental Biology-Plant*, 59, 140-146 **(2.6)\***
262. Pathania, S., Singh, H., Mavi, MS., Choudhary, OP., Sharma, S. (2022). Effectiveness of the entropy weight method to evaluate abiotic stress tolerance in citrus root-stocks. *Spanish J of Agricultural Research* 20: e0801. 10.5424/sjar/202201-18616 **(7.23)**
263. Pathania, S., Lore, J.S., Kalia, A., Kaur, A., Sharma, M., Mangat, G.S., Sandhu, J.S. (2022). Conversion of sheath blight susceptible *indica* and *japonica* rice cultivars into moderately resistant through expression of antifungal  $\beta$ -1,3-glucanase transgene from *Trichoderma* spp. *Transgenic Research*, 31, 537-551 **(8.79)**
264. Patil, K., Sikka, R., and Mavi, M. S. (2022) Effect of rice residue biochar on the bioavailability of cadmium to Indian mustard under combined lead and cadmium spiking in a loamy sand soil. *Agricul Res J*, 59(5):856-863. **(5.44)**
265. Peshin, R., Singh, K., Garg, L., Hansra, B. S., Nanda, R., Sharma, R. (2023). Impact evaluation of rice integrated pest management dissemination programs on adoption and pesticide use in Punjab, India. *International J of Tropical Insect Science*, 43: 869-880 **(1.17)\***
266. Peshin, R., Singh, K., Hansra, B. S., Sharma, R., Nanda, R., Singh, N., Garg, L. and Yangsdon, S. (2022). Long-term Impact of Cotton Insecticide Resistance Management Programme: A Case Study from Punjab, India. *Indian J of Ecology*, 49: 1968-1979. **(5.79)**
267. Poonia, B. K., Sidhu, A. and Sharma, A. B. (2022). Cyclo (l-proline-l-serine) Dipeptide Suppresses Seed Borne Fungal Pathogens of Rice: Altered Cellular Membrane Integrity of Fungal Hyphae and Seed Quality Benefits. *J of Agricultural and Food Chemistry*, 70.7: 2160-2168. **(11.28)**
268. Raina, S., Gupta, A., Singh, A., Surasani, V. K. R. and Sharma, S. (2022). Functionality of pasta enriched with pumpkin seed meal: cooking quality, techno-functional properties, textural and structural characterization. *Int J Food Sci Technol*, 58(5): 2735-43. **(3.61)\***
269. Randhawa, H. S., Kaur, C., Singh, G. and Taggar, G. K. (2023). Impact of chickpea varieties and sowing dates on pod borer, *Helicoverpa armigera* (Hubner). *Legume Research* DOI: 10.18805/LR-4895. **(6.67)**
270. Rangiri, S. K., Sudha, M. K., Kaur, H., Uppal, N., Singh, G., Vikal, Y. and Sharma, P. (2023). DNA-free genome editing for ZmPLA1 gene via targeting immature embryos in tropical maize. *GM Crops Food*, 14(1): 1-7. DOI:10.1080/21645698.2023.2197303 **(9.12)**
271. Rangari, S.K., Sudha, M.K., Kaur, H., Uppal, N., Singh, G., Vikal, Y., Sharma, P. (2023). DNA-free genome editing for ZmPLA1 gene via targeting immature embryos in tropical maize. *GM Crops and Food*, 14(1):1-7, DOI: 10.1080/21645698.2023.2197303. **(3.11)\***
272. Rani, H., Bhardwaj, R.D., and Kaur, S. (2023). Understanding the influence of genotype and temperature on proteolytic activity in distinct barley genotypes. *J Food Sci*, 88(4), 1718-1730 **(9.69)**

273. Rani, H., Bhardwaj, R.D., Kaur, S. and Grewal, S. (2022). Investigating diverse barley (*Hordeum Vulgare* L.) germplasm for thermostability of  $\beta$ -amylase, a key player of Diastatic power. *Cereal Chem*, 99(6), 1339-1348 DOI:10.1002/cche.10596 **(7.81)**
274. Rani, N., Walia, S. S. and Aulakh, C. S. (2022). Evaluation of Organic Fertilizer in Transplanted Basmati Rice. *J of Extension Education*, 58 (1): 191-195 **(5.95)**
275. Ranjan, R., Yadav, R., Gaikwad, K. B., Bainsla, N. K., Kumar, M., Babu, P. and Dharmateja, P. (2023). Spring wheat's ability to utilize nitrogen more effectively is influenced by root phenology variation. *Plants*, 12(5): 1010. **(9.01)**
276. Ratanoo, R., Walia, S. S., Saini, K. S. and Dheri, G. S. (2022). Residual effects of chemical fertilizers, organic manure and biofertilizers applied to preceding Gobhi sarson crop on summer mung bean (*Vigna radiata* L.). *Legume Research*, DOI: 10.18805/LR-4767 **(6.59)**.
277. Reetika, Kaur, J., Singh, T. and Saini, K. S. (2022). Influence of rice (*Oryza sativa*) straw incorporation and integrated nutrient management on growth, yield, and nutrient uptake in potato (*Solanum tuberosum*) and onion (*Allium cepa*) under rice–potato–onion cropping system. *Indian J of Agronomy*, (Accepted) **(5.55)**
278. Ruchika, Singh, S., Buttar, D. S., Choudhary, A. and Pawar, T. (2023). Evaluation of the bioformulation of potent strains of *Trichoderma* spp. and *Pseudomonas* spp. against Fusarial wilt of bottle gourd (*Lagenaria siceraria*) *Plant disease Research*, 37(2): 99-109 **(4.76)**
279. Sabhikhi, H. S., Hunjan, M.S., and Kaur, Y. (2023). Development of common scab in potato cv. *Kufri Pukhraj* in Indian Punjab is influenced by scab lesion severity on seed tubers and duration of crop in the field. *J Plant Dis Prot*, 130, 867-873 DOI:10.1007/s41348-023-00719-7 **(7.85)**
280. Sahni, T., Sharma, S., Verma, D., Kaur, H. and Kaur, A. (2022). Synthesis and *in vitro* fungitoxicity evaluation of syringaldehyde Schiff bases and  $\beta$ -lactams. *Organic Prep and Proc International*, 54(5):1-10 DOI: 10.1080/00304948.2022.2057142 **(7.18)**
281. Saini, R., Das, R., Adhikary, A., Kumar, R., Singh, I., Nayyar, H. and Kumar, S. (2022). Drought priming induces chilling tolerance and improves reproductive functioning in chickpea (*Cicer arietinum* L.). *Plant Cell Reports*, 41, 2005-2022. DOI: 10.1007/s00299-022-02905-7. **(10.57)**
282. Saini, R., Adhikary, A., Juneja, S., Kumar, R., Singh, I., Nayyar, H. and Kumar, S. (2023). Drought priming triggers diverse metabolic adjustments and induces chilling tolerance in chickpea (*Cicer arietinum* L.). *Plant Physiology and Biochemistry*, 194: 418-439. **(11.43)**
283. Salaria, P., Jain, S., Bhardwaj, R. D., Rani, R. and Jhanji, S. (2023). Physiological and biochemical responses of chilli pepper (*Capsicum annuum* L.) to sudden wilt syndrome. *Physiological and Molecular Plant Pathology*, 126, 102038 DOI: 10.1016/j.pmp.2023.102038. **(8.74)**
284. Salaria, P., Jain, S., Rani, R. and Kumar, S. (2022). Evaluation of chilli germplasm for resistance against sudden wilt syndrome. *Plant Disease Research*, 37 (2): 169-172. **(4.76)**
285. Salaria, S., Shayla, B., Singh, I., Rani, U., Kumar, A. S., Gill, B. S., Singh, S. (2023). Introgression of morphological, phenological and productivity traits along with disease resistance from *Cicer pinnatifidum* into cultivated chickpea: a success story. *Euphytica*, 219: 47 **(8.19)**
286. Saloni, Bhullar, M.B. and Kaur, P. (2023). Seasonal incidence of sucking insects on capsicum grown under protected conditions. *Agricultural Research J*, 59:1095-1099 **(5.44)**
287. Samita, Utreja, D. and Dhillon, N.K. (2022). An Efficacious Protocol for the Reduction of Benzothiazole Using Mg/MeOH and their Antinematic Activity against *Meloidogyne incognita*. *Russian J of Bioorganic Chemistry*, 48: 135–42. **(0.796)\***
288. San, S. H., Sagar, D., Krishnan, V., Awana, M., Singh, A., Bhowmik, A., Singh, R. and Chander, S. (2022). Effects of *Helicoverpa armigera* (Hubner) infestation on metabolic sensors dynamics in chickpea. *Allelopathy J*, 57(1): 83-108 **(6.96)**
289. Sanchez, J., Kaur, P.P., Pabuyan, I.C.M., Karampudi, N.B.R., Kitazumi, A., Sandhu, N., Catolos, M., Kumar, A., De L.R., Benildo, G. (2022). Decussate network with flowering genes explains the variable effects of qDTY12.1 to rice yield under drought across genetic backgrounds. *The Plant Genome*, 15, DOI: 10.1002/tpg2.20168 **(10.09)**
290. Sandhu, A. K., Mandal, K., Sharma, S., Sahoo, S. K. and Sharma, A. (2023). Residual behavior of tebuconazole and trifloxystrobin in okra fruits and soil. *Commun Soil Sci Plant Anal*, 54(10):1388-1396. **(7.33)**
291. Sandhu, K. K., Vashishat, N. and Sidhu, A. (2022). Larvicidal potential of copper sulphide nano aqua dispersions against *Aedes aegypti* (Linnaeus). *Afr. Entomol*, 30: 1-5. DOI: 10.17159/2254-8854/2022/a13589 **(0.58)\***
292. Sandhu, N., Sethi, M., Kaur, H., Dhillon, A., Kumar, A., Kaur, A., Kaur, S., Singh, V., Bentley, A. R., Chhuneja, P. (2023). Mining natural genetic variations for nitrogen use efficiency utilizing nested synthetic hexaploid wheat introgression libraries. *Environmental and Experimental Botany*, 212, 105394 DOI: 10.1016/j.envexpbot.2023.105394. **(11.55)**
293. Sandhu, S., Yousuf, N., Singh, G. and Kumar, M. (2023). Deciphering variability for heat tolerance index in maize hybrids and identification of stress resilient heterotic combinations. *J Environ Biology*, 44:193-199. **(5.57)**
294. Sandhu, S.K. and Kaur, P. (2023). A case study on the changing pattern of monsoon rainfall duration and its amount during the recent five decades in different agroclimatic zones of Punjab state of India. *Mausam*, 74(3): **(6.94)**
295. Sandhu, S.K., Attri, A. and Bala, R. (2022). Effect of meteorological parameters on Karnal bunt incidence in wheat under different agroclimatic zones of Punjab. *J Agrometeorol*, 24(1): 66-71. **(6.55)**
296. Sanghera, G.S. and Kashyap, L. (2022). Stress indices based on cane and sugar yields: Implications in selection of sugarcane varieties for drought tolerance. *Agric Res J*, 59: 816-834. **(5.44)**



297. Sarkar, A., Sandhu, S., Pal, L., Kushwah, A. and Kumar, M. (2022). Productivity based assessment of tolerance to high plant density stress in tropical maize (*Zea mays* L.) inbred lines and their single cross hybrids. *Indian J Genet Plant Breeding*, 82(2): 153-160. **(7.34)**
298. Sekhon, N. S., Aggarwal, P., Babbar, N., Kaur, S., Kaur, N. and Sardana, V. (2022). Suitability of brassica cultivars for ready to eat canned sag preparation. *Agric Res J*, 59(3): 515-523. **(5.44)**
299. Sharma, A., Arif, M.A.R., Shamshad, M., Rawal, K.S., Brar, A., Burgueño, J., Shokat, S., Kaur, R., Vikram, P., Srivastava, P., Sandhu, N., Singh, J., Kaur, S., Chhuneja, P. and Singh, S. (2022). Preliminary Dissection of Grain Yield and Related Traits at Differential Nitrogen Levels in Diverse Pre-Breeding Wheat Germplasm through Association Mapping. *Mol Biotechnol*, 65:116-130. DOI: 10.1007/s12033-022-00535-8 **(8.86)**
300. Sharma, A., Sharma, R.P., Sankhyani, N.P., Kumar, R. and Meena, H.M. (2023). Effect of FYM, lime and fertilizers on forms of soil acidity and relationship with soil properties in acid Alfisol. *Indian J Ecol*, 50(2):306-312, DOI: DOI:10.55362/IJE/2023/3894. **(5.79)**
301. Sharma, A., Arif, M.A.R., Shamshad, M., Rawle, K.S., Brar, A., Burgueño, J., Shokat, Kaur, S., Vikram, P., Srivastava, P., Sandhu, N., Singh, J., Kaur, S., Chhuneja, P., Singh, S. (2023). Preliminary dissection of grain yield and related traits at differential nitrogen levels in diverse pre-breeding wheat germplasm through association mapping. *Molecular Biotechnology*, 65, 116–130 **(8.70)**
302. Sharma, A.B., Sidhu, A., Manchanda, P., Ahuja, R. (2022). 1,2,4-triazolyldithiocarbamate silver nano conjugate: Potent seed priming agent against bakanae disease of rice (*Oryza sativa*). *European J of Plant Pathology*, 162, 825-841 **(7.91)**
303. Sharma, D., Sikka, R., and Singh, D. (2022) Interactive effects of soil lead and cadmium on dry matter yield and metal content of Indian mustard (*Brassica juncea* (L.) Czern) *J Indian Soc of Soi Sci*, 70(4):491-498. **(5.39)**
304. Sharma, H., Singh, S., Shamshad, M., Padhy, A.K., Kaur, R., Kashyap, L., Srivastava, P., Mavi, G.S., Kaur, S., Sharma, A., Sohu, V.S., Bains, N.S. (2023). Variability in iron, zinc, phytic acid and protein content in pre-breeding wheat germplasm under different water regimes. *Plant Growth Regulation*, 100, 531-543. **(10.17)**
305. Sharma, H., Singh, S., Shamshad, M., Padhy, A.K., Kaur, R., Kashyap, L., Srivastava, P., Mavi, G.S., Kaur, S., Sharma, A., Sohu, V.S. and Bains, N.S. (2023). Variability in iron, zinc, phytic acid and protein content in pre-breeding wheat germplasm under different water regimes. *Plant Growth Regul*, 100:531-543. DOI: 10.1007/s10725-022-00943-5 **(9.24)**
306. Sharma, K., Dhingra, M., Kaur, R., Singh, S., Kaur, A., Kaur, S., Sharma, A. (2022). Evaluation of *Triticum durum*–*Aegilops tauschii* derived primary synthetics as potential sources of drought stress tolerance for wheat improvement. *Cereal Research Communications*, 50, 1205-1216 **(6.80)**
307. Sharma, M., Sandhu, J.S. (2022). Shoot regeneration in recalcitrant Indica rice through partial desiccation of callus. *Agricultural Research J*, 59:841-843. **(5.44)**
308. Sharma, M., Lore, J.S., Kaur, A., Sandhu, J.S. (2022). Transgenic rice expressing *Trichoderma* Spp. *endochitinase* gene exhibits moderate resistance to sheath blight. *Plant Cell Tissue and Organ Culture*, 153:1-13 **(8.71)**
309. Sharma, N., Mandal, K. and Sharma, S. (2022). Dissipation and risk assessment of fluopyram and trifloxystrobin on onion by GC–MS/MS. *Environ Sci Pollut Res*, 29(53):80612-80623. **(10.22)**
310. Sharma, N., Mandal, K., Bhullar, H.S., Brar, P. K. and Sharma, S. (2022). Validation of analytical methodology for dissipation and persistence of diafenthiuron and cyantraniliprole on okra. *Int J Environ Anal Chem*, DOI: 10.1080/03067319.2022.2118589 **(8.83)**
311. Sharma, N., Mandal, K., Jyot, G. and Singh, B. (2022). Estimation of residues of flubendamide and deltamethrin in chickpea. *Indian J Entomol*, 85, 337-342. DOI: 10.55446/IJE.2022.591. **(5.08)**
312. Sharma, N., Sharma, S. and Mandal, K. (2023). Validation of simple and efficient analytical methodology for estimation of forchlorfenur on residues. *Environ Monit Assess*, 195:68 DOI: 10.1007/s10661-022-10647-y **(8.51)**
313. Sharma, P., Singh, V. and Angmo, P. (2023). Changes in soil biological and chemical environment during wheat growth stages under nitrogen and straw management practices in rice-wheat system. *J of Plant Nutrition*. 46, 3599-3616 DOI:10.1080/01904167.2023.2209112. **(7.71)**
314. Sharma, R., Sharma, S., Bhandari, M., Bobade, H., Sohu, R. S. and Singh, B. (2023). Characterization of bioprocessed white and red sorghum flours: Anti-nutritional and bioactive compounds, functional properties, molecular, and morphological features. *J Food Sci.* (Accepted). **(9.17)**
315. Sharma, S., Malhotra, N., Singh, A., Sharma, R., Domínguez, R. and Lorenzo, J. M. (2022). Modulation in Techno-Functional, Textural Properties, In Vitro Starch Digestibility and Macromolecular–Structural Interactions of Pasta with Potato (*Solanum tuberosum* L.). *Moecules*, 27(22): 7835-7853. **(10.41)**
316. Sharma, S., Parmar, V., Sharma, R. and Singh, B. (2023). Virgin coconut and mustard oleogels as affected by beeswax and candelilla wax: functional, textural, rheological and morphological characteristics. *Int J Food Sci Technol*, 58: 3293-302. **(9.71)**
317. Sharma, S. Singh, P., Chauhan, S., Choudhary, O.P. (2022). Landscape position and slope aspects impacts on soil organic carbon pool and biological indicators of a fragile ecosystem in highaltitude cold arid region. *J Soil Science and Plant Nutrition*, 22: 6235-6255. DOI: 10.1007 /s42729-022-00831-x **(9.87)**
318. Sharma, S., Vashisht, B.B., Singh, P., Singh, Y. (2022). Changes in soil aggregate- associated carbon, enzymatic activity and biological pools under conservation agriculture based practice in rice-wheat system. *Biomass Conversion and Biorefinery*, 13(15): 1-18. DOI:10.1007/ s13399-021-02144-y **(10.99)**

319. Sharma, S., Singh, P., Kaur, S. Singh, Y. (2022). Fertilizer-N application and rice straw incorporation impacts on crop yields, potassium use efficiency and potassium fractions in a rice–wheat cropping system. *Communications in Soil Science and Plant Analysis*, 53(7): 793-813. DOI: 10.1080/00103624.2022.2028816. **(7.33)**
320. Sharma, T. and Shera, P.S. (2023). Biological characteristics of ectoparasitoid, *Fulgoraecia melanoleuca* (Fletcher) on various stages of its host, *Pyrilla perpusilla* (Walker). *Int J Trop Insect Sci*, 43: 373-382. DOI:10.1007/s42690-022-00938-9 **(7.02)**
321. Shehnaz and Sikka, R. (2022) Residual bioavailability of nickel in nickel spiked sandy loam soil impact on swede rape (*Brassica napus* L.) growth and uptake of micronutrients. *Agric Res J*, 59(4): 669-676. **(5.44)**
322. Sheikh, M.M., Riar, T. S., Walia, S. S. and Garg, L. (2023). Integrated farming systems: A comparative status in Punjab, India and Northern part of Bangladesh. *J of Community Mobilization and Sustainable Development*, 18 (1): 19-26. **(5.65)**
323. Shikha, K., MadhumalThayil, V., Shahi, J.P., Zaidi, P.H., Seetharam, K., Nair, S.K., Singh, R., Tosh, G., Singamsetti, A., Singh, S. and Sinha, B. (2023). Genomic-regions associated with cold stress tolerance in Asia-adapted tropical maize germplasm. *Sci Reports*, 18,13(1):6297. DOI: 10.1038/s41598-023-33250-8. **(11.00)**
324. Sidhu, A. S., Aulakh, C. S., Singh, S. and Singh, D. (2022). Organic and Natural farming in North-West India: Farmers' perspective. *Agricultural Research J*, 59:1078-85. DOI: 10.5958/2395-146X.2022.00150.8 **(5.44)**
325. Sidhu, A. S., Aulakh, C.S., Thakur, M. and Singh, A. (2022). Natural farming in India: Rationale and Implications. *Agricultural Mechanization in Asia, Africa and Latin America* 53(7): 1-12. **(6.29)**
326. Sidhu, G.S., Rattanpal, H.S., Arora, A., Singh, J. (2022). Effect of chemical mutagens and phytophthora culture filtrate on survival and plant regeneration from callus of *Citrus jambhiri* Lush. *Fruits*, 77, 1-9 **(6.80)**
327. Sikka, R., Kalia, A. and Ahuja, R. (2022) Phytoremediation of heavy metal contaminated soils: challenges and future prospects. *Agric Res J*, 59(3): 382-93. **(5.44)**
328. Singh, A., Kaur, L., Garg, L., Singh, D. (2022). Adoption Status of Recommended Practices in Marigold and Gladiolus in Punjab State. *Indian. J. Ext. Edu*. 58:101-105 **(5.95)**
329. Singh, A., Aulakh, C. S., Chawla, N. and Sidhu, A. S. (2023). Pre-harvest exogenous application of growth regulators extends storability and maintains the seed potato quality. *J of Stored Products Research* 102: 129-137. DOI: 10.1016/j.jspr.2023.102129 **(8.83)**
330. Singh, B., Kaur, A., Chandi, R.S. and Sharma, A. (2023). Virus-vector relationship of squash leaf curl China virus and its transmission through whitefly vector, *Bemisia tabaci* (Gennadius) causing yellow vein mosaic disease of pumpkin. *Indian Phytopathology*, 76: 889-896. DOI:10.1007/s42360-023-00647-4 **(5.95)**
331. Singh, B., Sandhu, S.K. and Kaur, A. (2023). Effect of meteorological parameters on population dynamics of brinjal shoot and fruit borer under central Punjab, India. *Vegetos* 36: 1-7 **(5.27)**
332. Singh, B., Bhatia, D., Narang, D., Kaur, R., Chhuneja, P. (2022). High-resolution genetic mapping of QTL governing resistance to corn leaf aphid, *Rhopalosiphum maidis* (Fitch) in barley. *Cereal Research Communications*, 51:379-389. **(6.80)**
333. Singh, D.P., Jain, M. and Goyal, M. (2022). Assessment of variability and association analysis of forage traits in cowpea [*Vigna unguiculata* (L.) Walp]. *Forage Res*, 48 (3): 315-19. **(4.84)**
334. Singh, D.P., Sohu, R.S., Goyal, M. and Singh, P.P. (2023) Analysis of variability and correlations among different forage traits in guar (*Cyamopsis tetragonoloba* L. Taub.). *Electron J Plant Breed*, 14 (1): 323-28. **(5.14)**
335. Singh, D.P., Jain, M., Goyal, M. and Sandhu, S. (2023). Principal component analysis for fodder growth and quality traits in maize (*Zea mays* L.) *Range Management and Agroforestry* (Accepted) **(6.37)**
336. Singh, G., Brar, H. S., Virk, H. K., Khokhar, A., Kaur, C., Singh, K. and Gupta, R. K. (2023). Effect of foliar-applied urea on symbiotic parameters, yield and monetary returns of irrigated chickpea. *J of Plant Nutrition*, 46(8): 1668-1682. **(8.28)**
337. Singh, G., Virk, H. K., Khokhar, A., Kaur, C., Brar, H. S., Singh, K., Singh, M., Kaur, K., Singh, M., Singh, M., Kaur, G., Singh, J., Taggar, G. K., Singh, R. and Gill, K.K. (2023). Response of pigeonpea varieties to sowing dates at high plant density under different agroclimatic zones of Punjab. *Agricultural Research J*, 60(1): 13-23. **(5.44)**
338. Singh, G., Gudi, S., Amandeep, Upadhyay, P., Shekhawat, P. K., Nayak, G., Goyal, L., Kumar, D., Kumar, P., Kamboj, A., Thada, A., Shekhar, S., Koli, G. K., Meghna D. P., Halladakeri, P., Kaur, R., Kumar, S., Saini, P., Singh, I. and Ayoubi, H. (2022). Unlocking the hidden variation from wild repository for accelerating genetic gain in legumes. *Frontiers in Plant Science*, 13:1035878, DOI:10.3389/fpls.2022.1035878. **(11.75)**
339. Singh, G., Singh, R. and Singla, A. (2022). Efficacy of Different Insecticides against Blister Beetle *Mylabris pustulata* Thunberg (Coleoptera:Meloidae) in Pigeonpea and Mungbean. *Pesticide Research J*, 34(2): 152-155 **(5.49)**
340. Singh, G., Singh, R. and Singla, A. (2022). Estimation of crop losses in *Cajanus cajan* (L.) Millsp. and *Vigna radiate* (L.) Wilczek caused by blister beetle, *Mylabris pustulata* Thunberg (Coleoptera: Meloidae). *International J of Tropical Insect Science* 42: 3143-3150. DOI: 10.1007/s42690-022-00861-z **(6.77)**
341. Singh G., Buttar, D.S., Singh, N., Aulakh, S. K., Sharma, S. P. and Hunjan, M.S. (2022). Molecular identification and phylogenetic analysis of different races of *Fusarium oxysporium* f.sp. *melonis* in Muskmelon using RAPD markers under Punjab conditions. *Agricultural Research J*, 59 (3): 453-461. **(5.44)**
342. Singh, G., Kang, J. S., Kingra, P. K. and Kaur, J. (2022). Microclimate and spectral characteristics of maize-wheat crop rotation under different tillage systems, planting methods and nitrogen application timings *Agricultural Research J*, 59(1): 58-66. **(5.44)**



343. Singh, G., Mavi, MS., Choudhary, OP., Kaur, M., Singh, BP. (2022). Interaction of pyrolysed and un-pyrolysed organic materials enhances carbon accumulation in soil irrigated with water of variable EC. *Soil & Tillage Research* 215: 105193. **(13.37)**
344. Singh, G., Singh, S., Singh, M., Dhatt, K. K. (2023). Effect of post-emergence herbicides on economic weed management and turfgrass quality characteristics of Bermuda grass Selection No. 1, *Indian J of Weed Sci*, 55 (1):86-94 **(5.84)**
345. Singh, G., Kang, J.S., Kaur, J., Gill, J.S. and Singh, H. (2022). Nitrogen scheduling in maize in relation to tillage interventions and planting methods in Indian Punjab. *Maydica*, 67(1): M4 **(6.54)**
346. Singh, G., Singh, B., Singh, A., Kumar, V., and Surasani, V. K. R. (2023) Development and Characterization of Barley-based Non-Conventional Pasta Supplemented with Chickpea flour. *Int J Food Sci Technol*, DOI:10.1111/ijfs.16553 **(9.71)**
347. Singh, G. and Aggarwal, N. (2023). Estimation of economic threshold level (ETL) of *Bemisia tabaci* (Gennadius) in brinjal (*Solanum melongena* L.) *J Ent. Res*, 47 (1): 140- 145. **(5.89)**
348. Singh, G. and Aggarwal, N. (2023). Preference and Performance of *Bemisia tabaci* (Gennadius) on Different Host Plants. *Indian J Entomol* 85: 1-6. **(5.08)**
349. Singh, G. and Aggarwal, N. (2023). Alternate hosts of *Bemisia tabaci* (Gennadius) and their role in its carry-over to cotton in North-Western India. *Int J Pest Manag*, DOI: 10.1080/09670874.2023.2172227. **(7.77)**
350. Singh, G., Singh, S., Shukla, J. N., Kumar, V., Emyr Davies, T. J., Kaur, G., Pandher, S., Kaur, R. (2022) Doublesex homolog is sex specifically spliced and governs the sexual differentiation process in the whitefly, *Bemisia tabaci* biotype Asia II-1. *Gene*, 850: 146929 **(9.69)**
351. Singh, G., Chandi, A. K. and Kaur, A. (2023). Antifeedant activity of *Azadirachta indica* formulations against *Spodoptera frugiperda* (J. E. Smith). *Indian J of Ecology* (Accepted). **(5.79)**
352. Singh, G., Kaur, N., Khanna, R., Kaur, R., Gudi, S., Kaur, R., Sidhu, N., Vikal, Y., and Mangat, G.S. (2022). 2Gs and plant architecture: breaking grain yield ceiling through breeding approaches for next wave of revolution in rice (*Oryza sativa* L.). *Critical Reviews in Biotechnology*, 1-24. DOI: 10.1080/07388551.2022.2112648 **(14.43)**
353. Singh, H., Kaur, J., Bala, R., Srivastava, P., Sharma, A., Grover, G., Dhillon, G.S., Singh, R.P., Chhuneja, P., Bains, N.S. (2022). Residual effect of defeated stripe rust resistance genes/QTLs in bread wheat against prevalent pathotypes of *Puccinia striiformis* f. sp. *tritici*. *PlosOne*, 17:1-20 **(9.24)**
354. Singh, H., Grewal, S. K., Singh, R. and Bhardwaj, R. D. (2022). Induced defense responses in cultivated and wild chickpea genotypes against *Helicoverpa armigera* infestation. *Biologia Futura*, 74(1-2): 231-246. DOI: 10.1007/s42977-022-00151-2 **(6.82)**
355. Singh, H., Singh, J., Ade, P.A., Raigar, O.P., Kaur, R., Khanna, R., Mangat, G.S., Sandhu, N. (2022). Genetic evaluation of a diverse rice panel for direct seeded adapted traits using Kompetitive allele specific primer assay. *Agronomy*, 12, DOI: 10.3390/agronomy12092083 **(9.42)**
356. Singh, J. and Singh, V. (2022). Mid-season proximal sensing for site-specific need-based fertilizer nitrogen management in spring maize. *J of Plant Nutrition*, 45: 2146-2157. DOI: 10.1080/01904167.2022.2046075. **(7.71)**
357. Singh, J. and Singh, V. (2022). Chlorophyll meter based precision nitrogen management in spring maize. *J of Plant Nutrition*, 46: 17-27. DOI: 10.1080/01904167.2022.2071727. **(7.71)**
358. Singh, J., Mavi, M.S., Saini, S. (2022). Fertilizer prescription for target yield of wheat (*Triticum aestivum*) in alluvial soils. *Indian J of Agricultural Sciences*, 92: 1502-1505 **(6.37)**
359. Singh, K., Kumar, P., Sharma, S. and Singh, D. (2022). Entrepreneurship development and socio-economic impact of Farmer FIRST Programme: A case of mushroom cultivation in Punjab. *J of Community Mobilization and Sustainable Development*, 2: 678-683 **(5.3)**
360. Singh, K, Kumar, P., Kalra, V. P. and Singh, D. (2022). Promotion of natural resource management technologies through frontline demonstrations in rice-wheat rotation in Punjab. *Indian J of Ecology*, 49: 2016-19 **(5.79)**
361. Singh K, Kumar P, Kalra V P and Singh D (2022) Evaluation of short duration varieties of paddy through frontline demonstrations in Punjab. *Indian Journal of Ecology*, 49: 2051-54 **(5.79)**
362. Singh, L., Dhillon, G.S., Kaur, S., Dhaliwal, S.K., Kaur, A., Malik, P., Kumar, A., Gill, R.K., Kaur, S. (2022). Genome-wide association study for yield and yield-related traits in diverse blackgram panel (*Vigna mungo* L. Hepper) reveals novel putative alleles for future breeding programs. *Frontiers in Genetics*, 13: 1-17. **(10.60)**
363. Singh, L., Kaur, S., Aggarwal, P., and Kaur, N. (2023). Characterisation of industrial potato waste for suitability in food applications. *Int J Food Sci Technol* 58(5): 2686-94. **(9.71)**
364. Singh, M., Nara, U., Kaur, K., Rani, N. and Jaswal C. (2022). Genetic, genomic and biochemical insights of celery (*Apium graveolens* L.) in the era of molecular breeding *J of applied Research on Medicinal and Aromatic Plants* 31: 1-16. DOI: 10.1016/J.jarmap.2022.100420 **(9.97)**
365. Singh, M., Riari, T.S. and Garg, L. (2022). Problems Faced by Mushroom Growers in Punjab. *J. of Community Mobilization and Sustainable Dev.* 17: 889-891 **(5.65)**
366. Singh, M., Nara, U., Rani, N., Pathak, D., Kaur, K. and Sangha, M. K. (2022). Comparison of Mineral Composition in Microgreens and Mature leaves of Celery (*Apium graveolens* L.) *Biological Trace Element Research*, 201(8):1-11 **(9.74)**
367. Singh, M., Kumar, T., Sood, S., Malhotra, N., Rani, U., Singh, S., Singh, I., Bindra, S., Kumar, S. and Kumar, S. (2022). Identification of promising chickpea interspecific derivatives for agro-morphological and major biotic traits. *Frontiers in Plant Sciences*, 13: 1-14. DOI: 10.3389/fpls.2022.941372. **(11.75)**

368. Singh, M., Kaur, K., Singh, M., Singh, M., Kaur, G., Singh, J., Taggar, G. K., Singh, R. and Gill, K. K. (2023). Response of pigeonpea varieties to sowing dates at high plant density under different agroclimatic zones of Punjab. *Agricultural Research J*, 60(1): 13-23 **(5.44)**
369. Singh, M., Kaur, S., Kaur, A., Yadav, I.S., Sharma, P., Chhuneja, P., Singh, K. (2022). Nucleotide diversity and molecular characterization of soluble starch synthase I gene in wheat and its ancestral species. *J of Plant Biochemistry and Biotechnology*, 32:92-105 **(7.18)**
370. Singh, M., Kaur, A., Singh, S., Sandhu, J.S. (2022). In planta genetic transformation in pigeonpea: Occurrence and analysis of chimerism in transformants. *Agricultural Research Journal*, 5:989-997 **(5.44)**
371. Singh, N., Taggar, M.S., Kaur, J., Kalia, A. and Garg, T. (2023). Optimization of bioethanol production from corn cobs by simultaneous saccharification and fermentation using response surface methodology. *J of Cell Chem and Technology*, 57 (3-4): 359-368. **(7.29)**
372. Singh, P., Kumar, P. and Kaur, L. (2023). Comparative analysis of plant protection measures in conventionally planted and high density planted Kinnow. *J of Community Mobilization and Sustainable Development*, 18: 309-314 **(5.3)**
373. Singh, R., Paalli, S. S., Brar, A. S. and Kaur, C. (2022). Growth and phenology of wheat (*Triticum aestivum* L.) as influenced by irrigation scheduling under *in situ* rice residue management. *Archives of Agronomy and Soil Science*, 69: 1376-1392. DOI: 10.1080/03650340.2022.2089877 **(9.09)**
374. Singh, R., Pal, R. K., Gill, K. K., Mishra, S. K., Kaur, A. (2022). Validation of medium range weather forecasts and its economic impact on cotton-wheat cropping system in South-Western Punjab *Mausam*, 73(4), 915-928. **(6.64)**
375. Singh, R., Kaur, S., Aggarwal, P., and Kaur, N. (2022). Characterization of starch isolated from commercial and non-commercial potato cultivars. *Agric Res J*, 59(3): 524-530. **(5.44)**
376. Singh, R., Kaur, N., Praba, U. P., Kaur, G., Tanin, M. J., Kumar, P., Neelam, K., Sandhu, J. S. and Vikal, Y. (2022). A Prospective Review on Selectable Marker-Free Genome Engineered Rice: Past, Present and Future Scientific Realm. *Frontiers in Genetics*, 13:882836. DOI: 10.3389/fgene.2022.882836 **(10.60)**
377. Singh, S., Kaur, J., Ram, H., Singh, J. and Kaur, S. (2023). Agronomic bio-fortification of wheat (*Triticum aestivum* L.) to alleviate zinc deficiency in human being. *Rev Environ Sci Bio-Technol*, 22(2): 505-526. DOI: 10.1007/s11157-023-09653-4 **(20.00)**
378. Singh, S., Saini, M. K. and Sharma, D. K. (2022). Compatibility of newer molecules with pests' natural enemies- A review *International J of Agricultural Sciences*, 18(1): 501-513. **(4.58)**
379. Singh, S., Kaur, P., Bhullar, M.B. (2022). Demographic response of *Neoseiulus longispinosus* (Evans) on *Tetranychus urticae* Koch to different seasons in Punjab, India. *Agricultural Research J*, 59: 1095-1099. **(5.44)**
380. Singh, S., Kaur, P. and Sandhu, S.S. (2022). Crop-weather calendars for optimizing maize yield in Punjab. *Agric Res J*, 59 (1): 146-151. **(5.44)**
381. Singh, S., Kaur, J., Ram, H., Singh, J. and Kaur, S. (2023). Agronomic bio-fortification of wheat (*Triticum aestivum* L.) to alleviate zinc deficiency in human being. *Rev Environ Sci Biotechnol*, 22:505-526. **(20.4)**
382. Singh, S. (2023). Biorational management of gram caterpillar, *Helicoverpa armigera* (Hubner) in chickpea under organic farming. *Indian J of Entomology*, 85: e23884 **(5.08)**
383. Singh, S., Singh, I., Kumar, A., Bindra, S., Singh, G. and Singh, P. (2022). Notification and germplasm registration: Chickpea variety-PBG 8. *Indian J of Genetics and Plant Breeding*, 82: 375 **(6.51)**
384. Singh, S., Singh, I., Kumar, A., Singh, G. and Bindra, S. (2022). Notification and germplasm registration: Desi Chickpea variety-PBG 9. *Indian Journal of Genetics and Plant Breeding*, 82: 376 **(6.51)**
385. Singh, V., Kunal, Singh, M. and Singh, B. (2022). Spectral indices measured with proximal sensing using canopy reflectance sensor, chlorophyll meter and leaf colour chart for in-season grain yield prediction of basmati rice. *Pedosphere*, 32 (6): 812-822. **(9.91)**
386. Singh, V., Kunal, Kaur, J., Bhatt R., Kaur, S., Dhillon, B.S., Singh, K.B., Singh S, Sharma, and Bijay-Singh (2022). Site-Specific Fertilizer Nitrogen Management in Less and High N Responsive Basmati Rice Varieties Using Newly Developed PAU-Leaf Colour Chart. *Communications in Soil Science and Plant Analysis*, 54: 1334-1349. DOI: 10.1080/00103624.2022.2144346 **(7.58)**
387. Singh, V., Aggarwal, P., Kaur, S., and Kaur, N. (2022). Intermediate moisture date (*Phoenix dactylifera* L.) based dessert with natural sugars: Phytonutritional profile, characterization, sensory quality, and shelf-life studies. *J Food Proc Preserv*, 46(12): e17237. **(8.19)**
388. Singh, Z., Singh, G., Aggarwal, N., Virk, H. K. and Sharma, P. (2022). Symbiotic efficiency vis-a-vis chickpea performance as affected by seed inoculation with Mesorhizobium, phosphorus solubilizing bacteria, and phosphorus application. *J of Plant Nutrition*, 45(2): 246-258. **(8.28)**
389. Singla, D., Yadav, I.S. (2022). GAAP: A GUI-based genome assembly and annotation package. *Current Genomics*, 23, 77-82 **(8.24)**
390. Sohi, H.S., Gill, M.I.S. Chhuneja, P., Arora, N.K., Maan, S.S., Singh, J. (2022). Construction of genetic linkage map and mapping qtl specific to leaf anthocyanin colouration in mapping population 'Allahabad Safeda' × 'Purple Guava (Local)' of guava (*Psidium guajava* L.). *Plants*, 11, 1-13 **(9.94)**



391. Sunidhi, Singh, D., Kaur, M. and Kaur, L. (2023). Entrepreneurial behaviour of chilli growers in Punjab State. *J of Community Mobilization and Sustainable Development*, 18(1): 71-78 **(5.67)**
392. Tamboli, A.A., Yadav, J.S., Kumar, P., Malik, K., Meena, H.M. and Rani, M. (2023). Irrigation levels and anti-transpirants impact on performance of Indian mustard (*Brassica juncea*). *Indian J Agril Sci*, 93(2): 169–174, DOI: 10.56093/ijas.v93i2.119905. **(6.37)**
393. Thakur, K., Kapoor, S., Kapoor, A., Aggarwal, P., Kumar, V., and Tyagi, S. K. (2023). Tomato seed oil enriched mayonnaise: Structural, rheological, and biochemical characterization. *J Food Sci Technol*, 60(9): 2486-2496. DOI: 10.1007/s13197-023-05771-7 **(8.70)**
394. Tanin, M.J., Sharma, A., Saini, D.K., Singh, S., Kashyap, L., Srivastava, P., Mavi, G.S., Kaur, S., Kumar, V. and Kumar, V. (2022). Ascertaining yield and grain protein content stability in wheat genotypes having the Gpc-B1 gene using univariate, multivariate, and correlation analysis. *Frontiers in Genetics*, 13: 1-21. **(10.60)**
395. Thakur, K., Sharma, S., Sharma, R., Bhardwaj, R., Sohu, R. S. and Singh, B. (2023). Characterization of ozonated pearl millet and sorghum starches: Pasting profile, functional properties, in vitro digestibility, molecular interactions and morphology. *Starch Starke*, 75(11-12): 1-23. DOI: 10.1002/star.202300020. **(8.74)**
396. Thakur M, Kumar R, Parul Sharma, P and Sharma R (2023) Assessment of genetic purity and earliness in F1 and F2 population of cucumber (*Cucumis sativus* L.) using SSR markers. *Genetika-Belgrade*, 5(1) 33-44. **(6.75)**
397. Thakur, R., Sharma, S., Devi, R., Sirari, A., Tiwari, R. K., Lal, M. K., and Kumar, R. (2023). Exploring the molecular basis of resistance to *Botrytis cinerea* in chickpea genotypes through biochemical and morphological markers. *PeerJ*, 11: 1-28. e15560. **(9.06)**
398. Thesiya, M.R., Lore, J.S., Bhatia, D., Kalia, A., Hunjan, M.S. and Kaur, R. (2023). Histopathological patterns and differential behaviour of *Rhizoctonia solani* causing sheath blight in rice (*Oryza sativa* L.). *J of Phytopathology*, 171: 352-361. DOI: 10.1111/jph.13194. **(7.83)**
399. Thind, H. S., Sharma, S., Sidhu, H.S., Singh, V. and Singh, Y. (2023). Tillage, crop establishment and residue retention methods for optimising productivity and profitability under rice-wheat system. *Crop Pasture Sci*, DOI: 0.1071/CP21595. **(8.29)**
400. Un-Nisa, W., Sandhu, S., Ranjan, R. and Sharda, R. (2023). Root plasticity: an effective selection technique for identification of drought tolerant maize (*Zea mays* L.) inbred lines. *Sci Reports*, 13, 5501 DOI: 10.1038/s41598-023-31523-w **(11.00)**
401. Verma, D., Sharma, S., Sahni, T., Kaur, H. and Kaur, S. (2022). Designing, antifungal and structure activity relationship studies of Azomethines and  $\beta$ -lactam derivatives of aza heterocyclic amines. *J of Ind Chem Society*, 99(8):100587 DOI: 10.1016/j.jics.2022.100587. **(6.24)**
402. Verma, D., Sharma, S., Sahni, T., Kaur, A. and Kaur, H. (2022). Synthesis, characterization and biological evaluation of benzylidenes and  $\beta$ -lactams bearing aza heterocyclic moieties. *Biological Forum*, 14(3):1017-1024. **(5.11)**
403. Verma, M., Pandove, G., Oberoi, H.K., Kaur, S., Kalia, A., Singh, D. P. and Kaur, J. (2023). Quality of forage oats (*Avena sativa* L.) as affected by seed biopriming with liquid bacterial inoculants. *Indian J Agric Sci*, 93 (5): 576-578. **(6.37)**
404. Walia, S. S., Babu, S., Gill, R. S., Kaur, T., Kohima, N., Panwar, A. S., Yadav, D. K., Ansari, M. A., Ravishankar, N., Kumar, S., Kaur, K., Ansari, M. H. (2022). Designing resource-efficient and environmentally safe cropping systems for sustainable energy use and economic returns in Indo Gangetic Plains, India. *Sustainability*, 14(21): 14636 **(9.25)**
405. Walia S S, Gill R S, Kaur T and Aulakh C S (2022) Bio-intensive complimentary cropping systems for north-west India. *Indian Journal of Agricultural Sciences* 92(8): 936-941. **(6.37)**
406. Vij, S., Pathak, D., Rathore, P., Kumar, H., Sekhon, P.S., Bhatia, D., Chhuneja, P., Singh, K. (2022). Molecular mapping of CLCuD resistance introgressed from synthetic cotton polyploid in upland cotton. *Journal of Genetics*, 101:1-8. **(7.17)**
407. Yadav, B. K., Garg, N., Pandove, G. and Kalia, A. (2022). Effect of Irrigation Water Quality, Nitrogen Doses and Microbial Inoculants on Soil Enzyme Activity and Green Pod Yield of Cowpea (*Vigna unguiculata*) in Loamy Sand Alluvial Soil of Semi-Arid Region of Punjab, India. *Journal of Soil Salinity and Water Quality*, 14(1):53-62 **(4.94)**
408. Yadav, B. K. and Pal, R. K. (2022). Effect of weather variability on soil temperature, enzyme activities and nutrient availability under pear tree orchard in semi-arid condition. *Mausam*, 73(2): 405-412. **(6.64)**
409. Yadav, I.S., Bhardwaj, S.C., Kaur, J., Singla, D., Kaur, S., et al (2022). Whole genome resequencing and comparative genome analysis of three *Puccinia striiformis* f. sp. *tritici* pathotypes prevalent in India. *Plos One*, 17: 1-24. e0261697. DOI: 10.1371/journal.pone.0261697 **(9.75)**
410. Yadav, I.S., Bhardwaj, S.C., Kaur, J., Singla, D., Kaur, S., Kaur, H., Rawat, N., Tiwari, V.K., Saunders, D., Uauy, C. (2022). Whole genome resequencing and comparative genome analysis of three *Puccinia striiformis* f. sp. *tritici* pathotypes prevalent in India. *Plos one* 17:1-24 **(9.24)**
411. Yadav, K. and Garg, L. (2022). Awareness and Adoption Status of Safety Measures used in Pesticide Handling by Vegetable Growers in Punjab. *J of Community Mobilization and Sustainable Dev*, 17: 1353-1361 **(5.65)**

## Book

1. Suri, K.S. and Kooner, R. (2023). *Mukh faslaan diyan kheti samasiyavan*. Punjab Agricultural University, Ludhiana, p 268.

## Book Chapters

1. Babbar, N., Bansal, P., Aggarwal, P., Singh, K. and Kaur, S. (2022). Utilization of Honey in Processed Food Products. In: Imran, M., Ahmed, M.H. and Ahmad, R.S. (ed). Honey Composition and Properties, Intel Open. <http://www.intechopen.com/books/honey-composition-and-properties>
2. Bhattacharya, S., Singh, V.K., Chaudhary, A., Baskar, S. (2022). Carbon Nanotubes on Soil Microbial Community and Crop Sustainability. In: Baskar, C., Ramakrishna, S., Daniela La Rosa, A. (ed). Encyclopedia of Green Materials, Springer, Singapore. DOI: 10.1007/978-981-16-4921-9\_246-1.
3. Bhullar, M.S., Kaur, T., Singh, M., Gill, J.S. and Kaur, P. (2022). Weed Management in Direct Seeded Rice- A Success Story. In: J.S. Mishra, Sushil Kumar and A.N. Rao (ed). Technological Glimpses on Weeds and their Management, 3rd Intl. Weeds Conf, pp 9-12, Anand, Gujarat.
4. Bobade, H., Gupta, A. and Sharma, S. (2022). Beta-glucan. In: Kaur, J. and Nayik, G. A. (ed). Nutraceuticals and Health Care, pp 343-358, Academic Press, USA.
5. Bobade, H., Kaur, H. and Yadav, D. N. (2024). Application of Wheat and its Constituents in Diverse Functional Food Products. In: Gupta, O.P., Kumar, S., Pandey, A., Khan, M.K., Singh, S.K. and Singh, G.P. (ed). Wheat Science, pp 339-372, CRC Press.
6. Chakraborty, M., Chaturvedi, G.K., Singh, V.K., Baskar, S. (2022). Permaculture as a Green Material for Land Management. In: Baskar, C., Ramakrishna, S., Daniela La Rosa, A. (ed). Encyclopedia of Green Materials. Springer, Singapore. DOI: 10.1007/978-981-16-4921-9\_242-1.
7. Dhaliwal, S. S., Sharma, V., Sharma, S., Walia, S. S., Singh, J., Verma, V., and Rani, N. (2022). Effect of Vermicompost, Farm Yard Manure and Biofertilizers on Soil Health and Plant Nutrition. In: Earthworms and their Ecological Significance, pp. 1-27, Nova Science Publishers Inc.
8. Goyal, M. and Kaur, A. D. (2022). Sugar Beet as Cattle Feed: Scope and Prospects. In: Misra, V., Srivastava, S. and Mall, A.K. (ed). Sugar Beet Cultivation, Management and Processing, pp 931-95, Springer, Singapore DOI:10.1007/978-981-19-2730-0\_46
9. Gupta, A., Bobade, H., Sharma, R. and Sharma, S. (2022). Technological and Analytical Aspects of Bioactive Compounds and Nutraceuticals from Roots and Tubers Sources. In: Riari, C. S. and Panesar P. S. (ed). Bioactive Compounds and Nutraceuticals from Plant Sources: Extraction Technology, Analytical Techniques, and Potential Health Prospective, pp 398, Apple Academic Press, USA.
10. Gupta, N., Ram, H. and Cakmak, I. (2022). Micronutrients: Soil to Seed. In: Kumar, S., Dikshit, H.K., Mishra, G.P. and Singh, A. (ed). Biofortification of Staple Crops, Springer Nature Singapore (eBook) DOI: 10.1007/978-981-16-3280-8
11. Jat, M.L., Gupta, N., Jat, H.S., Parihar, C.M., Sidhu, H.S. and Singh, Y. (2022). Water Management in Conservation Agriculture. In: Conservation Agriculture in India: A Paradigm Shift for Sustainable Production, pp 119-137, Routledge, Taylor & Francis.
12. Jeet, K. (2023). Graphene Quantum Dots and their Role in Environment Sustainability, in Graphene Quantum Dots Biomedical and Environment Sustainability Application, pp 227-249, Elsevier, Woodhead Publishing.
13. Jeet, K., Kaur, R. and Kaur, M. (2022). Nanocellulose for Food Packaging Applications, in Nanotechnology Interventions in Food Packaging and Shelf Life, pp 39-60, CRC Press, Taylor and Francis.
14. Kartik, S., Kaur, R., Kumar, V., Kumar, S., Singh, A. and Gautam, N. (2022). Prebiotic and Probiotic Potential of Cereals. In: Sneh Punia Bangar (ed). Functional Cereals and Cereal Foods Properties, Functionality and Application, pp 163-188, Springer Nature.
15. Kaur, A., Kaur, S., Sharma, A., Chhuneja, P. (2022). Channelizing novel diversity through synthetics for wheat improvement. In: Kashyap, P.L., et al. (ed). New Horizons in Wheat and Barley Research: Global Trends, Breeding and Quality Enhancement, pp 565-621, Springer Nature, Singapore.
16. Kaur, H. (2023). Bacterial Leaf Streak. In: Gogoi, R., Hooda, K.S., Khokhra, M.K. and Jeevan, B. (ed). Compendium of Maize Diseases, pp 56-59, Indian Phytopathological Society, ICAR-IARI, New Delhi.
17. Kaur, H. (2023). Bacterial Stalk Rot. In: Gogoi, R., Hooda, K.S., Khokhra, M.K. and Jeevan, B. (ed). Compendium of Maize Diseases, pp 73-76, Indian Phytopathological Society, ICAR-IARI, New Delhi.
18. Kaur, K., Kaul, S. and Passi, P. (2023). Biofortification of Colored Cereals with Essential Micronutrients. In: S.P. Bangar and M. Kumar (ed). Functionality and Application of Colored Cereals: Nutritional, Bioactive and Health Aspects, pp 241-266, Elsevier.
19. Kaur, M., Manchanda, P., Singh, A. (2022). Quality improvement through bio-fortification In: Purewal S S et al. (ed). Maize, pp 1- 40, CRC Press.
20. Kaur, P., Neelam, K., Babbar, A., Vikal, Y. (2022) Biotechnological interventions for creating novel resistance against major insect pests of rice. In: Tanda A S (ed). Molecular Advances in Insect Resistance of Field Crops: Modern and Applied Approaches, pp.181-213, Springer.
21. Kaur, R., Kaur, M., Kaur, P., Sharma, P. (2022) Characterization of drought tolerance in maize Omics approaches. In: Sharma et al. (ed). Bioinformatics in Agriculture, pp.279-274, Academic Press.
22. Kaur, S., Brar, N. S. and Bhullar, M. S. (2022). Scope of Cultivation of Sugarbeet under Indian Subtropical Conditions. In: Varucha Misra, S. Srivastava and A K Mall (ed). Sugarbeet Cultivation, Management and Processing, pp 143-159, Springer, Singapore. DOI: 10.1007/978-981-19-2730-0



23. Kumar, S., Kumar, V., Sharma, R., Manhas, A., Chaudhary, S., and Sharma S. (2023). Edible Nano Emulsion Coating Materials: Potential for Fruits and Vegetables. In: Megh R Goyal (ed). Nanotechnology Horizon in Food Process Engineering, pp 267-321, Apple Academic Press, USA.
24. Kushwah, A., Sharma, S.R., Choudhary, K.B. and Vij, S. (2022). Advances in Male Sterility Systems and Hybrid Breeding in Rice. In: Bohra, A., Parihar, A.K., Naik, S. and Chandra, A. (ed). Plant Male Sterility Systems for Accelerating Crop Improvement, pp. 17-41, Springer Nature, Singapore DOI:10.1007/978-981-19-3808-5\_2.
25. Malhotra, P.K., Kumar, A., Kaur, A. and Sanghera, G.S. (2023). Understanding Plant Biological Clocks: A Prospective to Boost Future Agriculture. In: Gupta, V., Singh, R.P., Barun and Kumar, R. (ed). Modern Plant Biotechnology Risks and Implications in Agriculture, pp 1-18, Mahima Research Foundation and Social Welfare.
26. Manchanda, P., Sharma, D., Kaur, A., Singh, A. (2022). Improvement of genetic variation for nutrients and bioactive food components in cereal crops. In: Bangar, S. P. and Siroha, A. K. (ed). Functional Cereals and Cereal Foods: Properties, Functionality and Applications, pp.51-80, Springer.
27. Miglani, G.S. Wajhat-un-nisa, Sandhu, S.K. (2023). Cryptic Genetic Variation in Evolution and Crop Improvement. (Accepted) CRC, Taylor and Francis.
28. Mohanpuria, P., Sidhu, G.S., Singh, S. (2022). DsRNA-mediated vital genes silencing of fruit fly, *Bactrocera dorsalis* (Hendel) for producing RNAi plants. In: Yanik T (ed). New Visions in Biological Science, pp 78-97, BP International.
29. Sharma, A., Shamshad, M., Kaur, S., Srivastava, P., Mavi, G.S. and Sohu, V.S. (2022). Tackling a cereal killer on the run: Unending fight between wheat breeding and foliar rusts. In: Kashyap, P.L., et al. (ed). New Horizons in Wheat and Barley Research: Global Trends, Breeding and Quality Enhancement, pp. 227-242, Springer Nature, Singapore.
30. Sharma, D., Kaur, A., Manchanda, P. (2022). MiRNA-based genetic engineering for crop improvement and production of functional foods. In: Bangar, S. P. and Siroha, A. K. (ed). Functional Cereals and Cereal Foods: Properties, Functionality and Applications, pp 401-429, Springer.
31. Sharma, D., Gahtyari, N.C., Sharma, P., Khulbe, R.K., Pal, R.S., Kant, L. (2022). Doubled Haploidy: An Accelerated Breeding Tool for Stress Resilience Breeding in Cereals. In: Gowdra Mallikarjuna, M., Nayaka, S.C., Kaul, T. (ed). Next-Generation Plant Breeding Approaches for Stress Resilience in Cereal Crops. Springer, Singapore. DOI: 10.1007/978-981-19-1445-4\_6
32. Sharma, H.C., Dhillon, M.K., Manchanda, P., Taggar, G.K., Sarao, P.S. (2022). Molecular markers molecular markers for insect resistance insect resistance: Potential and limitations. In: Tanda, A. S. (ed). Molecular Advances in Insect Resistance of Field Crops: Modern and Applied Approaches, pp 87-116, Springer.
33. Shera, P. S., Sharma, S., Karmakar, P. and Singh, S. (2023). Encyrtid Parasitoids. In: Omkar (ed). Parasitoids in Pest Management, pp 129-150, CRC Press Taylor and Francis Group, Boca Raton, FL.
34. Singh, A., Singh, P., Singh, V.K. and Singh, S. (2022). Precision Agriculture: A Tool for Sustainable Agriculture In: Baskar, C., Ramakrishna, S., Daniela La Rosa, A. (ed). Encyclopedia of Green Materials. Springer, Singapore. DOI: 10.1007/978-981-16-4921-9\_260-1.
35. Singh, B., Narang, D., Chhuneja, P. (2022). Current understanding of the plant defense mechanism plant defense mechanism and available genetic resources genetic resources for aphid aphids resistance in wheat. In: Tanda, A. S. (ed). Molecular Advances in Insect Resistance of Field Crops: Modern and Applied Approaches, pp 293-314, Springer.
36. Singh, P., Singh, A., Singh, V.K., Singh, O. (2022). Green Manuring for Sustainable Agriculture. In: Baskar, C., Ramakrishna, S., Daniela La Rosa, A. (ed). Encyclopedia of Green Materials. Springer, Singapore. DOI: 10.1007/978-981-16-4921-9\_261-1
37. Singh, S., Singh, V.K., Singh, A., Singh, O. (2022). Zero-Budget Natural Farming: Way to Sustainable Future. In: Baskar, C., Ramakrishna, S., Daniela La Rosa, A. (ed). Encyclopedia of Green Materials. Springer, Singapore. DOI: 10.1007/978-981-16-4921-9\_264-1.
38. Singh, V. K., Prakash, R., Kushwaha, D.P. (2023). Impact of Surface Temperature on Soil Chemical Properties using Coupled Approach of Satellite Imagery, Gamma Test and Regression Based Models in Semi-arid Area. In: Pande, C.B., Kumar, M., Kushwaha, N.L. (ed). Surface and Groundwater Resources Development and Management in Semi-arid Region. Springer Hydrogeology, Springer, Cham. DOI: 10.1007/978-3-031-29394-8\_18.
39. Singh, V. K., Singh, Gill, A.A., Singh, A., Singh, O., Singh, T. (2022). Natural Potassium Fertilizers for Sustainable Agriculture. In: Baskar, C., Ramakrishna, S., Daniela La Rosa, A. (ed). Encyclopedia of Green Materials. Springer, Singapore. DOI: 10.1007/978-981-16-4921-9\_262-1.
40. Singh, Y., Sidhu, H.S., Jat, M.L., Gupta, N., Parihar, C.M. and Jat, H.S., (2022). Crop Residue Management in Conservation Agriculture. In: Conservation Agriculture in India: A Paradigm Shift for Sustainable Production, pp 158-178, Routledge, Taylor & Francis.
41. Virk, H.K. and Singh, G. (2023). Weed and Nutrient Management in Summer Pulses in IGP. In: Kumar, N., Nath, C.P., Sah, U. and Singh, N.P. (ed). Sustainable Production of Pulses in Diverse Agro-ecosystems, Vol. 1, Strategies for Enhancing Production, pp 157-172. Scientific Publishers, Jodhpur, India.
42. Walia, S. S. and Kaur, T. (2022). Integrated farming Systems: Research, Extension and Scope in Punjab. In: Secondary Agriculture: Sustainability and Livelihood in India, pp. 47-58, Springer.
43. Yadav, B. K. and Pandove, G. (2022). Scope of Liquid Bio-Fertilizers for Sustainable Crop Production in Horticulture. In: Current Development in Biosciences and Agriculture, pp 139-152, National Press Associates.

## College of Agricultural Engineering & Technology

### Research Papers in National and International Journals:

1. Aggarwal, R., Satpute, S. and Kaur, S. (2022). Solar photovoltaic pump sets as a substitute for conventional pump sets. *Current Science*, 122(3):337-343. **(7.10)**
2. Alam, M.S. and Saini, M.K. (2022). Optimal mechanical exclusion devices for management of Khapra beetle in stored wheat. *Indian J of Entomology*, DOI: 10.55446/IJE.2022.6611750,1-6 **(5.08)**
3. Arora, P., and Singh, D. Copy Move Image Forgery Detection with Exact Match Block Based Technique. *Oriental J of Computer Science and Technology*, 12(3): 123-131. **(6.78)**
4. Aslam, R., Alam, M.S., Kaur, J., Panayampadan, A.S., Dar, O.I., Kothakota, A., and Pandiselvam, R. (2022). Understanding the effects of ultrasound processing on texture and rheological properties of food. *J of Texture Studies*, 53(6), 775–799. **(9.22)**
5. Bajpai, A., Kaushal, A., Sidhu, H. S. and Jain, A. K. (2023). Experimental Evaluation of Irrigation Methods for Yield, Water Productivity, and Economics of Paddy-Wheat Cropping System under Conservation Agriculture. *J AgricEng*, 60:1-14. **(4.79)**
6. Bhatia, S., Kaur, R., Alam, M. S. and Singh, S. (2023). Dietary Fibre Concentrate from Carrot Pomace: Process Optimization, Antioxidative and Functional Properties. *Agric Res J*, 60 (1): 105-112. **(5.44)**
7. Choudhary, K., Alam, M. S., Kaur, G. and Gupta, S. K. (2022). Optimization of Fibre and Protein Rich Extruded Soybean-Rice Based Ready to Eat Snacks. *International J of Environment and Climate Change*, 12(2):61-73. **(5.13)**
8. Dar, M. U. D. and Singh, J. P. (2022). Assessment of DRAINMOD-NII model for prediction of nitrogen losses through subsurface drained clay under cultivation in south west Punjab, India. *Water Supply*, 22 (10): 7732–7749 **(7.75)**
9. Dhaloiya, A., Kaur, P. and Singh, J. P. (2022). Spatio-Temporal Mapping of Waterlogged Area in South-western Districts of Punjab Using GIS. *J Soil Salinity and Water Quality*, 14(2):251-258 **(4.94)**
10. Duhan, D., Singh, M. C., Singh, D., Satpute, S., Singh, S., Prasad, V. (2023). Modeling reference evapotranspiration using machine learning and remote sensing techniques for semi-arid subtropical climate of Indian Punjab. *J Water Climate Change*, 14 (7): 2227–2243. **(8.80)**
11. Garg, N., Choudhary, O. P., Thaman, S., Sharma, V., Singh, H., Vashistha, M., Sekhon, K. S., Sharda, R. and Dhaliwal, M. S. (2022). Effects of irrigation water quality and NPK-fertigation levels on plant growth, yield and tuber size of potatoes in a sandy loam alluvial soil of semi-arid region of Indian Punjab. *Agric Water Mgt*, 266, 107604, DOI: 10.1016/j.agwat.2022.107604 **(10.52)**
12. Garg, D., Dar, R. A. and Phutela, U.G. (2022). Characterization of novel euryhaline microalgal cultures from Punjab, India for bioactive compounds. *Arch Microbiol*, 204: 370. **(7.88)**
13. Goel, N., Singh, S.K., Dixit, A.K., Singh, A., Singh, M. and Jain, L. (2022). Refinement of wheat straw harvester for paddy straw harvesting and bruising. *J Agril Engg*, 59: 201-16. **(4.79)**
14. Goyal, P., Sharda, R., Siag, M. and Biwalkar, N. (2023). Development of the crop coefficient for vertically trained cucumber vines grown in soilless media under naturally ventilated greenhouse conditions. *Irrigation and Drainage*, 72: 377-389. **(1.42)\***
15. Gupta, S., Mohan, N., Nayak, P., Nagaraju, K.C. and Karanam, M., (2022). Deep vision-based surveillance system to prevent train–elephant collisions. *Soft Computing*, 26(8): 4005-4018. **(9.5)**
16. Hansara, G.D.S., Singh, J. P. and Sahota, P. P. (2022). Composite radial filter for removal of agrochemicals from agricultural runoff. *Water Supply*, 22 (6): 6130-6141 **(7.75)**
17. Jain, R., Singh, J. and Dhiman, P. (2022). Geoinformatics and surface water. *International Journal of Early Childhood Special Education*, (INT-JECSE). 14(2):5064-5069. **(0.76)\***
18. Kalsi, B. S., Singh, S., Alam, M. S. and Bhatia, S. (2023). Microwave Drying Modelling of Stevia rebaudiana leaves using artificial neural network and its effect on color and biochemical attributes. *J of Food Quality*, 1-12, DOI: 10.1155/2023/2811491 **(9.20)**
19. Kalsi, B.S., Singh, S. and Alam, M. S. (2022). Influence of ultrasound processing on the quality of guava juice. *J Food Process Engg*, 46 (6), e14163, DOI: 10.1111/jfpe.14163 **(8.36)**
20. Kaul, S., Kaur, K., Kaur, P. and Kaur, J. (2022). Development and shelf-life assessment of Ready-to-Bake frozen potato Paranthas fortified with iron and zinc. *International J of Food Science and Technology*, 57, 7214-7221. **(9.61)**
21. Kaur, A., Saini, M. K., Sharma, S. and Kooner, R. (2022). Novel molecules targeted control of brinjal shoot and fruit borer, *Leucinodes orbonalis* in subtropical conditions of Punjab (India). *Pesticide Research J*, 34(1):44-45 DOI:10.5958/2249-524X.2022.00008.5. **(5.49)**
22. Kaur, A., Taggar, M.S., Kalia, A. and Singh, M. (2022). Nitrate-induced carbohydrate accumulation in *Chlorella sorokiniana* and its potential for ethanol production. *Bio Res* 15:253-63. DOI:10.1007/s12155-021-10292-2. **(8.81)**
23. Kaur, G., and Bhatia, S. (2022). Radish leaf protein concentrates: Optimization of Alkaline extraction for production and Characterization of an alternative plant protein concentrate. *J of Food Measurement and Characterization*, 16(4) 3166-3181 **(8.43)**
24. Kaur, G. and Bhatia, S. (2022). Alpha-amylase-assisted extraction of protein concentrates from *Raphanus sativus* L. leaves. *Biomass Conversion and Biorefinery*, 13(16), 15051-15065. **(10.90)**



25. Kaur, G., Kaur, P., Kaur, G. and Mehta, S. (2022). Comparison of physiochemical properties and colour of wheat flour: Effect of milling speed, packaging and storage. *AgricEngInt: CIGR J*, 24(4): 153-163. **(6.00)**
26. Kaur, G., Kumar, M. and Birwal, P. (2022). Effect of drying and packaging on storability of stevia leaves (*Stevia rebaudiana* Bertoni). *Agricultural Engineering Today*, 46(1):25-32. **(4.23)**
27. Kaur, G., Singh, H. and Prasad, C. (2022). Response surface methodology to optimize process parameters for dehulling of oats. *Asian J of Dairy and Food Research*, DOI: 10.18805/ajdfr: 1-6). **(5.75)**
28. Kaur, G., Sidhu, G., K., and Kaur, P. (2023). Moisture sorption isotherms characteristics for shelf-life prediction of peanuts (*ArachisHypogaea* L.) *J of the Science of Food and Agriculture*, 103(6): 3077-3092. DOI:10.1002/jsfa.12475 **(10.13)**
29. Kaur, G., Sidhu, G.K., Kaur, P. and Kaur, A. (2022). Influence of ozonation and roasting on functional, microstructural, textural characteristics, and aflatoxin content of groundnut kernels. *J of Texture Studies*, 53, 908-922. **(9.94)**
30. Kaur, G., Taggar, M.S. and Kalia, A. (2023). Cellulase-immobilized chitosan-coated magnetic nanoparticles for saccharification of lignocellulosic biomass. *Environ Sci Pollut Res*, DOI: 10.1007/s11356-023-27919-w **(11.19)**
31. Kaur, H., Kaur, A., Kaur, P. and Kaur, K. (2023). Incorporation of pea peel powder: Effect on dough quality, physical properties and shelf life of the cookies. *J Food SciTechnol*, 60: 2591-2606. DOI: 10.1007/s13197-023-05780-6. **(9.12)**
32. Kaur, J., Taggar, M. S., Kalia, A., Sanghera, G.S., Kocher, G.S. and Javed, M. (2023). Valorization of sugarcane bagasse into fermentable sugars by efficient fungal cellulolytic enzyme complex. *Waste and Bio Valor* 14:963.975. DOI: 10.1007/s12649-022-01918-3. **(9.70)**
33. Kaur, K., Kaur, P., Kumar, S., Zalpouri, R. and Singh, M. (2022). Ozonation as a Potential Approach for Pesticide and Microbial Detoxification of Food Grains with a Focus on Nutritional and Functional Quality. *Food Reviews International*, 39: 6129-6161. DOI: 10.1080/87559129.2022.2092129 **(12.04)**
34. Kaur, K., Kumar, S., Kaur, P. Saini, M.K., Singh, A., Bala, M. and Singh, D.(2023). Optimization of process parameters for ozone disinfection of *C. Maculatus*: Effects on germination, in vitro protein digestibility, nutritional, thermal and pasting properties of mung bean grains. *J Science and Engineering- Decision on Manuscript ID BOSE-2022-0103.R1* **(8.60)**
35. Kaur, K., Kumar, S., Kaur, P., Saini, M.K., Singh, A., Bala, M. and Singh, D. (2023). Optimization of process parameters for ozone disinfection of *C. Maculatus*: Effects on germination, in vitro protein digestibility, nutritional, thermal and pasting properties of mung bean grains *Ozone: Science & Engineering*, 1-16, DOI: 10.1080/01919512.2023.2210615. **(8.60)**
36. Kaur M, Bhatia S, Gupta U, Decker, E, Tak Y, Bali M and Bala S (2023) Microalgal bioactive metabolites as promising implements in nutraceuticals and pharmaceuticals: inspiring therapy for health benefits. *Phytochemistry Reviews*, 22, 903–933. **(13.70)**
37. Kaur M, Kumar M and Sethi V P (2022) Maintaining the freeze thawing characteristics of tomato through development and evaluation of magnetic field assisted freezing system. *J of Food Processing and Preservation*. 46 (9), e16900. **(8.61)**
38. Kaur, M., Kumar, S., Kumar, M. and Lalremmawii (2023) Ohmic heating technology systems, factors governing efficiency and its application to inactivation of Pathogenic microbial, enzyme inactivation, and extraction of juice, oil, and bioactive compounds in the food sector. *J Food and Bioprocess Technology*. 1-26 **(11.50)**
39. Kaur P, Zalpouri, R., Modi, R., Sahota, P.P., Dhillon, T. S. and Kaur, A. (2023). Development and standardization of processing technique for ready-to-use lab fermented Kanji mix using refractance window dried black carrot powder. *Scientific Reports* 13, 185, DOI: 10.1038/s41598-023-27450-5 **(11.00)**
40. Kaur, P., Kocher, G.S. and Taggar, M.S. (2023). Comparative assessment of fungal consortium ligninolytic enzymes versus sequential acid-alkali pretreatments for bioethanol production from rice straw. *Bioener Res*, DOI: 10.1007/s12155-023-10612-8. **(9.85)**
41. Kaur, S., Singh, M., Zalpouri, R. and Kaur, K. (2023) Potential application of domestic solar dryers for coriander leaves: Drying kinetics, thermal efficiency, and quality assessment. *Environ Prog and Sust Energy*, 42(4): DOI:10.1002/ep.14092 **(8.82)**
42. Kumar, S., Shastri, S., Mahajan, S., Singh, K., Gupta, S., Rani, R., Mohan, N. and Mansotra, V. (2022). Lite Covid Net: A lightweight deep neural network model for detection of COVID-19 using X-ray images. *International J of Imaging Systems and Technology*, 32 (5):1464-1480. **(8.7)**
43. Kumar, S., Singh, M., Singh, S.K. and Bhullar, M.S.(2022). Droplet distribution and weed control efficacy of unmanned aerial vehicle sprayer in wheat crop. *J Agril Engg*, 59: 126-36. **(4.79)**
44. Kumar, S. M. and Singh, D. (2022). Estimating Volume and Mass of Tomato Fruits by Image Processing Technique. *Ind J of Ecology*, 49 (6): 2179-2183. **(5.79)**
45. Madane, D. A., Singh, M. C., Sharma, P. and Mane, M. (2023). Water and carbon footprint assessment of onion crop cultivated under differential irrigation scenarios. *Arab J Geosci*, 16:419. DOI: 10.1007/s12517-023-11518-7 **(6.0)**
46. Madane, D. A., Singh, M. C. and Satpute, S. (2023). Carbon footprint status of Indian Punjab in relation to different pre- to post-harvest activities of paddy cultivation. *Paddy Water Environ*, 21: 325–341. **(7.55)**
47. Madane, D. A. and Waghaye, A. M. (2023). Spatio-temporal variations of rainfall using innovative trend analysis during 1951–2021 in Punjab State, India. *Theor Appl Climatol*, 153: 923–945. **(9.41)**
48. Mahajan, K., Gupta, S. K., Sharma, S. R. and Kapoor, S. (2022). Effect of precooling on quality of pear fruits during storage. *Indian J Hortic*, 79(4): 502-06. **(6.16)**

49. Mann, H. S., Verma, A., Singh, M. and Singh, T.(2022). Electrical conductivity-based mapping of paddy yield using TDR soil sensor. *J of Agricultural Engineering (India)* 59 (3): 269-278.74(1): 207–213. **(6.93)**
50. Megha, M., Gill, P.P.S., Jawandha, S. K., Kaur, P. and Sinha, A. (2023). Sodium alginate enriched with pomegranate peel extract maintains pear cv. Punjab Beauty cell membrane integrity and postharvest life. *South African J of Botany* 158: 149-157. DOI: 10.1016/j.sajb.2023.05.011. **(9.11)**
51. Mishra, S., Sanjay, S. and Kaur, S. (2023). Performance of filter media for improving the irrigation water quality of village pond. *Indian J of Soil Conservation*, 51(1): 76-81. **(5.28)**
52. Mishra, P.K., Singh, M., Mandal, B., Singh, D., Bector, V. and Patel, B. (2021). Computer Aided Design and Development of a Tractor Operated Cotton Header. *Ama-Agricultural Mechanization in Asia Africa and Latin America*, 52(3):24-34. **(6.00)**
53. Sharma, N., Kaushal, A. and Yousuf, A. (2023).SWAT model application for simulating water balance and water yield in the lower Sutlej sub-basin. *J Soil Water Conserv*, 22:75-82 DOI: 10.5958/2455-7145.2023.00010.3 **(5.20)**
54. Sharma, N., Kaushal, A., Yousuf, A., Sood, A., Kaur, S. and Sharda, R. (2023 ). Geospatial technology for assessment of soil erosion and prioritization of watersheds using RUSLE model for lower Sutlej sub-basin of Punjab, India. *Envir Sci Pollut Res*, 30:515–31 DOI: 10.1007/s11356-022-22152-3 **(11.19)**
55. Nayak, P., Vaheed, S., Gupta, S. and Mohan, N., 2023. Predicting students' academic performance by mining the educational data through machine learning-based classification model. *Education and Information Technologies*, 28: 14611-14637, DOI: 10.1007/s10639-023-11706-8 **(9.00)**
56. Ozukum, M., Kumar, S., Alam, M. S., Sharma, S. R. and Awasthi, A.(2022). Microwave drying of paddy: Drying kinetics and modeling. *Agricultural Research J*, 59(4), DOI:10.5958/2395-146X.2022.00107.7. **(5.44)**
57. Ozukum, M., Kumar, S., Kaur, K. and Singh, A. (2022). Effect of microwave drying of paddy on milling characteristics, cooking quality, and microstructure of rice. *ActaAlimentaria*, 59(4): 758-770 **(7.00)**
58. Panayampadan, A.S., Alam, M. S., Aslam, R. and Kaur, J. (2022). Vacuum impregnation process and its potential in modifying sensory, physicochemical and nutritive characteristics of food products. *Food Engineering Reviews*, 14: 229-256 **(11.76)**
59. Panayampadan, A.S., Alam, M.S., Aslam, R., Gupta, S.K. and Sidhu, G.K. (2022). Effects of alternating magnetic field on freezing of minimally processed guava, *LWT- Food Science and Technology*, 163(4): 1-9 **(10.95)**
60. Pandey, K., Singh, K.G. and Singh, A. (2022). Multi sensors based smart nutrient reuse system for closed Soilless culture under protected cultivation. *Computers and Electronics in Agriculture*, 204, DOI: 10.1016 /j. Compag. 2022107495 **(11.57)**
61. Prasad, C., Kaur, G. and Jaiswal, A.K. (2022). Performance Evaluation of Mobile Liquid Cooled Thermoelectric Refrigeration System for Storage-Cum-Transportation of Fruits and Vegetables. *Foods*, 11(13), 1896, DOI: 10.3390/foods11131896: 1-18. **(10.35)**
62. Prasad, C., Kaur, G., Kalnar,Y. and Raleng, A. (2022). Performance and Technoeconomic Viability of Water-Cooled Thermoelectric Refrigeration System for Storage-Cum-Transportation of Fruits and Vegetables. *Agricultural Mechanization in Asia, Africa and Latin America*, 53(3): 68-73. **(6.23)**
63. Parmar, R., Jain, L., Prakash, A., Sharda, S., Kumar, S., Singh, M. and Singh, H. (2023).Automatic Spray Control System for Four Wheel Drive (4WD) Self-Propelled High Clearance Boom Sprayer, *Agric Research J*, 60(2): 246-254, DOI: 10.5958/2395-146X.2023.00038.8**(5.44)**
64. Raouf, A., Shafiq, A.M., Ali, A., Tao Yang, Manickam, S. (2023). A chemometric approach to evaluate the effects of probe-type ultrasonication on the enzyme inactivation and quality attributes of fresh amla juice. *Ultrasonics Sonochemistry*, 2:106268, 1-11, DOI:10.1016/j.ultsonch.2022.106268. **(15.64)**
65. Ratra. S., Singh, K. Methodical strategy for STATCOMs optimal placement to enhance voltage stability margin considering circular optimization algorithm. *J of VLSI Design Tools and Technology (JovDTT)*, 11(2):24-34. **(9.91)**
66. Roy, T., Alam, M. S. and Gupta, R. (2023). Optimization of foaming process for development of modified aloe polysaccharide (MAP) juice and powder using foam-mat drying. *Food Science and Biotechnology*, 4(2): 1-14 **(9.23)**
67. Saeed, A., Alam, M. S., Aslam, R., Gupta, S. K. and Kaur, G. (2022). Effects of alternating magnetic field on freezing of minimally processed guava. *LWT - Food Science and Technology*, 163:1-9. **(10.95)**
68. Sahni, T., Sharma, S., Verma, D., Kumar, S., Sharma, P. and Bhatia, S. (2022). Experimental validation of syringic Schiff bases with pyridine moiety as antibacterial and antioxidant agents along with in silico studies. *The Pharma Innovation J*, 11(4): 417-426 **(5.23)**
69. Saini, M.K., Alam, M. S. and Bhatia, S. (2022). Integrated management of Callosobruchusmaculatus (Fab.) in Mung bean stored as seed. *Indian J of Ecology*, 49 (5): 1989-1995. DOI: 10.55362/ IJE/2022/3772. **(5.79)**
70. Samota, M. K., Kaur, M., Sharma, M., Sarita, Krishnan, V., Thakur, J., Rawat, M., Phogat, B. and Guru, P. N. (2023). Hesperidin from citrus peel waste: extraction and its health implications. *Quality Assurance and Safety of Crops and Foods*, 15(2): 71–99. **(10.00)**
71. Sethi, V. P. (2023). A simulated study on the performance evaluation of amorphous silicon solar PV module for temperature, irradiance and tilt angle dependence. *Global J of Engineering and Technology Advances*, 14(02): 8-29 **(12.46)**
72. Sethi, V. P. (2023). Microcontroller based logic control system for automated novel paddy straw bale combustor technology applied to greenhouse heating. *Global J of Engineering and Technology Advances*, 14(02): 30-42 **(12.46)**



73. Sharma D K, Alam M S, Saini M K and Bhatia Surekha (2022). Evaluation of some botanicals, thermal treatment and packing materials against pulse beetle, *Callosobruchus chinensis* in chickpea. *Ind J of Entomology*, 1-6. DOI: 10.5958/ije.2021.141 **(5.08)**
74. Singh, J. P., Singh, M. C. and Singh, T. (2022). Design of sub-surface drainage system for a farm in Muktsar district of Punjab. *Agric Res J*, 59 (3): 563-569 **(3.9)**
75. Singh, L. P., Kumar, P. and Lohan, S. K. (2023). Development of a real-time work-related postural risk assessment system of farm workers using a sensor-based artificial intelligence approach. *J of Field Robotics*, 1-14. DOI: 10.1002/rob.22215. **(6.38)\***
76. Singh, M. C., Sanjay, S. and Prasad, V. (2023). Remote sensing and GIS-based watershed prioritization for land and water conservation planning and management. *Water SciTechnol*, 88 (1): 233–265. **(8.43)**
77. Singh, M. C., Satpute, S., Prasad, V. and Sharma, K. K. (2022). Trend analysis of temperature, rainfall, and reference evapotranspiration for Ludhiana district of Indian Punjab using non-parametric statistical methods. *Arabian J of Geosciences*, 15(3): 275. **(7.83)**
78. Singh, M., Biswas, A., Verma, A., Singh, T. and Choudhary, O. P. (2023). Way forward to adopt agricultural practices for paddy straw management based on carbon sequestration and GHG emissions. *Paddy Water Environ*, 21:295-305 **(7.55)**
79. Singh, M.C., Kaur, P., Singh, J. P., Singh, K. G., Singh, A. and Kirandeep. (2023). Postharvest Physicochemical Quality Assessment of Greenhouse Produced Soilless Cucumbers in Relation to Differential Fertigation. *J of Agri. Engg.*, 60(1): 38-50. DOI: 10.52151/jae2023601.1795. **(4.79)**
80. Singh, M.C., Sur, K., Al-Ansari, N., Arya, P.K., Verma, V.K. and Malik, A. (2023). GIS integrated RUSLE model-based soil loss estimation and watershed prioritization for land and water conservation aspects. *Frontiers in Environmental Science*, 11:1136243, DOI: 10.3389/fenvs.2023.1136243 **(11.41)**
81. Singh, P., Kaur, G., Singh, A. and Kaur, P. (2023). Starch based bio-nanocomposite films reinforced with montmorillonite and lemongrass oil nanoemulsion: Development, characterization and biodegradability. *J of Food Measurement and Characterization*, 17, 527–545. **(9.01)**
82. Singh, R., Kaur, G. and Kaur, G. (2022). Shelf-life Prolongation of Spring Groundnut Pods (*Arachis hypogaea* L.) using Packaging Systems. *J of Scientific and Industrial Research*, 81: 393-401. **(7.07)**
83. Singh, R., Singh, R.P., Singh, R. (2022). Biogas driven multigenerational integrated with simultaneous charging-discharging type thermal energy storage system Environmental Penalty cost Lower heating Value Organic Rankine cycle. *Energy Convers. Manag.*, 270, 116234. **(17.5)**
84. Singh, S. and Singh, M. C. (2023). Performance of colored capsicums as affected by plant training systems in a naturally ventilated polyhouse. *International J of Vegetable Science*, 29 (3): 1-10. DOI:10.1080/19315260.2023.2215760 **(1.35)\***
85. Singh, S., Saini, M. K. and Sharma, D. K. (2022). A Review on Compatibility of newer molecules with pest's natural enemies. *International J of Agricultural Sciences*, 50(1): 501-513. DOI: 10.15740/HAS/IJAS/18.1 **(4.73)**
86. Singh, S., Gill, R. S., Hans, V. and Mittal, T. C. (2022). Experimental performance and economic viability of evacuated tube solar collector assisted greenhouse dryer for sustainable development. *Energy*, DOI: 10.1016/j.energy.2021.122794 **(14.85)**
87. Singh, G., Ubhi, M.K., Kiran Jeet, Singla, C. and Kaur, M. (2023). "A" *Processes* 11(6): 1727. DOI: 10.3390/pr11061727 **(3.5)\***
88. Singh, M.C., Sur, K., Singh, J. P., Satpute, S., and Singh, S. (2022). Comparison of empirical models with FAO model for estimating reference evapotranspiration using python interface. *Ind J Agril and Allied Sci*, 8(4): 82-86 **(3.55)**
89. Singh, N., Taggar, M.S., Kaur, J., Kalia, A. and Garg, T. (2023). Optimization of bioethanol production from corn cobs by simultaneous saccharification and fermentation using response surface methodology. *CelluChem and Tech*, 57:359-68. **(7.39)**
90. Singla, C., Aggarwal, R., Kaur, S. and Sharma, R. (2023). Artificial Intelligence based Approach to Study the Impact of Climate Change and Human Interventions on Groundwater Fluctuations. *Aqua* (Accepted) **(4.00)\***
91. Solanki, C., Gupta, S. K. and Alam, M. S. (2022). Effects of pre-milling microwave dosage on dehulling of chickpea and pigeonpea. *Agricultural Mechanization in Asia, Africa and Latin America*, 53(4): 7065-7077. **(6.17)**
92. Tak, Y., Kaur, M., Kumar, R., Gautam, C., Singh, P., Kaur, H., Kaur, A., Bhatia, S., Jha, N. K., Gupta, P. K., and Amarowicz, R. (2022). Repurposing Chia Seed Oil: A Versatile Novel Functional Food. *J of Food Science*, 1-22, DOI: 10.1111/1750-3841.16211 **(9.17)**
93. Tiwari, R. K., Mittal, T. C., Sharma, S. R. and Rani, S. (2022). Effect of the distillation methods on the chemical properties of the turmeric essential oil. *J Food Process Preserv*, DOI: 10.1111/jfpp.17247 **(8.19)**
94. Tiwari, R. K., Mittal, T. C., Singh, S., Sharma, S. R. and Rani, S. (2022). Design and development of solar hybrid distillation system for essential oil extraction from turmeric. *J Food Process Preserv*, DOI: 10.1111/jfpp.17066 **(9.19)**
95. Verma, N., Taggar, M.S., Kalia, A. and Javed, M. (2022). Comparison of various delignification/desilication pre-treatments and indigenous fungal cellulase for improved hydrolysis of paddy straw. *Biotech*, 3 12 :1-14 **(8.41)**
96. Vijayan V, D., Madane, D. A. and Haldar, D. (2023). Monsoon paddy crop discrimination using machine learning algorithms to multi-temporal Sentinel-1A (C-band) data in Alathur block of Palakkad district of Kerala state, India. *Paddy Water Environ* 21: 365–375 **(7.55)**

97. Wagh, M.D., Alam, M.S. and Aslam, R. (2023). Vacuum Impregnation of Ascorbic Acid and Calcium Lactate Improves Quality Attributes and Functionality of White Button Mushrooms. *J of Food Processing and Preservation*, DOI: 10.1155/2023/6728630 **(8.61)**
98. Zalpouri, R., Singh, M., Kaur, P. and Singh, S. (2022). Refractance Window Drying- A Revisit on Energy Consumption and Quality of Dried Bio-origin Products. *Food Engineering Reviews*, 14: 257-270. DOI:10.1007/s12393-022-09313-3 **(12.74)**
99. Zalpouri, R., Singh, M., Kaur, P., Kaur, A., Gaikwad, K. K. and Singh, A. (2023). Drying Kinetics, Physicochemical and Thermal Analysis of Onion Puree Dried using a Refractance Window Dryer. *Processes*, 11(3):700. DOI: 10.3390/pr11030700 **(9.35)**
100. Zalpouri, R., Singh, M., Kaur, P. Singh S (2022). Refractance Window Drying—a Revisit on Energy Consumption and Quality of Dried Bio-origin Products. *Food Engg Rev*, 14:257-70. DOI: 10.1007/s 12393-022-09313-3. **(11.76)**

## Books

1. Dogra, R., Singh, M., Yadavika, Singla, M., Kumar, D. and Gupta, R. (2023). Renewable Energy and Green Technology. Brillion Publishing, New Delhi, p 323

## Book Chapters

1. Dar, Mehraj U Din, Singh, J.P. and Singh, K. (2022). Simulation of Nitrogen Balance in Rice-Wheat System under Sub Surface Drainage Conditions at TehriMuktsar Punjab using DNDC Model. In: Existing Climate Change Scenario and its Arising Risks, pp. 109-113, Mahima Research Foundation and Social Welfare, Varanasi.
2. Kaur, M., Kaur, G., Birwal, P., Kaur, R. and Sandhya. (2022). Storage of Maize and its products. In: Maize: Nutritional composition, Processing and its Industrial uses, pp. 325-333, CRC Press: Taylor and Francis.
3. Kaur, P., Singla, D., Taggar, M.S., Sarao, L.K. (2023). Potential technologies for advanced generation biofuels from waste biomass. In: Srivastava N, Verma, B, Mishra, P. (ed). Agroindustrial Waste for Green Fuel Application. Clean Energy Production Technologies, pp. 121-68, Springer, Singapore. DOI: 10.1007/978-981-19-6230-1\_51.
4. Kaur, S., Dar, M.U.D. and Kamra, S.K. (2022). Hydrosalinity modeling of Water and Salt Dynamics in Irrigated Soil Groundwater Systems. In: Current Directions in Water Scarcity Research, Vol. 7, pp. 409-430, Elsevier.
5. Kumar, S., Kaur, T., Kaur, J. and Kaur, G. (2023). Specialty Mushrooms: Boon to Health. In: Microbial Interventions to Achieve United Nation's Sustainable Development Goals, Vol. 1, pp. 24-37, Iterative International Publishers.
6. Ratra, S., Singh, K., Singh, D. (2022). Energy Storage Systems and Charging Stations Mechanism for Electric Vehicles. In: Energy Storage Technologies in Grid Modernization, pp.317-340, Scrivener Publishing. DOI: 10.1002/9781119872146.
7. Ratra, S., Urvashi, Tandon, R., Kirandeep, Ganai, S. (2022). Development of Value Chain for Onion with Storage Emphasis. In: Innovative Storage Solutions: The Best Way Forward for Reducing Post Harvest Losses and Doubling Farmer's Income at ICAR Sponsored Winter School, ed. 1, pp. 275-280, CIPHET Ludhiana
8. Sharma, K.K., Chawla, S., and Singh, M.C. (2023). Protected Cultivation: Technology, Constraints, and Its Global Status In: Singh, M.C., and Sharma, K.K. (ed). Protected Cultivation: Structural Design, Crop Management Modeling, and Automation Apple Academic Press.
9. Singh, J.P., and Dhaloiya, A. (2022). Technology for Smart Agriculture under Climate Change Scenario. In: Existing Climate Change Scenario and its Arising Risks, pp. 101-108
10. Singh, M., Sidhu, H.S., Lohan, S.K. (2022). Machinery Development for Conservation Agriculture. In: Sharma, A.R. (ed). Conservation Agriculture in India: A Paradigm Shift for Sustainable Production, pp. 179-198, Taylor & Francis Books.
11. Singla, D. and Taggar, M.S. (2023). Mixed Lignocellulosic Feedstocks: An effective approach for enhanced biofuel production. In: Srivastava, N., Verma, B., Mishra, P. (ed). Agro-industrial Waste for Green Fuel Application. Clean Energy Production Technologies, pp 249-79, Springer, Singapore. DOI: 10.1007/978-981-19-6230-1\_8

## Manuals

1. Biwalkar, N., Raheja, A., Satpute, S., and Garg, S. (2023). A Practical Manual on Soil and Water Conservation Engineering. Department of Soil and Water Engineering, PAU, Ludhiana. P118
2. Satpute, S., Thaman, S., Singla, C. and Biwalkar, N. (2023). A Practical Manual on Sprinkler and Drip Irrigation System. Department of Soil and Water Engineering, PAU, Ludhiana. P 50

## Research Bulletins

1. Alam, M.S., Sandhya and Sharma, R. (2023). Impact of PAU Ludhiana Centre in Entrepreneurship Development under AICRP on PHET, Bulletin No. PAU/COAET/PFE/PHET/02/2023, P13
2. Kaur, G. and Alam, M.S. (2023). Microbial Interventions in Food Processing. Annual Workshop on AICRP-PHET. P 9
3. Kaur, S., Aggarwal, R. and Gill, A.K. (2022). Estimation of carbon emissions from Groundwater pumping. Department of Soil and Water Engineering, PAU Ludhiana, P 40
4. Sharma, P., Madane, D. (2022). Mitigating Strategies for Greenhouse Gas Emission under Protected Cultivation. Indian Farmers' Digest. 55(3): 41-43.
5. Singh, M., Singh, A., Goyal, R., Dixit, A., Mehta, C.R., Badegaonkar, U., Kumar, M. and Bangale, R. (2023). PAU Smart Seeder- A Success Story. AICRP, ICAR-CIAE, Bhopal. Extension Bulletin No.: CIAE/FIM/TB/2023/342. P 21



## College of Basic Sciences & Humanities

### Research Papers in National and International Journals:

- Agarwal, D., Singh, J.M. and Horo, A. (2022). An economic analysis of Mentha cultivation in Punjab. *Ind J Econ Develop*, 18: 501-506. **(6.23)**
- Akansha, Kaushal, S., Arora, A., Heena, Sharma, P. and Jangra, J. (2023). Chemical composition and synergistic antifungal potential of *Nigella sativa* L. seeds and *Syzygium aromaticum* (L.) Merr. & L. M. Perry buds essential oils and their major compounds, and associated molecular docking studies. *J. Essent. Oil. Bear Pl*, 26: 602-625. **(7.69)**
- Ali, M., Dixit, A. K., Manes, G. S., Modi, R.U., Singh, A. and Mahal, A. K. (2022). Evaluation of an integral dust separation system based wheat straw combine for improvement in animal feed quality. *ANFT*, 22: 641-652. **(6.00)**
- Anantha, V. P. B. and Sidana, B. K. (2022). Growth performance of Indian spices: State-wise analysis. *Agricultural Research J*, 59(2): 334-347.
- Anju, Bhushan, K. and Kocher, G.S. (2023). Preliminary Research on the Analytical and Volatile Profiles of Beers Produced with Raw Malt and Roasted Specialty Malts. *JASBC*, DOI: 10.1080/03610470.2023.2213604 **(8.28)**
- Arora, K., Kumar, S., Adhale, P., Bhoi, P. B. and Vatta, K. 2023. Addressing the impact of COVID-19 on dairy value chains: Evidence from Punjab, India. *Current Science*, 124 (5): 570-577.
- Arora, P., Thukral, R., Singla, N. and Bansal, N. (2023). Antireproductive changes instigated by efficient drug delivery via papaya seed chloroform extract-based nanoparticles in male rat *Bandicota bengalensis*. *Pestic Biochem Physiol*, DOI:10.1016/j.pestbp.2023.105408 **(10.63)**
- Arora, R., Singh, P., Sarangi, P. K., Kumar, S., Chandel, A. K. (2023). A critical assessment on scalable technologies using high solids loadings in lignocellulose biorefinery: challenges and solutions. *Crit Rev Biotechnol*, DOI: 10.1080/07388551.2022.2151409
- Arora, S., Kler, T. K., Kaur, G. and Kaur, N. (2023). Depredatory bird damage assessment and its management techniques in guava. *Erwerbs-Obstbau*, 3: 5. **(7.20)**
- Babbar, B. K., Singla, N., Kaur, H., Verma, M., Rani, K., Bala, B. and Jain, S. (2022). Bio-ecology, behaviour and management of blue bull, *Boselaphus tragocamelus*. *Int J Pest Manag*, DOI: 10.1080/09670874.2022.2104402 **(7.91)**
- Babbar, B. K., Singla, N., Kaur, N., Kalra, S. (2022). Development of integrated rodent management module in pea crop. *Agric Res J*, 59(4): 699-705. DOI: 10.5958/2395-146X.2022.00100.4 **(5.44)**
- Bains, H. K. (2022). Don d'observation chez Robert Challe. *Shodh Drishti*, 13 (7.1): 139-141.
- Bains, H.K. (2022). Knowledge of English causes some Confusion to Beginners in French. *International J of Creative Research Thoughts*, 10 (7): 108-110.
- Bains, H.K. (2022). Le Culte de la Sincérité et de la Franchise chez Robert Challe. *Interdisciplinary J of Contemporary Research*, 9 (7): 37-40.
- Bains, H.K. (2022). L'influence de Malebranche sur la doctrine déiste de Robert Challe. *Shodh Drishti*, 13 (10): 59-63.
- Bains, H.K. (2023). Robert challe et les Jesuites. *Shodh Drishti*, 14 (1): 273-276.
- Bains, H.K. (2023). L' oraginalité de l'œuvre de RC. *Shodh Drishti*, 14 (2): 127-129.
- Bains, H.K. (2023). La soif de spiritualité chez RC. *IJCR*, 10 (3): 108-110.
- Bains, H.K. (2023). Laisser-aller chez RC. *Shodh Drishti*, 14 (3): 138-140.
- Bains, H.K. (2023). Robert challe signale les difficultés. *IJCR*, 10 (4): 22-24.
- Bala, B. and Babbar, B. K. (2022). Response of *Rattus rattus* towards salivary glands extract of conspecifics. *Biological Forum*, 14: 369-377 **(5.11)**
- Bala, B. and Babbar, B. K. (2023). Sex pheromones of clitoral gland: Their chemical identification and role in social & reproductive behaviour of house rat, *Rattus rattus* *Biologia*, (Accepted) **(7.65)**
- Bhadwal, S. and Sharma, S. (2022). Selenium alleviates physiological traits, nutrient uptake and nitrogen metabolism in rice under arsenate stress. *Env Sci Pollut Res*, DOI: 10.1007/s11356-022-20762-5 **(10.22)**
- Bhadwal, S. and Sharma, S. (2022). Selenium alleviates carbohydrate metabolism and nutrient composition in arsenic stressed rice plants. *Rice Sci*, 29(4): 385-396. **(9.33)**
- Bhandari, S. (2022). Charting Environmental Trauma to Foreground Socio-ecological Interdependencies in Zora Neale Hurston's *Their Eyes Were Watching God* and Jesmyn Ward's *Salvage the Bones*. *Re-Markings*, 21(2): 120-126.
- Bhandari, S. (2022). Impact of Social Media on English Language Acquisition: Perception of Undergraduate Students of Punjab. *Literary Voice*, 17(2): 307-314
- Brar, L.K., Sharma, P., Chuj, P., Kaur, P. Sharma, R. and Banga, S.S. (2022). Effect of elevated temperature on phenology, growth, yield components and seed yield of *Brassica juncea* grown in temperature gradient tunnels (TGT). *J Agrometeorology*, 24 (4): 359-366.
- Brar, S. K., Dhaliwal, S. S., Sharma, V., Sharma, S. and Kaur, M. (2023). Replacement of rice-wheat cropping system with alternative diversified systems concerning crop productivity and their impact on soil carbon and nutrient status in soil profile of north-west India. *Cogent Food Agric*, 9(1): 2167483. **(8.31)**
- Brar, S. K., Dhaliwal, S. S., Sharma, V., Sharma, S. and Kaur, M. (2023) Soil quality assessment in diversified long term experimentation under different agriculturally based cropping systems. *J Solid Sci Plant Nutr*, 23: 1727-1739. **(9.6)**

30. Chahal, T.S., Singh, J., Gill, P.P., Grewal, S.K., Sinha, A. (2023). Seasonal variations in biochemical and antioxidant properties in Daisy' Tangerine fruits during fruit development. *Erwerbs-Obstbau*, DOI: 10.1007/s10341-023-00881-0 **(7.21)**
31. Chand, G., Dhaliwal, S. S., Sharma, V., Verma, G., Singh, J. and Kaur, M. (2023). Variation of physico-chemical properties among different soil orders under different land use systems of the Majha region in North-Western India. *Sustainability*, 15(6): 4779. **(9.8)**
32. Chand, P., Singh, J. M., Sachdeva, J., Singh, J., Agarwal, P., Jain, R., Rao, S. and Kaur, B. (2022). Irrigation water policies for sustainable groundwater management in irrigated northwestern plains of India. *Current Science*, 123: 1225-1231.
33. Chaudhary, V., Katyal, P., Puniya, A. K., Panwar, H., Arora, M., Kaur, J., et al. (2023). Pilot-scale process to produce bio-pigment from *Monascus purpureus* using broken rice as substrate for solid-state fermentation. *Eur Food Res Technol*, 249(7): 1845-55. **(9.50)**
34. Chaudhary, V., Katyal, P., Panwar, H., Kaur, J., Aluko, R. E., Puniya, A. K., Poonia, A. K. (2022). Antioxidative, anti-inflammatory and anticancer properties of the red biopigment extract from *Monascus purpureus* (MTCC 369). *J Food Biochem* 46(9): e14249. DOI: 10.1111/jfbc.14249. **(8.72)**
35. Chauhan, A. and Sukhmani. (2022). Adoption of Soil Nutrient Testing for Resource Management: A study of Farmers' perception. *J Agril Develop Policy*, 32(2):260-269 **(3.84)**
36. Chauhan, S.K., Dhillon, W.S. Gupta, N., Panwar, P. and Rajni. (2021). Effect of wind breakers using *Euclyptus* on cultivation of kinnow mandarin *Ind J Hort*, 30:268-272 **(6.16)**
37. Chavan, S., Sekhon, M.K. and Jadhav, A. (2023). Dynamics of mango exports and impact of Sanitary and phytosanitary measures on Indian horticulture export, *Indian J Econ Develop*, 19 (1): 165-68.
38. Chhabra, D. and Gupta, M. (2022). Calendar anomalies in commodity markets for natural resources: Evidence from India. *Resour Policy*, 79: 1-17. **(14.22)**
39. Chhabra, D. and Gupta, M. (2022). Presence of calendar anomalies in Indian commodity markets: empirical evidence on Nkrishi and MCX-Agri. *J Agril Develop Policy*, 32: 107-116. **(3.61)**
40. Chhabra, R., Sharma, R. and Kaur, T. (2021). Phyto-allelopathic effect of different tree leaves aqueous extracts on seed germination and seedling growth of *Echinochloa crus-galli* (L) Beauv. *Ind J Weed Sci*, 53(3) 318-323.
41. Chhabra, R., Sharma, R., Hunjan, M., Sharma, V.K., Thakur, S. and Chauhan, S. (2022). Physio-biochemical and histological alterations in response to sheath blight disease of rice. (*Oryza sativa* L.) *J Phytopathology*, 170(11-12): 778-90.
42. Chhabra R, Sharma R, Kaur A and Sharma VK and thakur S (2023) Phytochemical characterization and antifungal ability of three meliaceae species against *Bipolaris oryzae*. *Agri Res J*, 60(1): 146-152.
43. Chhabra, R., Sharma, R., Hunjan, M., Sharma, V.K., Thakur, S. and Chauhan, S. (2023). Efficacy of botanical extracts imparting systemic acquires resistance against rice sheath blight incited by *Rhizictoniasolani*. *J Plant Dis Protec*, 130: 551-569
44. Chopra, S. and Bansal, S. (2022). Paddy stubble burning in Punjab: An architect of breathing woes. *Indian J of Ecology*, 49(5): 1830-1836
45. Choudhary, A., Kumar, A., Kaur, N., Sharma, A. and Kaur, H. (2023). Cushion of mathematical modeling – more reliable approach for biochemical analysis in evaluating salinity stress tolerance in wheat. *Plant Growth Regul*, 101:331-344 DOI: 10.1007/s10725-023-01021-0 **(9.24)**
46. Chugh, P., Sharma, P., Sharma, R. and Singh, M. (2022). Study on heat stress indices and their correlation with yield in Indian mustard genotypes under diverse conditions. *Ind. J. Plant Breeding*, 82(2):186-192.
47. Davit, H., Kaushal, S. and Hunjan, M. S. (2022). Chemical composition and antibacterial potential of *Terminalia arjuna* (Roxb. ex DC.) Wight Arn. Leaves essential oil against phytopathogenic bacteria of rice and potato. *J Essent Oil-Bear Plants*, 25 (3): 468-481. **(7.69)**
48. Dhanger P., Khurana, R., Dixit, A. K., Singh, M., Mahal, A. K. (2023). Performance evaluation of an electronically controlled tractor-operated applicator for liquid urea application. *Indian J Agric Sci*, 93(2): 190-194. **(6.37)**
49. Dharni, K. and Rathore, R. (2023). Status and Trends of Production and Export of Hive products from India. *IJE&D*, 19(1): 209-215. **(5.15)**
50. Dudeja, I., Mankoo, R. K. and Singh, A. (2023). Citric acid crosslinked ternary blended (polyvinyl alcohol, lignin, lemongrass essential oil/nanoemulsions) biopolymeric hydrogel films: Structural, functional, antioxidant, antifungal and biodegradable properties. *J Food Measure Charact*, 17: 3774-88. DOI: 10.1007/s11694-023-01905-9 **(9.01)**
51. Dudeja, I., Mankoo, R. K., Singh, A. and Kaur, J. (2023). Development, characterization and biodegradability of rice straw lignin based sustainable biopolymeric films. *Int J Food Sci Technol*, 58: 2754-2763. DOI: 10.1111/ijfs.16105. **(9.61)**
52. Dudeja, I., Tandon, R. and Kalia, A. (2023). Grapefruit peel essential oil nanoemulsions: Preparation, characterization, stability and antifungal potential against *Penicillium digitatum* of Kinnow. *Int J Food Sci Technol*, 58:1-10
53. Ekta and Utreja, D. (2023). Sulfonamide functionalized silica nanocomposite: Characterization and fluorescence "turn-on" detection of Fe<sup>3+</sup> ions in aqueous samples. *Photochem Photobio Sci*, 1-13. **(10.33)**
54. Ekta, Utreja, D. and Sharma, S. (2023). Computational Studies and fluorescent turn-off sensing of biologically important Cu<sup>2+</sup> ion in irrigation water via Schiff base. *Chem select*, 8(22): e202204038. **(8.31)**
55. Fujita, K., Ohno, A., Vatta, K. (2023). Contrasted agrarian change in Punjab, India: Case study of two villages in Ludhiana and Jalandhar districts. *Economic and Political Weekly*, 58 (5): 41-51.



56. Gaba, J., Sharma, S., Kaur, H., Kaur, P. (2022). Thymol and its Derivatives for Management of Phytopathogenic fungi of Maize. *Curr Bioact Compd*, 18(7):61-9. **(6.66)**
57. Gaba, J., Sharma, S., Kaur, P. (2022). Preparation and Biological Evaluation of Thymol Functionalized 2-Pyrazoline and Dihydropyrimidinone Hybrids. *Org Prep Proced Int*, 54(4):312-23. **(7.63)**
58. Gaba, Y. and Vashishat, N. (2022). Pesticide residue analysis in excreta of spotted owl *Athene brama* and barn owl *Tyto alba*. *Indian J Entomol*, 85 (1): 205-08. **(5.08)**
59. Garg, K., Kumar, B., Banga, G. and Mehra, P. (2022). Inventory shrinkage among retail stores in Punjab. *PIJMR*, 15(1-2): 18-43.
60. Garg, V., Kaur, M., Sangha, M. K. and Javed, M. (2022). Ternary CTAB@Co3O4@GO nanocomposite as promising superoxide dismutase mimic. *Bulletin Mater Sci*, 45: 145. DOI: 10.1007/s12034-022-02709-1. **(7.78)**
61. Gill, M. K., Kocher, G. S. and Panesar, A. S. (2022). Evaluation of fungal consortium lignozyme for biodelignification of Agricultural residues. *Biofpr*, 16(6): 1772-80.
62. Gill, M. K., Kocher, G. S. and Panesar, A. S. (2022). Sequential fermentation of organosolv pretreated corn stover for improved cellulose hydrolysis and bioethanol yield. *Agric Res J*, 59(4): 777-83.
63. Grewal, J. K., Kaur, M., Mandal, K. and Sharma, V. K. (2022). Carbon Quantum Dot-Titanium Doped Strontium Ferrite Nanocomposite: Visible Light Active Photocatalyst to Degrade Nitroaromatics. *Catalysts*, 12(10): 1126. **(10.50)**
64. Grewal, J. K., Kaur, M., Sharma, R. K., Oliveira, A. C., Garg, V. K. and Sharma, V. K. (2022). Structural and photocatalytic studies on oxygen hyperstoichiometric trimetallic titanium doped strontium ferrite nanoparticles. *Magnetochem*, 8(10):120. **(9.33)**
65. Grewal, J. K., Kaur, M., Ubhi, M. K., Oliveira, A. C., Garg, V. K. and Sharma, V. K. (2023). Structural, magnetic and photocatalytic properties of core-shell reversal nanocomposites of titanium doped strontium ferrite and silica. *J Mater Res*, 38: 1919-34. **(9.02)**
66. Grewal, S.K., Sharma, K.P., Bharadwaj, R.D., Hegde, V., Sidhu, S.K., Singh, S., Jain, P.K., Rasool, S., Arya, D.K., Agrawal, P.K., Mondal, B. Characterization of chickpea cultivars and trait specific germplasm for grain protein content and amino acids composition and identification of potential donors for genetic improvement of its nutritional quality. *Plant Genetic Resources*, 2023:1-1. DOI: 10.1017/S147926212300028X **(7.28)**
67. Grewal, H. K., Kler, T. K. and Sidhu, S. K. (2023). Exploring cattle sheds as complementary avifaunal habitat niches in rice dominated agricultural areas in Punjab, India. *Emir J Food Agric* 35 (5):408-16 **(6.84)**
68. Gudi, S., Saini, D. K., Halladakeri, P., Singh, G., Singh, S., Kaur, S., Goyal, P., Srivastava, P., Mavi, G. S. and Sharma, A. (2023). Genome-wide association study unravels genomic regions associated with chlorophyll fluorescence parameters in wheat (*Triticum aestivum* L.) under different sowing conditions. *Plant Cell Rep.*, 42: 1453-72. DOI: 10.1007/s00299-023-03041-6.
69. Guleria, A., Kaur, K. and Sachdeva, J. (2023). Assessment of co-integration among kinnow markets in India. *Indian J of Economics and Development*, 19: 102-111.
70. Gupta, A. and Kumar, B. (2023). FPO: A boon for India Farmers. *J of Progressive Agriculture*, 14(1):1-11.
71. Harish, G.N., Singh, R., Sharma, S., Taggar, G. K. (2022). Changes in defense-related antioxidative enzymes amongst the resistant and susceptible soybean genotypes under whitefly, *Bemisia tabaci* (Hemiptera: Aleyrodidae) stress. *Phytoparasitica*, 51: 63-75 DOI: 10.1007/s12600-022-01028-9 **(7.81)**
72. Heena, Kaushal, S., Kalia, A. and Kaur, V. (2022). Proximate, mineral, chemical composition, antioxidant and antimicrobial potential of dropped fruits of *Citrus reticulata* Blanco. *J Food Meas Charact*, 16 (6): 4303-4317. **(8.43)**
73. Horo, A. and Singh, J.M. (2022). Quantification of linkages within the prevailing integrated farming systems of Punjab. *Economic Affairs*, 67: 697-702
74. Jain, E. and Vashishat, N. (2022). Toxicity of acephate to liver and kidney of female wistar rats. *Indian J Entomol*, 85(2): 322-26. **(5.08)**
75. Jain, L., Singh, H., Banga, G. and Mehra, P. (2022). A comparative study of attitude and buying behaviour of consumers of Ludhiana and Chandigarh towards ecofriendly products. *PIJMR*, 15(1-2):44-64.
76. Jain, S. and Sukhmani. (2022). Impact of knowledge and practices of processors on management of Paddy waste and by products. *IJE&D*, 18(4): 876-883 **(5.15)**
77. Jain, S., and Singh, R. (2023). Food Labelling: An Educational Tool for Consumer Awareness. *Int J Educ Manag*, 13(1): 72-77.
78. Jain, S., Singla, N., Kalra, S. and Mahal, A. K. (2022). Effectiveness of different management strategies against Nilgai population (*Boselaphus tragocamelus*) in Punjab Province of India. *Anim Biol*, 73(4): 43-64. DOI: 10.1163/15707563-bja10096:1-22. **(7.48)**
79. Jain, S., Singla, N., Kalra, S. and Mahal, A. K. (2023). Effectiveness of Different Management Strategies against Nilgai Population (*Boselaphus tragocamelus*) in Punjab Province of India. *Anim Biol J*, 73: 43-64. DOI: 10.1163/15707563-bja10096 **(7.48)**
80. Jiwan, Sharma, R. and Walia, S.S. (2021). Weed composition and nutrient uptake by weeds in sole and intercrops during rabi season. *Ind J Ecol*, 48(1): 300-303
81. Kapil, S., Mankoo, R.K., Dudeja, I., Singh, A. and Kaur, J. (2022). Structural, antioxidant, antibacterial and biodegradation properties of rice straw xylan (native and modified) based biofilms. *Int J Food Sci Technol*, 58(5):2772-2781 **(9.61)**

82. Kaur, A., Chhabra, R., Sharma, R., Sharma, V.K., Sharma, P. and Khattar, N. (2023). Botanical extracts: A step towards eco friendly pest management strategy *Agric. ResJ*, 60 (2): 167-176
83. Kaur, A., Kaur, M., Singh, V. and Vyas, P. (2023). Nanocomposites of Ferrites with TiO<sub>2</sub>, SiO<sub>2</sub> and Carbon Quantum Dots as Photocatalysts for Degradation of Organic Pollutants and Microbes, *Magnetochemistry*, 9(5):127. DOI: 10.3390/magnetochemistry9050127 **(9.3)**
84. Kaur, A., Pandey, K., Kaur, R., Vashishat, N., Kaur, M. (2022). Nanocomposites of Carbon Quantum Dots and Graphene Quantum Dots: Environmental Applications as Sensors. *Chemosensors*, 10(9):367. **(10.22)**
85. Kaur, A., Sekhon, M. K., and Chopra, S. (2022). Time series modelling for forecasting area, production and productivity of maize in Punjab. *Indian J of Extension Education*, 58 (1): 42-47.
86. Kaur, A., Sharma, S. and Singh, N. (2022). Comparison studies on sucrose metabolism and phenolic content during fruit growth and maturation in pear cultivars *Acta Aliment*, 51: 348-359. **(7.00)**
87. Kaur, A., Kaur, M., Singh, V. and Vyas, P. (2023). Nanocomposites of ferrites with TiO<sub>2</sub>, SiO<sub>2</sub> and carbon quantum dots as photocatalysts for degradation of organic pollutants and microbes. *Magnetochemistry*, 9(5):127. DOI: 10.3390/magnetochemistry9050127 **(9.3)\***
88. Kaur, A., Kocher, D.K. and Kumar, R. (2022). Larvicidal potential and residual activity effect of kinnow peel oil against *Aedes aegypti* L. *J Vector Borne Dis*, 59(3): 228-35 **(7.69)**
89. Kaur, A., Kocher, G.S. and Keshani. (2022). Extraction and characterization of essential oils from peel of kinnow (*Citrus reticulata* L.). *Agric Res J*, 59(5): 964-969. DOI: 10.5958/2395-146X.2022.00135.1 **(5.44)**
90. Kaur, A., Walia, G. S., Singh, R. (2022). Leveraging social media platforms for valuing agri-entrepreneurship in Punjab, India. *Indian J. Ext. Edu.*, 58(3): 70-73. **(5.95)**
91. Kaur, B., Singh, A., Banga, G. and Kumar, B. (2022). A study of Impulse buying behaviour of consumers in organised retail stores. *PIJMR*, 15(1-2): 65-83.
92. Kaur, D., Grewal, S.K., Bhardwaj, R.D., Singh, S. (2023). Insights into changes of enzyme activity for maintaining redox homeostasis in chickpea under water deficit stress. *Acta Physiol Plant*, 45, 7. DOI: 10.1007/s11738-022-03480-w **(8.74)**
93. Kaur, H., Singh, A., Sirari, A., Sharma, S. and Tripathi, K. (2022). Identification of lentil resistant donors and biochemical basis of resistance against *Uromycesvicia-fabae*. *Plant Dis Res*, 37: 237. **(4.76)**
94. Kaur, H., Jain, L., Banga, G. and Kumar, B. (2022). Ethical consumerism: Buying for a better world. *Int J Educ Manag*, 12 (3): 217-220. **(4.58)**
95. Kaur, H., Katyal, P., and Chandel, S. (2022). Assessment of water quality using different physicochemical and biological parameters: a case study of Buddha nallah, Punjab, India. *Environ Conserv J* 23(3): 145-159. DOI: 10.36953/ECJ.10392241. **(5.66)**
96. Kaur, H., Kaur, M., Aggarwal, R., Sharma, S. and Singh, D. (2022). Nanocomposite of MgFe<sub>2</sub>O<sub>4</sub> and Mn<sub>3</sub>O<sub>4</sub> as polyphenol oxidase mimic for sensing of polyphenols. *Biosensors*, 12(6): 428 **(11.51)**
97. Kaur, H., Sharma, P., Sharma, R., Sardana, V. and Banga, S.S. (2022). Terminal heat stress modulates growing degree days Heat use efficiency and yield stability Index in *Brassica juncea*. *Annals of Plant and Soil Research*, 24(30): 415-423.
98. Kaur, J., Bedi, S., Singh, R., Singh, T. (2023). Effect of priming on enhancing storability of high and low vigour brinjal (*Solanum melongena* L.) seeds. *J Appl Hortic*, 25(1): 48-53. **(5.13)**
99. Kaur, J., Jawandha, S.K., Gill, P.P., Grewal, S.K., Singh, H., Adhikary, T. (2023). Beeswax enriched gibberellic acid coatings preserve antioxidant properties and quality of lemon fruit under cold storage condition. *Acta Physiol Plant*, 45, 93 DOI: 10.1007/s11738-023-03567-y **(8.74)**
100. Kaur, J., Jawandha, S.K., Gill, P.S., Jan, Z., Grewal, S.K. (2023). Composite coatings of beeswax+ naphthalene acetic acid preserved fruit quality and antioxidants in stored lemon fruits. *Food Sci Biotechnol*, DOI: 10.1007/s10068-023-01364-4 **(9.23)**
101. Kaur, J., Mankoo, R. K. and Chahal, G. K. (2023). Phytotoxicity evaluation of rice straw biopolymer-based hydrogels. *Cellulose Chem Technol*, 57 (3-4): 295-304. **(7.39)**
102. Kaur, J., Mankoo, R. K. and Chahal, G. K. (2023). Synthesis of rice straw biopolymers based hydrogels and their use as media for growth of monocot (wheat) and dicot (moong bean) plants. *Chem Papers*, 77: 2539–2555 DOI: 10.1007/s11696-022-02644-9 **(8.15)**
103. Kaur, J., Mankoo, R. K., Dudeja, I. and Kapil, S. (2022). Recent approaches to the synthesis of hydrogels from lignocellulosic biomass: A Review. *Cellulose Chem Technol*, 56 (7-8): 891-906. **(7.47)**
104. Kaur, J., Sharma, R., Kaur, R. (2022). Propagation of *Terminalia chebula* from explants and seeds collected from different agro-ecological regions of north-western states of India. *Vegetos*, 35: 158–167.
105. Kaur, J., Sharma, R., Sharma, M. and Chhabra, R. (2021). Evaluation of physiological and biochemical changes in garlic (*Allium sativum* L.) bulbs stored under different temperature conditions. *Plant Physiology Reports*, 26: 412–418.
106. Kaur, J. and Dharni, K. (2022). Application and performance of data mining techniques in stock market: A review. *Intell Syst Account Finance Manag*, 29(4): 219-241. **(2.9)\***
107. Kaur, J. and Dharni, K. (2023). Data Mining Based Stock price prediction using hybridization of technical and fundamental analysis. *Data Technol App*, 57(5):780-800, DOI: 10.1108/DTA-04-2022-0142 **(7.66)**



108. Kaur, J., Singla, N. and Kalra, S. (2022). Ecological and behavioural aspects of five striped palm squirrel, *Funambulus pennantii* Wrought on in natural habitat in agricultural landscape. *Indian J Ecol*, 49(6): 2436-2441. DOI: 10.55362/IJE/2022/3844. **(5.08)**
109. Kaur, J., Taggar, M.S., Kalia, A., Sanghera, G.S., Kocher, G.S. and Javed, M. (2022). Valorization of sugarcane bagasse into fermentable sugars by efficient fungal cellulolytic enzyme complex. *Waste Biomass Valorization*, 14(3):1-13. **(9.70)**
110. Kaur, K., Kler, T. K. and Sandhu, S. K. (2023). T-perches determining avian feeding guilds in maize crop. *Indian J Entomol*, DOI.: 10.55446/IJE.2023.700. **(5.08)**
111. Kaur, K., Tandon, R., Kalia, A. and Babu, N.J. (2023). Fabrication of *Monarda citriodora* essential oil nanoemulsions: Characterization and antifungal activity against *Penicillium digitatum* of kinnow. *J Food Meas Charact*, 17:3044-60. **(9.01)**
112. Kaur, K., Utreja, D. and Rani, R. (2022). Anti-fungal evaluation of synthesized 1,3,5-triazine derivatives against phytopathogenic fungi. *Agri Res J*, 59(5): 945-952. **(5.44)**
113. Kaur, K., Utreja, D., Dhillon, N. K. and Pathak, R. K. (2022). 3-Hydroxy-3-alkylindolin-2-ones: Regioselective synthesis, molecular docking and nematicidal studies against *Meloidogyne incognita*. *J Environ Sci Health, B*. 1-13. **(8.506)**
114. Kaur, K., Utreja, D., Dhillon, N. K., Anupam and Buttar, H.S. (2022). Heterocyclic moieties as prospective Nematicides: An overview. *Curr Org Chem*, 26: 1703-1724. **(8.22)**
115. Kaur, M., Bhardwaj, R. D., Singla, P., Kaur, S., Grewal, S. K. (2023.) Drought stress-induced alterations in source-sink relationships in barley during grain development. *Gesunde Pflanzen*, DOI: 10.1007/s10343-023-00887-4. **(8.08)**
116. Kaur, M., Gaba, J., Singh, K., Bhatia, Y., Singh, A., Singh, N. (2023). Recent Advances in Recognition Receptors for Electrochemical Biosensing of Mycotoxins- A Review. *Biosensors*, 13(3):391. **(11.97)**
117. Kaur, M., Gupta, N., Kaur, N., Sohu, R. S., Mahal, A. K. and Choudhary, A. (2023). Preliminary screening of sorghum (*Sorghum bicolor* L.) germplasm for salinity stress tolerance at the early seedling stage. *Cereal Res Commun*, 51 (3): 603-611 DOI: 10.1007/s42976-022-00327-5 1-11. **(7.24)**
118. Kaur, M., Sharma, S., and Sodhi, H. S. (2022). White rot fungus *Calocybe indica*: Incredible factory of lignocellulolytic enzymes and their potential applicability for mushroom cultivation. *Acta Aliment*, 51(3): 424-436 **(7.00)**
119. Kaur, N. and Kocher, D. K. (2023). Ovicidal, larvicidal and pupicidal potential of neem seed kernel extract against *Aedes aegypti* L. *Intl J Trop Insect Sci*, 43(3): 1089-96 **(7.02)**
120. Kaur, N. and Kocher, D.K. (2023). Eucalyptus oil nanoemulsion as potent ovicidal and pupicidal agent against *Aedes aegypti* Linnaeus. *Theor Biol Forum*, 12(1): 14-19 **(6.46)**
121. Kaur, P., Kocher, G. S. and Taggar, M. S. (2023). Comparative Assessment of Fungal Consortium ligninolytic Enzymes versus Sequential Acid-Alkali Pretreatments for Bioethanol Production from Rice Straw. *Bioenergy Res*, DOI: 10.1007/s12155-023-10612-8
122. Kaur, P., Zalpouri, R., Modi, R., Sahota, P.P., Dhillon, T.S. and Mahal, A. K. (2023). Development and standardization of processing technique for ready-to-use lab fermented Kanji mix using refractance window dried black carrot powder. *Scientific Reports*, 13(1):185. DOI: 10.1038/s41598-023-27450-5 **(11.00)**
123. Kaur, R., and Kaur, N. (2023). Biochemical and histological parameters in *Labeo rohita* inhabiting Aquatic ecosystems of Ludhiana and Muktsar districts of Punjab. *J Soil Salin Water Qual*, (Accepted) **(4.94)**
124. Kaur, R., Manchanda, P., Bhushan, K., Kalia, A. and Sidhu, G.S. (2022). Quantification of phenolic constituents and bioactive properties of callus and leaf tissue of *Citrus jambhiri* Lush. *Agric Res J*, 59(4): 725-729. DOI: 10.5958/2395-146X.2022.00103.X **(5.44)**
125. Kaur, R., Sharma, S. and Sodhi, H. S. (2022). Effect of citric acid dips and packaging materials on browning in button mushroom. *Indian J Hort*, 79(3): 370-375. **(6.00)**
126. Kaur, R., Sharma, S., Kaur, S. and Sodhi, H. S. (2022). Biochemical characterization with kinetic studies of melanogenic enzyme tyrosinase from white button mushroom *Agaricus bisporus*. *IJBB*, 59(7): 718-725. **(7.00)**
127. Kaur, R., Singh, R., and Aulakh, R. K. (2022). Diversity of arthropods in relation to insecticide and biopesticide treatments in okra. *Indian J Entomol*, 59(5): 938-944. **(5.08)**
128. Kaur, S. and Sood, P. (2023). Quantification of heavy metal residues in fecal matter of blue rock pigeon (*Columba livia*) in Punjab. *Indian J Entomol*, Ref. No. e23019 DOI:10.55446/IJE.2023.1019 **(5.08)**
129. Kaur, S., Kocher, D.K., Kaur, A. and Kumar, R. (2023). Larvicidal potential and retention efficacy period of citronella leaf oil against *Aedes aegypti* L. *Indian J Entomol*, e22607, DOI: 10.55446/IJE.2023.607, 1-6 **(5.08)**
130. Kaur, S., Singla, N. and Mahal, A. K. (2022). *Carica papaya* modulates the organ histology, biochemicals, estrous cycle and fertility of *Bandicota bengalensis* rats. *J Appl Anim Res*, 50(1): 289-98. DOI: 10.1080/09712119.2022.2068556 **(7.63)**
131. Kaur, T., Babbar, B. K., Kumar, S. and Katyal, P. (2023). Mammalian diversity recorded along River Beas in Punjab, India. *Indian J Ecol*, (Accepted) **(5.79)**
132. Kaur, V., Kaushal, S., Heena and Utreja, D. (2024). Occurrence, isolation, pharmacological potential, metabolism, and toxicity of Myristicin: a naturally occurring alkoxy-substituted allylbenzene *Mini Rev Org Chem*, 21: 473-493. **(8.49)**
133. Kaura, V., Malhotra, P. K., Mittal, A., Sanghera, G.S., Kaur, N., Bhardwaj, R. D., Cheema R. S. and Kaur, G. (2022). Physiological, Biochemical, and Gene Expression Responses of Sugarcane under Cold, Drought and Salt Stresses. *J Plant Grow Regul*, DOI: 10.1007/s00344-022-10850-8. **(10.27)**

134. Khokhar, S., Taggar, G.K., Grewal, S. K.(2023). Alteration in the developmental physiology of *Maruca vitrata* (Fabricius) on jasmonic acid and salicylic acid treated pigeonpea. *Arthropod-Plant Interact*, 17, 389-400. DOI: 10.1007/s11829-023-09970-z **(8.41)**
135. Khwaja, H. K., Sekhon, M. K. and Bhardwaj, S.(2022). Growth impact and effectiveness of administered prices for major crops in Punjab, *J of Agriculture Development and Policy*, 32(1): 117-124.
136. Kler, T.K., Hora, H.K., Sood, A. and Kumari, P. (2023). Predicting avian diversity with geospatial technologies. *Indian J Entomol* 85 (1): 145-49.
137. Kler, T.K., Kumar, M., Kumar, S. and Sidhu, S.K. (2022). Avian diversity in agricultural habitats of Punjab state. *Agric Res J, PAU* 59(6): 1100-10. **(5.44)**
138. Krishi, Kaur, L. and Kaur, A.(2022). Problems faced by the women due to the Guru Gobind Singh Refinery: A social impact assessment, *Indian J of Extension Education*, 58: 111-115.
139. Kumar A, Sharma R, Sharma, A. Choudhary, P.,Srivastava, P.,and Kaur, H.(2021).Morpho- physiological evaluation of *Elymus semicostatus* (Nees ex Steud.) Melderis as potential donor for drought tolerance in Wheat (*Triticum aestivum* L.). *Genet Resour Crop Evol* 69: 411–430
140. Kumar, R., Kumar, S., and Chahal, P. (2023). Information and communication technologies (ICTs) implementation. *Indian J of Agricultural Sciences*, 93(1): 119-121.
141. Kumar, S., and Sharma, R.(2023). Resource use efficiency optimization of major farming systems in hills of Himachal Pradesh. *Indian J of Ecology*, 50(3): 893-899.
142. Kumar, S., Arora, K., Singh, P., Gupta, A. K, Sharma, I. and Vatta, K. (2022). Performance comparison of ARIMA and time delay neural network for forecasting of potato prices in India. *Agricultural Economics Research Review*, 35(2): 119-134.
143. Kumar, S., Gupta, A. K., Arora, K. and Vatta, K. (2022). Effect of rainfall in predicting tomato prices in India: An Application of SARIMAX and NARX Model. *J of Agricultural Development and Policy*, 32 (2): 159-164.
144. Kumar, S., Kaur, H., Hunjan, M.S. and Kaur, K. (2023). Biochemical changes induced in the maize leaf sheath upon inoculation with *Rhizoctonia solani* incitant of banded leaf and sheath blight. *Cereal Res Commun*, 51: 413-423.**(7.24)**
145. Kumar, S., Sidana, B. K., and Thakur, S. (2023). Climate change and its impact on productivity of major kharif and rabi crops in Punjab. *Mausam*, 74(1): 151-160.
146. Kumar, S., Kler, T. K., Sekhon, G.S. and Sahni, T. (2022). Partial altitudinal movement of Himalayan Bulbul *Pycnonotus leucogenys* in Himalayan Siwalik range. *J Pharm Innov*, 11(6): 1732-38.
147. Lohan, S. K., Narang, M. K., Javed, M., Kumar, V., Majumdar, A. and Raghuversingh, P. (2022). Optimization and evaluation of machine field parameters of remotely controlled two-wheel paddy transplanter. *J Field Robotics*, 39: 984-998 DOI:10.1002/rob.22080. **(12.38)**
148. Madhvi, Utreja, D. and Kalia, A. (2022). p-Toluenesulfonic acid: An effective catalyst to synthesize 5-aryl-pyrimido[4,5-b]quinoline-2,4(1H,3H,5H,10H)-diones and their antimicrobial activity *Russ J Org Chem*, 58(9): 1327–35. **(6.86)**
149. Mahajan, M., Singla, P. and Sharma, S. (2023). Sustainable postharvest processing methods for millets: A review on its value-added products. *J Food Process Eng*, e14313.DOI:10.1111/jfpe.14313 **(2.98)\***
150. Mahajan, N., Gupta, M., Choudhary, T. F. and Mavi, H. K. (2023). Analyzing the short and long-run impact of various inputs on rice productivity: Evidence from major paddy producing states of India. *Indian J of Economics and Development*. 19: 173-80.
151. Manchanda, P., Kaur H., Mankoo, R. K., Kaur, A., Kaur, J., Kaur, S. and Sidhu, G. S. (2023). Optimization of extraction of bioactive phenolics and their antioxidant potential from callus and leaf extracts of *Citrus sinensis* (L.) Osbeck, *C. reticulata* Blanco and *C. maxima* (Burm.) Merr. *J Food Measure Charact*, 17: 1343-53. **(9.01)**
152. Mandla, D., Singla, N., Brar, S.K. and Singla, L.D. (2022). Molecular and phylogenetic analysis and risk assessment of a trematode parasite, *Artyfechinostomum sufrartyfex* Lane, 1915 with a new host record from India. *Biologia*, 78(3):119-128. DOI: 10.1007/s11756-022-01241-1 **(7.65)**
153. Mankoo, R.K., Kaur, J. and Chahal, G. K. (2023) Characterization of rice straw lignin phenolics and evaluation of their role in pollen tube growth in *Cucurbita pepo* L. *Natural Prod Res*, 16: 1-6. DOI: 10.1080/14786419.2023.2225126. **(8.49)**
154. Modi, R. U., Manes, G. S., Mahal, J.S., Dixit, A. K., Singh A. P. and Mahal, A. K. (2022). Field evaluation of tractor-operated seeder for sowing mat type paddy nursery. *Indian J Agric Sci*, 92(9): 1066-1070. **(6.37)**
155. Nikhanj, P. and Kumari, J. (2023). Optimization of edible coating conditions using statistical Response Surface Methodology for shelf life extension of fresh-cut guava. *Acta Aliment*, (Accepted) **(7.00)**
156. Palia, G., Thakur, S., Sharma, R., Sharma, J.P. and Dhakad, A.K. (2023). Genetic divergence and correlation estimates for quantitative traits in *salix*. *Acta Physiologiae Plantarum* 45:99. DOI: 10.1007/s11738-023-03573-0.
157. Poply, S., Dharni, K., Rathore, R. and Grewal, I. (2022). Investigation of stock herding in India food processing sector. *GNA Journal of Management and Technology*, 13(1): 96-103.
158. Pranneshraj, V., Sangha, M. K., Djalovic, I., Miladinovic, J. and Djanaguiraman, M., (2022).Lipidomics-assisted GWAS (IGWAS) Approach for improving high-temperature stress tolerance of crops.*Int J Mol Sci*, 23 (16): 9389.**(11.92)**
159. Preet, T., Ghai, N., Jindal, S. K., and Sangha, M. K. (2023). Salicylic Acid and 24-epibrassinolide induced thermotolerance in bell pepper through enhanced antioxidant enzyme system and heat shock proteins. *J Agr Sci Tech*, 25(1): 171-83. **(7.28)**



160. Priya, B., Utreja, D. and Kalia, A.(2022). Schiff Bases of Indole-3-Carbaldehyde: Synthesis and evaluation as antimicrobial agents. *Russ J Bioorg Chem*,1-9. **(7.00)**
161. Rana, S., Kapoor, S., Sharma, S. and Kalia, A. (2023). *Pleurotus florida* mediated biosynthesis of nanoparticles and biofortification. *Food Sci Biotechnol*, 32(14): 2079-2092. **(9.23)**
162. Ranguwal, S. and Kaur, G.(2022). Women entrepreneurship in India vis-à-vis Punjab- status, motivation and challenges. *J of Community Mobilization and Sustainable Development*, 17(2): 480-488
163. Ranguwal, S. and Kaur, P. (2022). Access to institutional credit in rural Punjab. *The J of Rural and Agricultural Research*, 22 (2): 9-15.
164. Ranguwal S and Kumar R. (2021). The Covid 19 pandemic and agriculture: Mitigation strategies followed by Punjab farmers. *Indian Journal of Extension Education*, 57(3): 164-170.
165. Ranguwal, S. and Mavi, H. K.(2022). Adoption status of improved paddy varieties and fertilizer use in Moga district of Punjab. *Indian J of Rice Research*, 15: 85- 93.
166. Ranguwal, S., Sidana, B. K., and Kumar, S.(2022). Carbon footprints of rice-wheat cultivation across farm size categories: Evidence from Punjab in India. *J of Cereal Research*, 14 (2): 8-17.
167. Rani, H., Bhardwaj, R. D. and Kaur, S. (2023). Understanding the influence of genotype and temperature on proteolytic activity in distinct barley genotypes. *J Food Sci*, 88: 1718-1730. DOI: 10.1111/1750-3841.16509. **(9.69)**
168. Rani, H., Bhardwaj, R. D., Kaur, S. and Grewal, S. K. (2022). Investigating diverse barley (*Hordeum Vulgare* L.) germplasm for thermostability of  $\beta$ -amylase: A key player of diastatic power. *Cereal Chemistry*, 99: 1339-1348. **(7.98)**
169. Rani, M., Utreja, D., Dhillon, N.K. and Kaur, K. (2022). A convenient one-pot synthesis of Bis(indolyl)methane derivatives and their antinematic evaluation against root knot nematode *Meloidogyne incognita*. *Russ J Org Chem*, 58(10): 1527–1533. **(6.86)**
170. Rara, S., Singla, N., Brar, S. K., Mandla, D. and Singla, L. D. (2023). Severe Infection of *Nippostrongylus brasiliensis* in *Bandicota bengalensis* Inhabiting Commensal Areas of Punjab, India: Prevalence, Risk Factor Analysis, Molecular Identification and Phylogenesis. *Acta Parasitologica*, 68: 172-81. DOI: 10.1007/s11686-022-00652-z **(7.53)**
171. Rashmi, Kaushal, S. and Sharma, P. (2022). Antimicrobial and antioxidant potential of banana (*Musa sapientum*) peel extracts of variety Grand Naine, 5-hydroxymethylfurfural major compound in methanolic peel extracts and its derivatives. *Agric Res J*, 59 (5): 953-963. **(5.44)**
172. Rathore, R. (2022). Entrepreneurial Behavior of Farmers towards Cultivation of Medicinal and Aromatic Plants in the Ujjain district of Madhya Pradesh. *IRJEE*, 22(4): 64-67. **(5.22)**
173. Rathore, R. (2022). Financial feasibility analysis of *Ghrithkumari* (Aloe vera) cultivation as farm business enterprise in Churu district of Rajasthan. *Econ*, 67(4): 543-549. **(5.08)**
174. Rathore, R. (2023). Dairy Entrepreneurship in *Kandi* region of Punjab: Prospects and Constraints. *IJBMS*, 14(3): 450-56. **(5.1)**
175. Raviraj, P. and Adhale, P.(2022). Understanding India's reliance on pulses for food and nutritional security. *Agricultural Situation in India*, 79 (7): 24-30.
176. Saini, R., Kaur, M., Singh, R., Arora, K., Singh, G., Kaur, G., Singh, S., Singh, A., Singh, D. (2022). Understanding sustenance of small farm holders: A Study of income inequality among farm households in Indian Punjab. *Sustainability*, 14:13438.
177. Saklani, S., Grover, K., Choudhary, M., Sandhu, S. K. and Javed, M. (2022). Fatty Acid Composition and Oxidative Potential of Food Products Prepared Using Low Erucic Brassica Oils. *Proc Natl Acad Sci, India Sec B Biol Sci*, 93: 107–117 DOI: 10.1007/s40011-022-01415-6.
178. Sandhu, K. K., Vashishat, N. and Kocher, D. K. (2023). Potential larvicidal bioefficacy of copper sulfide-based hybrid nanoemulsions of eucalyptus oil against *Aedes aegypti* (Linnaeus). *J Vector Borne Dis*, 60 (3): 79-87 **(6.74)**
179. Sandhu, K. K., Vashishat, N. and Kocher, D.K. (2023). Formulation of eucalyptus oil-zinc sulfide hybrid nanoemulsion and evaluation of its larvicidal potential against *Aedes aegypti*. *Afr Entomol*, 60 (3): 79-87 **(7.19)**
180. Sandhu, K. K., Vashishat, N. and Sidhu, A. (2022). Larvicidal potential of copper sulphide nano aqua dispersions against *Aedes aegypti* (Linnaeus). *African Entomol*, 31: 1-8 **(7.19)**
181. Sekhon, M. K., Kaur, A. and Chopra, S.(2022). Marketing infrastructure development in Punjab and farm laws 2020: Some observations. *J of Agricultural Development and Policy*, 32 (2): 180-188.
182. Sendhil, R., Arora, K., Kumar, S., Lal, P., Roy, A., Jayakumara, V. R., VEDI, S., and Pouchepparadjou, A.(2023). Price dynamics and integration in India's staple food commodities—evidence from wholesale and retail rice and wheat markets. *Commodities*, 2(1): 52-72.
183. Seth, K., Singla, N. and Javed, M. (2022). Impact of nutrition intervention on health indices of undernourished Punjabi women: a cross sectional study. *Int J Inno Sci Res Tech*, 7: 226-37.
184. Shafiqullah, Kataria, P., and Mouzam, S. M.(2022). Status of India in Global Organic production and Export. *Indian J of Economics and Development*, 18(3): 556-565.
185. Sharma, I. and Sekhon, M.K. and Singh, P.(2022). Cost structure and production efficiency of small-scale wheat farms in Punjab. *Indian J of Economics and Development*, 17 (1): 847-854
186. Sharma, I., Arora, K., Kumar, S., Bhoi, P. B. and Vatta, K.(2023). Global trade competitiveness of Indian buffalo meat: Trends and determinants. *Buffalo Bulletin*, 42(1): 105-124.

187. Sharma, R. K., Dhillon, J., Kumar, S., Vatta, K., and Krishna, N. R.(2023). Crop-climate link in the southeastern USA: A case study on oats and sorghum. *J of Agriculture and Food Research*, 12: 100626.
188. Sharma, R. K., Kumar, S., Vatta, K., Bheemanahalli, R., Dhillon, J. and Reddy, K. N.(2022). Impact of recent climate change on corn, rice, and wheat in southeastern USA. *Scientific Reports*, 12(1): 16928.
189. Sharma, R. K., Kumar, S., Vatta, K., Dhillon, J. and Krishna, N. R.(2022). Impact of recent climate change on cotton and soybean yields in the southeastern United States. *J of Agriculture and Food Research*, 9: 100348.
190. Sharma, Y., Sidana, B. K., Kumar, S., Kaur, S., Sekhon, M. K., Mahal, A. K., and Mehan, S.(2023). Pre and Post Water Level Behaviour in Punjab: Impact Analysis with DiD Approach. *Sustainability*, 15(3): 2426.
191. Sharma, S., Madaan, K. and Kaur, R. (2022). Cordycepin: A hidden metabolite with pharmacological potential. *Int J Med Mushrooms*, 24(8): 1-20 **(7.71)**
192. Sharma, Y., Sidana, B. K., Kumar, S., Kaur, S., Sekhon, M. K., Mahal, A. K. and Mehan, S. (2023). Pre and Post Water Level Behaviour in Punjab: Impact Analysis with DiD Approach. *Sustainability*, 15(3): 2426. **(9.89)**
193. Sharma, N., Kaur, N. and Singh, N. D. (2022). Seasonal prevalence of intestinal parasites as bioindicators of aquatic ecosystem and their impact on histology and biochemical parameters of *Labeorohita* in Ludhiana district of Punjab. *J Soil Salin*, 14(2): 244-50 **(4.94)**.
194. Shilpa, Kler, T. K. and Kaur, G. (2023). Assessment of avian feeding guilds in winter and rainy crop seasons of guava. *Indian J Entomol*, (Accepted) **(5.08)**
195. Singla A, Sharma R, Chhabra R, Vij L and Singh P (2023) Influence of varying shade intensities of green net on physiological and biochemical components of different *Ocimum* species. *Russ J Plant Physiol*, 70: 1-10 **(7.47)**
196. Shivani, Grewal, S.K., Gill, R.K., Virk, H.K. and Bhardwaj, R.D. (2022). Impact of post-emergent imazethapyr on morpho-physiological and biochemical responses in lentil (*Lens culinaris* Medik.). *Physiol Mol Biol Plants*, 28:1681–1693. DOI: 10.1007/s12298-022-01244-x **(8.39)**
197. Shivani, Grewal, S.K., Gill, R.K., Virk, H.K., Bhardwaj, R.D. (2023). Effect of herbicide stress on synchronization of carbon and nitrogen metabolism in lentil (*Lens culinaris* Medik.). *Plant Physiol Biochem*, 1; 196:402-14, DOI: 10.1016/j.plaphy.2023.01.063 **(11.44)**
198. Sidana, B. K., Kaur, A., Thakur, S. and Kaur, S.(2022). Trends of green house gas emissions: Inter sectoral analysis. *J of Agricultural Development and Policy*, 32(1): 94-98.
199. Sidhu, R., Kaushal, S., Kaur, V. and Sharma, P. (2023). Chemical composition, synergistic antimicrobial and antioxidant potential of *Hibiscus rosa-sinensis* L. leaves essential oil and its major compound. *J. Essent. Oil. Bear Pl*, 26: 469-485 DOI: 10.1080/0972060X.2023.2189529 **(7.69)**
200. Sidhu, S. K., Sekhon, G. S., Kumar, S., Kler, T. K. and Chandi, A. K. (2022). Diversity of insectivorous avian species and their foraging activities at ponds in agricultural habitats in Punjab, India. *Pak J Zool*, DOI: 10.17582/journal.pjz/2022021. **(6.00)**
201. Singh, A., Bhardwaj, U., Kaur, R. and Vyas, P. (2023). Chemical composition, microencapsulation and comparative antimicrobial studies of unencapsulated and encapsulated carrot seed essential oil. *J Essen Oil Bear Plants*, 26(1): 232-243. **(7.70)**
202. Singh, G., Ubhi, M. K., Jeet, K., Singla, C. and Kaur, M. (2023). A Review on Impacting Parameters for Photocatalytic Degradation of Organic Effluents by Ferrites and their Nanocomposites. *Processes*, 11(6):1727. **(9.5)**
203. Singh, H., Grewal, S.K., Singh, R., Bhardwaj, R.D.(2023). Induced defense responses in cultivated and wild chickpea genotypes against *Helicoverpa armigera* infestation. *Biol Futura*, 74:231-246 DOI: 10.1007/s42977-022-00151-2 **(7.07)**
204. Singh, J. M., Kaur, A., Chopra, S., Kumar, R., Sidhu, M. S. and Kataria, P. (2022). Dynamics of production profile of pulses in India. *Legume Research*, 45: 565-572.
205. Singh, J. M., Sachdeva, J., Bhangu, P. K. S., Singh, J., Kaur, B. and Kumar, H. (2022). Groundwater saving in Punjab: Role of short duration paddy varieties in agricultural sustainability. *Indian Jof Ecology*, 49: 358-362.
206. Singh, N., Singh, A. S., Singh, B. and Singh, G.(2023). A study for sustainability and conjunctive management need of groundwater. *J of Academic Research on Management Accounting and Finance*, 11 (1): 1-6.
207. Singh, O.K., Priscilla, L., Vatta, K.(2022). Land use dynamics and its implication for the agricultural sector in Indian Punjab. *Agricultural Economics Research Review*, 35:172-172.
208. Singh, P. and Zhawar, V.K. (2022). GABA improves secondary metabolic and defense activities under stripe rust (*Puccinia striiformis* f. sp. *tritici*) in wheat. *J Plant Pathol*, 104: 1475–1481. DOI: 10.1007/s42161-022-01186-z **(7.73)**
209. Singh, P., Arora, K., Kumar, S., Gohain, N. and Sharma, R. K. (2023). Indian millets trade potential-cum-performance: Economic perspective. *Indian J of Agricultural Sciences*, 93 (2): 200-204.
210. Singh, P., Sharma, S. and Kaur, L.(2022). Rural micro-entrepreneurs in Sub-mountainous agro ecological zone Punjab: An Analytic Hierarchy Process (AHP) Analysis. *Agricultural Research J*, 59: 178-184.
211. Singh, P., Sharma, S. and Kaur, L. (2023). Enhancing socio-economic status through entrepreneurship in sub-mountainous Punjab. *J of Community Mobilization and Sustainable Development*, 18: 365-371.
212. Singh, P., Zhawar, V.K., Pannu, P.P.S. (2023). Effect of gamma-aminobutyric acid on resistance against stripe rust (caused by *Puccinia striiformis* f. sp. *tritici*) in wheat cultivars. *J Environ Biol*, 44: 159-166. DOI:10.22438/jeb/44/2/MRN-5027 **(5.7)**



213. Singh, S. and S. Ranguwal.(2022). Paddy residue management alternatives in Punjab, India: An economic analysis. *Indian J of Ecology*, 49 (4): 1556-60. **(5.79)**
214. Singh, S., Kaushal, S., Hunjan, M. S. and Sharma, P. (2022). Chemical composition and molecular docking studies of *Cyamopsis tetragonoloba* (L.) Taub. Leaves and fruits extracts as antifungal agents against rice phytopathogenic fungi *Arch Phytopathol Plant Prot*, 55 (10): 1179-1200. **(6.73)**
215. Singh, S., Sekhon, M.K., Anurag, C. and Sumit, B. (2022). Status and performance of farmer producer organizations in Gurdaspur district of Punjab. *Indian J of Agricultural Marketing*, 36(1): 96-104
216. Singh, Y. J., Grewal, S. K. and Gill, R. K. (2022). Proline metabolism and phenylpropanoid pathway act independently in conferring resistance against yellow mosaic virus infection in black gram. *Physiol Mol Plant Pathol* 116: 101713: DOI: 10.1016/j.pmpp.2021.101713 **(7.65)**
217. Singh, A., Bhardwaj, U., Kaur, R and Vyas, P. (2023). Chemical composition, microencapsulation and comparative antimicrobial studies of unencapsulated and encapsulated carrot seed essential oil. *J Essent Oil-Bear Plants*, 26 (1): 232-243. **(7.7)**
218. Singh, A., Duche, R. T., Wandhare, A. G., Kaur, J., Singh, B. P., Sihag, M. K., et al (2023). Milk-derived antimicrobial peptides: overview, applications, and future perspectives. *Probiotics Antimicrob Proteins*, 15 (1): 44-62 **(11.27)**
219. Singh, R. and Sukhmani. (2022). Farmer's preference towards In situ and Ex situ Techniques in Paddy Straw Management in Punjab. *Int J Educ Manag*, 12(3): 191-195 **(4.58)**
220. Singh, R., Singla, N., Walia, G. S. (2023). Management of rodent pests in wheat sown under different tillage systems. *Indian J Ento*, 85(3): 692-696.
221. Singha, S. and Rathore, R. (2023). Consumers' opinions and constraints towards buying Jute products in Jalpaiguri and Ludhiana District- A Comparative Study. *Asian J Agric Ext Economics Social*, 41(4): 75-81. **(4.82)**
222. Singla, A., Sharma, R., Chabbra, R., Vij, L. and Singh, P.(2021). Effect of varying shade intensities of green nets on growth and stomatal attributes of different *ocimum* species. *Proc. Natl. Acad. Sci*, 91: 865–878. DOI:10.1007/s40011-021-01280-9
223. Singla, D., Sangha, M. K., Singh, M., Pathak, M. and Bala, M. (2022). Variation of mineral composition in different fruit parts of bitter gourd (*Momordica charantia* L.) *Biol Trace Element Res*,201(10):4961-4971 **(9.74)**
224. Singla, N., Singh, R., Kaur, N. and Babbar, B. K. (2023). Field efficacy of reduced active ingredient zinc phosphide formulation against rodents. *Indian J Entomol*, 85(1): 267-270.
225. Sood, P. (2022). Imidacloprid induced reproductive toxicity in female albino rats. *Indian J Entomol*, DOI: 10.55446/IJE.2022.534 **(5.08)**
226. Sood, P. (2023). Pesticide Usage and its toxic effects-a review. *Indian J Entomol*, DOI: 10.55446/IJE.2023.505 **(5.08)**
227. Supreetha, B.G., SINGH, N. and Sharma, S. (2022). Influence of mulching on fruit development and quality attributes of strawberry. *Ind J Hortic*, 79(2):221-228 **(6.00)**
228. Tejinder Preet, Ghai, N., Jindal, S.K. and Sangha, M.K. (2023). Salicylic acid and 24-epibrassinolide induced thermotolerance in bell pepper through enhanced antioxidant enzyme system and heat shock proteins. *J of Agricultural Science and Technology*, 25(1): 171-183 **(7.10)**
229. Thakur R, Devi R, Lal MK, Tiwari RK, Sharma S and Kumar R (2023) Morphological, ultrastructural and molecular variations in susceptible and resistant genotypes of chickpea infected with botrytis grey mould. *Peer J*,11:e15134 DOI: 10.7717/peerj.1513 **(3.06)\***
230. Thapar, S. and Kaur, R. (2022). Information Needs of Punjab Farmers and Constraints in Online Access: A Snapshot. *Media Mimansa*, 16(2):7-15.
231. Thukral, K., Kaur, K., Suneja, Y. and Kaur, G. (2023). Distinctive characteristics of nitrogen metabolism in teosinte versus modern maize for water logging tolerance. *J Plant Growth Regul*, 42(7), 4193-4206. **(10.64)**
232. Toor, A. (2022). Lynne Cherry's A River Ran Wild: A Story of Eco-Social Restoration. *Pragati's English J*. 22(2): 35-44. **(5.86)\***
233. Toor, A. (2022). Ecofeminist Analysis of Animalisation of Women in PETA's Campaigns and Alexander McQueen's Fashion Shows. *Re-Markings*, 21(2): 104-111. **(11.48)\***
234. Toor, A. (2023). Foregrounding the Non-Human in Jim Corbett's Jungle Lore. *Research J of English Language and Literature*. 11(1): 33-39. DOI: 10.33329/rjelal.11.1.33 **(6.89)\***
235. Tumasyan, A., Adam, W., Andrejkovic, J. W., Kalsi, A.K. et al. [CMS Collaboration] (2022). Search for high-mass resonances decaying to a jet and a Lorentz-boosted resonance in proton-proton collisions at  $\sqrt{s} = 13$  TeV. *Physics Letters B*, 832:137263. **(10.89)**
236. Tumasyan, A., Adam, W., Andrejkovic, J. W., Bergauer, T., Chatterjee, S., Kalsi, A. K. et al. [CMS Collaboration] (2022). Search for a  $W'$  boson decaying to a vector-like quark and a top or bottom quark in the all-jets final state at  $\sqrt{s} = 13$  TeV. *JHEP*, 09:088. **(6.37)\***
237. Tumasyan, A., Adam, W., Andrejkovic, J. W., Bergauer, T., Chatterjee, S., Kalsi, A. K. et al. [CMS Collaboration] (2022). Search for new physics in the lepton plus missing transverse momentum final state in proton-proton collisions at  $\sqrt{s} = 13$  TeV. *JHEP*, 07:067. **(6.37)\***

238. Tumasyan, A., Adam, W., Andrejkovic, J. W., Bergauer, T., Chatterjee, S., Kalsi, A. K. et al. [CMS Collaboration] (2023). Search for CP violation using  $t\bar{t}$  events in the lepton+jets channel in pp collisions at  $\sqrt{s} = 13$  TeV. *JHEP*, 06:081. **(6.37)\***
239. Tumasyan, A., Adam, W., Andrejkovic, J. W., Bergauer, T., Chatterjee, S., Kalsi, A. K. et al. [CMS Collaboration] (2022). Identification of hadronic tau lepton decays using a deep neural network. *JINST*, 17:P07023. **(1.41)\***
240. Tumasyan, A., Adam, W., Andrejkovic, J. W., Bergauer, T., Chatterjee, S., Kalsi, A. K. et al. [CMS Collaboration] (2022). Search for Higgs Boson Pair Production in the Four b Quark Final State in Proton-Proton Collisions at  $\sqrt{s} = 13$  TeV. *Phys Rev Lett*, 129:081802. **(9.16)\***
241. Tumasyan, A., Adam, W., Andrejkovic, J. W., Bergauer, T., Chatterjee, S., Kalsi, A. K. et al. [CMS Collaboration] (2022). Search for Resonances Decaying to Three W Bosons in Proton-Proton Collisions at  $\sqrt{s}=13$  TeV. *Phys Rev Lett*, 129: 021802. **(9.16)\***
242. Tumasyan, A., Adam, W., Andrejkovic, J. W., Kalsi, A. K. et al. [CMS Collaboration] (2023). Strange hadron collectivity in pPb and PbPb collisions. *JHEP*, 05:007. **(6.37)\***
243. Tumasyan, A., Adam, W., Andrejkovic, J. W., Kalsi, A. K. et al. [CMS Collaboration] (2023). Search for Higgs boson decays to a Z boson and a photon in proton-proton collisions at  $\sqrt{s} = 13$  TeV. *JHEP*, 05:223. **(6.37)\***
244. Tumasyan, A., Adam, W., Andrejkovic, J. W., Kalsi, A. K., et al. [CMS Collaboration] (2023). Search for heavy resonances and quantum black holes in  $e\mu$ ,  $e\tau$ , and  $\mu\tau$  final states in proton-proton collisions at  $\sqrt{s}= 13$  TeV. *JHEP*, 05:227. **(6.37)\***
245. Ubhi, M. K., Kaur, M., Grewal, J. K., Oliveira, A. C., Garg, V. K. and Sharma, V. K. (2022). Insight into photocatalytic behavior of magnesium ferrite–bentonite nanocomposite for the degradation of organic contaminants. *J Mater Res.*,38: 990-1006. **(9.02)**
246. Ubhi, M. K., Kaur, M., Singh, D. and Sharma, V. K. (2023). Structural and adsorptive properties of boron- and phosphorous-doped graphene oxide: Insight into effective removal of Pb(II) and As(III). *J Water Process Eng*, 52(6): 103539. **(13.34)**
247. Ubhi, M. K., Kaur, M., Singh, D., Javed, M., Oliveira, A. C, Garg, V. K. and Sharma, V. K. (2022). Hierarchical nanoflowers of Mg Fe<sub>2</sub>O<sub>4</sub>, bentonite and B-P-co-doped grapheme oxide as adsorbent and photocatalyst: Optimization of parameters by Box-Behnken methodology. *Int J Mol Sci*,23: 9678. **(11.92)**
248. Utreja, D., Salotra, R., Kaur, G., Sharma, S. and Kaushal, S. (2022). Chemistry of Quinolines and their Agrochemical potential. *Curr Org Chem*, 26:1895-1913. **(8.22)**
249. Vatta, K., Bhogal, S., Green, A. S., Petrie, C. A., Sharma, H., and Dixit, S.(2022). Groundwater use and sustainability in Punjab agriculture: insights from a field survey. *Agricultural Economics Research Review*, 35(1): 45-56.
250. Vatta, K., Kaur, A., Sidana, B. K., Bhangu, P. K. S. and Kaur, A.(2022). Agricultural credit in Punjab: trends and future potential. *Agricultural Economics Research Review*, 35: 61-73.
251. Verma, V., Kaur, M. and Sharma, S. (2022). Insight into peroxidase and polyphenol oxidase mimic activity of spinel ferrite nanoparticles and their GO composites. *Mater Chem Phys*, 279: 125727 **(10.09)**
252. Verma, M., Kaur, H. and Babbar, B. K. (2023). Synergistic toxic and contraceptive potential of neem seed extract and andrographolide-based bait against black rat, *Rattus rattus*. *Wildlife Research, (Special issue on Fertility Control for Wildlife in 21st Century)* Accepted **(2.18)\***
253. Verma, N., Taggar, M. S., Kalia, A., Kaur, J. and Javed, M. (2022). Comparison of various delignification/desilication pre-treatments and indigenous fungal cellulose for improved hydrolysis of paddy straw. *3 Biotech*, DOI: 10.1007/s13205-022-03211-5. **(8.41)**
254. Verma, J., Singh, P. and Sharma, R. (2023). Evaluation of air pollution tolerance index and anticipated performance index of selected roadside tree species in Ludhiana. *Environ Monit Assess*, 195:240 **(8.51)**.
255. Viz, L., Sharma, R. and Chhabra, R.(2022). Influence of coloured shade nets on growth and biochemical constituents in four species of *Ocimum*. *Bangladesh J of Botany* 51(3)547-554
256. Zalpouri, R., Singh, M., Kaur, P., Kaur, A. and Gaikwad, K. K. (2023). Drying Kinetics, Physicochemical and Thermal Analysis of Onion Puree Dried Using a Refractance Window Dryer. *Processes*, 11: 700. DOI: 10.3390/pr11030700 **(9.35)**

## Books

1. Kocher, G.S., Arora, R., Kaur, J., Katyal, P. and Sharma, G.S. eds. (2022). Microbial Interventions to Achieve United Nation's Sustainable Development Goals. IIP Iterative International Publishers, Karnataka, India, p 199.
2. Thapar, S., Singh, N.P., Bector, V. and Toor, A. (2023). Roots of Prosperity: The Incredible Saga of Punjabi Farmers in Foreign Lands. Punjab Agricultural University, Ludhiana, p 44.
3. Toor, A. (2022). A Handbook of Technical and Research Writing. Crescent Publication, New Delhi, p 144.

## Book Chapters

1. Al-Tawaha, A. R., M. S., Vyas, P., Karnwal, A., Benkeblia, N., Sanmukh, G. S. (2022). Biological nitrogen fixation in nonlegume plants and changing climate. In: Climate Change and Agriculture: Perspectives, Sustainability and Resilience, pp 227-238, John Wiley & Sons, Ltd.
2. Arora, R., Bharti, V. K. (2023). Recent advances in green-synthesis of silver nanoparticles and their biomedical applications: A future perspective. In: Rafiq Lone and Javid Ahmad Malik (ed). Implications of nanoecotoxicology on environmental sustainability, pp 206-223, IGI Global, USA.



3. Arora, R., Thakur, S., Kaur, S. and Kumar, S. (2022). Bioprocessing of agricultural residues for biofuel production current scenario. In: PratibhaDheeran and Sachin Kumar (ed). Extremophiles General and plant biomass based biorefinery, pp 239-256, CRC Press, Boca Raton.
4. Arora, V., Sharma, S. G. and Katyal, P. (2023). Impact of pesticide overuse on quality of irrigation water and crops. In: Kocher et al (ed). Microbial interventions to achieve United Nations Sustainable Development Goals, pp. 177-90, Iterative International Publishers, Karnataka, India.
5. Gaba, J., Ekta, Sood, P., Kaur, P., Verma, D. (2023). *Habenaria Intermedia* D. Don and *Habenaria Edgeworthii* Hook., f. ex Collett.: The Western Himalayan Medicinal Plants. In: Sharma, A., Nayik, G.A. (ed). Immunity Boosting Medicinal Plants of the Western Himalayas, pp. 205-30. Springer Nature, Singapore.
6. Gaba, J., Ekta, Sood P. and Kaur, P. (2023). *Cordyceps sinensis* (Caterpillar fungus)/ (Yarsagumba)/ *Cordyceps militaris*, Family Ophiocordicipitaceae In: Sharma, A., Nayik, G. A. (ed). Edible and Medicinal Mushrooms of the Himalayas, pp. 67-94, CRC Press.
7. Gaba, J., Ekta, Sood P., Kaur, P. and Verma, D. (2023). *Habenaria Intermedia* D. Don and *Habenaria Edgeworthii* Hook., f. ex Collett.: The Western Himalayan Medicinal Plants In: Sharma, A., Nayik, G. A. (ed). Immunity Boosting Medicinal Plants of the Western Himalayas, pp. 205-230, Springer, Singapore.
8. Garcha, S. (2023). Microbes from Wild plants. In: Kaur S, Dwibedi V, Sahu PK and Kocher GS (ed.). Futuristic approaches in biofertilizer industry through metabolomics, proteomes and gene editing, pp. 173-187, Springer Nature.
9. Garcha, S. (2023). Present Scenario- Status of Biofertilizer in India. In: Kaur S, Dwibedi V, Sahu PK and Kocher GS (ed). Futuristic approaches in biofertilizer industry through metabolomics, proteomes and gene editing, pp.21-36, Springer Nature.
10. Jain, S. and Singh, R. (2022). Food packaging technologies in Post-Harvest. In: S.P. Singh (ed.), Global Research Initiatives for Sustainable Agriculture & Allied Sciences, Vol.2, pp. 97-100, Astha Foundation, Meerut.
11. Jain, S. and Singh, R. (2022). Women entrepreneurship in India. In: N.K. Singh, A. Kumar, and M. Jindal (ed.), Enabling economy through entrepreneurship, innovation and incubation, Vol. 1, pp 60-67, Germany, Weser Books.
12. Katyal, P., Priyanka, Sharma, S. G., Natt, S. K. (2023). Risks related to contaminated water and strategies for their control. In: Kocher et al (ed). Microbial interventions to achieve United Nations Sustainable Development Goals, pp. 64-81., Iterative International Publishers, Karnataka, India.
13. Kaur, A. P. and Singh, R. (2022). Migrant networks and credit: Dynamics of Punjabi migration to the gulf countries. In: M. M. Rahman and A. Al-Azm (eds.), *Social Change in the Gulf Region*, pp. 207-221, Gulf Studies. Springer
14. Kaur, R., Urvashi and Kumar, A. (2023). Species of the *Berberis* Genus found in the Western Himalayas. In: Sharma, A., Nayik, G.A. (ed). Immunity Boosting Medicinal Plants of the Western Himalayas, pp 107-42. Springer, Singapore.
15. Kaur, H. and Singh, R. (2021). Rural Marketing and Role of Women Entrepreneurs. In: Singh, N.K., Kumar, A., and Jindal, M. (ed). Enabling economy through entrepreneurship, innovation and incubation, Vol.1, pp. 13-19, Germany, Astha Foundation.
16. Kaur, H. and Singh, R. (2022). Dimensions of Food Security and Climate Change. In: Singh, S.P. (ed.), Global Research Initiatives for Sustainable Agriculture & Allied Sciences, Vol. 2, pp. 45-49, Astha Foundation, Meerut.
17. Kaur, M. and Singh, R. (2022). Role of Food Processing in Agribusiness. In: Singh, S.P. (ed.), Global Research Initiatives for Sustainable Agriculture & Allied Sciences, Vol. 2, pp. 118-121, Astha Foundation, Meerut.
18. Kaur, S., Rakhra, G. and Arora, R. (2022). Advancements in hemicellulosicextremozymes and their applications A future perspective. In: PratibhaDheeran and Sachin Kumar (eds). Extremophiles General and plant biomass based biorefinery, pp. 183-201, CRC Press, Boca Raton.
19. Kaur, S., Sharma, S. G., Katyal, P., Phutela, U. G. (2023). Bio-Strategies for Remediation of Heavy Metal from Contaminated Groundwater. In: Kocher et al(ed). Microbial interventions to achieve United Nations Sustainable Development Goals, pp. 107-14, Iterative International Publishers, Karnataka, India.
20. Natt, S. K., Arora, R., Johal, M. K., and Katyal, P. (2023). Low FODMAP sourdough diet to alleviate Irritable Bowel Syndrome. In: Kocher et al(ed). Microbial interventions to achieve United Nations Sustainable Development Goals, pp. 12-23, Iterative International Publishers, Karnataka, India.
21. Nikhanj, P., Singh, M. P., Saini, S., Kaur, G. and Kumari, J. (2023). Fresh Cut Fruits and Vegetables Disinfection Pretreatment: A Novel Approach to Extend Fresh Cut's Shelf Life. In: Food Processing and Packaging Technologies-Recent Advances, pp-1-24 Intech Open.
22. Savita, Mehra, P. and Kumar, B. (2022). The shadow side of social media: Social media fatigue, its causes and consequences. In: Kumar, S. (ed). Recent Advances in Management, IT and Social Science, pp 44-49, National Press Associates, New Delhi, India.
23. Singh, M. P., Nikhanj, P., Singh, P., Singh, R. K. and Sharma, A. (2022). Bio preservation: an alluring method to safeguard food from spoilage. In: New and Future Developments in Microbial Biotechnology and Bioengineering: Sustainable Agriculture: Revisiting Green Chemicals, pp: 449-47, Elsevier.
24. Sood, P. (2023). Severe COVID-19. In: Effect and Approach to Pandemic Covid-19 on Various Sectors, pp. 13-22, Bright Sky Publishers, New Delhi.
25. Tandon, R., Pooja and Kaur, M. (2023). Green Packaging: An Imminent Eco-Friendly Approach. In: Encyclopedia of Green Materials, pp. 1-11, Springer Nature.

26. Tandon, R., Pooja, and Kaur, M. (2023). Green packaging, an imminent eco-friendly approach. In: Encyclopedia of Green Materials, pp. 1-11, Springer.
27. Thapar, S. and Kaur, R. (2023). Influence of Farmers' Demographic Variables on Their Usage and Preferences towards Online and Mobile Media in Punjab. In: Dr T.R. Venkatesh and Dr Vivekanand Pandey (ed). Rethinking Media Perspectives in Building a Self-Reliant India, pp. 19-41, Amity University, Patna and UNICEF.
28. Urvashi and Kaur, R. (2023). Saussurea Lappa C.B. Clarke: Kushta/Kut. In: Sharma, A., Nayik, G.A. (ed). Immunity Boosting Medicinal Plants of the Western Himalayas, pp 433-62. Springer, Singapore.
29. Utreja D., Kaur, K., Dhillon, N.K., Anupam, Singh, S. (2023). Natural Product Chemistry in Agriculture. In: Green Chemistry in Agriculture and Food Production, pp 1-28, CRC Press, Taylor & Francis Group, Boca, Raton, London, New York.
30. Vyas, P., Rana, A.K. and Kasana, R. C. (2022). Role of plant growth-promoting bacteria in rainfed and irrigated crops. In: Plant Growth Promoting Microorganisms of Arid Region, pp. 163-147. Springer Nature, Singapore.
31. Vyas, P., Rana, A.K. and Kaur K. (2022). Role of microbial biofilms in bioremediation. In: Environmental Microbiology Advanced Research and Multidisciplinary Applications, pp. 163-147. Bentham Science Publishers Pvt. Ltd, UAE.

### Research Bulletins

1. Kler, T. K., Kumar, M., Vashishat, N. and Chaudhary, V. (2022). Depredatory Bird Species and their Eco- friendly Management in Agricultural Ecosystem of Punjab. P 21.
2. Singla, N. and Babbar, B. K. (2022). Potential of Different Antifertility Agents in Rodent Management. P64
3. Singla, N., Babbar, B. K., Singh, R. and Kaur, N. (2022). Rodent Pests: A Practical Guide for Management. P87

### College of Community Science

#### Research Papers in National and International Journals:

1. Aggarwal, R. and Bains, K. (2023). Protein and amino acid profile of meals in habitual diets of young Indian women. *IJBMS*, 14 (2):49-57. **(5.11)**
2. Aggarwal, R., Bains, K. and Jain, R. (2023). Effect of milk or milk derived food supplementation on body composition of young Indian women. *Asian J Dairy Food Res*, 48: 348-54. DOI:10.18805/ajdfr.DR-2066. **(5.75)**
3. Aggarwal, R., Bains, K. and Grewal, D. K. (2023) Beneficial effects of  $\gamma$ -oryzanol in Rice Bran for improving the health status of community. *J Comm mobilization Sustain Dev*, 18(1): 179-85. **(5.67)**
4. Arora, T., Sharma, S. and Dharni, K. (2022). Impact of COVID 19 on online food ordering and consumption pattern among college students. *Int J AgriSci*, 14: 11182-87. **(4.58)**
5. Bal, S.K., Gupta, R. and Bisht, D. (2023). Drudgery Reduction of Farm Women Through Technology Intervention. *J Community Mobilization and Sustainable Development*, 18(2): 652-656. **(5.67)**
6. Banga, S., Kumar, V., Kumar, S., Sharma, R., Kaur, R. and Grover, K. (2022). Process optimization for the development of fruit – based diet drink: A low- calorie approach. *J Food Process Preserv*, 46: 1-10. DOI: 10.1111/JFPP.16674. **(8.19)**
7. Bawa, K., Brar, J. K., Singh, A., Gupta, A., Kaur, H. and Bains, K. (2022). Wheatgrass powder-enriched functional pasta: Techno-functional, phytochemical, textural, sensory, and structural characterization. *J Texture Stud*, 53: 517-530. DOI:10.1111/jtxs.12680. **(9.22)**
8. Bhandal, S., Mann, S.K., Sidhu, K. and Kaur, K. (2023). Information Processing Behaviour of Farm Women. *J Comm Mob and Sustainable Dev*, 18:67: 70. **(5.67)**
9. Bhatt, P., Sharma, S., Grover, K., Sharma, S., Dharni, K. and Dhatt, A.S. (2023). Optimisation of nutritional composition, bioactive compounds and antioxidant activity of Broccoli (*Brassica oleracea*) microgreen sprinkler using alternate drying techniques. *Asian J of Dairy and Food Research*, 8: 1-8, DOI: 110.18805/ajdfr.DR-1955. **(5.75)**
10. Bisht, D., Martolia, D. and Bal, S.K. (2023). Buying practices followed by homemakers of Ludhiana city. *J Community Mobilization and Sustainable Development*, 18(2): 565-572. **(5.67)**
11. Garg, R., Singla, N., Gupta, M. and Jain, R. (2022). Sensory attributes and antioxidant potential of value-added products of grapefruit (*Citrus paradisi*). *Asian J Dairy Food Res*, : 1-7. DOI: 10.18805/ajdfr. DR-1881. **(5.75)**
12. Grewal, V. and Singla, N. (2022). Risk Factors associated with the Prevalence of Fluorosis in the Endemic Area of Punjab (Bathinda District). *Curr J App Sci Tech*, 41:31-41. **(4.71)**
13. Gupta, A., Sharma, S., Vig, D. and Dharni, K. (2022). Study on screen viewing pattern and its outcomes in relation to healthy eating, body composition indices and cognition among adolescents. *Int J AgriSci*, 14: 11171-76. **(4.58)**
14. Gupta, S. and Kaur, H. (2022). Assessment of Musculoskeletal Problems of Polyhouse Workers through Subjective Analysis Technique. *J Community Mobilization and Sustainable Development*, 17(4): 1181-86. **(5.67)**
15. Gupta, S. and Kaur, H. (2023). Occupational Risk Analysis while Performing Polyhouse activities in Ludhiana. *Int. J Edu and Mgt*, 13(1): 33-37. **(4.68)**
16. Joshi, N., Sharma, S. and Sharma, P. (2022). Enrichment programme efficacy on core life skills: A quasi experimental study among university students. *Ind. J Ext Edu*, 58 (4), 134–38. **(5.95)**
17. Kamboj, A., Mahajan, S. and Singh, K. (2022). Mulching practices and awareness of farmers for biodegradable mulches made from textile waste from Mansa and Moga. *Int J of Curr Microbiol App Sci*, 11: 47-56. **(5.3)**



18. Kaur, H., Kaur, M., Aggarwal, R., Sharma, S. and Singh, D. (2022). Nanocomposite of MgFe<sub>2</sub>O<sub>4</sub> and Mn<sub>3</sub>O<sub>4</sub> as polyphenol oxidase mimic for sensing of polyphenols. *Biosensor*, 12: 428, DOI: 10.3390/bios12060428 **(5.74)\***
19. Kaur, J., Kaur, K. and Sharma, M. (2022). Knowledge level of rural women regarding safe and judicious use of chemicals at household level. *J of Community Mobilization and Sustainable Development*, 18 (1):328-30 **(5.30)**
20. Kaur, P., Choudhary, M., Katyal, P. and Kaur, A. (2023). Evaluation of prebiotic and antioxidant potential of citrus peel waste. *Acta Scientific Nutritional Health* 7: 64-71. **(1.31)\***
21. Kaur, S., Kaur, N., Aggarwal, P. and Grover, K. (2022). Sensory attributes, bioactive compounds, antioxidant activity and color values of jam and candy developed from beetroot (*Beta vulgaris* L.). *J Applied Nat Sci*, 14:459-468 **(4.28)**
22. Kharkwal, A., Sharma, P. and Pandey, A. (2023). Designing and Development of Decision Support System for the Management of Lifestyle Diseases. *J Community Mobil & Sust Dev*, 18 (1): 205-212. **(5.30)**
23. Kharakwal, V., Bains, K., Bishnoi, M. and Devi, K. (2023). Health risk assessment of arsenic, lead and cadmium from milk consumption in Punjab, India. *Environmental Monitoring and Assessment* 195, DOI:10.1007/s10661-023-11256-z. **(3.30)\***
24. Mahar, J.B., Sharma, S., Kaur, R., Grover, K., Dharni, K. and Nara, U. (2022). Ameliorative effect of lemongrass (*Cymbopogon Flexuosus* Nees ex Steud.) W. Watson and celery (*Apium graveolens* L.) against CCl<sub>4</sub> induced oxidative stress and acute hepatotoxicity in rats: An *in vivo* assessment. *Ann Phytomed* 11(1):1-8. **(5.95)**
25. Mahorana, G. and Gupta, R. (2022). Assessment of Occupational Stress of Teaching Professionals during Covid 19 Pandemic. *J Krishi Vigyan*, 10(2): 12-17. **(4.55)**
26. Martolia, D. and Gupta, R. (2022). Exposure to Work related Risk factors Experienced by Gardeners. *J. Community Mobilization and Sustainable Development*, 3:782-786. **(5.67)**
27. Martolia, D. and Gupta, R. (2023). Environmental and Ergonomic Risk Factors of Professional Gardeners. *J Krishi Vigyan*, 11(2): 101-105. **(4.55)**
28. Martolia, D. and Bisht, D. (2022). Stress experienced during COVID 19 pandemic and coping strategies sought by homemakers of Ludhiana. *J Community Mobilization and Sustainable Development*, 18(2): 529-534. **(5.67)**
29. Naveena, J. H. and Choudhary, M. (2023). Consumption pattern of rice bran oil among adults in the highest rice producing region of Punjab. *Proc Nat Acad Sci India, Sect. B Biol. Sci*, 93: 957-65 DOI: 10.1007/s40011-023-01494-z **(0.96)\***
30. Pratiksha and Sharma, P. (2022). Knowledge about causes, effects and mitigation of soil pollution among farming families of Punjab. *J Community Mobil and Sust Dev*, 17 (1): 321-328. **(5.30)**
31. Pratiksha and Sharma, P. (2023). Construction of knowledge test to measure the knowledge level of farming families regarding environmental pollution in Punjab, India. *Asian J Agri Ext, Eco and Soc*, 41 (7): 165-171. **(4.78)**
32. Saklani, S., Grover, K., Choudhary, M., Sandhu, K. S. and Javed, M. (2022). Fatty acid composition and oxidative potential of food products prepared using low erucic brassica oils. *Proc Natl Acad Sci India Sect B Biol Sci*, 93: 107-117 DOI: 10.1007/s40011-022-01415-6. **(0.96)\*\***
33. Sehgal, S., Sharma, S., Sood, A., Dharni, K., Kakkar, C., Batta, S. and Sahotra, M. (2023). Assessment and prediction of malnutrition and sarcopenia in liver cirrhosis patients. *Nutrire*, 48: 6, DOI: 10.1186/s41110-023-00189-9 **(1.28)\***
34. Singla, N., Bakhetia, P., Jain, R. and Aggarwal, R. (2023). Efficacy of region-specific dietary intervention on the nutritional status of undernourished farm women. *Acta Scientific Nutritional Health*, 7: 77-84. DOI: 10.31080/ASNH.2023.07.1209. **(1.31)\***
35. Seth, K. and Singla, N. (2022). Organoleptic, nutritional and shelf stability analysis of formulated nutrient dense ingredient mix. *ChemSci Rev Lett*, 11: 91-103. **(4.75)**
36. Singh, R., Kaur, N. and Grover, K. (2022). Development of pseudo cereal quinoa based gluten free product to manage celiac disease among children. *Curr J App Sci Tech*, 41:14-32. **(4.71)**
37. Singla, P., Grover, K. and Dhillon, P. K. (2022). Investigating natural sweeteners vis a vis their nutritional, antinutritional and bioactive characteristics. *J Comm Mobilization Sustain Dev*, 17 (4):204-12. **(5.30)**
38. Singla, N., Bakhetia, P. and Jain, R. (2022). Impact of high-fiber ingredient mix on nutritional indices of the women suffering from metabolic syndrome. *Proc. Natl. Acad. Sci., India, Sect. B Biol. Sci*, 92: 223-30. **(0.96)\***
39. Sharma, M. and Singh, A. (2022). Inclusion of women in Dairy enterprise. *Indian J of Extension Education*, 57 (3): 192-95. **(5.95)**
40. Sharma, M., Bhatia, M. and Singh, P. (2023). Farmer's perspective on relevance and importance of kisanmelas. *J of Community Mobilization and Sustainable Development*, 18 (1):277-82. **(5.30)\***
41. Tamta, M. and Mahajan, S. (2022). Development of apparel products from Eri/Ramie blended and union fabrics. *Int J of Bio Resource and Stress Mgmt*, 13(7):765-70. **(5.11)**
42. Vaishali and Gupta, R. M. (2023). Socio-economic Status and Information Dissemination Behaviour of Dairy Farmers of Rural Punjab. *J Comm Mob Sustain Develop*, 18(2): 609-614. **(5.30)**
43. Verma, M., Singla, N., Aulakh, C.S. and Jain, R. (2023). Influence of organic, integrated and conventional production systems on concentration of phytonutrients in cereals and legumes. *Agri Res J*, 60: 113-20 **(5.44)**
44. Yogesh and Sharma, S. (2022). Role of vitamin D beyond bone health: A systematic review. *Annals of Phytomedicine*, 11(2): 1-8. DOI: 10.54085/ap.2022.11.2.0 **(5.95)**

## Book Chapters

1. Abrol P., Sharma, P. and Gupta, R.M. (2022). Climate Change Communication: Challenges, Approaches and Role of Extension Personnel. In: Existing Climate Change Scenario and its Arising Risks, pp.117 -126, Mahima Research Foundation and Social Welfare, Varanasi.
2. Gupta, R., and Bisht, D. (2023) Chhote Paimaane ki Khadya Pransaskaran Ikaai Hetu Kam Unchaai Wali Karya Taalika. In: Grameen Mahilaon Hetu Shram Daksh Taknikiyaan, pp. 123-126. BioTech Books, New Delhi.
3. Kamboj A., and Mahajan, S. (2022). Fashion and Textile Museums across the world. In: Handbook of Museum Textiles, Vol. I: Conservation and Cultural Research, pp.101-21. Wiley Education Services, Scrivener Publishing, US.
4. Kumari, S., and Gupta, R. (2023). Matar Ki Turrai Ke Liye Sanchayan Thella. In: Grameen Mahilaon Hetu Shram Daksh Taknikiyaan, pp. 189-192. BioTech Books, New Delhi.
5. Moharana, G., and Bal, S.K. (2023). Entrepreneurship Development: A Step towards Economic Empowerment of Women in Agriculture. In: Agri-preneurship development in seed sector for rural emplyment, pp.147-154. ICAR- Indian Institute of Wheat and Barley Research, Karnal.
6. Sharma P., MeghaliNath and Kaur, M. (2023). Gender Mainstreaming for Women Empowerment. In: Rashmi and Bhowmick A (ed).Unequal images: Looking through gender lens.pp. 29-44, Mittal Publications, New Delhi.
7. Sharma P., Mittal, R., and Pratiksha. (2022.) Role of Home Science in Sustainable Development of Community. In: Chauhan A and Dhawan D (ed).Home Science as a Vocational Subject: Challenges and Opportunities, pp. 63-84, Star Publications, Agra.
8. Shatakshi, Sharma, P., and Kaur, M. (2023). Empowering women through financial literacy. In: Rashmi and Bhowmick A (ed).Gender and Diversity, pp. 63-84, Mittal Publications, New Delhi.

## Manuals

1. Bisht, D. (2023). Management of Resources and System Dynamics: A Course Manual. Department of Resource Management and Consumer Science, PAU, Ludhiana. P 73.
2. Bisht, D., Bal, S.K. and Kaur, H. (2023). Ergonomics in Household and Farm Technologies: A Course Manual. Department of Resource Management and Consumer Science, PAU, Ludhiana. P 67.

## Research Bulletins

1. Rana, S. (2023). *Drudgery Reducing Tools for Women in Agriculture*. P 8.
2. Rana, S. (2023). *Aurta de Kheti Kam SukhaleKarn Wale SudhreSandh*. P 8.
3. Rana, S. (2023). Solar Dryer: Fuel and Environment Saving Equipment. P 8.

## College of Horticulture & Forestry

### Research Papers in National and International Journals:

1. Aeer, S.D., Jindal, S.K., Patel, S.A.H. and Chawla, N. (2023). Heterotic Pattern Involving Rin, Nor and Alc Alleles for Yield and Quality Traits in Tomato (*Solanum lycopersicum* L.). *Brazilian Archives of Bio. Technol*,66: e23230169, DOI: 10.1590/1678-4324-2023230169 **(7.14)**
2. Arora, H., Jindal, S.K. and Chawla, N. (2022). Combining ability analysis for yield and quality traits in exotic lines of tomato (*Solanum lycopersicum* L.). *Agri Res J*, 59(3): 394-399. **(5.44)**
3. Arora, H., Jindal, S.K., Sharma, A., Gill, R. and Chawla, N. (2022). Development and evaluation of hybrids resistant to late blight and leaf curl virus diseases in tomato. *Genetika*, 54(2): 801-816. **(6.40)**
4. Arora, R., Bons, H.K. and Kocher, G. S.(2023). Fermentative processing of unexploited fruit, karonda (*Carissa carandus* L.) into alcoholic beverages. *South African J of Botany*,158:73-79. **(9.11)**
5. Angmo, D., Sharma, S.P., Kalia, A., Brar, N.S. and Bharadwaj, V. (2022). Effect of cold stress on field performance, chlorophyll fluorescence, electrolyte leakage and leaf gas exchange parameters of potato (*Solanum tuberosum* L.) genotypes. *Potato Res*,66: 641–661 (2023). DOI: 10.1007/s11540-022-09593-6 **(8.56)**
6. Babanjeet, Singh K, Talwar, D. and Jindal, S. K.(2022). Influence of potassium nitrate on yield and quality of chilli. *Agri Res J*, 59(6): 1034-1041. **(5.44)**
7. Babanjeet, Talwar D, Singh K and Jindal S K 2022). Influence of nitrogen and potassium on growth and yield of chilli (*Capsicum annum* L.). *Veg Sci*, 49(1): 41-46. **(4.93)**
8. Baljinder, Sandhu, S.K., Kaur, N. (2023). Micrometeorological parameters and grain yield of wheat in poplar based agroforestry system. *Journal of Cereal Research*, 15(1):73-80. **(4.57)**
9. Bharti, G., Dubey, R.K., Deepika, R., Dubey, M. and Singh, S. (2023). Evaluation of Indoor Ornamental Plants Suitable for Indoor Vertical Garden in Response to Different Nutrient Formulations. *Indian J of Ecology*, 50 (3): 690-694. **(5.79)**
10. Bhullar, M.B., Kaur, P. and Dhall, R. K. (2022). Efficacy of biorationals against the two-spotted spider mite infesting cucumber cultivated under net house. *Zoosymposia*, 22: 245. DOI: 10.11646/zoosymposia.22.1.147. **(4.93)**
11. Bolagram, R. and Dhatt, K. K. (2023). Exploitation of heterosis in a diallel crosses of periwinkle (*Catharanthus roseus*) for morphological traits. *Indian J Agrsci*, 93 (5):495-500. **(6.37)**
12. Bons, H.K. and Pal, R. K. (2022).Survival of loquat under the subtropical conditions of Punjab. *J of Agrometeorology*, 24(3): 321-324. **(6.55)**

13. Bons, H.K. and Sharma, A. (2023). Impact of foliar sprays of potassium, calcium, and boron on fruit setting behavior, yield, and quality attributes in fruit crops: a review. *J Plant Nutrition*, 46:13, 3232-3246. **(8.28)**
14. Bons, H.K. and Singh, K. (2022). Impact of mineral nutrients on powdery mildew and quality attributes in umranber (*Ziziphus mauritiana*). *Indian J of Agricultural Sciences*, 92 (11): 1316-1320. **(6.37)**
15. Chahal, T. S., Singh, J., Gill, P.P.S., Kaur, S., Sinha, A. (2023). Seasonal Variations in Biochemical and Antioxidant Properties in 'Daisy' Tangerine Fruits During Fruit Development. *Erwerbs-Obstbau*, 65: 1685–1692 (2023). DOI: 10.1007/s10341-023-00881-0 **(7.21)**
16. Chhabra, R., Sharma, R., Hunjan, M. S., Sharma, V. K., Thakur, S. and Chauhan, S. K. (2023). Efficacy of botanical extracts on imparting systemic acquired resistance against rice sheath blight incited by *Rhizoctonia solani*. *J Plant Dis Prot*, 130: 551–569. **(7.85)**
17. Chhabra, R., Sharma, R., Hunjan, M. S., Sharma, V. K., Thakur, S. and Chauhan, S. K. (2022). Physio-biochemical and histological alterations in response to sheath blight disease of rice (*Oryza sativa* L.) *J of Phytopathology*, 170(11-12): 778-790. **(7.83)**
18. Chhabra, R., Sharma, R., Kaur, A., Sharma, V. K. and Thakur, S. (2023). Phytochemical characterization and antifungal ability of three meliaceae species against *Bipolaris oryzae*. *Agric Res J*, 60 (1): 146-152. **(5.44)**
19. Dhaliwal, S.K., Gill, R.K., Sharma, A. Kaur, A., Bhatia, D., Kaur, S. (2022). A large-effect QTL introgressed from ricebean imparts resistance to Mungbean yellow mosaic India virus in blackgram (*Vigna mungo* (L.) Hepper). *Theor Appl Genet*, 135: 4495–4506. **(11.7)**
20. Dhakad, A.K., Oberoi, H.K. and Lamba, J.S. (2022). Screening of *Moringa oleifera* seed sources for nutritional values and mineral profiling- a potential tree fodder in north-western India. *Forage Research*, 48(3): 294-303. **(4.84)**
21. Dhali, R. K., Kaur, H. and Manchanda, P. (2023). Genetics and marker-assisted breeding for sex expression in cucumber. *Frontiers in Genetics*, 14: 1180083. **(10.77)**
22. Dhatt, A.S., Sidhu, M.K. and Garcha, K.S. (2023). Development of alloplasmic male sterile lines and their assessment for heterotic potential in eggplant (*Solanum melongena* L.). *Journal of Horticultural Science and Biotechnology*, 1-11. **(7.92)**
23. Dhatt, K. K. and Singh, S. (2022). Morphological variability of dahlia (*Dahlia variabilis* L.) genotypes under subtropical conditions of Punjab. *Agric Res J*, 59 (5): 926-930. **(5.44)**
24. Dhatt, K.K. and Thakur, T. (2022). Effect of herbicides in managing weeds and on *Gladiolus hybridus* Hort. growth and flowering. *Indian J of Weed Science*, 54(1):77-80 **(5.84)**
25. Dhatt, K. K., Jhanji, S. and Kaur, G. (2023). Assessment of priming of cormels with plant growth substances on vegetative growth and cormel-associated traits in gladiolus. *Annals of Plant and Soil Research*, 5(2) 304-309. **(5.22)**
26. Gaikwad, P.N., Sharma, V., Singh, J., Sidhu, G.S., Singh, H. and Omar, A.A. (2023). Biotechnological advancements in *Phytophthora* disease diagnosis, interaction and management in citrus. *Scientia Horticulturae*, 310:111739 DOI: 10.1016/j.scienta.2022.111739. **(10.34)**
27. Garg, R., Singla, N., Gupta, M. and Jain, R. (2022). Sensory Attributes and Antioxidant Potential of Value-added Products of Grapefruit (*Citrus paradisi*). *Asian J of Dairy and Food Research*. DOI: 10.18805/ajdfr.DR-1881. **(5.75)**
28. Gaur, K., Jhanji, S. and Dhatt, K.K. (2022). Effects of benzyl adenine (BA) and gibberellic acid (GA3) on physiological and biochemical attributes of gladiolus (*Gladiolus grandiflorus* L.) spikes. *Bangladesh J of Botany*, 51(2): 297-304. **(6.31)**
29. Goyal, H., Gill, M.S., Gill, P.P.S., Jawandha, S.K., Singh, N.P. (2023). Changes in Physicochemical and Enzymatic Activities of Mango Hybrids during Fruit Ripening. *Erwerbs-Obstbau*, 65: 355–362. **(7.21)**
30. Ingle, Y.V., Arora, A., Kakoti, R.K. and Patil, P. (2023). Eco-friendly management of *Phytophthora* root rot and gummosis in mandarin. *Indian J of Ecology*, 50: 706-711. **(5.79)**
31. Jhanji, S. and Dhatt, K. K. (2022). Unravelling physiological and biochemical attributes influencing post harvest quality of gladiolus spikes after packaging and low temperature storage. *Indian Journal of Experimental Biology*, 60 (1): 41-48. **(6.82)**
32. Jhanji, S. and Kaur, R. (2022). Evaluation of phenoglad model on phenological development of gladiolus varieties under subtropical conditions of Punjab. *Journal of Agrometeorology*, 24 (4):353-358. **(6.55)**
33. Jhanji, S., Gaur, K. and Dhatt, K. K. (2023). Evaluation of corm treatments with benzyladenine and gibberellic acid on growth and flowering attributes of gladiolus. *Agricultural Research J*, 60(2):238-245. **(5.44)**
34. Jhanji, S., Kaur, G., Kaur, R. and Dhatt, U. K. (2023). Physiological and biochemical changes during flower development and senescence in Chrysanthemum and Gladiolus. *Acta Physiologiae Plantarum* 45:14. DOI: 10.1007/s11738-022-03486-4 **(8.74)**
35. Katoch, S., Arora, A., Kaur, A., Singh, H., and Hunjan, M.S. (2022). Graft transmission and confirmation of *Candidatus Liberibacter asiaticus* using PCR with species specific primers. *Plant Disease Research* 37: 187-191. **(4.58)**
36. Kaur, A., Singh, R. and Singh, P. (2023). Plant Spacing Combined with Nitrogen Nutrition Affects Loose Flower Production in *Rosa gruss-an-teplitz* Under Open Conditions. *Int J Environ Clim Change* 13(8):771-776. **(5.13)**
37. Kaur, B., Garcha, K.S., Bhatia, D., Khosa, J.S., Sharma, M., Mittal, A., Verma, N. and Dhatt, A.S. (2022). Identification of single major QTL and candidate gene(s) governing hull-less seed trait in pumpkin. *Front. Plant Sci*, 13:948106. DOI: 10.3389/fpls.2022.948106 **(12.63)**

38. Kaur, G. and Jhanji, S. (2023). Plant growth regulators preserved the longevity of cut stems of Chrysanthemum morifolium by orchestrating physio-biochemical and anatomical responses. *Plant Physiology and Biochemistry*, 196: 1098-110. **(11.74)**
39. Kaur, G. and Jhanji, S. (2023). Plant growth regulators improved cutting induced physio-biochemical responses to postponement senescence in chrysanthemum. *Indian J of Experimental Biology*, 61(6): 450-462. **(6.94)**
40. Kaur, H., Dhall, R. K. and Sharma, P. (2023). Association studies in pea for yield and yield attributing traits. *Genetika*, 55(1): 373-385. DOI: 10.2298/GENSR2301373K. **(6.75)**
41. Kaur, H., Manchanda, P., Kumar, P., Dhall, R. K., Chhuneja, P. and Weng, Y. (2023). Genome-wide identification and characterization of parthenocarpic fruit set-related gene homologs in cucumber (*Cucumis sativus* L.). *Scientific Reports*, 13(1): 2403. **(11.00)**
42. Kaur, J., Sidhu, M. K., Sarao, N. K. and Dhatt, A. S. (2023). Development of partially-fertile cross between *Solanum melongena* and *Solanum sisymbriifolium* through embryo rescue technique. *Indian J. Genet. Plant Breed*, 83(3):1-8. **(7.32)**
43. Kaur, J., Jawandha, S.K., Gill, P.P.S., Grewal, S. K., Singh, H. and Adhikary, T. (2023). Beeswax enriched gibberellic acid coatings preserve antioxidant properties and quality of lemon fruit under cold storage condition. *Acta Physiologiae Plantarum*, 45: 93 DOI: 10.1007/s11738-023-03567-y **(8.74)**
44. Kaur, J., Jawandha, S.K., Gill, P.P.S., Zahwa, J. and Grewal, S.K. (2023). Composite coatings of beeswax+naphthalene acetic acid preserved fruit quality and antioxidants in stored lemon fruits. *Food Science and Biotechnology*, 32: 100821. DOI: 10.1007/s10068-023-01364-4 **(9.23)**
45. Kaur, J., Kaur, G., Kaur, K. and Arora, N.K. (2022). Effect of Chloromequat Chloride Application on Vegetative Growth and Overall Quality of Grape Cultivars under Protected Cultivation. *Erwerbs-Obstbau*, 65: 1921–1929. DOI: 10.1007/s10341-022-00781-9. **(6.89)**
46. Kaur, J. and Singh, B. (2022). Role of phosphorus and potassium nutrition in enhancing yield, nutrient use efficiency and quality of wheat under variable aged poplar (*Populus deltoides* Bartr.) plantations in India. *Agroforestry Systems*, 96: 1065-75. **(8.55)**
47. Kaur, J., Kaur, N., Sandhu, S.K., Kaur, H. (2023). Microclimate and thermal indices of Garden Pea (*Pisum sativum* L.) under poplar (*Populus deltoides* Bartr.) based agroforestry system. *Journal of Agrometeorology*, 25(2): 330-332. **(6.00)**
48. Kaur, M., Sharma, M., Dhatt, A.S., Sharma, A., Khosa, J.S., Meena, O.P., Chawla, N. and Sidhu, M.K. (2023). Evaluation of F1 hybrids for horticultural and quality traits and pumpkin yellow vein mosaic disease resistance in pumpkin. *Indian J Hortic*, 80, DOI: 10.58993/ijh/2023.80.1.11 **(6.00)**
49. Kaur, R., Dhillon, T. S., Dhall, R. K. and Devi, R. (2022). Environmental effects on yield and quality of French bean genotypes grown in poly-net house. *Vegetable Science*, 49(2): 169-175. **(4.93)**
50. Kaur, R., Sharma, S.P., Kalia, A., Kaur, N and Manchanda, P. (2023). In vitro induction and selection of mutants obtained through gamma irradiation with improved processing traits in potato (*Solanum tuberosum* L.), *International Journal of Radiation Biology*, **(9.35)**
51. Kaur, S., Jindal, S. K., Sharma, A. and Gill, R. (2023). Marker-assisted identification of *Meloidogyne incognita* and *Phytophthora infestans* resistant elite indeterminate tomato lines for protected cultivation. *Indian J Genet Plant Breed*, 83(1):103-113. **(7.34)**
52. Kaur, P., Dhakad, A.K., and Dhillon, G.P.S. (2022). Genetic variability assessment of morphometric and economically important traits for *Eucalyptus* clones in north western India. *Ind Forester*, 148 (12): 1196-1203. **(5.10)**
53. Kaur, P., Arora, A., Singh, H. and Hunjan, M.S. (2022). Molecular characterization of *Xanthomonas citris* subsp. *citri* isolates and its resistance sources in citrus germplasm. *Agricultural Research J*, 59(4):706-717 **(5.44)**
54. Kaur, P., Brar, J.S. and Kaur, G. (2022). Salicylic acid and ascorbic acid extend the shelf life of guava (*Psidium guajava* L.) fruits under cold and ambient storage conditions. *Agric Res J*, 59 (4): 718-724. **(5.44)**
55. Kaur, P., Singh, R. and Singh, P. (2023). Plant Spacing Combined with Nitrogen Nutrition Affects Loose Flower Production in *Rosa gruss-an-teplitz* Under Open Conditions. *International J of Environment and Climate Change*, 13 (8) 771-776. **(5.13)**
56. Kaur, R., Kaur, N., Kumar, S., Dass, A. and Singh, T. (2023). Carbon capture and sequestration for sustainable land use – A review. *Indian J of Agricultural Sciences*, 93 (1):11-18. **(6.37)**
57. Kaur, R., Singh, B. and Dhaliwal, S.S. (2022). Macronutrient status of soils under different plantation cycles of poplar (*Populus deltoides* Bartr.) based agroforestry system in Punjab. *Indian J of Ecology*, 49 (4): 1417-23. **(5.79)**
58. Kaur, S., Boora, R. S., Singh, D. and Singh, G. (2022). Standardization of propagation techniques in sapodilla [*Manilkara achras* (mill.) Fosberg] cv. *Kalpatti* under north Indian conditions. *Agric Res J*, 59 (6): 1119-24. **(5.44)**
59. Kaur, S., Gill, M. S., Gill, P.P.S., Jawandha, S. K., and Singh, N.P. (2023). Influence of Harvest Date on Storage Quality of Asian Pear (*Pyrus pyrifolia*) Fruit. *Erwerbs-Obstbau*, 65, 1331–1339. DOI: 10.1007/s10341-023-00896-7 **(7.21)**
60. Kaur, Y., Arora, A. and Thind, S.K. (2023). Management of *Phytophthora nicotianae*, the incitant of citrus foot rot with new generation fungicides. *Agricultural Research J*, 60: 66-73. **(5.95)**



61. Khar, A., Zimik, M., Verma, P., Singh, H., Mangal, M., Singh, M. C. and Gupta, A. J. (2022). Molecular marker-based characterization of cytoplasm and restorer of male sterility (*Ms*) locus in commercially grown onions in India. *Molecular Biology Reports*, 49(6): 5535-5545. **(8.32)**
62. Kumari, P., Sharma, R., Panwar, S., Paul, S. and Banyal, N. (2022). Silicon as vital element in flower crop production. *J of Plant Nutrition*, 46(4):1-16. **(8.28)**
63. Maan, S.S., Brar, J.S., Mittal, A., Gill, M.I.S., Arora, N.K., Sohi, H.S., Chhuneja, P. (2023). Construction of Genetic Linkage Map and QTL mapping of fruit quality traits in guava (*Psidiumguajava* L.). *Frontiers of Plant Science*, 14:1788. **(12.63)**
64. Mahawer, A.K., Yadav, J. and Arora, N.K. (2022). Effect of hydrogen cyanamide (HCN) and abscisic acid (ABA) on fruit quality of Flame Seedless grapes (*Vitisvinifera* L.) during storage. *The Pharma Innovation J*, 11(2): 2336-2340 **(5.23)**
65. Majumdar, A., Sharma, A. and Belludi, R. (2023). Natural and engineered resistance mechanisms in plants against phytoviruses. *Pathogens*, 12:619. DOI: 10.3390/pathogens12040619 **(10.53)**
66. Malhotra, N., Sharma, S., Sahni, P., Singh, B., Sharma, S.P. (2022). Nutritional composition, techno-functionality, in-vitro starch digestibility, structural characteristics and storage stability of sweet potato flour and mash supplemented specialty pasta. *LWT*, 46(10): e16885. DOI: 10.1111/jfpp.16885 **(12.06)**
67. Manisha and Jhanji, S. (2022). Morpho-physiological and biochemical characterization of chrysanthemum varieties for early flowering under heat stress. *South African J of Botany*, 146: 603-613. **(8.32)**
68. Mann, G. S., Dubey, R. K., Singh, S., Deepika, R., Singh, D., and Kaur, N. (2023). Effect of growing media on growth and flowering of potted marigold (*Tagetes erecta* L.) irrigated with treated sewage water. *J of Plant Nutrition*, 1-14. **(8.28)**
69. Mangshatabam, A. Pal, R. K., Anjusha, S. G., Sharma, A. (2023). Assessing the Impact of Climate Change on Agricultural Production Using Crop Simulation Model. *Int. J. Environ*, 14(7), 538-550. **(5.19)**
70. Megha, M., Gill, P.P.S., Jawandha, S.K., Kaur, P. and Sinha, A. (2023). Sodium alginate enriched with pomegranate peel extract maintains pear cv. Punjab Beauty cell membrane integrity and postharvest life. *South African J of Botany*, 158: 149-157 **(9.11)**
71. Megha, M., Gill, P.P.S., Jawandha, S.K., Kaur, N. and Sinha, A. (2023). Effects of Sodium Alginate Plus Pomegranate Peel Extract Based Edible Coating on the Antioxidant Properties of Pear Fruit During Low Temperature Storage. *Erwerbs-Obstbau*, 65, 1341-1348. DOI: 10.1007/s10341-023-00883-y **(7.21)**
72. Monika, Dhatt, A.S., Sharma, M., Meena, O.P., Ram, H., Singh, Khosa J. and Sidhu, M.K. (2023). Optimization of yield and quality of hull-less seeded pumpkin (*Cucurbita pepo* var. styriaca) through foliar application. *Vegetable Science*, 50(1): 58-64. **(4.93)**
73. Nanglia, S., Mahajan, B.V.C, Singh, N.P., Bhullar, K.S. and Kaur, S. (2022). Forced air cooling delays pericarp browning and maintains post-harvest quality of litchi fruit during cold storage. *Acta Physiologiae Plantarum*, 44: 66. DOI: 10.1007/s11738-022-03405-7 **(8.35)**
74. Naveena Kumara, K.T., Singh, H., Kaur, N. and Kaur, K. (2023). CPPU and salicylic acid application improved fruit retention, yield, and fruit quality of mango cv. Dusehri. *The J of Horticultural Science and Biotechnology*, 98(5): 608-621. DOI: 10.1080/14620316.2023.2185164 **(7.92)**
75. Palial, G., Thakur, S., Sharma, R., Sharma, J. P. and Dhakad, A.K. (2023). Genetic divergence and correlation estimates for quantitative traits in *Salix*. *Acta Physiologiae Plantarum*, 45(99): 1-15. **(8.74)**
76. Parija, B., Kaur, N., Kaur, T. and Gill, R.I.S. (2023). Optimization of planting geometry and weed control improves the productivity of potato under poplar-based agroforestry system. *AgroforSyst*, 97: 1055-1069. **(8.42)**
77. Patel, S.A.H., Dhatt, A.S., Sharma, S.P. and Thakur, H. (2023). Screening of muskmelon (*Cucumismelo* L.) germplasm against fusarium wilt (*Fusarium oxysporum* f. sp. *melonis*) and its utilization in hybrid development. *Kavaka*, 59(2): 65-74. **(5.04)**
78. Pooja, Bhardwaj U., Kaur R. and Gill R. (2023). Antifungal activity of essential oil and emulsifiable concentrates of citronella and lemon grass against *Phomopsisvexans*. *Arch Phytopathol Plant Prot*, 56 (12): 942-960. DOI: 10.1080/03235408.2023.2242078 **(7.14)**
79. Preet, T., Ghai, N., Jindal, S. K. and Sangha, M. K. (2023). Salicylic acid and 24-Epibrassinolid induced thermotolerance in bell pepper through enhanced antioxidant system and heat shock proteins. *J AgrSci Tech*, 25(1): 171-183. **(7.28)**
80. Preet, T., Ghai, N. and Jindal, S. K. (2022). Mitigating the effects of elevated temperature through the use of growth regulators in bell pepper. *Agri Res J*, 59(3): 400-406. **(5.44)**
81. Rai, G.K., Kumar, P., Choudhary, S. M., Singh, H., Adab, K., Kosser, R., Magotra, I., Kumar, R.R. et al. (2023). Antioxidant Potential of Glutathione and Crosstalk with Phytohormones in Enhancing Abiotic Stress Tolerance in Crop Plants. *Plants*, 12: 1133. **(10.66)**
82. Rajput, P., Thakur, A. and Singh, H. (2022). Response on Phenological, Fruiting Behaviour and Growth Characteristics of F1 Candidates Rootstock Seedlings of Peach *Prunuspersica* (L.) Batsch]. *International J of Environment and Climate Change*, 12(11):1101-1112. **(5.13)**
83. Rana, N., Singh, S., Dhakad, A.K. and Dhatt, K.K. (2023). Coding phenological growth stages of yellow bells (*Tecomastans* (L.) Juss. ex Kunth) based on BBCH scale and its implications for urban greening. *Current Plant Biology*, 34: 100284. **(11.4) (5.4)\***

84. Rana, N., Singh, S., Dhakad, A.K. and Dhatt, K.K. (2023). Coding phenological growth stages of Yellow Bells (*Tecomastans* (L.) Juss. Ex Kunth) using BBCH scale. *Current Plant Biology*, 34(2023):100228. **(5.4)**
85. Rani, M., Jindal, S. K. and Meena, O. P. (2023). Genetic variability for plant growth, fruit, seed and biochemical traits in bell pepper breeding populations under North Indian conditions. *Genetika*, 55(1):111-124. **(6.75)**
86. Rattanpal, H.S., Uppal, G. S., Gupta, M. and Gill, B. S. (2022). Assessing genetic diversity in rough lemon (*Citrus jambhiri* Lush) using morphological characters. *Journal of Environmental Biology*, 43: 651-59. **(6.78)**
87. Saini, S. K., Monga, D., Mohan, M., Sharma, A. and Beniwal, J. (2023). Reduction in Seed Cotton Yield Corresponding with Symptom Severity Grades of Cotton Leaf Curl Disease (CLCuD) in Upland Cotton (*Gossypium hirsutum* L.). *Int.J.Curr. Microbiol.App.Sci*, 9(11): 3063-3076. **(5.95)**
88. Saini, S., Thakur, A., Singh, H. and Bhatia, D. (2022). Variations in the hybrid progeny of low chill whitex yellow fleshed peaches. *Indian J of Horticulture*, 79(4), 402-409. **(6.16)**
89. Salaria, P., Jain, S., Devi, R., Rani, R. and Jhanji, S. (2023). Physiological and biochemical responses of chilli pepper (*Capsicum annuum* L.) to sudden wilt syndrome. *Physiological and Molecular Plant Pathology*, 126(31):102038 **(9.02)**
90. Salaria, P., Jain, S., Rani, R. and Jindal, S. K. (2022). Evaluation of chilli germplasm for resistance against sudden wilt syndrome. *Pl Dis Res*, 37(2):169-172. **(4.76)**
91. Sandhu, A.K., Mandal, K., Sharma, S., Sahoo, S.K. and Sharma, A. (2022). Residual Behavior of Tebuconazole and Trifloxystrobin in Okra Fruits and Soil. *Communications in Soil Science and Plant Analysis*, 54(10):1388-1396, DOI: 10.1080/00103624.2022.2146132 **(7.33)**
92. Sharma, A., Sundouri, A. S., Kumar, A., Rathore, J. P. and Bons, H.K. (2023). Effect of different methods of pollination on physio-chemical properties of plum cultivars under temperate regions of North India. *Agriculture Association of Textile Chemical and Critical Reviews J*, 11(2): 144-151. DOI: 10.58321/AATCCReview.2023.11.02.144 **(6.78)**
93. Sharma, R., Kumari, P., Sharae, H. and Paul, S. (2023). Insight to the biotechnological interventions in flower crops for abiotic stress tolerance. *Scientia Horticulturae*, 318: 112102. **(10.34)**
94. Sidhu, M.K., Chaudhary, S. and Sharma, M. (2023). Genetics of quantitative traits from interspecific crosses between *Luffa hermaphrodita* × *Luffa cylindrica*. *Vegetable Science*, 50(1): 52-57. **(4.93)**
95. Sidhu, R. K., Sidhu, M.K. and Dhatt, A.S. (2022). Inheritance studies for different quantitative and qualitative fruit traits in brinjal (*Solanum melongena* L.). *J of Horticultural Sciences*, 17(2): 298-306. **(5.08)**
96. Singh, A., Singh, R. and Singh, P. (2022). Effect of consortium biofertilizer on growth and flowering of African marigold (*Tagetes erecta* L.). *Agric. Res. J*, 59 (2): 323-327. **(5.44)**
97. Singh, A., Singh, D., Singh, R., Jindal, S. K. (2022). Assessment of combining ability of watermelon germplasm derived from diverse geographic origin for yield and quality traits. *Genetika*, 54(2): 959-976. **(6.40)**
98. Singh, B., Gill, R.I.S. and Kaur, N. (2022). Performance of poplar plantation under different levels of nutrients in an agroforestry system. *Indian For*, 148: 479-85. **(5.10)**
99. Singh, B., Kaur, N., Gill, R.I.S. and Singh, J. (2023). Productivity of trees and crops under integrated nutrient management in poplar-based agroforestry system. *Indian J Agrofor*, 25: 87-94. **(5.19)**
100. Singh, B., Kaur, A., Chandi, R.S. and Sharma, A. (2023). Virus–vector relationship of squash leaf curl China virus and its transmission through whitefly vector, *Bemisia tabaci* (Gennadius) causing yellow vein mosaic disease of pumpkin. *Indian Phytopathol*, 76: 889–896. DOI: 10.1007/s42360-023-00647-4 **(5.95)**
101. Singh, G., Buttar, D.S., Singh, N., Aulakh, S.K., Sharma, S.P., and Hunjan, M.S. (2022) Molecular identification and phylogenetic analysis of different races of *Fusarium oxysporum* sp. *melonis* in muskmelon using RAPD markers under Punjab conditions. *Agri. Res. J*, 59(3): 453-461. **(5.44)**
102. Singh, G., Singh, S., Singh, M. and Dhatt, K. K. (2023). Efficacy of post-emergence herbicides on weed control and turfgrass quality characteristics in Bermuda grass selection no. 1. *Indian Journal of Weed Science*, 55(1): 1–5. **(5.84)**
103. Singh, H., Mauro, L., Goyal, A. and Khar, A. (2023). Genotypic variation in Na, K and their ratio in 45 commercial cultivars of Indian tropical onion: A pressing need to reduce hypertension among the population. *Frontiers in Nutrition*, 10: 1098320. **(12.65)**
104. Singh, H. and Khar, A. (2022). Potential of onion (*Allium cepa* L.) as traditional therapeutic and functional food: An update. *Indian J of Agricultural Sciences*, 92(11): 1291–97. **(6.37)**
105. Singh, H., Verma, P. and Khar, A. (2022). Screening of short-day onion cultivars of India for vitamin-C content. *Indian J of Horticultural Sciences*, 79(2): 160-167. **(6.16)**
106. Singh, H., Sekhon, B. S., Kumar, P., Dhall, R. K., Devi, R., Dhillon, T. S., Sharma, S., Khar, A., Yadav, R. K., Tomar, B. S. and Ntanasi, T. (2023). Genetic Mechanisms for Hybrid Breeding in Vegetable Crops. *Plants*, 12(12): 2294. **(10.66)**
107. Singh, J., Chahal, T. S., Gill, P.P.S., Jawandha, S. K. (2023). Comparison of Fruit Color and Quality Changes during Fruit Development in 'Kinnow' and 'W. Murcott' Mandarins. *Erwerbs-Obstbau*, 65: 369–377. **(7.21)**
108. Singh, J., Singh, B. and Dhaliwal, S.S. (2022). Long term impact of poplar and eucalyptus based agroforestry systems on physico-chemical properties and nutrient status of soil in north-western India. *Range Management and Agroforestry*, 43 (1): 66-73. **(6.37)**
109. Singh, J., Sharma, A., Sharma, V., Gaikwad, P.N., Sidhu, G.S., Kaur, G., Kaur, N., Jindal, T., Chhuneja, P. and Rattanpal, H.S. (2023). Comprehensive genome-wide identification and transferability of chromosome-specific highly variable microsatellite markers from citrus species. *Scientific Reports*, 13: 10919, DOI: 10.1038/s41598-023-37024-0 **(11.00)**



110. Singh, M., Bala, M. and Singh, S. (2022). Optimization of nitrogen application and planting geometry for production of cut flowers of *Chrysanthemum morifolium*. *J of Horticultural Sciences*, 17 (2): 363-370. **(5.08)**
111. Singh, M. and Dhatt, K. K. (2022). Assessment of combining ability for morphological traits in periwinkle (*Catharanthus roseus* (L.) G. Don) genotypes using diallel analysis. *J. Hortic. Sci. Biotechnol*, 97 (2): 265-271. **(7.64)**
112. Singh, N., Dhatt, K.K., and Singh, S. (2022). Growth and flowering of pompon Dahlia in response to application of organic manures. *Indian J of Horticulture*, 79(3):346-52. **(6.16)**
113. Singh, P., Kang, K.K., Kaur, G. and Brar, J.S. (2022). Impact of different mulches on soil temperature and plant growth in guava nursery under subtropical conditions. *Agric Res J*, 59 (5): 918-925. **(5.44)**
114. Singh, S., Dhatt, K.K., and Kumar, P. (2023). Exploring the genetic diversity of Dahlia (*Dahlia variabilis* Desf.) germplasm using multivariate statistics. *J of Horticultural Sciences*, 18(1): 67-76. **(5.08)**
115. Singh, S., Singh, I., Miller, C.T., Dhatt, K.K. and Dubey, R.K. (2023). Increasing basal dose of Indole-3-butyric acid improves rooting and growth of different cutting types in dahlia. *Rhizosphere*, 27, 100729. **(9.44)**
116. Singla, R., Sharma, R., Chhabra, R., Vij, L. and Singh, P. (2023). Influence of varying shade intensities of green net on physiological and biochemical components of different *Ocimum species*. *Russ J Plant Physiol*, 70: 1021-4437 **(7.53)**
117. Singh, R., Thakur, S., Gupta, N. and Dhillon, G. P. S. (2023). Genetic variability and correlation estimates for morpho-physiological characteristics in half sib progenies of *Toonaciliata*. *Indian J of Ecology*, 50(2): 408-416. **(5.79)**
118. Singh, S., Gupta, M., Rattanpal, H.S., Singh, G. and Kaur, N. (2023). Studies on fruit pedicel concerning fruitlet abscission in Kinnow mandarin. *Indian J of Horticulture*, 80: 80-85. **(6.00)**
119. Singh, S., Dhaliwal, N.K., Pathania, P.C. and Sandhu, R.K. (2023). Record of ber butterfly, *Leptotesplinius* Fabricius, 1793 (Lycanidae: Lepidoptera) on ber and its population dynamics in Punjab, India. *Agricultural Research J*, 60 (2): 217-224 DOI: 10.5958/2395-146X.2023.00034.0 **(5.44)**
120. Singh, S., Sreedevi, K., Sandhu, R.K., Sharma, R.K. and Siraj, M. (2022). Occurrence of Cerambycid borer *Bandar pascoeii* (Lansberge) in Punjab. *Indian J of Entomology*, DOI: 10.55446/IJE.2022.588 **(5.08)**
121. Singh, S., Sandhu, R.K., Sharma, R.K., Kaur, P., Makkar, G.S. and Randhawa, H.S. (2022). Field efficacy of bio rational and chemical insecticides against mango leaf hoppers (*Amritodusatkinsoni* and *Idioscopus* spp). *Indian J of Agricultural Sciences*, 92(10): 1274-1278. **(6.37)**
122. Singh, V., Chahal, T. S., Gill, P.P.S., Jawandha, S. K., Singh, V. (2023). Fruit colour progression in grapefruit with relation to carotenoid and Brix-acid ratio. *Indian J of Horticulture*, 80:184-89. **(6.00)**
123. Singla, D., Sangha M K, Singh M, Pathak Mamta and Bala Manju (2023) Variation of mineral composition in different fruit parts of bittergourd (*Momordica charantia* L.) *Biological Trace Element Research*, 201: 4961-4971. <https://doi.org/10.1007/s12011-022-03546-3> **(10.08)**
124. Sinha, A., Gill, P.P.S., Jawandha, S.K., and Grewal, S.K. (2022). Composite coating of chitosan with salicylic acid retards pear fruit softening under cold and supermarket storage. *Food Research International*, 160:111724. DOI: 10.1016/j.foodres.2022.111724 **(12.48)**
125. Sodhi, R., Saralch, H.S., Thakur, S. and Kumari, A. (2023). Seed source variation in growth and biomass attributes of *Ulmus villosa* under nursery conditions in Punjab. *Indian J of Agroforestry*, 25(1): 70-76. **(5.19)**
126. Sohi, H.S., Gill, M.I.S., Chhuneja, P., Arora, N.K., Maan, S.S., Singh, J. (2022). Construction of Genetic Linkage Map and Mapping QTL Specific to Leaf Anthocyanin Colouration in Mapping Population 'Allahabad Safeda' × 'Purple Guava (Local)' of Guava (*Psidium guajava* L.). *Plants*, 11(15):2014. DOI: 10.3390/plants11152014 **(9.94)**
127. Sran, T. S., Jindal, S. K., Sharma, A. and Chawla, N. (2023). Genetics of novel leaf curl virus disease resistant pepper genotypes and antioxidative profile analysis of their progenies. *SciHort*, 308: 111563, 1-13. **(10.34)**
128. Sran, T. S., Jindal, S. K., Sharma, A. and Bhatia, D. (2023). LCVD resistance breeding in heat tolerant bell pepper: Combined phenotypic and marker-assisted backcrossing for introgression of LCVD resistance from hot pepper. *Euphytica*, 219: 50. **(8.19)**
129. Supreetha, B.G., Singh, N.P., Sharma, S. (2022). Fruit development and mineral profiling under different mulching regimes of strawberry. *Indian J of Horticulture*, 79:213-220 **(6.16)**
130. Tasal, P., Arora, R., Arora, N.K., Jawandha, S.K. (2022). Influence of Aloe vera and salicylic acid on storage life of grapes cv. Flame Seedless. *Indian J of Horticulture*, 79:363-69 **(6.16)**
131. Tejukumar, B.K., Singh, P., Hiremath, V., Jhanji, S., Dubey, R.K., and Pooja, A. (2023). Influence of shade levels on morpho-physiological characteristics of potted spathiphyllum. *Indian J of Horticulture*, 80(2):171-176. **(6.00)**
132. Thakur, K. R., Ghai, N., Jindal, S. K., Kumar, S. and Sharma, K. (2023). Performance of twelve bell pepper (*Capsicum annuum* L) genotypes to elevated temperature. *J BiomechSciEng*, 18 (1):49-60. **(6.48)**
133. Thakur, S., Gautam, K., Chauhan, S. K. and Sharma, J. P. (2023). Tailoring tree ideotypes for multiple purposes in agroforestry. *Forestry Chronicle*, 98:1, 1-7. **(7.17)**
134. Thakur, T. and Dhatt, K.K. (2022). Effect of Salinity on Seed Germination Indices and Seedling Parameters of Marigold (*Tagetes erecta*). *Current Advances in Agricultural Sciences*, 14 (1):115 **(11.7)**
135. Thakur, T., Singh, N. and Garg, A. (2022). Seed germination and seedling growth of annual chrysanthemum (*Glebionis coronaria* L) as influenced by priming and growing media. *Current Advances in Agricultural Sciences*, 14(2): 170-174. **(5.12)**

136. Thakur, T. and Dhatt, K.K. (2023). Evaluation of genotypes and correlation studies in Marigold (*Tagetes spp.*) for growth and yield attributes. *Environment Conservation J*, 24(1), 198–203. **(5.66)**
137. Varun, B. H., Singh, R. and Jindal, S. K.(2023). Genetic variability studies for heat tolerance in tomato (*Solanum lycopersicum* L.) for yield and fruit quality. *Electron J Plant Breed*, 14(2): 724-729. **(5.14)**
138. Verma, J. and Singh, P. (2022). Bio-Monitoring of Air Quality Using Leaf Characteristics. *Indian J of Ecology*,49(6): 2404-2407. **(5.79)**
139. Verma, J., Singh, P. and Sharma, R. (2023). Evaluation of air pollution tolerance index and anticipated performance index of selected roadside tree species in Ludhiana, India. *Environ Monit Assess*, 195:240. **(8.5)**
140. Verma, N., Garcha, K.S., Sharma, M., Sharma, A., Dhatt, A. S. (2023). Gene effects for begomovirus resistance and plant architecture attributes in pumpkin (*Cucurbita moschata* Duchesne) 59, *Czech J. Genet. Plant Breed*, DOI:10.17221/56/2022-CJGPB. **(7.30)**
141. Verma, N., Garcha, K.S., Sharma, A., Sharma, M., Bhatia, D., Khosa, J.S., Kaur, B., Chhuneja, P., Dhatt, A.S. (2023). Identification of a major-effect QTL associated with begomovirus resistance in *Cucurbita moschata* Duchesne. *Phytopathology*, 113:824-835. **(10.01)**
142. Verma, N., Dhatt, A.S., Sharma, A., Garcha, K.S., Sharma, M., Bhatia, D., Khosa, J.S., Kaur, B. (2023). Genetics of begomovirus resistance in *Cucurbita moschata* Duchesne: A novel resistant source PVR-1343. *Sci. Hort*, 322: 112393. **(10.34)**
143. Verma, T. and Jhanji, S. (2022). Evaluation of post-harvest quality of marigold flowers after packaging and storage in different seasons. *Bangladesh J of Botany*,51(2): 247-254. **(6.31)**
144. Yue, Z., Liu, S. Marc De Meyer, Liao, Z., Zhao, Y., Massimiliano, V., Feng, S., Qin, Y., Singh, S., Wee, S.L., Jiang, F., Guo, S., Hu Li, Deschepper, P., Vanbergen, S., Hélène D, Alies van Sauers-Muller, Syamsudin, T.S., Kawi, A.P., Kasina, M., Badji, K., Said, F., Liu, L., Zhao, Z. and Li, Z. (2023). Genomes of the cosmopolitan fruit pest *Bactrocera dorsalis* (Diptera: Tephritidae) reveal its global invasion history and thermal adaptation. *J of Advanced Research* (In Press). **(18.82)**

### Books

1. Brar, J.S., Singh, H., Kang, K.K. and Kaur, G. (2022). Orchard Management (Year-round operations). PAU/2022/FB/E/33, Communication Centre, p 118
2. Singh, A., Brar, J.S., Singh, M., Singh, S., Sandhu, R.K., Kaur, T. and Bhullar, M.S. (2023). *Phaldar Bootiyan Diyan Mukh Samasyavaan*. 6th Revised Edition, Communication Centre, Punjab Agricultural University, Ludhiana, p 262
3. Singh, S. (2022). *Baghana de mitter: Punjab vich Phaldarbutian de Kire-Makorian Nu Nashtkaran vale Shikari, Par-Bhakhshi ate Roganu*. Communication Centre, Punjab Agricultural University, Ludhiana, p 80

### Book Chapters

1. Belludi, R., Ramesh, G., Majumdar, A., Sharma, A., Sandhu, P.S., Noor, Mahammed N.R., Patina, H. (2023). Traditional to Modern Approaches in Detection of Major Pests and Diseases of Pulses and Cereal Crops In: Kumar A, Wajid H, Verma B and Singh CP (ed). *Pest Management Strategies in Pulses and Cereal Crops*, pp. 1-13, KD Publications.
2. Ganeshan, S., Arora, A. and Mareeswari, P. (2023). Diseases of Ber. In: A.K. Misra (ed). *Guide Book of Fruit Diseases*, pp. 173-195, Pub. Today & Tomorrow's Printers and Publishers, New Delhi.
3. Khar, A., Singh, H., and Verma, P. (2022). Mitigating Abiotic Stresses in Allium under Changing Climatic Scenario. In: Kole C (ed). *Genomic Designing for Abiotic Stress Resistant Vegetable Crops*. Springer, Cham, pp: 253-278. DOI: 10.1007/978-3-031-03964-5\_7
4. Maan, S.S., Sharma, V., and Brar, J.S. (2023). Improvement in fruit crops through radiation induced-mutations facing climate change. In: Penna S, Mohan Jain S. (ed). *Mutation breeding for sustainable production and climate resilience*, pp. 693-718, Springer Publication.
5. Miglani, G.S., S. Singh, Z. Li. and Sandhu, R.K. (2022). Intervention of modern genetic tools for managing insect-pests of fruit crops. In: A.K. Chakravarthy (ed). *Modern Genetic Tools for Pest Management in Agro-ecosystems*, pp. 483-513, Springer, Singapore, DOI: 10.1007/978-981-19-0264-2\_19
6. Singh, S., Reddy, PVR, Behere, G., Srivastava, P., Deka, S., Reddy, D.S., Kar, A., Kadu, R.V., Vijayakumar, S., Singh, V., Sandhu, R.K., Siraj, M., Sharma, R.K., Kaur, P., Kaur, N., Pathania, M., Kaur, J., Sharma, U., Hemjot and Patil, P. (2023). Biodiversity and IPM Strategies for insect, mite and snail pests in India. In: *Souvenir: Five Decades of Glorious Journey: Dr YSRHU Citrus Research Station*, pp. 89-105, Tirupati, Andhra Pradesh,
7. Singh, S., Singh, V., Sandhu, R.K., Haldhar, S., Siraj, M., Sharma, R.K., Kaur, P., Kaur, N., Pathania, M., Kaur, J., Kaur, J., Sharma, U. and Kaur, H. (2023). Biodiversity and IPM strategies for insect, mite and snail pests of citrus in India. In: S. Basanta Singh, Shravan M Haldhar, RK Dilip Singh, Narit Thaochan and Ashotosh A Murkute (ed). *Citrus Crop: Production and Management in NEH Region*, pp. 297-325, Scientific Publishers.

### Manuals

1. Gupta, M. and Arora, R (2022). *A Practical Manual on Tropical Fruits*, PAU, Ludhiana. P 36
2. Uppal, G.S., Jhanji, S., and Kang, K.K. (2023). *A Practical Manual of Fundamentals of Growth and Development of Horticultural Crops*, PAU, Ludhiana. P 34



## Research Bulletin /Extension Bulletin

1. Rattanpal, H.S., Singh, S., and Arora, A. (2022). Citrus Cultivation in Submountain Zone of Punjab (2nd edition). PAU, Ludhiana P 43.
2. Singh, H., Arora, R., and Gupta, M. (2022). Research Bulletin on Fruit Crops, Department of Fruit Science, PAU, Ludhiana. P 100.

## Directorate of Extension Education

### Research Papers in National and International Journals:

1. Aparna and Singh, S. (2023) Effect of Bypass Fat for Augmentation of Production during Transition Period in Cross Bred Cattle. *J of Krishi Vigyan*, 11(2):378-381 **(4.11)**
2. Anshuman J., Kaur, R., Rampal, V.K. and Rout, R.K. (2023) Professional Competence of Extension Personnel in Punjab State. *Agricultural Mechanization in Asia*, 54(1): 11485-11493 **(6.29)**
3. Aulakh, C.S., Sandhu, A.S., Singh, M. and Thakur, M. (2022). Planting Geometry Affects Potato (*Solanum Tuberosum* L.) Productivity and Economics in North-West India. *Agric Res J*, 59(5):876-880 **(5.44)**
4. Aulakh, C.S., Sandhu, A.S., Singh, M. and Thakur, M. (2022). Planting Geometry Affects Potato (*Solanum tuberosum*L.) Productivity and Economics in North-West India. *Agricultural Research J*, 59 (5): 876-880. DOI No. 10.5958/2395-146X.2022.00123.5 **(4.71)**
5. Basati, J. K., Kaur, Y., Hunjan, M. S., Lore, J. S., Kaur, H., Pannu, P.P.S. and Bal, R. S. (2022). Phenotypic Diversity in Phytopathogenic *Dickeya Zeae* associated with Rice and Maize in Punjab. *Pl. Dis. Res*, 37 (2): 178-186. **(4.76)**
6. Bhatt, R., Singh, P. and Sharma, S. (2023). Changes in Soil Organic Pool and Carbon Preservation Capacity of Macro and Microaggregates in response to landuse change in NorthWestern India. *J of Soil Science and Plant Nutrition*, 1-19. DOI: 10.1007/S42729-023-01239-X. **(9.61)**
7. Bhatt, R., Oliveira, M.W., Verma, K. K., Naresh, R.K., Prasad, S., Majumder, D. Singh, P.K., Kaur, R. Singh, B. and Tiwari, H. (2023). Millets for Global Human Health – A Comprehensive Review. *AMA-Agricultural Mechanization in Asia Africa and Latin America*, 54(4):12573-1260 **(6.29)**
8. Bhatt, R., Mandapelli, S.C., Kumari, P. Ch., Kadam, P.V., Chilakamari, L., Yadav, S., Kumar, B.N., Majumder, D., Oliveira, M.W., and Verma, K.K. (2023). Tillage Systems, Soil Environment and Properties: Global Meta-Analysis. *AMA-Agricultural Mechanization in Asia Africa and Latin America*, 54(4):12673-12704 **(6.29)**
9. Bhatt, R., Naresh, R.K., Tiwari, H., Singh, P.K. Das, D., Kumar, M., Banik, R. and Tomar, G. (2023). Farm-Yard Manure as a Resource for Integrated Nutrient Management. *The Pharma Innovation*, 12(4): 672-681 **(5.23)**
10. Bhatt, R., Oliveira, M.W., Garg, A.K., Sharma, S., Dalmo De Freitas Santos, Gathala, M.K., Majumder, D., Ishtiaque, A., Singh, M., Verma, K.K., Laing, A.M., Rajput, V.D., Busari, M., Yadav, M., Naresh, R.K., Chandra, M.S., Singh, J., Singh, G., Kaur, R. and Singh, B. (2023). Mechanical Transplanting of Rice for Reducing Water, Energy, and Labor Footprints with Improved Rice Yields in the Tropics. *AMA-Agricultural Mechanization in Asia Africa and Latin America*, 54(5):13253-13288. **(6.29)**
11. Bhatt, R., Verma, K.K., and Jamwal, N.S. (2023). Can Paddy Compost Eliminate N-Fertilization for Climate-Smart Sugarcane? *SugarTec* 25:2(3) DOI: 10.1007/s12355-023-01270-3 **(7.59)**
12. Bhatt, R., Oliveira, M.W., Verma, K.K., Garg, A.K., Kaur, G., Laing, A.M., Mandapelli, S.C., Majumder, D. (2023). Challenges, Scope, and Upcoming Strategies for Direct Seeding of Rice: A Global Meta-Analysis. *AMA-Agricultural Mechanization in Asia Africa and Latin America*, 54(4):12825-12863. **(6.29)**
13. Brar, H.S. and Singh, P. (2022). Pre- and Post-Sowing Irrigation Scheduling Impacts on Crop Phenology and Water Productivity of Cotton (*Gossypium Hirsutum* L.) in Sub-Tropical North-Western India. *Agricultural Water Management*, 27:107982. DOI: 10.1016/J.Agwat.2022.107982 **(10.52)**
14. Brar, J. S., Das, P., Adhikary, T. And Khehra, S. (2023). Energy Assessing and Optimising Energy Efficiency of Pear Orchards in North-Western India. *Scientist*, 3(3):337-351. **(7.72)**
15. Choudhary, A. K., Singh, N. and Singh, D. (2022). Management of Foot Rot of Citrus (*Citrus Jambhiri* Spp.) Using Biocontrol Agents. *Indian J of Agricultural Sciences*, 92 (9): 1148–1152. **(6.37)**
16. Dhaliwal, A.P.S., Singh, P., Singh, S. and Dhillon, G.S. (2022). Scientific Approaches for Sustainable Agriculture through Integrated Farming System. *Ecology Environment And Conservation*, 28(4) : 2204-2209 **(5.41)**
17. Dhaliwal, A.P.S., Singh, P., Singh, S. and Singh, V. (2023) Entrepreneurial Units Established by Youth. *J of Krishi Vigyan*. 11(2):133-139. **(4.55)**
18. Garg, A.K. (2023). Review of Changes in Soil Chemical and Biological Characteristics when Farming Practices Switch from Conventional to Organic. *Environment and Ecology*, 41(2B): 1276-1281. **(5.25)**
19. Gautam, A. and Aulakh, G. S. (2022). Impact of Sowing Technologies of Wheat Cultivation in Ferozepur, Punjab. *Indian J of Extension Education*, 58(4):173-175. **(5.95)**
20. Gautam A., Khurana R., Mishra P. K., Patel B., Dhimate A. S., Manes G. S., Dixit A. K. and Verma A. (2023). Development and Evaluation of Inclined Plate Precision Planter for Pelleted Vegetable Seed. *J of Agricultural Engineering*, 60(1): 24-37. DOI: 10.52151/jae2023601.1794 **(5.85)**

21. Gupta, R. K., Bhatt, R., Sidhu, M.S., Dhingra, N., Alataway, A. Dewidar, A.Z., Mattar, M., A. (2023). Evaluating Biogas Slurry for Phosphorus to Wheat an A Rice–Wheat Cropping Sequence. *J of Soil Science and Plant Nutrition*, 23: 3726-3734, DOI: 10.1007/S42729-023-01293-5 **(9.61)**.
22. Joshi, S., Bathla, S., Singh, A., Sharma, M., Stephen, B. and Sridhar, K. (2022). Development of Mung Bean (*Vigna Radiate* L.)-Based Next-Generation Vegan Milk: Processing, Nutritional Composition And Quality Attributes. *International J of Food Technology*, 58(2): 785-794 **(5.54)**
23. Kaur, B., Boparai, A.K. and Singh, K. (2022). Effect of organic and inorganic nutrient sources on agronomic performance of onion (*Allium cepa* L.) and soil properties. *Indian J of Ecology*, 50(2): 367-371. **(5.79)**
24. Kaur, J., Ram, H. and Kumar, V. (2023) Planting Geometry and Dehauling Schedule Affecting Productivity of Seed Potato (*Solanum tuberosum*). *India J of Agronomy*, 68(1):67-72 **(5.55)**.
25. Kaur, J., Ram, H. and Kumar, V. (2022) Performance of wheat (*Triticum aestivum*) as influenced by tillage, varieties and precision nitrogen management. *Indian J of Agricultural Sciences*, 92 (1): 118–22 **(6.37)**
26. Kaur, M., Sandhu P. S. And Singh, M. J. (2022). Economic Contribution of Home Makers in the Family Income through their Unpaid Household Work. *J of Community Mobilization and Sustainable Development*, 16(3): 913- 917. **(5.67)**
27. Kaur, M. and Sharma, K. (2022) Rice Productivity and Water Use Efficiency under different Irrigation Management System in Northwestern India. *Indian J of Extension Education*, 58(2): 65-68 **(5.95)**
28. Kaur, R., Singh, M. and Kumar, A. (2023). Impact of Cluster Frontline Demonstrations (Cflds) of Oilseeds on Productivity and Profitability of Gobhi Sarson in Sangrur District of Punjab. *J of Oilseed Brassica*, 14 (1) : 85-88 **(4.77)**
29. Khokhar, A., Bhat, M.A., Singh, Mj.Kaul, A., Sandhu, P.S., Yousuf, A., Dhillon, B.S. And Chary, G.R. (2021) Effects of Soil and Foliar Application of Urea on Growth, Yield and Economics of Rainfed Maize (*Zea Mays* L.) in Punjab. *Indian J Dryland Agricultural Research and Development*, 36(2): 27-32. **(4.88)**
30. Khokhar, A., Bhat, M. A., Singh, M. J., Yousuf, A., Sharma, V. and Sandhu, P. S. (2022). Soil Properties, Nutrient Availability Vis-A-Vis Uptake and Productivity of Rainfed Maize- Wheat System in Response to Long Term Tillage and N Management in Northwest India. *Comm. Soil Sci. Pl. Anal.* 53(4):1-20. **(7.58)**
31. Kumar, A. (2022). Performance of Cluster Beans (*Cyamopsis tetragonoloba*L.) for Yield and its Contributing Traits. *J Krishi Vigyan*, 10 (2): 241-244 **(4.55)**
32. Kumar, A. (2022). Assessment of French Bean (*Phaseolus Vulgaris* L.) Genotypes for Yield Traits. *J Krishi Vigyan*, 11(1):1-6 **(4.55)**
33. Kumar, A. (2023). Status of Protected Cultivation of Vegetables in Punjab. *J Krishi Vigyan*, 11 (2): 343-348 **(4.55)**
34. Kumar, D., Singh, S. And Lal, S. (2023) Job Satisfaction and Stress among the Field Veterinarians in the Jammu Region of Jammu and Kashmir. *J of Community Mobilization and Sustainable Development*, 18(3):365-370 **(5.67)**
35. Kumar, N.(2022). Genetic Variability, Correlation and Path Analysis of Agronomic Traits in Elite Sugarcane (*Saccharum* Spp.) Clones. *Frontier in Crop Improvement*, 10 (1): 40-45. **(4.67)**
36. Kumar, P., Kasniya, Singh, M., Romana, B.S. and Singh, A. (2022) Survey and Occurrence of Major Stresses of Rice in Sangrur District of Punjab. *Indian J of Ecology*, 49(6): 2105-2111. DOI: 2022/49/6/2105-2111 **(5.79)**
37. Kumar, P., Kasniya, Singh, M., Romana, B.S. and Singh, A. (2022) Economic Analysis of Different Rice Cultivars against Major Biotic Stresses. *J of Agriculture and Ecology*, 14: 146-152. DOI: 2022/14/146-152 **(4.36)**
38. Kumar, V., Aulakh, C.S. and Kaur, J. (2023) Planting geometry and dehauling schedule affecting productivity of seed potato (*Solanum tuberosum*). *India J of Agronomy*, 68(1): 67-72 **(5.55)**
39. Kumar, V. and Aulakh, C.S. (2022). Effect of planting geometry and potato seed tuber size on weeds and potato tuber yield. *Indian J of Weed Science*, 54(3): 291-295 **(5.84)**
40. Mishra, P.K., Singh, M., Dixit, A., Patel, B., Gautam, A., Pandey, S.K. and Sharma, K. (2023). Effect of Cleaning Methods on Trash Contents and Fiber Quality for Seed Cotton, *International J of Bio-resource and Stress Management*, 14(2): 338-346. DOI: 10.23910/1.2023.3281a **(5.11)**
41. Mittal, S., Saini, S.P., Meena, H.M. and Singh, P. (2023). Soil Manganese Dynamics and Performance of Wheat Cultivars in Relation to Soil and Foliar Manganese Application with and without Manures in NorthWestern, India. *J of Soil Science and Plant Nutrition*, 23: 1967-1980. DOI: 10.1007/S42729-023-01151-4 **(9.61)**
42. Naresh, R.K., Bhatt, R., Singh, P.K., Kumar, Y., Tiwari, H., Saini, A., Saha, C., Verma, A. and Thakur, H. (2023). Millet: The Super Food in Context of Climate Change for Combating Food and Water Security: A Review. *The Pharma Innovation*, 12(3): 1040-1049. **(5.25)**
43. Pal, R., Gupta, A., Wadhwa, M., Singh, P., and Singla, A. (2022). Relative Appraisal among different Sugarcane Varieties for Quality of Sugarcane Tops Silage as Non-Conventional Feed Resource. *Indian J of Animal Nutrition*, 39:1, 45-51 **(5.66)**
44. Princy and Makkar, G.S. (2022). ICT Usage By Farm Women: Access And Preferences *Indian J of Extension Education*, 58(1):200-203 **(5.96)**
45. Raj, R. and Kaur, B.(2022). Efficacy of fungicides in the management of purple blotch of Onion under District Jalandhar, Punjab conditions. *Vegetable Science*, 49(2): 262-265. **(4.9)**
46. Romana, B.S., Kaur, A. and Singh, K. (2022). Study of Socio-Economic Status of Vegetable Growing Community and Adoption of Improved Techniques and Varieties in Vegetable Hub of Malerkotla (Punjab): A Survey Investigation. *J of Agricultural Development and Policy*, 32(1): 36-41 **(3.61)**



47. Sabhikhi, H.S., Hunjan, M.S. and Kaur, Y. (2023). Development of Common Scab in Potato Cv. Kufri Pukhraj in Indian Punjab is influenced by Scab Lesion Severity on Seed Tubers and Duration of Crop in the Field. *J of Plant Diseases and Protection*, 130: 867-873. DOI: 10.1007/s41348-023-00719-7 **(7.93)**
48. Sandhu, A.S., Singh, P. and Singh, S. (2022). Yield Gaps and Economic Analysis of Gram (*Cicer Arietinum*) Cultivation in South-Western Punjab, India. *J of Community Mobilization and Sustainable Development*, 17(3): 957-962. **(5.67)**
49. Sandhu, A.S., Singh, P. and Kaur, N. (2022). Farmer's Field Evaluation of above-and below-ground agronomic attributes and Economic Indices of Different Onion (*Allium Cepa* L.). *J of Community Mobilization and Sustainable Development*, 17(4): 1298-1307. **(5.67)**
50. Sandhu, P.S., Yousuf, A., Singh, M.J., Sharma, V. and Khokhar, A. (2021). Rainwater Harvesting and Supplemental Irrigation for Improved Water Productivity of Wheat in Kandi Region of Punjab. *Indian J Dryland Agricultural Research and Development*, 36(2): 43-47. **(4.88)**
51. Singh, P., Sandhu, A.S. and Kaur, N. (2022). Adoption Status of Crop Production Practices for Direct Seeded Rice (DSR) in Bathinda District of South-Western Punjab, India. *Journal of Community Mobilization and Sustainable Development*, 17(4): 1284-1288. **(5.67)**
52. Sharma, A. and Brar, A.S. (2021) Investigation on Baler Technology for Ex Situ Paddy Residue Biomass Management with Energy Consum *International J of Environmental Science and Technology*, 19(7): 6267-6284. **8.86**.
53. Sharma, A. and Brar, A.S. (2022). Energy Input-Output Modeling and Sensitivity Analysis for on-farm Mechanically Paddy Straw Bales Formation. *Paddy and Water Environment*, 20 (2): 255-264. **(7.52)**
54. Sharma, A., Khar, S., Chaudhary, D. and Thakur, P. (2023). Study of Biometric Attributes of Plug Type Tomato Seedlings Pertinent to Transplanter Design. *Indian J of Ecology*, 50(2): 503-507 **(5.79)**
55. Sharma, K., Kaur, M. and Singh, G. (2022) Adoption Status of Various Rice Residue Management Technologies in Sri Muktsar Sahib District of Punjab. *J of Community Mobilization and Sustainable Development*, 2: 387-392 **(5.67)**
56. Sharma, M., Bhatia, M. and Singh, P. (2023). Farmers' Perspective on Relevance and Importance of Kisan Melas. *J of Community Mobilization and Sustainable Development*, 18(1): 277-282. **(5.30)**
57. Sharma, M., Verma, A. and Singh, Y. (2022). Gene Action Studies in Gynoecium Cucumber (*Cucumis Sativum* L.) Lines under Mid Hill Conditions of Western Himalayas. *Indian J. Plant Genet. Resour*, 35(1):49 DOI: 10.5958/0976-1926.2022.00008.0. **(5.54)**
58. Singh, A., Singh, P. and Mahajan, M. (2023). Agronomic and Biochemical Quality Attributes and Economic Indices of Sugarcane (*Saccharum Officinarum* L.) Cultivation in Saline Vis-À-Vis Non-Saline Soils of South-Western Punjab, India. *The Indian J of Agricultural Sciences*, 93(1):106-109. DOI: 10.56093/ljas.V93i1.130246 **(6.37)**
59. Singh, A., Singh, P., Dhillon, G.P.S., Sharma, S., Singh, B. and Gill, R.I.S. (2022). Differential Impact of Soil Salinity and Water Logging on Eucalyptus Growth and Carbon Sequestration Under Mulched Vs. Unmulched Soils in South-Western Punjab (India). *Plant and Soil*, 482:401-425. DOI: 10.1007/S11104-022-05700-1 **(10.19)**
60. Singh, A., Shoal, S.K. Singh, N.D., Arora, S. and Samiksha (2023). Cosmopolitan Honey Bee *Apis Mellifera* as Quick and Efficient Marker of Pesticide Pollution in Environment through RP- HPLC. *Environmental Sciences and Pollution Research, Verlag GmbH Germany, Springer Nature*, 21:1-11 **(11.16)**
61. Singh, A., Singh, P. and Mahajan, M. (2023). Net Primary Production, Biochemical Composition and Economics of Sugarcane (*Saccharum Officinarum*) Cultivation in Saline and Non-Saline Soils of South-Western Punjab, India. *International J of Plant Production*, 93(1): 106-106. DOI: 10.1007/S42106-023-00248-1 **(8.61)**
62. Singh, G. and Bal, R. (2022). Bio-Efficacy of Mortel (Fipronil 0.3 G) against Pink Stem Borer, *Sesamia Inferens* in Wheat. *J Krishi Vigyan*, 11(1):11-16. **(4.45)**
63. Singh, G., Virk, G.K., Khokhar, A., Kaur, C., Brar, H.S., Singh, K., Singh, M., Kaur, K., Singh, M., Singh, M., Kaur, G., Singh, J., Taggar, G.K., Singh, R. and Gill, K.K. (2023). Response of Pigeon Pea Varieties to Sowing Dates at High Plant Density under Different Agroclimatic Zones of Punjab. *Agric Res J*, 60 (1):13-23. **(5.44)**
64. Singh, J., Sandal, S. K., Yousuf, A. and Sandhu, P. S. (2023). Effect of Drip Irrigation and Fertilization on Soil Water Dynamics and the Productivity of Greenhouse Tomato. *Water*, 15: 2086. **(9.53)**
65. Singh, M., Aulakh, S.S. and Bimbraw, S.A. (2022). Manmade Problems in Indian Agriculture and their Solution. *J of Agricultural Reviews*. (Accepted) DOI: 10.18805/Ag.R-2382. **(4.63)**
66. Singh, Mj., Khokhar, A., Yousuf, A., Sandhu, P.S. and Dhillon, B.S. (2021). Evaluation of Tillage and Planting Methods for In-Situ Moisture Conservation in Rainfed Maize (*Zea Mays* L.)-Wheat (*Triticum Aestivum* L.) Cropping System. *Indian J Dryland Agricultural Research and Development*, 37(1): 1-9. **(4.88)**
67. Singh, N.P., Singh, J., Singh, S. and Gill, P.P.S. (2022). Soil-Leaf nutrient relationships with fruit quality and yield of litchi (*Litchi Chinensis*) in Northern India. *Indian J of Agricultural Sciences*, 92(12):1453-57 **(6.37)**
68. Singh, P., Dhaliwal, A.P.S. and Dhillon, G.S. (2022). Acquisition of Skills and Knowledge through Poultry Capacity Building Programs. *Asian J of Microbiology Biotechnology Environment Science*, 24(1):118-121 **(5.00)**
69. Singh, P., Sharma, S., Nisar, S. and Choudhary, O.P. (2023). Structural Stability and Organic Matter Stabilization in Soils: Differential Impacts of Soil Salinity and Sodidity. *J of Soil Science and Plant Nutrition*, 23:1751-1773. DOI: 10.1007/S42729-023-01136-3 **(9.61)**

70. Singh, P. and Benbi, D.K. (2023). Organic Carbon in Soils' Fine Fraction: Thresholds in Saturation Capacity and its Relationship with Carbon Stabilization. *Tropical Ecology*, 64(9):635-654 DOI: 10.1007/S42965-022-00288-0 **(7.32)**
71. Singh, P. and Sandhu, A.S. (2023). Energy Budgeting and Economics of Potato (*Solanum Tuberosum* L.) Cultivation under different sowing methods in North-Western India. *Energy*, 269:126755. DOI: 10.1016/J.Energy.2023.126755 **(14.86)**
72. Singh, P. K., Naresh, R.K., Reddy, M.B., Tiwari, H., Stutikerketta, N., Sharma, A., Das, D., Bhatt, R., Kataria, R.S. and Kumar, S. (2023). Irrigation Management Strategies to Increase Crop-Water Productivity and Grain Quality of Direct Seeded Rice in North West IGP: A Review. *International J of Plant and Soil Science*, 35(16):222-231. DOI: 10.9734/IJPSS/2023/V35i163148 **(5.07)**
73. Singh, P. K., Kumar, A., Naresh, R.K., Singh, V.K., Tiwari, H., Bhatt, R., Tomar, S.S., Chandra, M.S., Singh, P.K., Mahajan, N.C., Kumar, L. and Kataria, S.K. (2023). Mechanized Paddy Transplanting Impacts on the Productivity and Sustainability of the Rice Cultivation System in North West IGP: A Review. *AMA-Agricultural Mechanization in Asia Africa and Latin America*, 54 (6): 13529-13544 **(6.29)**
74. Singh, P. K., Naresh, R.K., Singh, N.K., Bhatt, R., Sahoo, P., Gupta, S., Kaur, A. and Tiwari, H. (2023). Effect of Conservation Tillage on Changes in Soil Aggregate- Associated Organic Carbon and Biological Pools to Nitrogen and Straw Alters in RWCS in North-Western India: A Review. *International J of Environment and Climate Change*, 13(7): 452-470. **(5.13)**
75. Singh, P. K., Naresh, R. K., Reddy, B.R., Tiwari, H., Stutikerketta, N., Sharma, A., Dhritimandas, Bhatt, R., Kataria, S.R., and Kumar, S. (2023). Irrigation Management Strategies to Increase Crop-Water Productivity and Grain Quality Of Direct Seeded Rice in North West IGP: A Review. *International J of Plant and Soil Science*, 35 (16): 222-231. DOI: 10.9734/IJPSS/2023/V35i163148. **(5.07)**
76. Singh, P.K., Naresh, R.K., Bhatt, R., Tiwari, H., Singh, O., Singh, A., Rojalinhota and Kumar, R. (2023). Efficient Crop Management Strategies to Improve Crop Resilience and Crop-Water Productivity Enhancement under Direct Seeded Rice Cultivation System in Adverse Climatic Conditions: A Review. *The Pharma Innovation J*, 12(4): 1988-1997. **(5.23)**
77. Singh, P.K., Naresh, R.K., Bhatt, R., Tiwari, H., Rajput, A., Sampath, L., Pradhan, S.R. and Goyal, A.M. (2023). Effect of Climate-Smart Agriculture Practices on Energy, Greenhouse Gas Mitigation and Resource Use Efficiency of Rice-Wheat Cropping System in North West IGP: A Review. *The Pharma Innovation*, 12(4): 1976-1987. **(5.23)**
78. Singh, S. and Chand, M.S. (2023). Performance of Coloured Capsicums as Affected by Plant Training Systems in Naturally Ventilated Polyhouse. *International J of Vegetable Science*, 29 (03): 1-11, DOI:10.1080/19315260.23.2215760
79. Singh, S., Sharma, R.K., Rastogi, A. and Khan, N. (2022). Variability in the Nutritional Value of Paddy Straw (*Oryza sativa*) Varieties. *J of Livestock*, 13(4):213-220 **(4.93)**
80. Singh, S. (2022). Influence of Surgical Castration under Local Anaesthesia on the Growth Rate of Suckling Piglets. *Veterinary Practitioner*, 23(1). **(5.10)**
81. Singh, S., Sandhu, R. K., Sharma, R. K., Kaur, P., Makkar, G. S., and Randhawa, H. S. (2022). Field efficacy of biorational and chemical insecticides against mango leaf hoppers (*Amritodus atkinsoni* and *Idioscopus* spp.). *The Indian J of Agricultural Sciences*, 92(10):12741278 DOI: 10.56093/ijas.v92i10.120584 **(6.97)**
82. Singh, S., Sharma, R.K. and Kumar, D. (2023). Variation in the In Vitro Dry Matter Digestibility of Different Paddy Straw Varieties of Jammu Region before and after Treatment with 4 % Urea Solution. *Veterinary Practitioner*, 24(1): 120-124. **(5.10)**.
83. Singh, V., Kunal, Kaur, J. Bhatt, R., Kaur, S., Dhillon, B.S., Singh, K.B., Singh, S. Sharma, S. and Singh, B. (2023). Site-Specific Fertilizer Nitrogen Management in less and high N Responsive Basmati Rice Varieties using Newly Developed PAU-Leaf Colour Chart, *Communications in Soil Science and Plant Analysis*, 54:10, 1334-1349. **(7.58)**.
84. Singh, V., Kunal, Kaur, J. Bhatt, R., Kaur, S., Dhillon, B.S., Singh, K.B., Singh, S., Sharma, S. and Singh, V. (2022). Site Specific Fertilizer Nitrogen Management in less and high N Responsive Basmati Rice Varieties using Newly Developed PAU Leaf Colour Chart. *Communication in Soil Science and Plant Analysis*, 54(10):1334-1349. DOI:10.1080/00103624.2022.2144346 **(7.58)**.
85. Singla, R. and Rampal, V.K. (2022). Constraints faced by Farmers in Adoption of Polyhouse Technology. *Indian J of Extension Education*, 57(3): 22-27 **(5.95)**
86. Sodhi, G.P.S, Singh, R.K., Ahuja, S. Kaur, A.P. and Kaur, S. (2023) Adoption behaviour of climate-resilient agricultural practices in Punjab under NICRA project. *Indian Journal of Extension Education*, 59(2): 46-50 **(5.95)**
87. Sood, P., Kanwar, V., and Kaur, G., Kaur, M.B. (2023). Correlation of Mental Health across Different Dimensions of Perceived Problems of Rural Adolescent. *J of Health and Well-Being*, 14(2):123 **(4.11)**
88. Thakur, P., Mavi, H.K. and Brar, A.S. (2022). Profitable and Sustainable Integration of Vegetables in Paddy-Wheat Cropping Pattern: A Successful Model in Moga District of Punjab. *Agricultural Research J*, 59 (1): 152-156. **(5.44)**
89. Thakur, S.S. and Chandel, R. (2022). Optimizing Field Performance of Axial Flow Rotary Combine with Single Rotor and Snap Roll Header for Maize Harvesting. *Agricultural Mechanization in Asia, Africa and Latin America*, 52(3): 53 **(6.29)**
90. Tiwari, H., Naresh, R.K., Bhatt, R., Aditiya, Kumar; Y., Manish, Das, D., and Kataria, S.K. (2023). Underutilized Nutrient Rich Millets: Challenges and Solutions for India's Food and Nutritional Security- A Review. *International J of Plant and Soil Science*, 35(2): 45-56. DOI: 10.9734/IJPSS/2023/V35i22758. **(5.02)**
91. Tiwari, H., Naresh, R.K., Kumar, A., Singh, P.K., Bhatt, R. Kumar, Y., Tomar, S., Reddy, M.B., Das, D., Singh, P.K., Kumar, L., Kataria, S.K. and Chandra, M.S. (2023). Impact of Integrated Nutrient Management on Wheat Productivity, Nutrient



Uptake and their use Efficiency in Sub-Tropical India. *AMA-Agricultural Mechanization in Asia Africa and Latin America*, 54(5): 13295-13311. (6.29).

92. Verma, A. and Sood, S. (2022). Evaluation of Okra Germplasm for Yield and its Related Traits under Sub Temperate Conditions of Western Himalayas (*Abelmoschus esculentus* (L.) Moench). *J of Community Mobilization and Sustainable Development*, 17:1426-1431 (5.67)

## Books

1. Naresh, R.K., Kumar, P., Singh, J.P., Bhatt, R., Kumar, Y., Gupta, R.K., Gupta, S.K. and Tomar, S.K. (2023). Artificial Intelligence in Agriculture: Opportunities, Risks and Future Perspectives. Jaya Publishing House, p 379
2. Naresh, R.K. Singh, P.K., Bhatt, R., Senapathy, M. Kumar, Y., Mauro Wagner De Oliveira, Tomar, S.S., and Tiwari, H. (2023). Techniques of Sustainable Millet Production. Elite Publishing House, New Delhi, p 203
3. Sharma, K., Singh, H., Tiwari, D., Kapila, P., and Singh, S. (2023). Management of Crop Residue-KVK Interventions and Outcomes. KrishiVigyan Kendra, Ludhiana, p 32
4. Singh, P.K., Naresh, R.K., Shukla, A.K., Chaudhary, A.P. and Bhatt, R. (2023). Natural Farming-Principles and Practices. Elite Publishing House, New Delhi, p 248
5. Bhadauria, P., Singh, S. Aparna, Singh, I. and Sheoran, P. (2023). Pig Farming: Techniques and Technologies. ICAR Agricultural Technology Application Research Institute, Zone-1, Ludhiana, Punjab, p 125.

## Books Chapters

1. Aulakh, S.S., Singh, S. and Brar, N.S. (2023). Commercial Vegetable Nurseries Types, Establishment, Operations, Management and Economics. In: Singh, R., Choudhary, S., Verma, A.K., Ravi Y. (ed). *Horticulture for Nutrition and Income Security*, pp 146-156, NIPA Publications.
2. Gupta, R., Kaur, B., and Kataria, S.K. (2022). Shri Amarjit Singh Bangu. In: *Compendium of Success Stories of Natural Farming*, pp 184-186, NITI Aayog (publisher).
3. Jhanji, S., Singh, S., Gautam, A., Saini, M.K. and Vani, V. (2022). Development of Value Chain for Flowers with Emphasis on Storage. In: *Innovative Storage Solutions: The Best Way Forward for Reducing Post-Harvest Losses and Doubling Farmer's Income*, pp 21-32, PME, ICAR-CIPHET publication, Ludhiana.
4. Kaur, G. and Princy (2022). Promoting Nutritional Gardening for Household Food Security. In: Kandpal, A.S. and Kandpal, N.K. (ed). *Economic upliftment of rural women*, pp 57-62, Jaya Publishing House, New Delhi.
5. Kaur, G., Bhatia, M., and Kapila, P. (2022). Entrepreneurship Development through Rural Crafts with special emphasis on Phulkari In: *Economic Upliftment of Rural Women*. In: A.S. Kandpal and N.K. Kandpal (ed). pp 25-38, Jaya Publishing House, Delhi.
6. Kaur, M., Malik, D.P., Malhi, G.S., Rehmani, MIA, Brar, A.S. (2023). Climate-Smart Agriculture Interventions for Food and Nutritional Security. In: *Ecological Footprints of Climate Change: Adaptive Approaches and Sustainability*, pp 445-464, Springer International Publishing.
7. Kaur, M., Kaur, G., Birwal, P., Kaur, R. and Sandhya (2022). Storage of Maize and its Products. In: *Handbook of Maize: Nutritional Composition, Processing and Industrial Uses*, pp 325, CRC Press, Taylor and Francis Group.
8. Kerketta, S., and Gupta, R. (2022). Integrated Farming System: Sustainable Agricultural Production System Recent Trends in Agriculture, pp 72-82, Vital Biotech Publication.
9. Khokhar, A., Singh, M. J., Yousuf, A., Sandhu, P. S., Sharma, V., Kumar, V. and Bhat M. A. (2022). Improved Agronomic Practices for Rainfed Crop Production in Kandi Region of Punjab. In: Chary et al (ed). *Improved Agronomic Practices for Rainfed Crops in India*, Improved Agronomic Practices for Rainfed Crops in India, pp 150- 163, Elsevier.
10. Kumar, S., Sharma, P. and Tyagi, M. 2023. Farm Mechanisation in Horticultural Crops. In: *Horticulture for Nutrition and Income Security*, pp 434-441, New India Publishing Agency.
11. Kumar, V., Mahajan, G., Sheng, Q., Chauhan, B.S. (2023) Weed Management in Wet Direct-Seeded Rice (*Oryza Sativa* L.): Issues and Opportunities. In: *Advances in Agronomy*, pp 179: 91-133, Elsevier Inc. Netherland. DOI: 10.1016/bs.agron.2023.01.002
12. Mauro Wagner De Oliveira, Verma, K.K., Bhatt, B., Terezinhabezerra Albino Oliveira (2023). The Use of Green and Organic Fertilizers for Sugarcane Production and Soil Fertility in Agro-Industrial Perspectives on Sugarcane Production under Environmental Stress. In: Krishan K. Verma, Xiupeng Song, Vishnu D. Rajput, Sushil Solomon, Yang-Rui Li, Govind P. Rao (ed). *Agro-industrial Perspectives on Sugarcane Production under Environmental Stress*, pp 193-213, Springer-VerlagGmbh, Heidelberger Platz 3, Berlin, Germany. DOI: 10.1007/978-981-19-3955-6\_11.
13. Singh, S. and Aulakh, S.S. (2023). Cultivation of Underutilized Minor Fruit Plants in India. *Horticulture for Nutrition and Income Security*. In: Ravindra Singh, Sharda Choudhary, A.K.Verma, Ravi Y. (ed). *Horticulture for Nutrition and Income Security*, pp 83-100, NIPA Publications.
14. Singh, S., Aulakh, S.S. and Brar, N.S. (2023). Commercial Vegetable Nurseries Types, Establishment, Operations Management and Economics. In: *Horticulture for Nutrition and Income Security*, pp. 146-156. Nipa Genx Electronic Resources and Solutions, New Delhi.
15. Singh, S., Reddy, PVR, Behere, G., Srivastava, P., Deka, S., Reddy, D.S., Kar, A., Kadu, RV, Vijayakumar, S., Singh, V., Sandhu, R.K., Siraj, M., Sharma, R.K., Kaur, P., Kaur, N., Pathania, M., Kaur, J., Kaur, J., Sharma, U., Hemjot and Patil (2023).

Biodiversity and IPM Strategies for Insect, Mite and Snail Pests in India. In: Souvenir: Five Decades of Glorious Journey: Dr YSRHU Citrus Research Station, Tirupati, Andhra Pradesh, pp 89-105.

16. Singh, S., Singh, V., Sandhu, R.K., Haldhar, S., Siraj, M., Sharma, R.K., Kaur, P., Kaur, N., Pathania, M., Kaur, J., Kaur, J., Sharma, U. and Kaur, H. (2023). Biodiversity and IPM strategies for insect, mite and snail pests of citrus in India. In: S. Basanta Singh, Shravan M Haldhar, RK Dilip Singh, NaritThaochan and Ashotosh A Murkute (ed). Citrus Crop: Production and Management in NEH Region, pp 297-325, Scientific Publishers.
17. Singh, V., Sandhu, R.K., Haldhar, S., Siraj, M., Sharma, R.K., Kaur, P., Kaur, N., Pathania, M., Kaur, J., Kaur, J., Sharma, U. and Kaur, H. (2023). Biodiversity and IPM Strategies for Insect, Mite and Snail Pests of Citrus in India. In: Singh, B., Haldhar, S.M., RK Dilip Singh, Thaochan, N., and Murkute, A.A. (ed): Citrus Crop: Production and Management in NEH Region, pp 297-325. Scientific Publishers.
18. Tyagi, M. (2023). Fruit Drop: Causes and Management in Fruit Crops. In: Singh, R., Choudhary, S., Verma, A. K. and Y. Ravi (ed). Horticulture for Nutrition and Income Security, pp 194-206.

### Extension Bulletins

1. Ankurdeep Preety and Singh, S. (2023). *Poplar di paneeri tyar krna/* Nursery Raising of Poplar. P 8
2. Aparna and Singh, S. (2023). *Bakrian dian much bimarian ate ohna to bchaav.* P 8
3. Aparna and Singh, S. (2023). *Dudharu pashuan vich mastitis da prabandhan.* P 8
4. Aparna and Singh, S. (2023). Important Diseases of Poultry Birds and their Prevention and Control. P 8
5. Ahuja, S., Ankurdeep Preety and Singh, S. (2023). *Kudarti Kheti.* P 8
6. Aparna, Ankurdeep, Preety and Singh, S. (2023). *Jhone di paraali di suchaji sambhal lyi uttam uprale.* P 8
7. Aulakh, C.S., Walia, S.S., Dhkal, M., Kumar, S., Rani, N., Kaur, J., Kaur, T., Sharma, S., Singh, J., Singh, A., Aulakh, G.S., Gautam, A. and Singh, M. (2022). Safe Food Production: Experiences and Way Forward. Punjab Agricultural University, Ludhiana. P 62
8. Bathla, S., and Bala, R. (2022): Flourishing Entrepreneur in Unique Activity. Success Stories of Progressive Women Farmers in Agripreneurs. P 131-132
9. Kapila, P., Kaur, J., Singh, H., Tiwari, D., and Singh, S. (2023). Reinventing Millets- The Superfood. P 12
10. Sharma, K., Singh, H., Kapila, P., Kaur, J., and Singh, S. (2023). Methods and Technologies for Crop Residue Management. P 12
11. Sharma, K., Singh, H., Kapila, P., Kaur, J., and Singh, S. (2023). *Prali Di Suchajji Sambh Sambhal Dia Taknikan.* P 12
12. Sharma, K., Singh, H., Kapila, P., Kaur, J., and Singh, S. (2023). Identification of Troubles, Causes and Methods of Troubleshooting During the Operation of Farm Machinery. P 12
13. Sharma, K., Singh, H., Tiwari, D., Kaur, J., and Singh, S. (2023). *Kheti Machinery Sanchalan Dauran Aun Valian Samasiyavan te Hall.* P 12

### MS RANDHAWA LIBRARY

#### Book Chapters

1. Kumar. S. (2023). Institutional repositories as a viable medium for digital preservation and accessibility of scholarly content: a case study of PAU Repository. In: BhanuPartap and Nitin Joshi (ed). Digital Transformation in Libraries and Information Centres, pp 156-163, Today & Tomorrow's Printer & Pub, New Delhi.
2. Sharma Y. and Sharma A. (2022). "Appraisal: A Tool to Quality Publishing". In: Babu, B. Ramesh et al (ed). Revitalizing the Libraries to the Android Society. Proc 6<sup>th</sup> I-LISS International Conference – IIC 2022, pp 797-801. National Institute of Technology, Warangal, Telengana, India.

# Summary and Highlights

Punjab Agricultural University - through its hallmark three-pronged mandate of research, teaching, and extension - continues to engage effectively with a range of challenges faced by the agriculture of the region. While keeping research activities aligned with the overarching challenges of climate change and sustainability, it continues to tap advances in digital technology and foster adaptive research and technology cross-pollination. The university has been helping the state shape its response and providing technological backstopping for addressing long persisting challenges like groundwater depletion and crop residue burning. It continues to provide scientific anchorage for the emergency response of line departments in engaging occasional challenges to plant health.

## RESEARCH

While staying aligned with imperatives like climate change and natural resources conservation, various research activities of the university delivered important outcomes in terms of various varietal, production and

protection technologies; farm mechanization; value addition through appropriate post-harvest processing, storage and food engineering interventions; agribusiness; value chain analysis; and subsidiary occupations.

## Crop Improvement

- The University developed/released 17 varieties of different crops: one each of wheat, maize, sorghum and oat; seven of vegetable crops (two each of potato and brinjal and one each of *Tarwanga*, okra, and coriander), five of fruit crops (two each of apple and dragon fruit, and one of sweet orange), and one of tuberose.
- Twelve varieties of different field crops (three of wheat, four of pulses, and five of fodder crops) and two brinjal varieties were notified/identified at the national level. Three-fourths of these varieties were released for the zones that do not include Punjab, testifying thereby wide adaptability of the varieties developed by the university.

### Varieties developed and released by PAU

|                 |                                                                                                                                         |
|-----------------|-----------------------------------------------------------------------------------------------------------------------------------------|
| Wheat           | PBW 826                                                                                                                                 |
| Maize           | PMH 14                                                                                                                                  |
| Forage crops    | SL 46 (sorghum) and OL 16 (oat)                                                                                                         |
| Vegetable crops | Punjab Potato 101, Punjab Potato 102, Punjab Himmat (Brinjal), PBHL 56 (Brinjal), Punjab Lalima (Okra), and Punjab Khushboo (Coriander) |
| Fruit crops     | Dorsett Golden (Apple), Anna (Apple), Vaniglia Sanguigno (Sweet Orange), Red Dragon (Dragon Fruit), and White Dragon (Dragon Fruit).    |
| Flower crops    | Arka Prajwal (Tuberose)                                                                                                                 |

### Varieties released/identified at national level

|                 |                                                                                           |
|-----------------|-------------------------------------------------------------------------------------------|
| Wheat           | PBW 826, PBW 872, and PBW 833                                                             |
| Pulses          | LL 1613 (lentil), ML 1839* and ML 2015* (Kharif mungbean), and Mash 878* (Kharif urdbean) |
| Forage crops    | PFM 13 or J 1009 (maize), BL 46 (berseem), LLC 6 (lucerne), PCB 166 and PCB 168 (bajra)   |
| Vegetable crops | Punjab Himmat* and PBHL 56* (brinjal)                                                     |

\*Identified at national level

## GERMPLASM COLLECTION, UTILIZATION AND EVALUATION

|              |                                                                                                                                                                                                                                                                                                                                                                                                                              |
|--------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Rice</b>  | <ul style="list-style-type: none"> <li>International Rice Research Institute, Manila, Philippines provided 52 breeding lines.</li> <li>ICAR-National Bureau of Plant Genetic Resources, New Delhi shared 500 land races.</li> </ul>                                                                                                                                                                                          |
| <b>Maize</b> | <ul style="list-style-type: none"> <li>The Winter Nursery Centre of the ICAR-Indian Institute of Maize Research (IIMR), Hyderabad provided 132 field corn inbred lines.</li> <li>International Maize and Wheat Improvement Center (CIMMYT) – Asia, Hyderabad provided 112 entries. Besides, it provided 75 temperate field corn lines for potential use in developing silage purpose and late maturing varieties.</li> </ul> |

|                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|--------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                      | <ul style="list-style-type: none"> <li>Five lines were procured from the ICAR-IIMR, New Delhi for strengthening popcorn specialty segment.</li> <li>Govind Ballabh Pant University of Agriculture &amp; Technology, Pantnagar, Uttarakhand shared one teosinte material.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <b>Barley</b>                        | <ul style="list-style-type: none"> <li>International Centre for Agricultural Research in the Dry Areas (ICARDA) provided 48 accessions.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| <b>Pulses</b>                        | <ul style="list-style-type: none"> <li>Mungbean and urdbean lines (48 each) were obtained from the ICAR-Indian Institute of Pulses Research (IIPR), Kanpur.</li> <li>International Crop Research Institute for Semi-Arid Tropics (ICRISAT), Hyderabad and the ICAR – National Bureau of Plant Genetic Resources, New Delhi provided 1584 chickpea entries.</li> <li>The ICAR-IIPR, Kanpur and ICRISAT, Hyderabad provided 40 and 10 pigeonpea lines, respectively.</li> <li>ICARDA – Food Legume Research Programme (FLRP) provided 35 lines of faba bean.</li> </ul>                                                                                                                                                                                                                                                    |
| <b>Oilseeds</b>                      | <ul style="list-style-type: none"> <li>The ICAR – Indian Institute of Soybean Research, Indore shared 26 wild types of soybean.</li> <li>ICRISAT shared single seed descent (SSD; F5 generation) for collar rot resistance; and SSD-F4 for high oleic acid and seed size.</li> <li>The university obtained GIRNAR 4 and GIRNAR 5 varieties of groundnut developed by the ICAR – Directorate of Groundnut Research, Junagadh.</li> <li>Regional Research Station, Bikaner of the Junagadh Directorate provided four advanced generation populations.</li> </ul>                                                                                                                                                                                                                                                           |
| <b>Forage crops</b>                  | <ul style="list-style-type: none"> <li>ICRISAT, Hyderabad provided 100 pearl millet lines.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| <b>Medicinal and aromatic plants</b> | <ul style="list-style-type: none"> <li>ICAR-National Research Centre on Seed Spices (ICAR-NRCSS) provided fennel variety Ajmer Fennel 2.</li> <li>CSIR-Central Institute of Medicinal and Aromatic Plants, Lucknow shared Mentha (CIM Unnati) and turmeric (Pitamber) varieties.</li> <li>ICAR-Indian Institute of Spices Research, Calicut provided Pragati variety of turmeric.</li> <li>Dr. Rajendra Prasad Central Agricultural University, Pusa shared Rajendra Sonia and Rajendra Sonali cultivars of turmeric.</li> </ul>                                                                                                                                                                                                                                                                                         |
| <b>Vegetable crops</b>               | <ul style="list-style-type: none"> <li>World Vegetable Center South and Central Asia, Hyderabad provided 106 lines of vegetable purpose soybean.</li> <li>Yellow Plum line of cherry tomato was procured from a Panipat (Haryana) farmer.</li> <li>Harike Local chilli material was collected from Harike region (Tarn Taran district).</li> <li>Bottlegourd germplasm was collected from some farmer fields of Himachal Pradesh and Rajasthan.</li> <li>Advanced okra lines of amphidiploids were sourced from Regional Station, Thrissur of the ICAR-NBPGR.</li> <li>Sher-e-Kashmir University of Agricultural Sciences and Technology, Srinagar provided 21 lines of French bean.</li> <li>In case of French bean, pole type (15 lines) and bush type (28) lines were collected from the northeast region.</li> </ul> |

### Screening of Germplasm

|               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|---------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Wheat</b>  | <ul style="list-style-type: none"> <li>Variability in asparagine biosynthesis from 7 days post-anthesis (DPA) to 35 DPA in some wheat landraces and cultivars was evaluated. BWL 5429 had the highest specific activity of asparagine synthetase at 21 DPA.</li> <li>Genotypes BWL 7502, BWL 7509, BWL 7511 and PBW 857 with protein content in the range of 14.6-15.3%, retained activity of sucrose metabolism enzymes during heat stress, indicating a built-up source-sink strength to ward off yield drop under heat stress.</li> <li><i>Berbet</i> introgression lines and 5 checks (PBW 803, PBW 725, KRL 210, <i>Berbet</i> and HD 2967) were evaluated under saline conditions (150mM NaCl) at seedling stage and adult plant stage. The <i>Berbet</i> derivatives L1 (0.44 kg/ha), L2 (0.36 kg/ha), L42 (0.40 kg/ha) and L 47 (0.40kg/ha) maintained stable grain yield under saline conditions. On the basis of vigour index, six derivatives (L1, L2, L10, L45, L47 and L50) were selected and their physiological basis of tolerance was studied.</li> </ul> |
| <b>Barley</b> | <ul style="list-style-type: none"> <li>Analysis of malting potential of 29 barley genotypes indicated that low malt <math>\beta</math>-glucanase activity led to high <math>\beta</math>-glucan content and low diastatic power, thereby affecting profile of fermentable sugars in the wort.</li> <li>Methylglyoxal pathway evaluation in four barley genotypes upon infection with <i>Bipolaris sorokiniana</i> depicted an increase in the glyoxalase III activity of the flag and lower leaves of resistant genotype PL 807 at growth stage (GS) 55 (half inflorescence emerged) and GS 87 (hard dough); whereas, it declined in other genotypes indicating the role of glutathione-independent pathway.</li> </ul>                                                                                                                                                                                                                                                                                                                                                   |

|                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|-------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Maize</b>                  | <ul style="list-style-type: none"> <li>Teosinte accessions (Acc.1 and Acc.2), I-172 and PMH-1 seedlings showed differential behaviour towards waterlogging stress. The highest nitrate, nitrite and nitric oxide contents in roots of Acc.1 seedlings optimally maintained glutamine synthetase –glutamate synthase (GS-GOGAT) pathway in the waterlogged roots.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| <b>Pulses</b>                 | <ul style="list-style-type: none"> <li>Two homologous genes, <i>LcALS2</i> and <i>LcALS3</i>, in the lentil genome were present on chromosomes 2 and 3, respectively. After imazethapyr (a post emergence herbicide) treatment, however, only <i>LcALS2</i> gene expression in tolerant genotypes surpassed susceptible genotypes.</li> <li>Methylglyoxal detoxification pathway contributes towards resistance against <i>Maruca vitrata</i> infestation in pigeonpea genotype AL1747.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| <b>Cotton</b>                 | <ul style="list-style-type: none"> <li>Ascorbate peroxidase (APX) activity in the parent tolerant to whitefly and thrips- LD 491- continuously increased till 60 days of pest infestation.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| <b>Millet</b>                 | <ul style="list-style-type: none"> <li>Two germplasm lines of each of Foxtail millet (R1F4 , R3 F3 ) and Proso millet (65BP 1 , 707P3 ) were selected and nutritionally evaluated. Foxtail millet line R3F3 and Proso millet line 707P3 were richer in proteins (13.59, 12.28g/100g), calcium (54.85, 40.95mg/100g), total dietary fibre (14.06, 18.46g/100g) and resistant starch (27.01, 20.91g/100g) and had lower predicted glycemic index (48.94, 54.39) and glycemic load (28.83, 32.51) than the other lines.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| <b>Vegetable crops</b>        | <ul style="list-style-type: none"> <li>Yellow vein mosaic disease (YVMD) raised total carbohydrates and total soluble sugars but reduced total soluble and crude proteins in susceptible bittergourd genotypes (Punjab-14, PAUBG-301, PAUBG-229 and PAUBG-31).</li> <li>The APX activity and APX transcripts were overexpressed in jassid resistant <i>Solanum melongena</i> - <i>S. insanum</i> derived lines; whereas catalase (CAT) activity and CAT transcripts were upregulated in susceptible introgression lines.</li> <li>Seven potato germplasm - Kufri Ganga, Kufri Pukhraj, LP/16-6-5, KP/16-3-12, KC-1, KP/16-9-61, and KP/16-27-15- were evaluated against late blight. KC-1 outperformed others with 30% disease severity followed by LP/16-6-5 (35% severity). The remaining five lines exhibited high susceptibility.</li> <li>In pot grown cucumber plants, PBRK-16, PBRK-28, PBRK-31, PBRK-24, PCG-10, PBRK-38, PBRK-37, and Punjab Kheera-1 lines showed moderate resistance to downy mildew.</li> </ul>                                                         |
| <b>Agroforestry germplasm</b> | <ul style="list-style-type: none"> <li><i>Casuarina</i> trials were conducted in the central plains of Punjab, at PAU Ludhiana; in the southwestern arid plains, at Chak Ruldu Singh Wala Farm, Bathinda; and in saline and waterlogged soil at University Farm, Ratta Kherra, Distt. Shri Muktsar Sahib. Under semi-arid conditions, the clones IFGTB CJ-9, IFGTB CH-1, IFGTB CH-2, IFGTB CH-4, IFGTB, PAU-2, PAU-3 and PAU-5 demonstrated above average performance with respect to plant height. In case of saline and waterlogged environment, IFGTB CJ-7, IFGTB CJ-9 and IFGTB CH-2 showed full survival (recorded six months after planting).</li> <li>In case of <i>Toona ciliata</i>, seed source S6 (Chabutra) and S2 (Kamahi Devi) and progenies of S6G2 (Chabutra), S2G1 (Kamahi Devi) and S3G2 (Ludhiana) were found superior.</li> <li>Three <i>Salix</i> clones UHFS 40, UHFS 08 and UHFS 34 were found at par with maximum volume index at 2 x 2 m spacing. The UHFS 08 clone produced maximum volume index (37803.86 cm<sup>3</sup>) at 2 x 2 m spacing.</li> </ul> |
| <b>Aloe Vera</b>              | <ul style="list-style-type: none"> <li>Irrespective of temperature of drying, carbohydrate and ascorbic acid contents of the selected lines were higher in gel than in leaves, whereas fibre, protein, ash and phenolic content were higher in leaves than in gel of all the three varieties. Various functional properties decreased with increase in drying temperature.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |

## BIOTECHNOLOGY

Biotechnologies related to abiotic and biotic stress management; nutraceutical, processing and premium market traits; and adaptation traits continue to feed into various crop breeding programmes of the university. Resistance biotechnologies are further complemented by molecular level studies on various insect-pests and causal pathogens.

- In case of wheat, major advances included identification and mobilization of novel genes for

stress; development of *Triticum dicoccoides* derived backcross introgression lines after transfer of grain size and rust resistance traits; mapping of *Aegilops triuncialis* and *T. dicoccoides* derived leaf rust resistance and powdery mildew resistance; transfer of terminal heat stress tolerance from *Ae. tauschii* and *Ae. Speltoides*; identification of heat shock factors (HSF) responsible for heat stress tolerance at seedling stage; and development of three important wheat varieties - PBWRS 1, PBW

833 and PBW Zn 2 by introgressing different quality and resistance traits through the MAS.

- In the case of rice, some salient applications included cloning three putative genes for characterizing *Bph34* and fine-mapping of major QTL for rice root-knot nematode resistance from *O. glaberrima* on chromosome 6.
- Major biotechnological interventions for maize included identification of 12 promising BC<sub>2</sub>F<sub>3</sub> southern leaf blight resistant pyramided lines; development of water efficient lines in the background of LM 23 and LM 24; identification of waterlogging tolerant lines and of 23 haplotypes for high alpha-tocopherol content; and evaluation of the CIMMYT maize panel against shoot fly and banded leaf and sheath blight resistance.
- Transgenic sugarcane was developed by expressing endochitinase gene cloned from *Trichoderma*.
- Development of Phytophthora tolerant rootstock hybrids in intergeneric F1 population using SNP markers and intergeneric hybrids for mapping citrus greening resistance genes, and cloning of flowering locus T (FT) gene from an accession of *Citrus reticulata* included major biotechnologies applied to citrus crop improvement.
- Assembling of guava draft genome, development of the PCR based SSR/InDel/ SNP markers, and preliminary work related to mapping of purple trait are some of the key initiatives in case of guava crop.
- Major biotechnological interventions in vegetable crops included: fine-mapping of ms-1 gene for

developing muskmelon hybrids, mapping of three QTLs associated with yellow mosaic in bittergourd, assembling of mitochondrial genome in onion lines, and identification and subsequent expression analysis of parthenocarp related genes in cucumber.

- Some important key insect-pest and pathogen related biotechnologies include: pharmacological characterization of CAPAr and ETHr genes in whitefly; screening of genes responsible for physiological functioning of whitefly; identification of mites collected from some Rajasthan regions by employing mtCOI nucleotide sequence homology; DNA barcoding for two of the natural enemies of fall armyworm; use of 16s RNA for identification of bacteria implicated in degradation of imidacloprid; molecular characterization of Fusarium species associated with Bakanae disease of rice; and multi-locus sequence typing of causal pathogens of Pokkah Boeng in sugarcane and stem rot in Berseem.

## SEED, NURSERY AND BIOFERTILIZER PRODUCTION

- During 2022-23, the university produced and distributed among farmers of the region 44, 372 quintal seed of various field crops, 884. 4 quintal of vegetable crops; 2.40 lakh fruit nursery plants; vegetable seedlings (worth Rs. 3.16 lakh); and 89 thousand agro-forestry seedlings.
- Biofertilizers were produced in respect of 15 crops, which were enough for a total acreage of 69 thousand acres.

## CROP PRODUCTION

### Field Crops

|              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|--------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Wheat</b> | <ul style="list-style-type: none"> <li>• Surface seeding-cum-mulching technology has been recommended for sowing wheat in combine-harvested paddy fields.</li> <li>• In the event of second irrigation getting delayed owing to winter rains and restricted infiltration under prolonged rice-wheat sequence, the recommended emergency response involves two sprays of 7.5% urea solution (15 kg urea in 200 litre water per acre) at 42 and 54 days after sowing as a substitute for surface application of solid urea fertilizer.</li> <li>• When soil organic carbon in residue retaining fields reaches 'high' (&gt;0.75%), P fertilizer can be cut down by half (12 kg/acre).</li> </ul> |
| <b>Rice</b>  | <ul style="list-style-type: none"> <li>• Seed priming with potassium nitrate (2% solution) for 12 hours helps improve establishment and productivity of direct seeded rice.</li> <li>• Critical climate parameters for optimum paddy growth in the state have been updated. During vegetative, flowering, and grain development stages, the respective maximum temperature ranges for rice are 34-40 °C, 30-35, and 32-35 °C. The respective minimum temperature ranges are 23-28, 25-27, and 20-25 °C.</li> </ul>                                                                                                                                                                             |



|                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|-------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Micro irrigation</b>                   | <ul style="list-style-type: none"> <li>A subsurface drip irrigation and fertigation module was recommended in the maize-pea-spring maize system for addressing groundwater depletion concerns, especially in spring maize.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <b>Organic/integrated farming systems</b> | <ul style="list-style-type: none"> <li>Organically cultivated Japanese mint (<i>Mentha arvensis</i> L.) should be supplied with 3 ton FYM per acre and the biofertilizer consortia @ 4 kg/acre.</li> <li>Package of production technologies for the new maize-pea-summer moong under organic cultivation has been recommended. The recommended package mainly involves seed treatment with biofertilizer consortia specifically developed for each of the three crops. Nitrogen requirement can be met from the combined use of FYM, vermicompost, and castor cake at different rates.</li> <li>Use of dredged fish pond sediment @ 6 ton/acre in maize and paddy can help save 25% of the recommended fertilizer dose in maize and wheat crop.</li> </ul> |
| <b>Vermicompost</b>                       | <ul style="list-style-type: none"> <li>Technology for upcycling surplus/waste maize silage into vermicompost has been recommended.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| <b>Paddy straw degradation</b>            | <ul style="list-style-type: none"> <li>PAU consortium, which is a mixture of bacterial and fungal cultures, was evaluated at two locations along with the Pusa Decomposer. The decomposer did not affect key soil parameters in a significant way at both the sites. At one site, maximum lignin degradation was under control plot (51.42%). However, at the other location, lignin degradation varied from 43.4 to 46.9% in control and decomposer sprayed plots, respectively. The culture spray did not impact wheat yield significantly.</li> </ul>                                                                                                                                                                                                   |

### Horticultural Crops

|                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|-----------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Brinjal-pea organic system</b> | <ul style="list-style-type: none"> <li>In order to meet nutrient needs of the brinjal-pea system under organic environment, FYM @ 5 ton per acre in brinjal and @ 2 ton per acre in pea should be applied.</li> <li>For controlling weeds, paddy straw mulch can be used @ 5 ton per acre in brinjal and @ 4 ton/acre in pea.</li> </ul>                                                                                                                                                                                                                                                     |
| <b>Garlic</b>                     | <ul style="list-style-type: none"> <li>Seed clove size larger than 9mm (A and B grade) effected 35% increase in the marketable yield .</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| <b>Container/indoor system</b>    | <ul style="list-style-type: none"> <li>Plant factory, a fully automated indoor system for production of leafy vegetables, has been established. It employs artificial light source, nutrient film technique (NFT) based hydroponic system, UV enabled leachate filtration, oxygenation system, an exhaustive wi-fi enabled environmental control system, double door entry and air curtain system against insect-pests, etc.</li> <li>Briquettes made from paddy straw were able to supplant upto one-fourth of cocopeat media without any significant drop in tomato fruit yield</li> </ul> |
| <b>Fertigation in orchid</b>      | <ul style="list-style-type: none"> <li>In order to meet nutrient needs of orchid grown in hi-tech greenhouse, NPK (19:19:19) fertilizer @ 1.2g per litre should be dispensed twice a week through stake drippers.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                 |

### Biofertilizers

- Consortium of three bacterial strains- *Advenella kashmirensis*, *Brevundimonas diminuta* and *Pseudomonas aeruginosa* - exhibited a significant increase in growth and yield parameters and helped save 25% of the recommended dose of fertilizers.
- Sphingobacterium spiritivorum*, *Bacillus* sp., *Pseudomonas aeruginosa* and *Serratia liquefaciens* exhibited 35.4 to 92.0% growth inhibition of *S. sclerotiorum* isolated from sunflower.
- Integrated application of FYM and two potential plant growth promoting (PGP) bacterial strains-*Pseudomonas flavescens* and *Pseudomonas putida* -increased microbial population and enzyme activities significantly over recommended fertilizer rates in broccoli.
- Some economical cell protectants , namely trehalose, carboxy methyl cellulose, and glycerol in wheat and rice bran-based liquid media formulae were optimized for enhanced shelf life of consortium biofertilizer (compatible combination of *Azotobacter*, *Bacillus* and *Pseudomonas* sp.).

## CROP PROTECTION

|                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|---------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Rice</b>         | <ul style="list-style-type: none"> <li>• A study on physio-biochemical and histological alterations in response to sheath blight revealed that after sheath blight infection, an increase in endogenous salicylic acid and other antioxidant enzymes was observed as a secondary defence response of the host plant. It was accompanied by down regulation of chlorophyll synthesis, reduced carbohydrates and accumulation of secondary metabolites.</li> <li>• Essential oil extracted from fenugreek (<i>Trigonella foenum-graecum</i> L.) seeds and leaves had Benzyl acetate (51.70%) and <math>\gamma</math>-tocopherol (42.09%) as major compounds. These compounds were tested for their antifungal activity against <i>Rhizoctonia solani</i> and <i>Drechslera oryzae</i>. The oil exhibited highest effectiveness with ED<sub>50</sub> values of 850 ppm against <i>R. solani</i> and 1120 ppm against <i>D. oryzae</i>.</li> <li>• Two biocontrol agents <i>Trichoderma harzianum</i> and <i>Bacillus amyloliquefaciens</i> FDK 21 were tested as seed treatment (@ 15 g/kg seed), seedling dip (15g/litre of water) and as a spray (15 g /litre of water) against sheath blight under field conditions. <i>Bacillus amyloliquefaciens</i> seedling dip exhibited 30.6% disease severity followed by 31.3% under seed treatment with <i>Bacillus amyloliquefaciens</i>.</li> <li>• Dwarf rice plant samples (22) were tested with primers specific to nine viruses and one MLO (mycoplasma like organism) reported to infect rice in different parts of world. Fifteen samples showed a typical ~1170 bp amplicon with southern rice black streak dwarf virus (SRBSDV) specific primers. Amplicons from two samples were cloned and sequenced. The sequence data analysed using BLASTn revealed 99% similarity with already sequenced segment 4 of SRBSDV in the GeneBank submitted from the countries where this disease has already been reported, whereas no similarity was observed with any of the other viruses.</li> <li>• Predominant weeds, namely <i>Poa annua</i>, <i>Avena fatua</i>, <i>Phalaris minor</i> and <i>Dicanthium annulatum</i> were tested for the infection of SRBSDV by using SRBSDV specific primers. None of the sample showed any amplification with these primers; hence they could not act as off-season hosts.</li> <li>• The highest incidence of Bakanae foot rot (6.92%) was observed where naturally infected seeds were sown in the uninoculated soil. When infected seeds were sown in the inoculated soil, the disease incidence was 5.96% in nursery and 8.63% in transplanted field. Contrarily, very low disease incidence was observed in case of healthy seed material. This suggested that seed borne inoculum is the primary source of disease and the soil borne inoculum cannot be implicated.</li> <li>• Two formulations of Citronella essential oil were tested as seed treatment at different concentrations against foot rot under artificial inoculation conditions. Terminal disease incidence was at par under both compositions.</li> <li>• Preliminary studies could not evidence penetration of <i>M. graminicola</i> larvae in barley, berseem, gobhi sarson, turnip, radish, carrot, garlic and potato. However, larval penetration and some adult stages were observed in other crops like wheat, oats, tomato, pea and onion, suggesting thereby their role as potential alternative hosts.</li> </ul> |
| <b>Basmati rice</b> | <ul style="list-style-type: none"> <li>• Trichoderma based biopesticide (total six quintal) was distributed during <i>Kharif</i> 2022-23 to the state farmers for managing foot rot of Basmati rice and for some citrus pathogens.</li> <li>• Large scale demonstrations of biocontrol based IPM in organic <i>basmati</i> rice (mechanical control by passing the 20-30 m long coir/jute rope before flowering, and 5-6 releases of <i>Trichogramma chilonis</i> and <i>T. japonicum</i> each @ 1,00,000 parasitoids/ha) showed lower incidence of rice insect pests.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| <b>Wheat</b>        | <ul style="list-style-type: none"> <li>• Off-season surveys were undertaken in Janjehli valley (Mandi district), Lag valley (Kullu), Shimla, Narkanda (Shimla district) and Nohradhar (Sirmaur district) of Himachal Pradesh during June 2023. High yellow rust severity was witnessed in Janjehli valley and Lag valley.</li> <li>• Foliar sprays of salicylic acid @ 0.01%, chitosan @ 0.25% and fermented butter milk @ 20% gave 69.2, 34.6 and 30.7% inhibition of yellow rust, respectively, as compared to control.</li> <li>• Analysis of 2521 grain samples for Karnal bunt and black point infected grains and shrivelled grains showed that Tarn Tarn, Gurdaspur, Hoshiarpur and Amritsar districts had high percentage of Karnal bunt infected samples (13.2 to 70.3%). Ropar led in black point infection and in shrivelled grains (82.5%, 97.5%).</li> <li>• Yellow rust severity showed significant differences across paddy straw management practices. The lowest severity (8.33%) was under Super Seeder and zero drill interventions.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |

|                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                  | <ul style="list-style-type: none"> <li>• Pink stem borer, <i>Sesamia inferens</i>, was found to remain active throughout the year on different crop hosts, namely rice (mid-August to November), wheat (mid-November to mid-March), maize (March to mid-October), and sugarcane (May-June). Damage recorded on true hosts- rice, wheat, maize and sugarcane - ranged from 1.05-5.10, 1.00- 4.50, 2.85-6.15 and 1.05-2.15 %, respectively. The highest pink stem borer damage in rice occurred in October, whereas in wheat, it was observed in the second fortnight of December.</li> <li>• Wheat sown with Happy Seeder recorded the highest pink stem borer incidence (3.69 per cent damaged tillers), whereas minimum pink stem borer damage (0.51% damaged tillers) was recorded under conventional tillage practices.</li> <li>• Wheat seed treatment with chitosan (@ 0.25%) was found effective in reinvigorating shrivelled seeds.</li> </ul> |
| <b>Pulses</b>    | <ul style="list-style-type: none"> <li>• The ETL in case of spotted pod borer, <i>Maruca vitrata</i>, in pigeonpea was worked out as two webs per plant ( on 10 or more randomly selected plants).</li> <li>• Whitefly, <i>Bemisia tabaci</i>, in mungbean can be managed by using homemade neem extract @ 1000 ml/ acre.</li> <li>• Pod sucking bug, <i>Clavigralla gibbose</i> Spinola, has been identified as a new pest of mungbean in the region. Use of homemade neem extract @ 1250 ml/acre provided effective in managing the pest.</li> <li>• Minimum percent pod damage (7.02%) by <i>Helicoverpa armigera</i> in chickpea was recorded in <i>Bacillus thuringiensis kurstaki</i> (DOR Bt 1 0.5 WP) @ 8g/ litre followed by NIBSM Bt 18 1% @ 10ml/litre (8.87%).</li> </ul>                                                                                                                                                                 |
| <b>Cotton</b>    | <ul style="list-style-type: none"> <li>• Bio-intensive pest management (BIPM) including timely sowing, placing pheromone traps, releases of <i>Trichogrammatoidea bactrae</i>, and application of azadirachtin 1500 ppm @ 2500 ml/ha resulted in lowering the incidence of pink bollworm.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| <b>Maize</b>     | <ul style="list-style-type: none"> <li>• A BIPM module involving two releases of <i>Trichogramma chilonis</i> @ 1,00,000 parasitized eggs/ha, one and two weeks after germination, followed by two sprays of <i>Bacillus thuringiensis</i> (NBAIR Bt 25 @ 10 ml/L) and two sprays <i>Metarhiziumanisopliae</i> (NBAIR Ma 35 @ 5 g/L) at 10 days interval resulted in 15.5% plant infestation (as compared to 32.4% in untreated control and 3.9% in chemical control).</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| <b>Sugarcane</b> | <ul style="list-style-type: none"> <li>• Large-scale demonstrations were conducted on the effectiveness of <i>Trichogramma chilonis</i> in managing stalk borer (<i>Chiloauricilius</i>). The module involved 10-12 releases of <i>Trichogramma chilonis</i> @ 50,000 per ha at 10 days interval during July to October, 2022. The intervention curtailed the pest incidence by 56.6% (over untreated control).</li> <li>• Releasing <i>T. chilonis</i> during mid April to June helped manage early shoot borer, <i>C. infuscatellus</i>.</li> <li>• Releasing <i>T. japonicum</i> @ 50,000 per ha eight times at 10 days interval during the same period helped manage top borer, <i>Scirpophaga excerptalis</i>.</li> </ul>                                                                                                                                                                                                                        |

## Vegetable Crops

|               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|---------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Potato</b> | <ul style="list-style-type: none"> <li>• The greatest decrease over two years (3<sup>rd</sup> year vs. 1<sup>st</sup> year) in potato tuberospheric population of <i>S. reticuliscabies</i> was observed in fallow-rice-potato rotation (95.8%), followed by cowpea-rice-potato, and sunhemp-rice-potato rotation.</li> <li>• Tubers harvested at 70 days after planting showed minimum disease incidence (15.2%) and disease severity (1.3%) of russet scab. These values were significantly lower than disease incidence and severity in the potatoes harvested at 80 days or more after planting. Results signify use of disease free seed and early harvesting for management of pathogen.</li> <li>• Combinations of near-infrared, green, red and SWIR bands of Sentinel- 2 were successfully used to discriminate the healthy plants from diseased plants in respect of late blight. Sensitive wavelengths for detecting the disease (with ≥ 20% disease infestation) in field experiments included 583 nm, 603, 1080 and 1301 nm.</li> <li>• Some essential oils, namely Citronella oil, Dill seed oil, and Clove oil provided late blight control (20-30%) under curative conditions.</li> <li>• Biocontrol agents, namely <i>Trichoderma harzianum</i> and <i>Pseudomonas fluorescens</i> were evaluated as tuber dip treatment, soil treatment and as their combination for managing black scurf of potato. The greatest inhibition of the disease was observed in tuber dip treatment with <i>Trichoderma harzianum</i> (35.90%) followed by tuber dip treatment with <i>Pseudomonas fluorescens</i> (32.5 %).</li> </ul> |
| <b>Onion</b>  | <ul style="list-style-type: none"> <li>• Pink rot of onion has been identified as a new disease. Fungal colonies were developed after five days of isolation. Microscopic examination confirmed the pathogen identity as <i>Phoma</i> and <i>Rhizoctonia</i> sp.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |

|                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Cucumber</b>  | <ul style="list-style-type: none"> <li>Red spider mite in the protectively cultivated cucumber can be managed by employing PAU homemade neem extract @ 1400 ml/acre in 100 litres of water. Dried neem fruit extract @ 5 kg/acre in 100 litres of water proved slightly more effective and can thus be used as an alternative measure.</li> <li>For managing cucumber wilt, three biocontrol agents, namely <i>Trichoderma harzianum</i>, <i>Pseudomonas fluorescens</i> and <i>Bacillus amyloliquefaciens</i> were evaluated as seed, soil, and their combination treatment. Maximum disease control (74.0%) of cucumber wilt was found in <i>T. harzianum</i> + <i>P. fluorescens</i> + <i>B. amyloliquefaciens</i> (seed + soil) treatment.</li> </ul>                                                                                                                                                                                                                                                                                                                |
| <b>Brinjal</b>   | <ul style="list-style-type: none"> <li>The EC formulations of citronella grass essential oil showed effectiveness against <i>Phomopsis vexans</i> (comparable to the effectiveness of Zineb 75 WP).</li> <li>Nanoemulsion formulations of leaf and flower extracts of <i>Ageratum conyzoides</i>, as well as the essential oil, were prepared and evaluated as fungicides against the phytopathogenic fungus <i>Phomopsis vexans</i> in brinjal. Nanoemulsions of the extracts and essential oil were characterized using SEM, TEM, and zeta potential. The essential oil nanoemulsion exhibited the highest antifungal activity against <i>P. vexans</i> (EC50 = 80 µg/ml).</li> <li>Three biocontrol agents, <i>Trichoderma harzianum</i>, <i>T. viride</i> and <i>Pseudomonas fluorescens</i> were tested as seed and soil treatment and as their combination for managing white rot. The highest control (85.0%) was found in <i>Pseudomonas fluorescens</i> based soil treatment followed by combined seed and soil treatment using <i>T. harzianum</i>.</li> </ul> |
| <b>Chilli</b>    | <ul style="list-style-type: none"> <li>Three biocontrol agents, namely <i>Trichoderma harzianum</i>, <i>Trichoderma viride</i> and <i>Pseudomonas fluorescens</i> were tested as seed treatment, soil treatment and their combination for managing damping off in chilli. Maximum disease control (85.0%) was noted in treatment of <i>P. fluorescens</i> + <i>T. viride</i> (seed + soil) followed by combined seed and soil treatment with <i>T. viride</i> (78.0 %).</li> <li>Leaf spot and fruit rot of chilli has been identified as a new disease. Based upon various morphological traits, the fungus was identified as <i>Alternaria</i> sp.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                          |
| <b>Muskmelon</b> | <ul style="list-style-type: none"> <li>As per a survey, yellowing and leaf curl were the most predominant virus infection symptoms in muskmelon crop throughout Punjab state.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |

## Fruit Crops

|                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Citrus</b>          | <ul style="list-style-type: none"> <li>A host of citrus pests, namely, citrus psylla, aphids, thrips and mites can be effectively managed by spraying soybean or cottonseed oil (10 litres per acre) mixed with 1.25 kg of detergent powder (acts as a surfactant) in 500 litres of water.</li> <li><i>In vitro</i> studies assessed the efficacy of <i>Monarda citriodora</i> essential oil and its micro and nanoemulsions, against <i>Penicillium digitatum</i>, a major postharvest fungal pathogen of Kinnow. Essential oils extracted from black cumin seeds (<i>Nigella sativa</i> L.) and clove buds (<i>Syzygium aromaticum</i>) were characterized by GC-MS. Thymoquinone (18.07%) and eugenol (68.64%) were identified as major constituents. Thymoquinone exhibited the most effective antifungal activity against <i>P. digitatum</i> and <i>Colletorichum gloeosporoides</i>.</li> </ul> |
| <b>Mango</b>           | <ul style="list-style-type: none"> <li>The IPM module developed for managing mango hopper involves cultural control measures like pruning of branches in dense orchards, avoiding high density planting, and spraying twice at weekly interval with PAU homemade neem or PAU homemade dharek extract @ 5 litres.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| <b>Litchi</b>          | <ul style="list-style-type: none"> <li>The BIPM module developed for fruit borer (<i>Conopomorpha sinensis</i>) control in litchi involves ploughing orchards during March-April, clean cultivation, regular collection and destruction of infested shed fruits during May-June, and six releases of <i>Trichogramma embryophagum</i>.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <b>New fruit crops</b> | <ul style="list-style-type: none"> <li>Mite populations collected from date palm in Hanumangarh, Bikaner and Jaisalmer were identified as <i>Raoiella indica</i>.</li> <li>Aqueous extracts of neem (<i>Azadirachta indica</i>), dharek (<i>Melia azadirachta</i>), and pongamia provided 45-60% reduction in mites two days after treatment under laboratory conditions. Under field conditions, the first spray effected 26.8 – 36.6 % reduction of <i>R. indica</i> and after second spray, more than 50 % drop was observed with PAU homemade neem extract, 46.9 with dharek extract, and 46.8% with pongamia extract.</li> </ul>                                                                                                                                                                                                                                                                  |

### UAV based Spray System

- Hexacopter drones fitted with appropriate spray systems were developed and evaluated. Standard, extended flat fan nozzles and anti-drift/air induction nozzles were found suitable for the system. For higher efficiency, the ideal operating parameters have been identified as: pressure of 1.38 kg/cm<sup>2</sup>, forward speed of 2-3 m/s, and flying height of 2-3m above the crop canopy.

### New Agrochemicals

- Spiro(dihydropyrimidinone-isatin) derivatives were synthesized by adding urea to the C-3 position of isatin under acidic conditions. These derivatives showed nematicidal potential against the root knot nematode, *Meloidogyne incognita*.
- Derivatives of bromo-substituted 4-methylsalicylic acid, ethoxy-substituted salicylic acid, and salicylanilides were synthesized. *In vitro* antibacterial studies against *Streptomyces sp.* and *Dickeya sp.* showed that derivative 4-(bromoethyl)-2-hydroxybenzoic acid had the best antibacterial activity against the Gram-positive strain *Streptomyces sp.*, whereas the derivative ethyl-2-ethoxy-4-methylbenzoate showed the best antibacterial activity against the Gram-negative strain *Dickeya sp.*

### PESTICIDE RESIDUE ANALYSIS

- In case of vegetable samples, 7.73% were contaminated and 0.54% had pesticide contamination above prescribed maximum residue limit (MRL). In case of fruit samples, 11 percent were contaminated; 3.9% rice samples were contaminated. However, no pesticide contamination was detected in samples of water, pulses and wheat.

### RODENT, BIRD AND VERTEBRATE PEST MANAGEMENT

Under both field and commensal situations, integration of repellent based formulations (RBF) with other methods provided 50-90% reduction in rodent and Blue bull activity for 30-50 and 14-42 days, respectively.

- Application of Neem seed and adrographolide (NSA) based palatable bait in reservoir fields can lead to cost-effective and long term management of rodents in surrounding fields also.
- The bait containing 10% papaya seed chloroform extract based solid lipid nanoparticles (PSCEN) was

found to cause significant antifertility effects which stayed unreversed upto 105 days after treatment withdrawal.

- Barcodes from cytochrome *b* and cytochrome *c* oxidase 1 genes were employed for identification of rodent species using fecal, fur, ear and tail samples.
- The rats gavaged orally @2mg/Kg body weight quineestrol for 10 days showed decrease in number of proteins in membrane of spermatozoa from testis to epididymis as ascertained by SDS-PAGE.
- A checklist of 213 bird species belonging to Punjab region was compiled and published.
- Out of 39 bird species observed on T-perches installed in cotton and maize fields, 44-52 % were insectivorous species during the vegetative and maturing stage of the crop.

### FOOD SCIENCE AND TECHNOLOGY

#### Oleogels

- Plant based oils (rice bran oil, virgin coconut oil and mustard oil) were transformed to oleogels using different oleogelators- stearic acids, linoleic acid, candelilla wax and beeswax. The resultant oleogels exhibited properties of solid fats and their functionality was evaluated in different food products such as muffins, cookies, and indigenous products.

#### Herb-based pasta

- Some commonly used medicinal herbs, namely *tulsi*, *ashwagandha*, *brahmi* and *shatavari* were incorporated (@ 2.5, 5.0, 7.5 and 10.0%) into pasta. The pasta enriched with herbs had enhanced functional properties and bioactive profile.

### Black carrot pomace extract based edible packaging films

- Black carrot pomace (BCP) extract was used for developing edible packaging films. Results showed that the increasing level of extract led to progressive increase in thickness, moisture and solubility of the films.

#### Essential oils from galgal

- The seed oil exhibited a good profile of palmitic (22.36 to 22.87%), oleic (27.77 to 29.25%), linoleic (31.43 to 32.14%), and linolenic acids (6.32 to 6.70%) along with other minor fatty acids.

Clevenger apparatus was found to be the best method based upon the ease of use and cost-effectiveness.

### **Bread premix fortified with sorghum and foxtail millet flour**

- Sorghum and foxtail millet flour can be successfully substituted up to 30% for the formulation of bread premix. This substitution improved the nutritional profile of bread premix.

### **Okra flour based value-added products**

- Okra flour based confections showed significantly ( $p < 0.05$ ) higher protein, fibre, minerals, total phenolic content, antioxidant activity and *in vitro* protein digestibility as compared to control.

### **Date powder from immature *khalal* dates**

- Tray dried powder from *khalal* dates exhibited higher yield, bioactive compounds and antioxidant activity than spray dried powder. However, functional properties were found to be superior in the spray dried powder.

### **Products from coloured potato varieties**

- Drum and tray drying methods were compared for preparing potato flakes from Lady Rosetta (white fleshed) and PP-1901 (purple flesh) varieties. Drum drying significantly reduced colour values, but the sample had higher water and oil absorption capacities. On contrary, tray-dried flakes had higher phenolics, flavonoids, anthocyanins, ascorbic acid, and antioxidant activity.

### **Blanching of potato**

- Three blanching methods - steam, hot water, and microwave – were evaluated. Microwave blanching demonstrated the highest preservation of bioactive compounds, followed by steam and hot water methods. Blanching increased antioxidant activity across all the samples.

### **Pasta incorporated with whole wheat flour**

- Optimized extrusion processing conditions for whole wheat flour are: 147.5% extrusion temperature, 15% feed moisture and 434 rpm screw speed. Extruded whole wheat flour can be incorporated up to 30%.

### **Accelerated aging of rice**

- Bath ultrasound treatment was developed for accelerating aging of paddy by following

these optimized variables: power 200 W, 35.5% temperature and 88.4 minutes time. Ultrasonication increased milling efficiency and cooking quality of rice, but head rice yield was adversely affected.

### **‘Ready to reconstruct’ (RTR) smoothie drink from processing waste**

- Seven different formulations of RTR smoothie mix were prepared using apple and grape pomace powder, dairy whitener, powdered sugar, hydrocolloid, anticaking agent, cocoa powder, dried mint, and ginger and cardamom powder. For tray drying of wet pomace, time, temperature, powder particle size, and hydrocolloid parameters were optimized.

### **Dried figs and fig bars**

- Osmotic dehydration method was developed for drying figs in order to preserve their nutritional worth, which can be lost during conventional drying. This method resulted in higher concentration of total phenols, antioxidants, total sugars, and reduced titratable acidity. Bars were developed by substituting sugar with honey and jaggery in different concentrations.

### **Galgal juice preservation**

- Optimum levels for salt and oil based preservation of galgal juice included: 3.54% white salt, 3.41% black salt and 3.32% mustard oil cap concentration. The juice, so preserved, had shelf stability for three months at ambient conditions and for 10 months under refrigerated conditions.

## **FOOD AND NUTRITION**

### **Microgreens**

- Some microgreens, namely spinach, coriander, broccoli, and carrots raised outdoors using seeds soaked overnight and harvested on 10<sup>th</sup> day were dehydrated using microwave technology. They were able to retain nutritional quality in terms of ascorbic acid, chlorophyll, antioxidant activity, zinc, iron, calcium, potassium, and magnesium levels.
- Different postharvest parameters – [MAP (Modified Atmospheric Packaging, GRAS (Generally recognized as safe) chemical treatments, and storage temperature] were optimized to prolong shelf life of microgreens. Among the organic chemical treatments, ascorbic acid + citric acid treated samples maintained significantly higher

nutrient status with respect to  $\beta$ -carotene, total phenols, flavonoids, chlorophyll and physiological quality (in terms of instrumental colour and microbial enumeration).

### Production and post-harvest management of wheatgrass

- Good quality wheatgrass can be raised by broadcasting wheat seeds in cocopeat trays (@ 50 g/ft<sup>2</sup>) followed by covering seed with a thin layer of cocopeat and sprinkling of water. Wheatgrass harvested at about 15 cm height and dried in a hot air oven at 50° C can be used to reconstitute juice or it can be freeze- or shade-dried and then ground to a powder for subsequent use in bread, biscuits and spice mix.

### Heavy metal analysis

- Some commonly consumed foods were analysed for their heavy metal/metalloid content and their impact on human health. Arsenic, cadmium, lead and mercury were within their permissible limits in wheat *chapatis*, cooked rice, cooked pulses, cooked vegetables, milk, and water.

### Fatty acid profiling

- Fatty acid profiling of 50 bakery products (sourced from different bakeries) indicated that decanoic acid, palmitic acid and myristic acid were the major saturated fatty acids (SFA) present in the bread. Palmitic acid predominated across all the biscuit products. Caprylic acid was the major SFA in all the cakes and pastries.

### Antioxidant and prebiotic potential of fruit peels

- Fruit peels (8) were evaluated for prebiotic and antioxidant potential. With regard to antioxidant capacity, the maximum total phenolic content (69.23 mg GAE/g) was recorded in pomegranate peel powder. Raw mango peel powder had the highest total flavonoid content (15.20 mg QE/g). Pomegranate peel powder exhibited the highest antioxidant activity. The study has significance in selecting fruit peels suitable for developing prebiotic rich products.

### Beetroot based drink

- Beetroot based metabiotic drink was developed and evaluated for nutritional and functional properties and for shelf life. The developed drink had lower TSS (5.13°Brix) and pH (5.77) values as compared to pure beetroot juice. Total sugar (9.00%), reducing (6.45%) and non-reducing sugar (2.55%) content of the metabiotic drink

was significantly lower than the beetroot juice. Though the metabiotic drink was organoleptically acceptable for 3 months, mineral content, bioactive compounds and antioxidant activity started sliding just after one month. The developed metabiotic drink can find use in managing metabolic disorders.

### Foxnut based confectionery

- Bakery products were prepared by incorporating foxnut powder at levels ranging from 10-25 percent with refined flour. Foxnut incorporated bakery products, namely cake, cookies, bread and doughnuts were highly acceptable at 20, 25, and 12.5 percent level of incorporation of foxnut powder.

### Wild melon based products

- In order to tap antioxidant, anti-inflammatory and analgesic value of wild melons, a range of products including jams, chutneys, and pickle were prepared. Shade-dried powder of wild melon had higher antioxidant activity than oven-dried powder. The percent retention of antioxidants during storage of three months varied were used.

### Gum berry based products

- Unripe and ripe gum berry fruits were analysed for their nutritional composition and antioxidant activity. Unripe fruits had higher content of ascorbic acid (20.16 mg/100g on fresh and 36.57 mg/100g on dry weight basis), whereas the total phenols, flavonoids, and antioxidant activity as analysed by the DPPH and ABTS method were higher in ripe fruits. Various processed products prepared using gum berry retained good antioxidant potential till 3 months.

### Effect of processing techniques on nutritional make-up of millets

- Effect of processing techniques on the nutritional profile and shelf life of foxtail and proso millet was studied. The four processing techniques- roasting, germination, boiling and pressure cooking - were applied to two lines each of foxtail (R1F4, R3F3) and proso (65BP1, 707P3) millet. Soluble, insoluble and total dietary fibre in foxtail and proso millet increased only with germination by (21.65, 17.85%), (10.05, 8.5%), and (10.7, 7.3%), respectively. Roasting increased shelf life of the flour up to 5 months with a gradual rise in moisture content, peroxide value, acid value, and free fatty acids from the start to 150<sup>th</sup> day in foxtail millet.

## POST-HARVEST MANAGEMENT

### Micro-processed pear products

- Micro-processed products, namely fruit bar (4-5 mm thick), fruit candy cubes (9 x 12 x 7 mm), nectar and jam were prepared using pear fruits. All these products showed a shelf life of minimum six months.

### Fresh-cut papaya and guava fruits

- In order to sustain quality of fresh-cut papaya and guava fruits, disinfectant pre-treatment has been standardized and recommended. Five different disinfectants – sodium hypochlorite (NaOCl), potassium metabisulphite (KMS), citric acid, acetic acid, and benzoic acid – were evaluated for their microbicidal efficacy. Disinfectant pre-treatment with NaOCl outperformed other chemicals in curtailing microbial load over fresh cut fruits.

### Preparation of Kombucha

- A domestic scale (5 litre capacity) fermentation technology has been developed and recommended for preparing Kombucha.

### Modified Aloe Polysaccharide

- Modified Aloe Polysaccharide (MAP) powder of acceptable quality was developed for use in health products and pharmaceutical industries.

### Processing of medicinal plants

- Operational parameters - heating temperature, holding time and solvent to leaf ratio - were optimized for extraction of sweet component from stevia powder using ohmic heating.
- A process for extraction of stevioside and spray dried powder was developed.
- Process parameters for extraction of essential oil from semi-dried aerial parts of Mentha (*Mentha arvensis*) using three methods, namely hydro-distillation, microwave assisted extraction method, and enzyme assisted extraction method were optimized using response surface methodology.

### Processing for juice

- Suitability of high intensity ultrasound for inactivating polyphenol oxidase (PPO) and peroxidase (POD) in fresh Indian Gooseberry juice and the subsequent effects on biochemical attributes were optimized using response surface methodology.
- An automated manothermo sonication (MTS) pilot scale plant for pre-treatment of juices has been designed and fabricated.

## Freezing System

- A Cell Alive System/Magnetic Assisted Freezing System (CAS) setup was developed for uniform and rapid freezing of water (present in fresh and fresh-cut produce) under the influence of external magnetic field for preparing frozen products.

## Storage Interventions

- A gadget with compatible suffice pouches was developed for effective application of essential oil to stored chickpea for protection against *Callosobruchus chinensis*. Some essential oils, namely mint oil @ 30 µl, garlic oil @ 40 µl and tulsi oil @ 150 µl proved effective in thermally disinfested stored chickpea grains.
- Storage behaviour and techno-economic feasibility of paddy, wheat and canola in hermetic bag and cocoon bag were studied. Cocoon bag yielded the highest profit margin (6.39%) due to minimum grain loss and limited decline in quality parameters.
- With combined ozonation-roasting treatment and vacuum packaging in a polymeric laminate, dried groundnut kernels can be stored upto 12 months under ambient conditions.

## AGRO-FORESTRY

### Determination of wood properties in *Casuarina* clones

- The *Casuarina* wood samples were taken from 6 ¼ year old clonal evaluation trial. These clones were earlier procured from the Institute of Forest Genetics and Tree Breeding, Coimbatore. The IFGTB CJ 9 recorded significantly higher wood density (751 kg/m<sup>3</sup>) over other clones. The lowest shrinkage was observed in the clone IFGTB CJ-108 (10.01%) followed by clone IFGTB CH6 (10.04%). Minimum swelling was observed for clone IFGTB-CJ108 (11.09 %). Holocellulose, an important enabler of pulp-making use, was the highest (64.40%) in IFGTB-CH2 clone. Clone IFGTB-CH4 had shorter and thinner fibre.

### Intercropping in casuarina

- Casuarina trees were planted in three different spacing arrangements (7 m x 3 m, 5 m x 3 m and 3 m x 3 m). Four crops - wheat, gobhi sarson, chickpea and oat - were sown as intercrops along with a sole crop check. In general, 7m x 3m spacing provided higher intercrop yield, whereas 3m x 3m spacing gave the lowest performance.

### Standardization of clonal propagation of *Casuarina*

- Studies have been initiated to identify the type and concentration of growth regulator, cutting type, etc. Preliminary results suggest that for higher rooting percentage of cuttings, Indole butyric acid is more effective than Indole acetic acid, Naphthalene acetic acid alone and in combination.

### Waste water irrigation

- Growth parameters and biomass of five tree species (Bamboo, Arjun, Gmelina, Burma Dek and Eucalyptus) were observed under five types of waste water: sewerage treatment plant (STP) water, untreated water flowing into STP, Buddha Nullah water, domestic sewage water, and normal water (as check). Collar diameter, height, and shoot weight were the lowest with normal water and increased with application of different waste waters.
- Growth of eucalyptus under sewage sludge (along with application of inorganic fertilizers) application was examined. Diameter at breast height (DBH) and height after two years of growth were the lowest in control and the highest with the application of sludge @ 15 kg/plant in addition to the recommended fertilizer rates.

## BEEKEEPING

### Bee venom

- Installing bee venom collection device in a 8 bee-frame for one hour led to the highest venom collection.

## MUSHROOM CULTIVATION

|                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|-------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Cultivation technology</b> | <ul style="list-style-type: none"> <li>Maximum yield of <i>Agaricus bisporus</i> (U3 strain) was harvested with the wheat straw based compost (19.34 kg/q compost) followed by paddy straw based and sugarcane bagasse based compost.</li> <li>Out of six <i>A. bisporus</i> strains raised on wheat straw compost (short method), the highest yield was obtained with AVTB-22-204 (20.53 kg/q compost) followed by AVTB-22-205 (18.72 kg/q compost).</li> <li>Six <i>Volvariella volvacea</i> strains (VV22-201 to VV22-206) were evaluated on paddy straw. The VV-22-205 and VV-22-206 gave the highest yield (15.38 and 14.93 kg/q dry straw, respectively).</li> <li>Six strains of <i>Calocybe indica</i> Ci 22-201 to Ci 22-206 were evaluated on wheat straw. The yield data indicated maximum yield for the strain Ci-22-205 (72.40 kg/q straw).</li> <li><i>Calocybe indica</i> strains, Ci 22-01 to Ci 22-12, were evaluated on wheat straw and paddy straw. In wheat straw based trials, Ci 22-07 and Ci 22-11 gave the highest yield (72.3 and 65.6 kg/q straw). However, paddy straw yielded lower.</li> </ul> |
| <b>Biofortification</b>       | <ul style="list-style-type: none"> <li>Fruit body extracts of <i>Pleurotus djamor</i> and <i>P. sajor-caju</i> were used for the synthesis of Se and ZnO nanoparticles (NPs) using the precursor salts at different concentrations. Visual colour change in the extracellular extracts of <i>Pleurotus</i> spp. treated with salts indicated the formation of biogenic NPs for both Se and Zn salts. The highest yield was found in BioZnNPs-PSC treated <i>P. sajor-caju</i> and BioZnNPs-PD treated <i>P. djamor</i> fruit body showed the highest total soluble protein content.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |

### Phenotypic screening for royal jelly production

- Comparative evaluation of royal jelly production by *A. mellifera* colonies headed by F1 queen bees reared from the selected colonies revealed that royal jelly production per colony per grafting attempt was significantly higher in the F1 queen colonies (over control).

### Breeding for less defensive behaviour

- Colonies with moderate stinging tendency were successfully developed. Out of F<sub>1</sub> colonies, 62% qualified for the least stinging category against 10 percent in the original stock.

### Cataloguing

- Bee samples (19) collected from different parts of the state have been submitted to the IARI National Insect Museum for detailed identification.

### Pollination

- Pollination carried out by *Apis mellifera* in muskmelon (MM 1426) grown under polyhouse conditions resulted in mean fruit weight of 550±132 g in comparison to 533±29g under hand pollination.

### Screening for hygienic behaviour

- Out of the selected 92 *Apis mellifera* colonies, 41 colonies (44.6% of the stock screened) were graded as highly hygienic (80.7-95 per cent hygienic behaviour).

### Migration routes

- Migration routes being recently followed by the beekeepers of the state to shift their honey bee colonies in search for bee flora available in other states have been documented.

|                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|---------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Value addition</b>     | <ul style="list-style-type: none"> <li>Lactic acid fermented paste formulations of <i>Volvariella volvacea</i> (paddy straw mushroom) were developed for enhancing shelf life. Salted and spiced paste was fermented using <i>Lactobacillus rhamnosus</i>. Sodium benzoate was used as preservative in unfermented pastes, whereas fermented formulations were kept devoid of any chemical preservative. In organoleptic evaluation, the spiced fermented mushroom paste scored significantly higher (8.3) than the salted fermented formulation (7.7).</li> <li>Intensity and duration of UV-B light exposure for maximum conversion of ergosterol to vitamin D<sub>2</sub> in <i>Pleurotus florida</i> was optimized. Irradiation at intensity 2.00 W/cm<sup>2</sup> for 60 minutes was considered appropriate for ensuring maximum conversion.</li> <li>Effect of different drying techniques on stability of vitamin D<sub>2</sub> was studied. Highest stability of vitamin D<sub>2</sub> was found in sun-dried, hot air dried and microwave dried samples.</li> </ul> |
| <b>Mushroom germplasm</b> | <ul style="list-style-type: none"> <li>Wild mushroom flora was surveyed in the districts of Punjab during the months from July, 2022 to March, 2023. Twenty mushrooms were collected and identified.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |

## LAC CULTURE

|                                |                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|--------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Germplasm</b>               | <ul style="list-style-type: none"> <li>Surveys were conducted for lac insect and host plants in Punjab, Delhi and Uttar Pradesh. The respective collections in case of Punjab and Delhi were 8 and 1. Uttar Pradesh survey, however, did not yield any lac insect.</li> <li>As a part of ex situ conservation and brood multiplication at the Regional Field Gene Bank, 55.74 kg brood lac was multiplied on various host plants.</li> </ul> |
| <b>Lac based fruit coating</b> | <ul style="list-style-type: none"> <li><i>Kinnow</i> mandarin fruits coated with Citrasol, Citrasine and a lac-based formulation prior to storage under ambient conditions were able to retain their post-harvest quality for 15 days, in comparison to 60 days under cold storage conditions.</li> </ul>                                                                                                                                    |

## FARM MACHINERY AND POWER ENGINEERING

|                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|----------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>PAU Surface Seeder</b>                    | <ul style="list-style-type: none"> <li>PAU Surface Seeder ensures simultaneous sowing of wheat and cutting and spreading of paddy straw in combine harvested paddy fields. It has a cutting and spreading unit over which a seed and fertilizer fluted roller metering system has been mounted. In comparison to other conventional paddy residue machines, PAU Surface Seeder is not only economical but also enhances ease and pace of straw management by way of higher field capacity with low tractor power requirement.</li> </ul>                                                                        |
| <b>Paddy straw bale shredder-cum-mulcher</b> | <ul style="list-style-type: none"> <li>A tractor operated paddy straw bale shredder-cum-mulcher for spreading mulch in widely spaced crops has been developed and recommended.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                       |
| <b>Potato digger-cum-collector</b>           | <ul style="list-style-type: none"> <li>A tractor operated potato digger has a hydraulically operated bucket attachment for tuber collection. It is a semi-mounted and tractor P.T.O powered machine. Average collection recorded at different farmer fields varied between 96.55- 98.89 % during a long run field test.</li> </ul>                                                                                                                                                                                                                                                                              |
| <b>Shaking based fruit harvester</b>         | <ul style="list-style-type: none"> <li>A tractor operated hydraulically controlled tree shaker has been developed which is capable of generating enough vibrations to shake any tree along with provision of holding of trunk at desired position up to a height of 2438 mm (8 ft.). Vibration unit also carries the grippers for gripping and vibration transfer. A separate collection unit of retractable umbrella type has been developed. The extended diameter of a fully opened umbrella is around 6705.6 mm (22 ft.). The machine has been evaluated on <i>Aonla</i> and <i>Jamun</i> trees.</li> </ul> |
| <b>Survey on farm accidents</b>              | <ul style="list-style-type: none"> <li>Selected villages (20 each) from each of the three districts (Sangrur, Shaheed Bhagat Singh Nagar, and Ferozepur) were surveyed for farm accidents. A break-up of the total 143 cases reported is: entanglement in machines (47 cases), collisions (26 cases), cuts (26 cases), falls/slips (9 cases), and overturning incidents (8 cases).</li> </ul>                                                                                                                                                                                                                   |
| <b>Dust management in combine harvesting</b> | <ul style="list-style-type: none"> <li>Dust concentration at operators level during wheat harvesting season ranged between 0.402-1.331 mg/m<sup>3</sup> for 1 micron size, 1.149-2.670 mg/m<sup>3</sup> for 2.5 micron size, and 1.750-4.359 mg/m<sup>3</sup> for 10.0 micron size. Dust concentration at operator level during paddy harvesting season ranged between 0.419-0.572 mg/m<sup>3</sup> for 1 micron size, 0.543-0.864 mg/m<sup>3</sup> for 2.5 micron size, and 1.395-1.613 mg/m<sup>3</sup> for 10.0 micron size.</li> </ul>                                                                      |

|                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|---------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                             | <ul style="list-style-type: none"> <li>During threshing of wheat crop, the particles were found to have no fixed shape. Different commercially available devices included different kinds of masks, disposable filters, and common cloth. The smallest void dimensions (in microns) were recorded in the filter element 7 followed by 11L and 9, respectively. However, the irregular crisscross orientation of the individual fibres in these three filter elements makes them most appropriate for filtering out the 2.5 µm suspended air particulates.</li> </ul>                                                                                        |
| <b>Remote controlled paddy transplanter</b> | <ul style="list-style-type: none"> <li>To minimize the operator's physical and mental stress, a virtual reality (VR) based remotely controlled system was developed for the operation of 2- wheel paddy transplanter. An Integrated Development Environment (IDE) with VR system was developed to remotely operate a 2-wheel paddy transplanter. Two front and rear first-person view (FPV) cameras were mounted for real-time transplanting operation, allowing the operator to perceive the field view through head mounted display (HMD) and control the machine via hand-held remote controller while comfortably sitting outside the field.</li> </ul> |
| <b>Machinery testing</b>                    | <ul style="list-style-type: none"> <li>A variety of machines were tested. This mandate earned a revenue of Rs. 50.73 lakh.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |

## RENEWABLE ENERGY AND WASTE UPCYCLING

|                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|----------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Solar drying</b>                                | <ul style="list-style-type: none"> <li>A solar dryer having latent heat storage for use after sunshine hours has been developed. It has a loading capacity of 30 kg of farm produce. The dryer was tested on bitter melon and ginger slices; it exhibited an average thermal efficiency of 36.7% and 37.9%, respectively. Specific energy consumption for the two materials was 59.7 and 69.7 MJ/kg, respectively.</li> <li>Solar assisted refractance window dryer was evaluated for drying of onion and coriander purees. Quality of the samples dried using this dryer was comparable with electrically operated refractance window dryer.</li> <li>Mushrooms were sliced, pre-treated with KMS solution and then dried using refractance window dryer. The dried and pre-treated samples retained their nutritional value far better than other methods.</li> </ul> |
| <b>Paddy straw based energy and other products</b> | <ul style="list-style-type: none"> <li>Chopped paddy straw based binderless briquetting technology has been developed and recommended. The technology employs chopped paddy straw and does not involve conventional biomass grinding.</li> <li>Maize and mustard stover, and shelled maize cobs were individually mixed with paddy straw in different proportions. Ash content decreased with increase in blending with other biomass.</li> <li>In order to make paddy straw and other biomass amenable to densification, a continuous type torrefaction machine having capacity of 20 kg per hour was fabricated.</li> </ul>                                                                                                                                                                                                                                           |
| <b>Bioenzymes</b>                                  | <ul style="list-style-type: none"> <li>Process technology for preparation of bioenzymes from fruit and vegetable wastes has been developed. These bioenzymes have been characterized for critical parameters and are being evaluated for different household and other applications.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |

## APPARELS AND TEXTILES

### Sisal fibre (*Agave americana*) for designing handloom textile products

- Three blended yarns were developed by blending sisal and cotton fibres at carding stage in 65:35, 50:50 and 35:65 ratio. Blended yarns in 35:65(12s) and 50:50 (8s) ratio were found optimum due to their desirable physical and mechanical properties.

### Development of union fabrics using non-conventional Bast fibres

- Fibres extracted from six plant materials, namely Spider hibiscus, Sleeping hibiscus, Lobster claw, Yellow oleander, Gardenia, and Black mulberry, were studied for their physio-chemical properties. Cellulose content of Gardenia was higher (84%)

than Spider hibiscus (80 %), Black mulberry (79 %), Sleeping hibiscus (70%), Yellow oleander (52%) and Lobster claw fibre (42%).

- On the basis of fibre properties and ease of extraction, three fibres- Spider hibiscus, Sleeping hibiscus and Lobster claw- were selected for yarn development. Spider hibiscus/viscose rayon (30:70) and Sleeping hibiscus/wool (50:50) yarn were selected for fibre development. Six union fabrics in plain, rib and twill weaves using Spider hibiscus/viscose rayon (30:70, 2.89s) and Sleeping hibiscus/wool (50:50, 1.77s) were developed. Physical and mechanical properties of the developed union fabrics indicated their suitability for developing home textiles and apparel products.

## AGRICULTURAL ECONOMICS AND SOCIOLOGY

|                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|-------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Maize market analysis</b>                    | <ul style="list-style-type: none"> <li>Production, trade, consumption and other aspects of maize at the global and national level were examined with special reference to Punjab. India exports about 80% of its maize largely to Bangladesh and Nepal. Major maize producing states of India such as Karnataka, Madhya Pradesh, Tamil Nadu and Uttar Pradesh have much lower cost of production ranging between Rs 1170-1214 per quintal against Rs. 1447 per quintal in Punjab. High cost of production and price fluctuations are two major deterrents in large scale expansion of maize area in the state.</li> <li>The study titled, "Production status, market integration and the law of one price: an exploration of the major maize markets of India" showed that India experienced the highest growth in maize crop output and consistent upticks in area, production, and yield. For the next five years, from 2020 to 2025, the chosen ARIMA model anticipated a rise in maize area, production, and yield of 10.58 million ha, 35.65 MT, and 3390.5 kg/ha, respectively. The market integration status depicted a unidirectional causality from the Punjab market to the other two selected markets (Madhya Pradesh and Uttar Pradesh).</li> </ul> |
| <b>Trade performance of millets</b>             | <ul style="list-style-type: none"> <li>The study on "Indian millets trade potential-cum-performance: economic perspective" examined the trade performance of millets, competitiveness and their impact on growth of agriculture. Indian millet exports contributed significantly to the global basket during the period 2000–2020. Revealed Comparative Advantage (RCA) analysis showed that Pakistan, Saudi Arabia, Vietnam, and Yemen were the major millet importing countries. India had a significant advantage in exporting millets to these partner countries during the period 2011–2020.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| <b>Crop planning for edible oil needs</b>       | <ul style="list-style-type: none"> <li>The study on "Production and marketing of oilseeds in India with special reference to Punjab" was undertaken to highlight the performance of oilseed cultivation in Punjab. Punjab mainly focuses on four oilseed crops, namely groundnut, rapeseed-mustard, sunflower, and sesamum. Area under oilseeds has declined from 86 thousand ha to 40 thousand ha during the period 2000-01 to 2019-20, which covered 0.49 per cent of gross cropped area in the TE 2019-20. Substantial progress of the state with respect to canola suggests potential of the state in meeting edible oil needs of the country. Strong position of the state with respect rice hints at a major role the state can play in enhancing rice bran oil production in the country.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| <b>Decentralized procurement of wheat</b>       | <ul style="list-style-type: none"> <li>The study titled "Decentralized procurement of wheat: insights from Punjab state" suggested that overall Pungrain had used 60% of its godown/plinth capacity for decentralised procurement. Total acquisition cost of wheat (Rs 2,174 per quintal) was same for both covered and plinth (CAP) and covered storage. A field survey conducted in Ludhiana and Bathinda districts of Punjab during the year 2022 identified low institutional credit availability as the major handicap. High transportation cost emerged as the main marketing constraint.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <b>Price behaviour and integration analysis</b> | <ul style="list-style-type: none"> <li>Price behaviour and integration across major wholesale and retail markets for rice and wheat in India were examined. Monthly data (July 2000 to June 2022) on prices viz. wholesale and retail were analysed using growth rate, instability index, seasonal price index, Bai-Perron's test for structural breaks, Johansen's test on cointegration, Granger causality test, and impulse response function. The findings indicated strong evidence of price dynamics in the selected markets in terms of spatial and temporal variation, clear-cut seasonality linked to production, and price divergence between wholesale and retail markets.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| <b>Analysis of farm credit in Punjab</b>        | <ul style="list-style-type: none"> <li>The study on "Agricultural credit in Punjab: trends and future potential" examined various aspects of agricultural credit in Punjab using primary and secondary data. The credit disbursement far outpaced the actual demand for agricultural credit. It caused a significant credit diversion towards house construction, immigration of family members, purchase of vehicles, expenditure on social ceremonies, etc. Changing consumption habits and rising incomes enhance the demand for processed products and increase the potential for credit expansion for agro-processing. Crop diversification efforts will also require a substantial allocation of institutional agricultural credit. Skill development, farm start-ups, FPOs, agro-machinery service centres, etc., can help expand institutional agricultural credit in Punjab.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                |



|                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|-----------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Land ownership and credit availability</b> | <ul style="list-style-type: none"> <li>A study was planned to analyse the benefits of clear land titles in accessing institutional credit, government schemes, overcoming of risks and uncertainties, improvement in net profits and other key variables. The survey covered 240 agricultural households, 120 each in groups of 'clear titles' and 'non-clear titles'. Farmers in the 'clear title group' were more experienced. Size of owned operational holding is larger in the 'clear titles' group, whereas leasing-in of land is more prevalent in the 'non-clear titles' group.</li> </ul>                                                                                                                                                                                                                                                                                                                                              |
| <b>Suicides by farmers</b>                    | <ul style="list-style-type: none"> <li>The study "Farmer suicides: causes and policy prescription in Punjab" was undertaken to analyse the causes leading to farmer suicides in Punjab and to recommend suitable policy interventions for engaging with the issue. Results suggested that total suicide rate in the state has shown an increasing trend since the year 2014, but has started ebbing after attaining a peak in the year 2017. Socio-economic profile of impacted houses looked bleak and was dominated by lack of education, disturbed marital relations, greater number of dependents, and absence of any support from extended family. Crop failure due to a variety of severe crop stresses and low yields attributed allegedly to poor quality inputs were other reasons. Credit repayment liability, unrealized expectations with respect to higher productivity or loan waiver relief aggravated mental stress.</li> </ul> |
| <b>Irrigation water pricing</b>               | <ul style="list-style-type: none"> <li>In a case study of Punjab state, cropping pattern optimization and volumetric water pricing were examined with respect to their impact on conserving natural resource base and enhancing farm income. Curtailing area under rice and taming groundwater depletion would remain remote possibility unless externalities of agricultural production, mainly the natural resource depletion, are internalized into the cost of production. Simulation of two possible alternatives for internalizing the externalities through two different volumetric water pricing policies gave a clear differential effect on water saving and the overall agricultural income in Punjab. The study suggested that direct and visible incentives are required to diversify the state's cropping pattern.</li> </ul>                                                                                                    |
| <b>Direct benefit transfer</b>                | <ul style="list-style-type: none"> <li>Results of the study titled, "Direct Benefit Transfer (DBT) Scheme in marketing of Farm Produce in Punjab: Performance and Perceptions" showed that about 70 % of the farmers had merely heard of and did not act to benefit themselves; whereas 22 per cent of the sampled farmers were scantily aware of the provisions of the scheme. About 68 % farmers had reported that they had received payment on an average after 10 days despite the provision of instant payment. However, the responses improved during the subsequent seasons.</li> </ul>                                                                                                                                                                                                                                                                                                                                                  |
| <b>Economics of farming</b>                   | <ul style="list-style-type: none"> <li>The university has been regularly conducting a study on "Economics of farming and the pattern of income and expenditure distribution among farmers in Punjab" for analysing the dynamics of landholding structure, cropping pattern, farm investment details, income and expenditure pattern, and their distribution among different categories of Punjab farms. For the year 2020-21, the average size of operational holding was 4.05 ha, out of which leased-in land formed 24.5 per cent and had direct relationship with the farm size.</li> </ul>                                                                                                                                                                                                                                                                                                                                                  |
| <b>Economics of paddy straw management</b>    | <ul style="list-style-type: none"> <li>A study aimed at evaluating impact of the Central Sector scheme for Promotion of Agricultural Mechanization (CSSPAM) on in situ paddy straw management in Punjab showed that 97 per cent of the farmers had wanted that scheme should prioritise on high powered tractors. More than 80 percent of the farmers cited inadequate availability of straw management machinery and skilled manpower for operating the machinery.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| <b>Woman entrepreneurship</b>                 | <ul style="list-style-type: none"> <li>A study aimed at assessing the status of establishments owned by women entrepreneurs in Punjab vis-a-vis India showed that the women-owned establishments formed 13.76 % of the total enterprise base at the national level, whereas at Punjab level, the corresponding share was 7.33%. Sangrur district had the highest number of rural women establishments (11.3%) whereas Jalandhar district had the highest (18.9%) women-owned urban enterprises.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                      |

## ENVIRONMENTAL STUDIES

### Water quality in Beas river

- Findings of the study suggested presence of coliforms and faecal coliforms in water flowing in Beas river, which renders it unfit for drinking. However, it can be used for irrigating agro-forestry plantations.

- Trace and nutrient elemental concentration was below the prescribed limits (World Health Organization and Bureau of Indian Standards).
- Some pathogens like urinary tract infection (UTI) bacteria, *Vibrio cholera*, *V. parahaemolyticus*, *Aeromonas hydrophilia*, *Salmonella typhi*, *Shigella* sp., *Listeria monocytogenes*, *Campylobacter jejuni* and *Staphylococcus aureus* have emerged as a major public health concern in water of the Beas river.

### Nanocomposites

- $\text{Mn}_3\text{O}_4$  and  $\text{MgFe}_2\text{O}_4$  nanoparticles and nanocomposites were synthesized using sol-gel and ultra-sonication methods. The  $\text{MgFe}_2\text{O}_4@ \text{Mn}_3\text{O}_4$  nanocomposite exhibited unique catalytic features and showed the best polyphenol oxidase (PPO) mimic activity among the synthesized materials.

### Chemosensors

- A chemosensor named TPC, based on thymol, was synthesized by reacting thymol and piperidine in methanol. TPC exhibited absorption at 277 nm, which increased by 2-fold and 1.5-fold in the presence of  $\text{Cu}^{2+}$  and  $\text{Pb}^{2+}$  ions, respectively. TPC showed no toxicity against tested plant growth-promoting rhizobacteria (PGPR) at all concentrations.
- An azomethine linkage-based synthesized chemosensor RM1 exhibited a colour change from colourless to light yellow in the presence of  $\text{Al}^{3+}$  ions in pure acetonitrile. UV-vis studies of RM1 revealed absorption bands at 278 nm and 347 nm, with the addition of  $\text{Al}^{3+}$  ions resulting in a new band at 412 nm.

### TECHNOLOGIES COMMERCIALISED

- During the report period, the university granted non-exclusive rights for 13 different technologies to 32 entrepreneurs.

### MEMORANDA OF UNDERSTANDING

To strengthen linkages with national and international institutions/organizations, PAU signed nine Memoranda of Understanding (MoU) during 2022-23.

### AWARDS AND HONOURS

- Punjab Agricultural University was adjudged the Best State Agricultural University and Third Best amongst Agricultural Universities and Institutes, under NIRF-2023 by NBA, Ministry of Education

(MOE), Government of India (GOI).

- The School of Organic Farming received the Best Centre Award (on-station) and the Best Centre Award (on-Farm) from ICAR- IIFSR, Modipuram, Meerut.
- Four scientists, namely, Dr Parveen Chhuneja (School of Agricultural Biotechnology), Dr Neena Singla (Zoology), Dr Kamal Vatta (Economics and Sociology), and Dr Sandeep Singh (Fruit Science) got international recognitions in their respective domains.

### EXTENSION

The University transfers new technologies to the farmers through various extension modes. During the period under report, some significant highlights are as follows:

- PAU organized seven *Kisan Melas* both during September 2022 and March 2023, besides organizing a Food Industry and Craft *Mela* in October 2022.
- The University organized 345 field days; 342 adaptive research trials; 135 on farm trials; 18907 cluster front line demonstrations; 3484 method demonstrations; 155 trainings (999 short, 207 vocational, 104 in-service and 52 sponsored); 459 exhibitions and four Research and Extension Specialists' Workshops for the benefit of farmers.
- The scientists of KVKs, FASCs of different districts and ATIC at PAU provided technical guidance to 72736 farmers. These included 37818 office visits, 22816 field visits and 72736 telephone contacts.
- Farmers were advised about best practices in cotton cultivation through the training camps, advertisements in the newspaper, WhatsApp, TV/ radio talks etc. Under the chairmanship of worthy Vice Chancellor meetings of Interstate Consultative Monitoring Committee for whitefly on cotton were also held.
- The Plant Clinic at ATIC, PAU, Ludhiana, KVKs and FASCs, advised 72736 farmers, and diagnosed 9723 samples.
- The Communication Centre published 12 issues each of monthly magazines *Progressive Farming* and *Changi Kheti* with a combined circulation of 1,66,100; revised editions of Package of Practices (twice a year of *Rabi* Crops and *Kharif* Crops); and



brought out 12 farm bulletins in English and 34 in Punjabi. In addition the Centre issued 1450 press releases (730 in English and 720 in Punjabi). It also organized 71 TV talks and 70 radio talks of PAU scientists and 54 episodes of PAU Live Programme (Facebook and YouTube). It also prepared six

documentaries and procured advertisements worth Rs 3,14,460/-.

## EDUCATION

The university offered nine undergraduate, 44 Masters', 29 Doctorate and two Diploma programmes.

## INFORMATION AND COMMUNICATION TOOLS (ICTs)

| ICT Technology                                                                                                                         | Total Number                           |
|----------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------|
| PAU <i>Kisan</i> App (Subscribers)                                                                                                     | 1,02,303                               |
| PAU Farm Inputs App (Subscribers)                                                                                                      | 4,730                                  |
| PAU Farm Machinery App (Subscribers)                                                                                                   | 2,988                                  |
| PAU Facebook (Followers)                                                                                                               | 56,436                                 |
| PAU Facebook Live/year (Programmes)                                                                                                    | 259 (reach 5 lakh in weekly programme) |
| PAU YouTube (Subscribers)                                                                                                              | 24,350                                 |
| PAU YouTube Live/Year (Programmes)                                                                                                     | 259 (reach 5 lakh in weekly programme) |
| PAU Twitter (Followers)                                                                                                                | 2,123                                  |
| Documentaries/Jingles                                                                                                                  | 773                                    |
| Farmers Portal on PAU Website (Views)                                                                                                  | 9,82,290                               |
| Digital Newspaper (Weekly) – <i>Kheti Sandesh</i>                                                                                      | 9,66,000 farmers                       |
| Weather Agro-advisory                                                                                                                  | About 9 lakh farmers                   |
| WhatsApp Groups by Communication Centre/all KVKs/FASCs (Farming Communities, Mushroom, Bee keeping, Dairy Farming, Home Science, etc.) | 900 (6592 messages sent)               |
| Toll Free / Missed Call Number<br>1800 180 5100                                                                                        | 5,200 farmers<br>(152 messages sent)   |
| PAU <i>Kisan Doots</i>                                                                                                                 | 7,295 (370 messages sent)              |
| KMASS                                                                                                                                  | 46496 farmers (143 messages sent)      |



# ANNUAL REPORT

2022-23

The Annual Report of  
**Punjab Agricultural University, Ludhiana**  
 for the year **2022-23**

**Authenticated**

Chandigarh, Dated

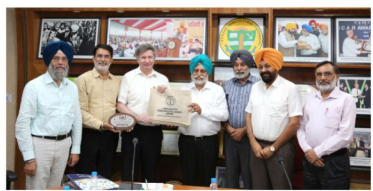
*[Handwritten Signature]*

Signature

ਖੇਤੀਬਾੜੀ ਤੇ ਕਿਸਾਨ ਭਲਾਈ, ਪਸ਼ੂ ਪਾਲਣਾ,  
 ਮੱਛੀ ਪਾਲਣਾ ਅਤੇ ਭੋਜਨੀ ਵਿਕਾਸ ਅਤੇ  
 ਫੁੱਡ ਪ੍ਰੋਸੈਸਿੰਗ ਮੰਤਰੀ, ਪੰਜਾਬ।

**S. Gurmeet Singh Khudian**

Hon'ble Agriculture Minister, Punjab





# **Punjab Agricultural University**

Ludhiana-141004 (Punjab) India Phone: +91-161-2401960-2401979

fax: +91-161-2400945 Website: [www.pau.edu](http://www.pau.edu)