Annual Report 2022

भा.कृ.अनु.प.–भारतीय बागवानी अनुसंधान संस्थान
हेसरघट्टा लेक पोस्ट, बेंगलूरू – ५६००८९

ICAR - Indian Institute of Horticultural Research
Hesaraghatta Lake Post, Bengaluru – 560089

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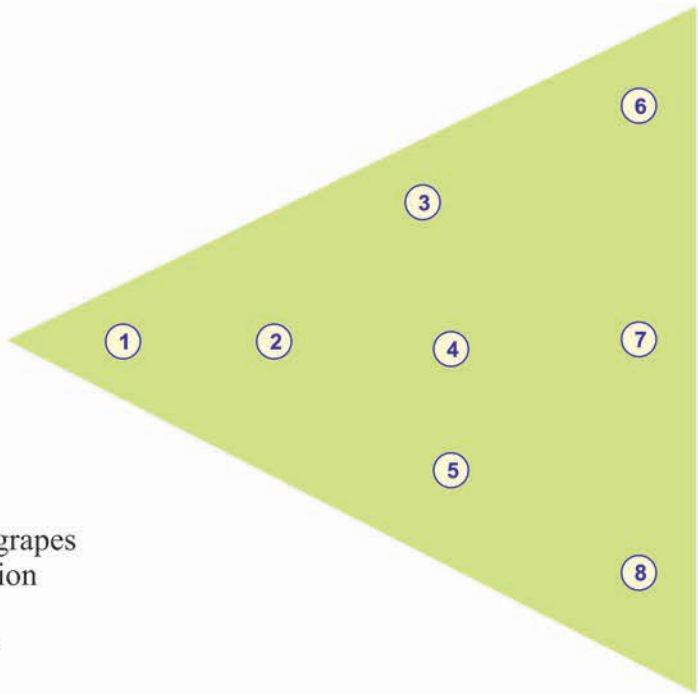

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Wild fruits of Coorg region

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Annual Report
2022

भाकृअनुप
ICAR

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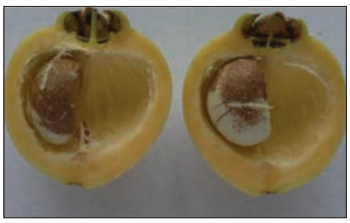
ICAR-IIHR

Varieties & Technologies Released by ICAR-IIHR during 2022




ARKA NEELACHAL AKSHAY


ARKA NEELACHAL YODHA

ARKA NEELACHAL BAINISHI


ARKA COORG RAVI


ARKA NEELACHAL RUCHITHA

ARKA ANIRUDH

ARKA DHAVAL

ARKA MANOHAR

ARKA NEELACHAL VRICHITHA

ARKA FLORAL AGARBATHI AND DHOOP

ARKA KAMALAM RTS BEVERAGE

Contents

PREFACE

The importance of horticultural crops, *viz.* fruits, vegetables, ornamentals, medicinal crops and mushrooms in improving the food, nutritional, health and livelihood security and country's economy has been well established. Growth and development in horticulture and allied sectors enabled us to achieve self-reliance in food security (estimated as 341.63 MT, 2022) with reasonable degree of resilience even in times of natural calamities.

The ICAR- Indian Institute of Horticultural Research (IIHR), Bengaluru, with its two regional stations at Bhubaneswar (Odisha) and Chettalli (Karnataka) has been in forefront in the horticultural research and development in the country, and conducting basic, strategic, anticipatory and applied research on various aspects of fruits, vegetable, ornamental, medicinal and aromatic plants and mushrooms. Over five decades of research, ICAR-IIHR has released more than 300 varieties and licensed technologies to various clients, thus paving the way for entrepreneurship in the field of horticulture. The impact of this can be seen in the North-Eastern region of the country, where seven states have adopted the Institute's vegetable varieties on a large scale.

During the current period (January-December, 2022), through the Institute Varieties & Technologies Identification Committee, nine promising varieties and four technologies were released. The varieties released were Arka Neelachal Akshay- rose apple (early maturing), Arka Coorg Ravi- avocado (high yield potential 150 to 200 kg/tree), Arka Neelachal Yodha- brinjal (good yield potential 45 to 50 t/ha) combined with high resistant to bacterial wilt disease), three Amaranthus varieties - Arka Neelachal Ruchitha (yield potential of 22.59 t/ha and resistant to white rust disease), Arka Neelachal Vrichitha (resistant to white rust disease having an yield potential of 7.08 t/ha), Arka Neelachal Bainishi (resistant to white rust disease having yield potential of 8.58 t/ha), and three Chrysanthemum varieties Arka Anirudh (early flowering 62.77 days), suitable for pot culture/bedding with resistance to white rust disease), Arka Dhaval (early flowering 69.17 days) and suitable for pot culture/bedding and Arka Manohar (early flowering (66.52 days) and suitable for pot culture, bedding). The improved technologies identified were Arka Microbial Sahishnu (a bacterial inoculant (*Bacillus amyloliquefaciens* strain P-72) suitable for tomato cultivation under deficit irrigation conditions), Arka Floral Agarbathi and Dhoop (plant-based bio-degradable and eco-friendly technology using floral wastes), Arka Vertical Growing System for Foliage Plants *Chlorophytum comosum, Sanseveria trifasciata, Syngonimum podophyllum* white and *Peperomia obtusifolia* and Arka Kamalam RTS beverage. Through the Central Varietal Release Committee (CVRC), one mango variety (Arka Neelachal Kesari), two chilli varieties (Arka Swetha & Arka Khyati), one brinjal variety (Arka Avinash) and one Teasel gourd variety (Arka Neelachal Shanti) were identified.

Further, through the Institute's Technology Management Unit, 33 technologies were licensed with exchange of MoUs on various aspects and three patents were also granted during this period. In Post Graduate education, ICAR-IIHR as an out-reach campus of IARI, New Delhi, offered 59 courses to the Ph.D. students

across various disciplines, while seven students were awarded their Ph.D. degrees. Adding to this, MoUs were signed with 11 universities and 7 students received M.Sc./Ph.D. degrees from other universities.

Under the outreach programme, the institute conducted 116 On and Off campus trainings and 224 Demonstrations (Field Demonstrations, On-Farm Trials, Front Line Demonstrations *etc*.). Under NEH, TSP, FFP and SCSP various programmes were conducted across the country for the benefit of horticultural farmers. Since the commencement of NEH programme, ICAR-IIHR varieties and technologies have spread across all NE states such as Assam, Manipur, Tripura, Meghalaya, Mizoram, Nagaland, Sikkim and Arunachal Pradesh covering about 4200 acres. More than 17 training programmes (on-campus and off-campus) on fruit, vegetable, flower crops, medicinal & aromatic plants, production and post-harvest technologies of fruits, kitchen gardening and mushroom cultivation *etc*., were organized in NEH regions in coordination with 15 KVKs and Department of Agriculture/ Horticulture. To increase the knowledge on latest horticulture production techniques, ICAR-IIHR along with KVKs and State Departments of Agriculture and Horticulture conducted 1020 demonstrations during 2022 with latest varieties and technologies developed by ICAR-IIHR, which has helped farmers in the NEH regions to increase productivity and quality of the diverse horticultural crops.

Among the prominent dignitaries, Hon'ble Union Minister for Agriculture and Farmers Welfare, Shri Narendra Singh Tomar ji visited the institute on 15th July, 2022 to inaugurate the Centre of Excellence for Protected Cultivation and Business Entrepreneurship and Start-up Support through Technology in Horticulture (BESST-HORT), a Technology Business Incubator of the Institute. Besides, Minister of Agriculture, Govt. of Uttar Pradesh, Shri Surya Pratap Shahi and Shri Manoj Ahuja, I.A.S, Secretary, Dept. of Agriculture & Farmers Welfare, GoI, New Delhi also visited the institute.

The scientists of the institute were bestowed with several prestigious national and international awards & recognitions, published over 170 research publications in peer-reviewed journals, besides over 180 other publications.

By recognizing the contributions of the ICAR-IIHR on various fronts, the Indian Council of Agricultural Research, New Delhi bestowed the institute with the top rank among all its 93 institutions for the year 2019-20 and 2020-21 (combined).

I place on record our sincere thanks to Dr Himanshu Pathak, Secretary (DARE) & Director General, ICAR and Dr Anand Kumar Singh, Deputy Director General (Horticultural Science), for their continued support, constant guidance and encouragements.

The institute is indebted to Chairmen and members of different nodal committees (QRT, RAC, IRC, IMC *etc*.) who have rendered their suggestions for the overall development of the institute. The institute is also thankful to all the central and state Govt. agencies which have provided assistance for undertaking different research and developmental activities.

I congratulate the Chairman and Members of the Publication Unit for bringing out this important publication within the stipulated time.

April, 2023

(Sanjay Kumar Singh)
Director, ICAR-IIHR

Introduction

Introduction

The ICAR-Indian Institute of Horticultural Research, an ISO 9001:2015 certified premier institute conducts basic, strategic, anticipatory and applied research on all aspects of fruits, vegetables, ornamentals, medicinal and aromatic plants and mushrooms. The Institute was the first horticultural research institute in the country established by the Indian Council of Agricultural Research (ICAR), New Delhi, on September 5, 1967, it was initially established at the ICAR headquarters at New Delhi, and subsequently shifted to Bengaluru in Karnataka on February 1, 1968. Dr. G.S. Randhawa was the founder Director, whose vision and dynamism helped the institute grow rapidly. The Institute took over the erstwhile National Hortorium of the Government of Karnataka, spread over an area of 24.7 ha at Hesaraghatta, and later on acquired an additional 238 ha of land from the surrounding village of Ivarkandapura. The Institute expanded the ambit of its research activities to the length and breadth of the country by establishing experimental stations at Lucknow, Nagpur, Ranchi, Godhra, Chettalli and Gonikoppal. Over the years, the experimental stations at Lucknow, Nagpur, Ranchi, and Godhra have grown in size and have attained the status of independent institutes. The ICAR-IIHR, Bengaluru has two Central Horticultural Experiment Stations located at Bhubaneswar in Odisha and Chettalli in Karnataka, and two Krishi Vigyan Kendras located at Gonikoppal and Hirehalli. The institute houses the Project Coordinating Unit of the ICAR-All India Coordinated Research Project on Fruits at its main campus.

Vision

Increasing research efforts to reorient and refine approaches for developing eco-friendly sustainable and widely adoptable technologies contributing towards increased food and nutritional security, quality and higher output, so that horticulture can become an enterprise and the farmer an entrepreneur.

Objectives

To address the food and nutritional security, the following objectives are envisaged:

- To serve as a national repository of horticultural crop germplasm and horticultural database
- To develop improved varieties/ hybrids through conventional breeding and through Marker Assisted Selection for biotic and abiotic stress tolerance in various horticultural crops
- Effective utilization of natural resources and enhancement of input use efficiency and plant health management
- Production of quality seed and planting material of horticultural crops
- Post-harvest management, value addition and horticultural waste utilization
- Dissemination of the technologies for improving on-farm production and productivity and to act as a specialized center for HRD in horticulture

Mandate

- Basic, strategic and applied research to enhance sustainable productivity, quality and utilization of horticultural crops
- Repository of horticultural genetic resources and scientific information
- Transfer of technology, capacity building and impact assessment of technologies
- Human resource development and education

Mission

To bring about improvement in fruit, vegetable, ornamental and medicinal crops through genetic manipulation, refinements in pre-and post-harvest technologies through precision horticulture, mechanization and other modern approaches.

Main Station, Hesaraghatta, Bengaluru

The main station is located at Hesaraghatta, 25 km north of Bengaluru city. The Institute houses laboratory complexes, experimental farms, administrative block and staff quarters located at the Hesaraghatta campus spread over 263 ha land. The Institute has also taken over 24 acres of land of IVRI at Yelahanka, Bengaluru, and about 2 acres in the UHS, Bengaluru campus. The experimental farm located at Hirehalli has a total area of 68 acres involved in breeder seed and foundation Seed production of ICAR-IIHR released vegetable varieties, and research work on fruit crops, particularly maintenance of jack fruit germplasm and a few flower crops in collaboration with ICAR-IIHR, Hesaraghatta, Bengaluru. In 2013, the station acquired an additional 26 acres of adjoining area for research purpose.

Growth

The physical growth of the Institute can be viewed in two phases. In the initial years up to 1990, wherein emphasis was laid on development of land and infrastructure. The blueprint of the entire farm area for carrying out experimental trials and laboratories for research and administrative office buildings was prepared. The entire arable land was divided into well-defined experimental blocks for carrying out field experiments and independent laboratory buildings for all the major scientific divisions. Currently, research activities are being carried out by eight divisions having state-of-the-art equipment like electron microscope, ultracentrifuge, LC-MS/ MS, GC-MS/MS, ICP-OES, HPLC, GLC, SFE, AAS, Rapid microbial identification systems, RT-PCR, *etc*., field facilities such as polyhouses, net houses, growth chambers, mist chambers, Gamma chamber, temperature gradient chambers and phenomics facility. Facilities like cold storage chambers, gene banks, seed processing, nursery units and communication channels like, local area network with video conferencing facilities, *etc*. are available. The Institute has also created cryopreservation facilities for long-term preservation of germplasm of various crops. A referral laboratory for food safety has been established in the year 2017, for analysis and certification of food contaminants in stakeholder's samples. Apart from this, the Institute houses an modern library, committee rooms, auditorium, food court, training hostel, bank, post office, dispensary, residential quarters and facilities for the students for research in Horticultural Sciences.

The main station at Hesaraghatta, Bengaluru, under the leadership of the Director, ICAR-IIHR, implements and monitors all the activities of the Institute. Considering the importance given to horticultural research and development in the country, ICAR-IIHR has the mandate to serve various stake-holders of the horticultural sector and for carrying out this mandate, the Institute has established various service-oriented units, namely, Prioritization, Monitoring and Evaluation Cell (PME); Institute Technology Management Unit (ITMU) and Consultancy and Processing Committee including Horti-business incubation facility; Agricultural Technology Information Centre (ATIC); Agricultural Knowledge Management Unit (AKMU); Regional Centre (South), of the ICAR-National Agricultural Education Accreditation Board (NAEAB); Vigilance Cell; P. G. Education, Publication Unit, Library and Women's Cell.

Central Horticultural Experiment Station (CHES), Chettalli, Kodagu, Karnataka

The Station was established in 1972 at Chettalli, with Citrus Experiment Sub-station at Gonikoppal. In the year 1992, the Citrus Experiment Sub-station at Gonikoppal was converted into a full-fledged KVK and all the research work along with the research laboratories of the erstwhile sub-station were shifted to Chettalli. The station occupies an area of 92 ha. The mandated crop of the center is Coorg mandarin with major emphasis on citrus dieback disease. The Station also works on underutilized fruit crops like, pummelo, avocado, mangosteen, *karonda*, rambutan *etc*. The Station has a well-developed nursery unit for production and distribution of true-to-the-type disease-free citrus and other planting materials and *Trichoderma* cultures. Transfer of Technology under the Tribal Sub-Plan project is also being taken up at this Station.

Central Horticultural Experiment Station (CHES), Bhubaneswar, Odisha

The station was established on November 6, 1992, to cater the research and developmental needs in horticulture for the tribal and coastal belts of Odisha and the adjoining region. Transfer of Technology in NEH region and Tribal Sub-Plan are also being taken up by the station. The station is spread over an area of 40 ha housing a full-fledged laboratory and office building and the experimental farm. It has strong unit for production of disease-free planting materials of fruit crops for benefit of the farmers of Eastern region of the country.

Krishi Vigyan Kendra (KVK), Hirehalli, Tumkuru, Karnataka

KVK, Hirehalli was sanctioned in the year 2009. Apart from the activities of a Krishi Vigyan Kendra, it has taken up activities of popularization of ICAR-IIHR developed technologies, production and distribution of seeds, planting material and technological products developed by ICAR-IIHR, Hesaraghatta, Bengaluru.

Krishi Vigyan Kendra (KVK), Gonikoppal, Kodagu, Karnataka

The KVK, situated in Kodagu district of Karnataka was established in the year 1954 by the Karnataka State Government as Citrus Research Station and was transferred to ICAR-IIHR, Bengaluru on February 1, 1972, under CHES, Chettalli, as Sub-station with the objective of investigating the nature and causes of citrus die-back disease in Kodagu and nearby areas till 1991. In 1992, the Citrus Research Sub-station was converted into a full-fledged KVK occupying an area of 17.5 ha.

ICAR-AICRP on Fruits

The institute houses the Project Coordinating Cell of All India Coordinated Research Project (AICRP) on Fruits. The AICRP on Tropical Fruits and Sub-Tropical Fruits were amalgamated and named as AICRP on Fruits

from August 21, 2013. The project has objective of collection, conservation and evaluation of germplasm, along with standardization of production technologies, *viz.*, rootstocks, population density, nutrition and water management and evolution of cost-effective, integrated insect pest and disease management practices under different agro-climatic conditions in citrus, banana, grapes, guava, litchi, jackfruit, mango, papaya and sapota. There are 23 centres throughout the country working on mango, 16 on guava, 13 on banana, 12 on citrus, 9 on papaya, 8 each on litchi and grapes, 5 on jackfruit, 4 on sapota. At present, there are 50 centres, including 30 SAU based centres, 14 ICAR-Institute-based centres, four CAU-based centre and one private unit and one under the Government of Arunachal Pradesh.

Accomplishments of ICAR-IIHR

The main research program of the institute in the initial years revolved around the improvement of the productivity by evolving high yielding varieties/ hybrids in fruits, vegetables, ornamentals, medicinal and aromatic plants and the development of advanced production technologies for yield enhancement. With the emergence of new challenges in horticulture, emphasis was later shifted to breeding hybrids/varieties for biotic and abiotic stresses, developing integrated water and nutrient management protocols, pests and disease management technologies, efficient post-harvest management practices and conducting frontier research in the areas like hi-tech horticulture, precision farming, information technology and biotechnological interventions.

There are 23 major Institute projects covering the above thematic areas in tropical horticultural crops. The institute conducts research on 54 major horticultural crops. ARKA^{R} is the trade mark of the varieties and technologies developed by ICAR-IIHR. Varieties and technologies developed are commercialized to encourage entrepreneurship. Entrepreneurship development through incubation of technologies and hand holding is done through BESST-HORT and Agri. Business Incubation (ABI) of the institute.

The institute has developed over 328 high yielding and disease resistant varieties and hybrids of fruits, vegetables, flowers, medicinal plants and mushrooms and the refined production technology for these crops including those for high density planting in fruit crops and organic and protected cultivation practices for vegetables. More than 136 technology products have already been commercialised. Notably, 102 of the institute's technologies have been picked up by around 560 licensees on non-exclusive basis through more than a thousand licences. The institute has also successfully linked biodiversity with livelihood security by identifying farmers as custodian of genetic diversity in perennial fruit crops.

The institute has been placing great emphasis on the promotion of entrepreneurship through horticultural technologies and at present there are three Technology Business Incubators (TBIs) in operation at the institute to hand hold and promote horticultural entrepreneurship. A recent first of its kind in the country is the starting of an online portal for the sale of the seeds of the institute releases varieties and hybrids, which has been well received by the public. Currently, ICAR- IIHR vegetable varieties including F_1 hybrids are being multiplied through 40 seed villages.

The institute has 154 scientific and 226 technical staff working on 54 horticultural crops. It has state-of-the-art laboratories including plant phonemics facilities, experimental and demonstration fields, poly-houses, modern library facilities and repository for horticultural germplasm with more than twelve thousand genotypes conserved. The institute has facilities for meetings and interactions with various stakeholders involved. It houses the project coordination cell of the ICAR-All-India Coordinated Research Project on Fruits and is actively involved with other AICRP on Arid Zone Fruits, Flowers, Medicinal plants and Vegetables for nationwide involvement in horticultural research and development. It has international linkages with World Vegetable Center (earlier Asian Vegetable Research and Development Centre), Taiwan and Bioversity International.

The facilities and sophisticated instruments besides being used for advanced research are also employed for rendering services and are accessible for other research agencies. Services of NABL Accredited National Food Referral Lab & Pesticide Residue Lab, DNA finger printing of varieties, disease-free certification of plant material, leaf, soil and water analysis, contract research and consultancy services for horticultural research and development are available. It serves as a DUS testing centre for varietal protection of horticultural crops.

Technology products and publications are made available through the Agriculture Technology Information Center (ATIC) that serves the role of providing solutions to farmer's problems through appropriate interventions. Production and supply of quality planting material and seed are taken up by the nursery and seed production units of the institute. Farmers can get the truthfully labeled seeds at their doorstep using IIHR Seed Portal linked with the SBI YONO app.

On the educational front the institute has been functioning as an Outreach Campus of Indian Agriculture Research Institute, New Delhi since 2014. This campus is equipped with smart class rooms, centralized facilities for the students' research. ICAR-IIHR has Memorandums of Understanding with more than 50 institutions for research, education and training.

Transfer of the technologies and varieties and their popularization is efficiently and effectively attempted through demonstrations in different agro-climatic regions of the country with the help of Krishi Vigyan Kendra's, National Horticultural Fairs, publications and the mobile app ARKA Bhagwani. These have helped in disseminating the research outputs to various parts of the country and the economic impact of the predominant 15 among them alone is estimated at more than Rs. 30,000 crore annually. The institute has received "ISO 9001:2015", certification for its activities. The institute continues to strive for excellence in horticultural research with an aim at boosting farm incomes and making horticulture an enterprise. With numerous inventions and contribution IIHR has emerged as one of the premier institutes in Horticulture with a commitment for betterment and furtherance of its mandate by harnessing the potential of latest scientific advancements.

The Institute had been adjudged as "The Best Institute" by Indian Council of Agricultural Research, New Delhi with the Sardar Patel Best Institute Award twice during 1999 and again in 2010. More recently, by recognizing the contributions of the ICAR-IIHR on various fronts, the Indian Council of Agricultural Research, New Delhi bestowed the institute with Top Rank among all its 93 institutions for the year 2019-20 and 2020-21 (combined).

* * * * * *

STAFF POSITION OF ICAR-IIHR AS ON DECEMBER 2022

Sl. No.	Category	Sanctioned	In-position	Vacant
1.	Scientific	153+1*	134+1*	19
2.	Technical	226	125	101
3.	Administration	96	49	47
4.	SSS	94	37	57
	Total	569+1*	345+1*	224

***Director**

UNIFIED BUDGET ALLOCATION 2022-23 (BE)

Rs. (Lakhs)

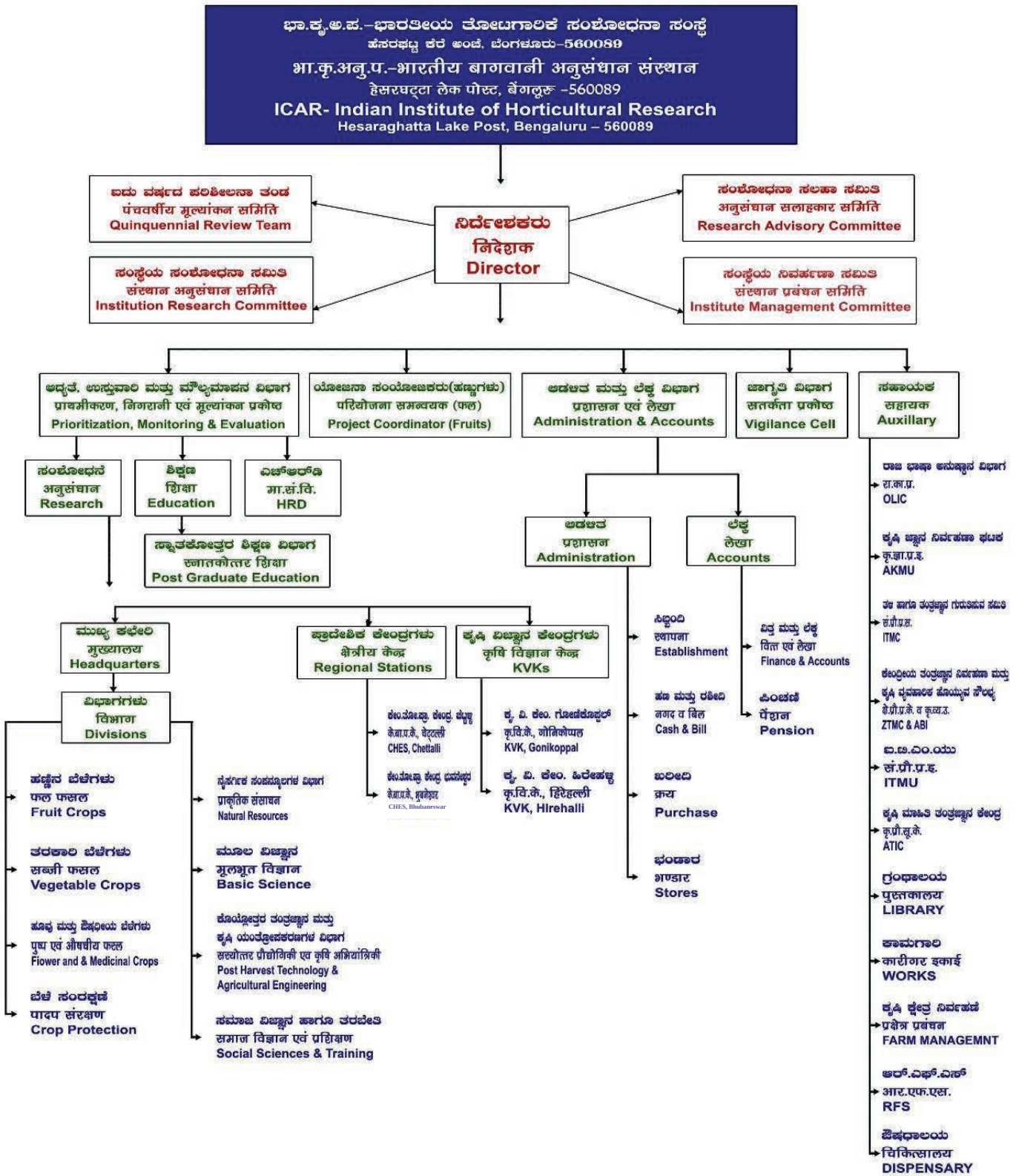
Sl.No.	Head	Other than NEH & TSP	NEH	TSP	SCSP	Grand Total
1	**2**	**3**	**4**	**5**	**6**	**7(3+4+5+6)**
1	Capital for creation of Capital Assets	285.00	0.00	0.00	0.00	285.00
2	Grant in Aid-Salaries	6500.00	0.00	0.00	0.00	6500.00
3	Grants in Aid-General					
	Pension & other retirement benefits	4500.00	0.00	0.00	0.00	4500.00
	Travelling allowance	20.00	0.00	0.00	0.00	20.00
	Research & Operational expenses	675.00	140.00	150.00	150.00	1115.00
	Administrative expenses	535.00	0.00	0.00	0.00	535.00
	Miscellaneous expenses	20.00	0.00	0.00	0.00	20.00
	Grand Total	12535.00	140.00	150.00	150.00	12975.00

EXPENDITURE UPTO DECEMBER 2022 (UNIFIED BUDGET)

Rs. (Lakhs)

Sl.No.	Head	Other than NEH & TSP	NEH	TSP	SCSP	Grand Total
1	**2**	**3**	**4**	**5**	**6**	**7(3+4+5+6)**
1	Capital for creation of Capital Assets	115.00	0.00	0.00	0.00	115.00
2	Grant in Aid-Salaries	5315.40	0.00	0.00	0.00	5315.40
3	Grants in Aid-General					
	Pension & other retirement benefits	3777.82	0.00	0.00	0.00	3777.82
	Travelling allowance	20.00	0.00	0.00	0.00	20.00
	Research & Operational expenses	670.00	80.50	101.61	112.07	964.18
	Administrative expenses	480.00	0.00	0.00	0.00	480.00
	Miscellaneous expenses	19.50	0.00	0.00	0.00	19.50
	Grand Total	10397.72	80.50	101.61	112.07	10691.90

ORGANOGRAM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ಐದು ವರ್ಷದ ಪರಿಶೀಲನಾ ತಂಡ
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Auxillary
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HRD
ಸ್ನಾತಕೋತ್ತರ ಶಿಕ್ಷಣ ವಿಭಾಗ
स्नातकोत्तर शिक्षा
Post Graduate Education
ಆಡಳಿತ
प्रशासन
Administration
ಲೆಕ್ಕ
लेखा
Accounts
ಮುಖ್ಯ ಕಛೇರಿ
मुख्यालय
Headquarters
ಪ್ರಾದೇಶಿಕ ಕೇಂದ್ರಗಳು
क्षेत्रीय केन्द्र
Regional Stations
ಕೃಷಿ ವಿಜ್ಞಾನ ಕೇಂದ್ರಗಳು
कृषि विज्ञान केन्द्र
KVKs
ವಿಭಾಗಗಳು
विभाग
Divisions
ಸಿಬ್ಬಂದಿ
स्थापना
Establishment
ಹಣ ಮತ್ತು ರಶೀದಿ
नगद व बिल
Cash & Bill
ಖರೀದಿ
क्रय
Purchase
ಭಂಡಾರ
भण्डार
Stores
ವಿತ್ತ ಮತ್ತು ಲೆಕ್ಕ
वित्त एवं लेखा
Finance & Accounts
ಪಿಂಚಣಿ
पेंशन
Pension
ಹಣ್ಣಿನ ಬೆಳೆಗಳು
फल फसल
Fruit Crops
ತರಕಾರಿ ಬೆಳೆಗಳು
सब्जी फसल
Vegetable Crops
ಹೂವು ಮತ್ತು ಔಷಧೀಯ ಬೆಳೆಗಳು
पुष्प एवं औषधीय फसल
Flower and & Medicinal Crops
ಬೆಳೆ ಸಂರಕ್ಷಣೆ
पादप संरक्षण
Crop Protection
ನೈಸರ್ಗಿಕ ಸಂಪನ್ಮೂಲಗಳ ವಿಭಾಗ
प्राकृतिक संसाधन
Natural Resources
ಮೂಲ ವಿಜ್ಞಾನ
मूलभूत विज्ञान
Basic Science
ಕೊಯ್ಲೋತ್ತರ ತಂತ್ರಜ್ಞಾನ ಮತ್ತು ಕೃಷಿ ಯಂತ್ರೋಪಕರಣಗಳ ವಿಭಾಗ
सस्योत्तर प्रौद्योगिकी एवं कृषि अभियांत्रिकी
Post Harvest Technology & Agricultural Engineering
ಸಮಾಜ ವಿಜ್ಞಾನ ಹಾಗೂ ತರಬೇತಿ
समाज विज्ञान एवं प्रशिक्षण
Social Sciences & Training
ಕೇಂ.ತೋಪ್ರ. ಕೇಂದ್ರ, ಚೆಟ್ಟಳ್ಳಿ
के.बा.प.के., चेट्टल्ली
CHES, Chettalli
ಕೇಂತೋಪ್ರ ಕೇಂದ್ರ ಭುವನೇಶ್ವರ
के.बा.प.के., भुवनेश्वर
CHES, Bhubaneswar
ಕೃ. ವಿ. ಕೇಂ. ಗೋನಿಕೊಪ್ಪಲ್
कृ.वि.के., गोनिकोप्पल
KVK, Gonikoppal
ಕೃ. ವಿ. ಕೇಂ. ಹಿರೇಹಳ್ಳಿ
कृ.वि.के., हिरेहल्ली
KVK, Hirehalli
ಐ.ಟಿ.ಎಂ.ಯು
सं.प्रौ.प्र.इ.
ITMU
ಕೃಷಿ ಮಾಹಿತಿ ತಂತ್ರಜ್ಞಾನ ಕೇಂದ್ರ
कृ.प्रौ.सू.के.
ATIC
ಗ್ರಂಥಾಲಯ
पुस्तकालय
LIBRARY
ಕಾಮಗಾರಿ
कारीगर इकाई
WORKS
ಕೃಷಿ ಕ್ಷೇತ್ರ ನಿರ್ವಹಣೆ
प्रक्षेत्र प्रबंधन
FARM MANAGEMNT
ಆರ್.ಎಫ್.ಎಸ್
आर.एफ.एस.
RFS
ಔಷಧಾಲಯ
चिकित्सालय
DISPENSARY
ರಾಜ ಭಾಷಾ ಅನುಷ್ಠಾನ ವಿಭಾಗ
रा.का.प.
OLIC
ಕೃಷಿ ಜ್ಞಾನ ನಿರ್ವಹಣಾ ಘಟಕ
कृ.ज्ञा.प.इ.
AKMU
ತಂತ್ರಜ್ಞಾನ ಗುರುತಿಸುವ ಸಮಿತಿ
सं.प्रौ.प.स.
ITMC
ಕೇಂದ್ರೀಯ ತಂತ್ರಜ್ಞಾನ ನಿರ್ವಹಣಾ ಮತ್ತು ಕೃಷಿ ವ್ಯವಹಾರಿಕ ಕೌಶಲ್ಯ ಸೌಲಭ್ಯ
के.प्रौ.प्र.के. व कृ.व्य.उ.
ZTMC & ABI

2. विशिष्ट सारांश

इस अध्याय में वर्ष 2022 के दौरान भा.कृ.अनु.प.–भारतीय बागवानी अनुसंधान संस्थान, बेंगलूरु की विशिष्ट उपलब्धियों को दर्शाया गया है।

फसल आनुवंशिक संसाधन

भा.कृ.अनु.प.–भारतीय बागवानी अनुसंधान संस्थान, बेंगलूरु को राष्ट्रीय सक्रिय जननद्रव्य स्थल द्वारा देश में कई बागवानी पौधों के आनुवंशिक संसाधनों के प्रबंधन के लिए नोडल केंद्र के रूप में मान्यता प्राप्त है। इस वर्ष के दौरान कुल 1,042 जननद्रव्य एकत्रित किए गए। कुल 12,564 जननक्षम जननद्रव्यों में, फलों के 1,988, सब्जियों के 9,553, फूलों के 848, औषधीय फसलों के 80 और मशरूम के 95 जननद्रव्य शामिल हैं। कुल 1,854 जननद्रव्यों में से, फलों के 323, सब्जियों के 1,347, फूलों के 177 तथा औषधीय फसलों के 7 जननद्रव्यों का लक्षण वर्णन किया गया। अमरूद और पपीते की चार जंगली प्रजातियों, पश्चिमी घाट के 25 खाने योग्य फलों, डाउनी/पाउडरी फफूंदी के प्रति सहनशील 10 वंशक्रमों, अनार के 213 यूएसडीए संग्रहों और जामुन के 109 जीनोटाइपों को प्रक्षेत्र जीन बैंक में संरक्षित किया गया। सब्जियों में कुल 915 जननद्रव्यों को एकत्रित किया गया, 1347 का लक्षण वर्णन किया गया और 12 को राष्ट्रीय पादप आनुवंशिक संसाधन ब्यूरो, नई दिल्ली में पंजीकृत किया गया। संस्थान ने फूलों और औषधीय फसलों के 848 जननद्रव्यों को भी एकत्रित किया है, जिनमें से 177 का लक्षण वर्णन किया गया और 4 जननद्रव्य राष्ट्रीय पादप आनुवंशिक संसाधन ब्यूरो, नई दिल्ली में पंजीकृत हैं। भा.कृ.अनु.प.– भारतीय बागवानी अनुसंधान संस्थान में कुल 249 फलों का संरक्षण किया जा रहा है, जिनमें अल्प–प्रचलित फल भी शामिल हैं। एवोकाडो एक्सेशन–22 उच्च औसत फल–वजन, गूदे की मात्रा, छिलके की मोटाई, टीएसएस, वसा की मात्रा और उपज सहित विशेष गुण वाला पाया गया।

सब्जियों में, विश्व सब्जी केन्द्र, ताइवान से बैंगन, मिर्च और शिमला मिर्च के चार विदेशी संग्रह एकत्रित किए गए; प्रजनन–पूर्व वंशक्रमों को विकसित करने के लिए *टेट्राफिलस* के छह जंगली एक्सेशनों, जैसे *एबेलमोस्कस केइली, ए. एंगुलोसस* किस्म *ग्रेडिफ्लोरस, ए. मेजोरेंसिस, ए. ट्यूबरकुलैटस, ए. मोस्चैटस* और *ए. टेट्राफिलस* का रखरखाव और उपयोग किया जा रहा है। चित्रदुर्गा, कर्नाटक से एकत्रित किया गया प्याज का वंशक्रम एलएसआर/18/37 एक्सेशन प्याज में संक्रमित होने वाले एन्थ्रेक्नोज के विरुद्ध अत्यधिक प्रतिरोधी पाया गया।

फूलों में, गुलाब के 326, गेंदे के 75, रजनीगंधा के 40, ग्लेडियोलस के 84, गुलदाउदी के 122 और चाइना एस्टर के 28 जननद्रव्यों को संरक्षित किया गया है तथा चाइना एस्टर के 37 वंशक्रमों को आईसी नंबर मिला है। औषधीय फसलों में, *एक्लिप्टा अल्बा* के 155, *बाकोपा मोनिएरी* के 82, *म्यूकुना प्रूरिएंस* के 85, *कोलियस फोरस्कोहली* के 45, *एंड्रोग्राफिस पैनिकुलेटा* के 54, *एलोवेरा* के 37, *सेंटेला एशियाटिका* के 27, *गिम्नेमा सिल्वेस्ट्रे* के 53 और *पाइपर बीटल* के 109 जननद्रव्यों को प्रक्षेत्र जीन बैंक में संरक्षित किया गया।

संग्रहीत जननद्रव्यों का लक्षण वर्णन भी किया गया। सब्जियों में, बैंगन के जननद्रव्य आईसी–362395 का, उपज की दृष्टि से बेहतर प्रदर्शन रहा; मिर्च के एक्सेशन एवीपीपी 1609–085, एवीपीपी 2003 और एवीपीपी 2007 उपज की दृष्टि से बेहतर पाए गए। भिण्डी के एक्सेशन आईआईएचआर–1676 में येलो वेन मोजेक विषाणु का संक्रमण हुए बिना, उच्च उपज दर्ज हुई; तरबूज के एक्सेशन आईआईएचआर–82 में गोदार्ति तना झुलसा के विरुद्ध 100 प्रतिशत पौधों का बचाव देखा गया; करेले के एक्सेशन आईआईएचएआर–26 और आईआईएचएआर–88 में फल मक्खी का कोई संक्रमण नहीं देखा गया। तुरई की प्रजाति आईआईएचएआर–45 ने उच्चतम उपज दर्ज की, जबकि, एक्सेशन आईआईएचआर–35, आईआईएचआर–37, आईआईएचआर–101,आईआईएचआर–114 और आईआईएचआर–147 टीओएलसीएनडीवि (VI=1 के साथ), और आईआईएच आर–डीएमआर–18–65–2 और आईआईएचआर–209 (गिल्की) फल मक्खी के प्रकोप के विरुद्ध प्रतिरोधी पाए गए; फ्रेंच बीन एक्सेशन आईआइएचआर–31 और आईआइएचआर–79 ने रतुआ रोग के प्रति उच्च स्तर की सहनशीलता दिखाई। मटर के एक्सेशन आईआईएच आर–13–10, आईआईएचआर–13–6, आईआईएचआर– 13–7, आई आईएचआर–13–22, आईआईएचआर–13–26, आईआईएचआर–132, चूर्णिल आसिता के प्रति सहनशील थे; कड़ी पत्ते के नौ एक्सेशनों में तीव्र सुवास था और एक्सेशन बीआरआर 18/5 और एलएसआर 18/9 कैल्शियम से भरपूर थे और एलएसआर/18/06 में लौह प्रचुर मात्रा में थे; सहजन के एक्सेशन आईआइएचआर–डी–134(41–84 टन/हे.), आईआइएचआर–डी– 137(37–39 टन/हे.) ने उच्च उपज दर्ज की; गाजर का एक्सेशन 88 मूलगाँठ सूत्रकृमि के विरुद्ध अत्यधिक प्रतिरोधी पाया गया। करेले का वंशक्रम आईआईएचआर–144–1 (आईएनजीआर 22161) और गुलदाउदी वंशक्रम आईआईएचआर–4–8(22182), आईआईएचआर–2–16 (22180) और आईआईएचआर–2–13 (22181) को उनके अद्वितीय गुणों के कारण भा.कृ.अनु.प.–राष्ट्रीय पादप आनुवंशिक संसाधन ब्यूरो, नई दिल्ली में पंजीकृत किया गया है।

गुलाब का जननद्रव्य *नॉक आउट* काला धब्बा रोग का प्रतिरक्षी पाया गया, जबकि *केयरफ्री ब्यूटी* एवं *क्रिफ्टी ज्यूटी* इसके प्रति अत्यधिक प्रतिरोधी पाए गए; गेंदे के जीनोटाइप अर्का मधु, पूसा अर्पिता, आईसी–250–332, आईसी–250–323 *आल्टरनेरिया* ब्लाइट रोग के मध्यम प्रतिरोधी पाए गए। औषधीय फसलों में, गुड़मार एक्सेशन आईआईएचआर–जीएस–18 और आईआईएचआर–जीएस–42 में पर्ण क्षेत्र अधिक था; ब्रह्मी के जननद्रव्य आईआईएचआर बीएम 23, आईआईएचआर बीएम 18, आईआईएचआर बीएम 16 और आईसी 324777 वृद्धि और उपज की दृष्टि से वांछनीय पाए गए।

फसल सुधार

अमरूद की 40 अंतरजातीय संकर संततियां सूत्रकृमि (*मेलोइडोगाइन इन्कोग्निटा*) और झुलसा (*फ्यूज़ेरियम ऑक्सीस्पोरम* जाति *साईडी*) के प्रतिरोधी पाई गईं; स्व–फलदार पौधों के विकास के लिए *ए. स्क्वैमोसा* प्रजाति बालानगर (बीसी$_1$एफ$_1$) के साथ अर्का सहन का पश्च–संकरण किया गया; पपीते की प्रजाति अर्का प्रभात में डबल हैप्लोइड को शामिल करने के लिए बीजांड के अनिषेक जनन हेतु *इन विट्रो* मार्ग का उपयोग किया गया; अनार में *नोडल ब्लाइट* के प्रतिरोध के लिए परिवर्तनशीलता पैदा करने हेतु उत्परिवर्तन प्रजनन शुरू किया गया; एवोकैडो वंशक्रम आईसी 0626510 फल–गुणवत्ता संबंधी लक्षणों की दृष्टि से आशाजनक पाया गया। केंद्रीय बागवानी परीक्षण केंद्र,

भुवनेश्वर में, इमली का जननद्रव्य सीएचईएस–बी–टीएम–3 (आईसी–639464) ने फली वजन, गूदे की मात्रा, रेशे की मात्रा, टीएसएस, अम्लता, टीएसएस एसिड अनुपात और शक्कर की मात्रा की दृष्टि से बेहतर गुणवत्ता–लक्षण दिखाए।

सब्जियों में, 21 सहनशील बीसी$_1$एफ$_2$ टमाटर संततियों, जो *ट्यूटा एब्सोल्यूटा* के प्रति प्रतिरोधक क्षमता रखती है तथा 88 एफ$_3$ वंशावलियों, जो पर्ण रोगों और फलों के फटने के कारण कम पतझड़ दर्शाती है, का चयन किया गया। अर्का अविनाश, जो उच्च उपज देने वाली एवं जीवाणु झुलसा का प्रतिरोधी बैंगन की किस्म है, को राजपत्र में अधिसूचित किया गया, और आईआइएचआर–104 χ अर्का केशव–2–5, आईआइएचआर–104 χ अर्का नीलकण्ठ–4–3 और आईआईएच आर–586 χ अर्का निधि–1–5 से चयनित पौधे उपज और जीवाणु झुलसा के प्रतिरोध के लिहाज से आशाजनक पाए गए। मिर्च की दो उच्च उपज वाले संकर अर्का श्वेता और अर्का ख्याति को राजपत्र में अधिसूचित किया गया था, और एफ$_1$ संकर एलसीवीएच 24, एलसीवीएच25, एलसीवीएच26, एलसीवीएच29, एलसीवीएच43 और अर्का गगन फाइटोफ्थोरा जड़–गलन के प्रति प्रतिरोधी पाए गए। भिंडी की उन्नत प्रजनन वंशावलियाँ, अर्थात आईआईएचआर– 385–11–5, आईआईएचआर–386–1–1–26 और आरआईएल–1 (आईआईएचआर–285–1 χ एसी–1685 एफ$_7$) येलो वेन मोजेक विषाणु से मुक्त थीं। अखिल भारतीय समन्वित सब्जी फसल अनुसंधान परियोजना की 40वीं वार्षिक समूह बैठक के दौरान खरीफ और रबी के लिए बेल वाली सेमफली की किस्म अर्का प्रधान की सिफारिश की गई। उच्च उपज, हरी लंबी रेशा–रहित फली, उच्च पोषक तत्व और अमीनो एसिड वाली ग्वार फली की वंशावली आईआईएचआरसीबी 22–1–1 में को संस्थान प्रौद्योगिकी प्रबंधन समिति द्वारा जारी करने के लिए पहचान की गई है। तुरई की अंतःप्रजनित प्रजाति आईआईएचआर आरवी–23–4 को फलों की लंबाई और उपज की दृष्टि से बेहतर पाया गया। करेले की प्रजाति आईआईएचआर–148–6, आईआईएचआर 148–10, आईआईएचआर आईपी–19–142–2 और आईआईएचआर–184–4 उपज की दृष्टि से आशाजनक पाई गईं, जबकि आईआईएचआर–आईपी–पीडीजीवाई–3 चूर्णिल आसिता का प्रतिरोधी पाया गया। कद्दू बटरनट वंशक्रम बीएन–8–2, बीएन–2–3–1 और बीएन–23 में उच्च उपज क्षमता थी। छप्पन कद्दू (*बुश स्क्वैश*) एसएआरवाय–4 χ एसक्यु–14 और एसक्यु–14 χ एसक्युजीएल–2 में प्रति पौधे में फलों की संख्या और उपज अधिक दर्ज हुई। पेठे के उन्नत प्रजनन वंशक्रम एजी–6–7–1–28–10, एजी–27–1–20, एजी–3–54–39–55 और एजी–1–52–15–25 में उच्च फल उपज दर्ज हुई। बेहतर ताजी पत्तियों की उपज के आधार पर कड़ी पत्ते की कुल 18 अग्रिम प्रजनन वंशावलियों का चयन किया गया।

गुलाब के वंशक्रम आईआईएचआरआर 9–13, आईआईएचआरआर 4–15–12 एवं आईआईएचआरआर 4–4–2 भू–दृश्य–निर्माण के लिए उपयुक्त थे, आईआइएचआरपी–7 एंथोसायनिन और प्रतिऑक्सीकारक से भरपूर था, आईआईएचआरआर 3–7–12 और अर्का निशिकांत काला धब्बा रोग के प्रतिरोधी थे। फ्रेंच गेंदा के वंशक्रम आईआईएचआर–एफएम–13 और आईआईएचआर–एफएम–411 फूलदार थे। रजनीगंधा का वंशक्रम आईआईएचआर 17 23 एसपी 08 की पहचान अर्का कीर्ति के नाम से जारी करने के लिए की गई, जो माला बनाने, उच्च उपज तथा जड़गाँठ सूत्रकृमि और *आल्टरनेरिया* पर्ण अंगमारी के प्रति प्रक्षेत्र प्रतिरोध के लिहाज से आशाजनक था। ग्लेडियोलस में उन्नत प्रजनन वंशक्रम अर्थात् आईआई एचआर–15–1–99, आईआईएचआर–15–1–48 और आईआई एचआर–15–1–212 की पहचान कर्तित फूल के उद्देश्य के लिए की गई। संकर चयन अर्थात, 15–1–99, 15–5–180, 15–5–247 और 15–1–35 *फ्यूजेरियम* झुलसा रोग के प्रति अत्यधिक प्रतिरोधी पाए गए।

संस्थान प्रौद्योगिकी प्रबंधन समिति द्वारा गमले में उगाने और संस्तरण (*बेडिंग*) के उद्देश्य से गुलदाउदी के तीन वंशक्रमों, आईआईएचआर 4–8, आईआईएचआर 2–16 और आईआईएचआर 2–13 की क्रमशः अर्का अनिरुद्ध, अर्का धवल और अर्का मनोहर के रूप में जारी करने के लिए पहचान की गई; और जीनोटाइप अर्का पिंक स्टार, गेंदा, पूसा अनमोल और अजय ने प्रकाश–असंवेदनशील प्रतिक्रिया दिखाई। चाइना एस्टर में, कर्तित फूल के लिहाज से 9 वंशक्रम और संस्तरण एवं गमले में उगाने के लिहाज से 10 वंशक्रम आशाजनक पाए गए। जरबेरा वंशक्रम एवी–35, एवी–47, एवी–21, वाई–10 और एवी–53 संरक्षित खेती की दृष्टि से आशाजनक पाए गए, जबकि, रेड डबल और पिंक डबल की पहचान खुले रूप से उगाने के लिए की गई। आबोली उत्परिवर्ती 2 का चयन मध्यम आकार के फूलों, उच्च उपज और अधिक निधानी आयु के गुणों के लिए किया गया, जबकि उत्परिवर्ती 3 का चयन गमले में उगाने के लिए किया गया। *सेंटेला एशियाटिका* पॉलीप्लोइड जीनोटाइप आईआई एचआर–सीए–28 ने उच्च औसत ताजा बायोमास उपज दर्ज की। विशिष्ट कालमेघ चयनों, जैसे एपी चयन 3 और चयन 1 और चयन 2 में पत्ती एण्ड्रोग्राफोलाइड की मात्रा अधिक पाई गई। भृंगराज चयन 43 में शुष्क बायोमास और वेडेलोलैक्टोन की मात्रा अधिक थी।

फसल उत्पादन

आम में बहुभ्रूणता अध्ययनों से पता चला है कि परागोद्भव के 9 से 12 दिनों के दौरान प्रबल बीजांड भ्रूणों द्वारा बहुभ्रूणीय गिरी की भ्रूण–थैली में युग्मज भ्रूण वृद्धि को दबा दिया गया; पर्ण वाष्पशील प्रोफाइल युग्मज और बीजांड पौधों को अलग करने के लिए एक प्रभावी बायोमार्कर है; पुष्पगुच्छ के प्रारंभिक, फलों के विकास की मटर एवं गोली की अवस्था में ट्राईकॉन्टानॉल (3–5 पीपीएम) के छिड़काव से पुष्पगुच्छ के आकार, फल–प्रतिधारण, उपज और फल की गुणवत्ता में सुधार हुआ। अमरूद की किस्म अर्का किरण में, सघन रोपण के तहत फलों और छंटाई की गई सामग्रियों ने प्रति पेड़ अधिक पोषक तत्वों का नुक़सान किया। वानस्पतिक और प्रजनन दोनों चरणों के दौरान 60% वाष्पन पुनःपूर्ति सहित ड्रिप सिंचाई ने उच्च लाभ–लागत अनुपात (3.63) दर्ज किया। जीए$_3$ (200 पीपीएम) का छिड़काव किए गए सीताफल के पौधों में सर्वाधिक फल उपज दर्ज की गई। अमरूद के गूटी बँधे पौधों में गर्मी और बरसात के मौसम की फसलों में बेहतर पौधों की ऊंचाई, छत्र–फैलाव एवं प्ररोहों की संख्या और उत्पादकता दर्ज हुई। कमलम में, *सिंगल पोल ट्रेलिस* सिस्टम सतत पिरामिड स्टैंड की तुलना में विकास और उपज के लिए बेहतर पाया गया, और 'T' स्टैंड और प्रति खम्भे के लिए 450 ग्रा. नत्रजनः 275 ग्रा. फॉस्फोरसः 650 ग्रा. पोटाश के पोषक स्तर के परिणामस्वरूप उच्चतम

फल उपज, बायोमास उपज और गूदा प्राप्ति हुई। क्रिमसन सीडलेस अंगूर में, 30 कैन भार और 11–13 पत्तों से अच्छी गुणवत्ता वाले गुच्छे प्राप्त हुए; गुलाबी और बैंगलूर ब्लू अंगूर में, ईथ्रेल के छिड़काव से बेरी के रंग में सुधार हुआ। अर्का माइक्रोबियल कंसोर्शियम से लेपित और अर्का किण्वित कोकोपीट + कम्पोस्ट में बोए गए बीजों में बेहतर वृद्धि पाई गई और एक वर्ष में दो बार 100 ग्राम चूना का मिट्टी में प्रयोग करने से पौध–छत्र और मूल–संधि की परिधि अधिक दर्ज हुई। केंद्रीय बागवानी परीक्षण केंद्र, भुवनेश्वर में फल–आधारित बहु–स्तरीय प्रणाली (आम+कमलम+अनन्नास) विकसित की गई है।

पानी में घुलनशील उर्वरकों के माध्यम से नत्रजन:फॉस्फोरस:पोटाश (कि.ग्रा./हेक्टेयर) (25:40:50 और 100:60:10) के द्वि–साप्ताहिक प्रयोग से क्रमशः बेल वाली सेमफली और खरबूजे में उच्च उपज दर्ज की गई। गुलाब की किस्म अर्का सावी ने *आर. मल्टीफ्लोरा, डॉ. हवे* और *नेटाल ब्रायर* मूलवृंतों पर बेहतर प्रदर्शन किया। लवणता और बाइकार्बोनेट विषाक्तता के लिए गुलाब के मूलवृंतों की जांच की गई। विभिन्न चरणों (रोपाई के 45 दिन से 180 दिन बाद) में रजनीगंधा के पत्तों के विश्लेषण में पोटाश > नत्रजन > कैलशियम > मैगनीशियम > फॉस्फोरस पोषक तत्वों की सघनताक्रम का पता चला। खण्डित मातृ कंदों से प्राप्त तकले के आकार के कंदों को अर्का किण्वित कोकोपीट+मिट्टी+गोबर की खाद (1:1:1 परिमाण/परिमाण) में बोने के साथ–साथ 150:75:125 कि.ग्रा./हेक्टेयर की दर से नत्रजनः फॉस्फोरसःपोटाश के प्रयोग से चार महीने के प्रवर्धन चक्र में कंदों का उत्पादन होता है। आबोली ने ड्रिप सिंचाई की तुलना में पलीता सिंचाई (wick irrigation) में बहुत अच्छा प्रदर्शन किया। *रोसा मल्टीफ्लोरा* मूलवृंत को 400:200:200 कि.ग्रा. नत्रजन:फॉस्फोरसःपोटाश /हेक्टेयर/वर्ष की खुराक से पौधे की ऊंचाई और प्राथमिक शाखाओं की संख्या में सुधार हुआ। जर्बेरा में, उच्च उपज और बेहतर गुणवत्ता वाले फूलों को बढ़ाने के लिए मिट्टी की शय्या पर सामूहिक पलीता प्रणाली (wick system) को सबसे अधिक वांछनीय पाया गया। जर्बेरा, लिलियम और जिप्सोफिला में वर्टिकल फार्मिंग का प्रयास किया गया। कर्तित गुलदाउदी में प्रकाश–अवधि के संशोधन से बेहतर गुणवत्ता वाले फूल प्राप्त हुए और विभिन्न किस्मों में पुष्पण की अवधि बढ़ी। गमले में अजवाइन, मंडूकपर्णी और पुदीना के उत्पादन का मानकीकरण किया गया। *सेंटेला एशियाटिका* में, अर्का किण्वित कोकोपीट+वर्मीकम्पोस्ट (1:1 परिमाण/परिमाण), जीवामृत (50 मि.ग्रा./गमला) के साप्ताहिक प्रयोग से वानस्पतिक विकास और पत्तियों के शुष्क वजन में सुधार हुआ; 75% प्रक्षेत्र क्षमता में एशियाटिकोसाइड (ग्रा./गमला) की उपज उच्चतम (460 ग्रा. एशियाटिकोसाइड/पौधा) पाई गई। मशरूम में, बाइफैसिक स्पॉन प्रौद्योगिकी और फसल–कटाई के बाद मशरूम–कैल्शियम संवर्धन प्रक्रिया को एल्म ऑयस्टर मशरूम *हिप्सीजाइगस अल्मारियस* में मानकीकृत किया गया।

उच्च घनत्व वाले अमरूद के रोपण के लिए फर्टिगेशन मॉड्यूल विकसित किए गए । अनार में, टीपीए 13 पृथक्कृत के तरल मिश्रण में पौधे की ऊंचाई, जड़ की लंबाई, जड़ बायोमास और पोषक तत्वों की काफी अधिक मात्रा दर्ज की गई। रोपाई सातवें दिन में *बेसिलस एमाइलोलिक्विफेशियंस* पी–72 का घोल के रूप में 5 कि.ग्रा./हे. की दर से प्रयोग के बाद दुबारा तीस दिन के बाद समान प्रयोग से टमाटर का विपणन–योग्य उपज 40% वाष्पन में असंरोपित पौधों की अपेक्षा 28.26% अधिक हुई। मीथाइलोट्रोफिक बैक्टीरिया के विभिन्न पृथक्कृतों को एलसी–एमएस के माध्यम से प्रजननशील बनाया गया। जैव–कार्बनिक खाद के उत्पादन की पद्धति का मानकीकरण किया गया। लाल मिर्च, अंगूर, बैंगन और टमाटर में कीटनाशक अवशेषों का अनुमान लगाया गया।

फसल संरक्षण

आम में पुष्पण–अंगमारी और पाउडरी मिल्ड्यू के पूर्वानुमान मॉडल में अनुकूल तापमान और सापेक्षिक आर्द्रता पर काम किया गया। जनवरी–मार्च और अगस्त–सितंबर 2022 में आम के फुदक (*इडियोस्कोपस निटिडुलस*) और थ्रिप्स (*सिर्टोथ्रिप्स डॉर्सालिस*) का प्रकोप देखा गया। आम के फल छेदक (सिट्रिपेस्टिे यूट्राफेरा) के प्रबंधन पर काम किया गया है, और फल मक्खी और गुठली घुन के प्रकोप के प्रति किस्मों की जांच की गई। अमरूद में टी मॉस्किटो बग के विरुद्ध कीट रोगवाहक का मूल्यांकन किया गया। अमरूद (किस्म अर्का किरण) में जड़गाँठ सूत्रकृमि के प्रबंधन के लिए एकीकृत मॉड्यूल विकसित किया गया। आम में, फल–मक्खी के प्रकोप का पता लगाने के लिए कुल 43 एक्सेशनों की जाँच की गई। प्रायर, सेलम, के–ओ–22, गोवाकोडूर, जवाहर, माया और आम्रपाली किस्मों में अनावरण की स्थिति के तहत कोई घटना दर्ज नहीं हुई। जीनोटाइपों की जांच एन्थ्रेक्नोज रोग के लिए भी की गई। सर्वेक्षण और टमाटर के विषाणु रोग ने 10 से 50 प्रतिशत विषाणु–प्रकोप का संकेत दिया। टमाटर से जुड़े विषाणुओं का लक्षण वर्णन किया गया। बैंगन और खीरे में मूलगाँठ सूत्रकृमि और शिमला मिर्च में फाइटोफ्थोरा ब्लाइट के लिए एकीकृत प्रबंधन मॉड्यूल मानकीकृत किए गए। रतुआ–रोधी वंशावलियों, जैसे अर्का बोल्ड, अर्का अनूप, अर्का सुकोमल और आईआईएचआर–79 में फेनोलिक्स, प्रतिऑक्सीकारक क्षमता, पेरोक्सीडेज और एलांटोइनेस का स्तर प्राकृतिक संक्रमण के बाद उल्लेखनीय रूप से बढ़ गया, जबकि रतुआ रोग के प्रति संवेदनशील वंशावलियों में यह स्तर कम हो गया। पॉटीवायरस प्रतिरोध के लिए मिर्च में अप्रभावी प्रतिरोध ईएलएफ4 जीन का जीनोम संपादन किया गया। लिलियम और ग्लैडियोलस के विषाणु का लक्षण वर्णन किया गया। जैव–नियंत्रण बैक्टीरिया (*बैसिलस प्यूमिलस*) आईआईएचआर बीपी–2 ने ग्लेडियोलस किस्म अर्का आयुष में जड़गाँठ सूत्रकृमि की संख्या को काफी कम कर दिया। गेंदे में जड़–रिसाव ने *मेलोइडोगाइन इनकोग्निटा* के अंडे सेने की क्रिया और इसके किशोरों की उच्च मृत्यु दर को रोक दिया, जिसको *इन विट्रो* स्थितियों के तहत दर्ज किया गया। गेंदे में, अर्का मधु, पूसा अर्पिता, आईसी–250–332, आईसी–250–323, सीजीएफएम–1 और केएयू–एम2 जीनप्ररूप *आल्टरनेरिया* अंगमारी रोग के मध्यम प्रतिरोधी पाए गए।

फसल उपयोग एवं कृषि यंत्रीकरण

इथलीन क्रिया अवरोधक 1– मिथाइलसाइक्लोप्रोपेन (1–एमसीपी) से सीताफल की भंडारण आयु बढ़ी और सीताफल के फलों के रंग और दृढ़ता पर प्रतिकूल प्रभाव हुए बिना फल देर से पके। 100µM मेलाटोनिन से अल्फांसो आम के पूर्व–भंडारण उपचार ने 8 °सेल्सियस पर भंडारण के दौरान 4 सप्ताह तक द्रुतशीतन को कम करने में मदद की। इथलीन इनहिबिटर 1–एमसीपी (500 पीपीबी) से पूर्व–उपचारित

पपीते के फलों को सामान्य परिस्थितियों में 2 सप्ताह तक और कम तापमान (15 °सेल्सियस) में भंडारण 3 सप्ताह तक निधानी आयु बढ़ाने में प्रभावी पाया गया। अंकुरित कंगनी और कुटकी के आटे को आम, अनानास और अनार के उपयोग के लिए तैयार (आरटीएस) पेय में शामिल किया गया ताकि ऑर्गेनोलेप्टिक रूप से स्वीकार्य पेय प्राप्त किया जा सके। बेहतर संवेदी गुणों के साथ कमलम और बेल से उपयोग के लिए तैयार (आरटीएस) पेय बनाने की प्रक्रिया को मानकीकृत किया गया। अनन्नास से वाइन बनाने की प्रक्रिया का मानकीकरण किया गया। कीवी फल से प्रोबायोटिक पेय तैयार करने की प्रक्रिया का मानकीकरण किया गया। सोडियम एल्गिनेट और सोया लेसिथिन के साथ शिमला मिर्च के फलों को आवरित करने से सामान्य परिस्थितियों में 8 दिनों तक और कम तापमान (8 °सेल्सियस) में 3 सप्ताह तक भंडारण किया जा सका। गाजर से प्रोबायोटिक पेय विकसित किया गया। उपयोग के लिए तैयार कद्दू पाउडर से सूप मिश्रण बनाने की प्रक्रिया को मानकीकृत किया गया। रिमोट से नियंत्रित बहुउद्देशीय प्राइम मूवर अभिकलन और विकास किया गया ।

आर्थिकी, सांख्यिकी और कंप्यूटर अनुप्रयोग अनुसंधान

आर्थिकी

फल और सब्जी बेचने के वाहन की आर्थिक संभावना का आकलन किया गया। वर्ष 2008–09 से 2021–22 की समयावधि में बीज एवं पौध सामग्री के साथ–साथ उन्नत प्रजनन वंशों की बिक्री के लिए 102 लाईसेंस जारी की गईं। इससे कुल मिलाकर रु. 2.27 करोड़ का आईपी लाइसेंस शुल्क प्राप्त हुआ। वर्ष 2008–09 से 2021–22 तक भारत की विभिन्न कंपनियों द्वारा फल फसलों में रु. 18.61 लाख की छह लाइसेंस, सब्जी फसलों में रु. 1.95 करोड़ की 65 लाइसेंस और पुष्प फसलों में रु. 19.0 लाख की 19 लाइसेंस प्राप्त की गईं। विभिन्न किस्मों के संकर बीज उत्पादन ने संकेत दिया कि टमाटर, मिर्च और भिंडी संस्थान में उत्पादित और बेचे गए तीन प्रमुख संकर थे। भा.कृ.अनु.प.–भा.बा.अनु.सं., बेंगलूरु के संकर बीजों और खुले परागित किस्मों के फसल–वार क्षेत्र–प्रसार का अनुमान लगाया गया।

सांख्यिकी

जर्बेरा, एस्टर और संतरे के अखिल भारतीय समन्वित अनुसंधान परियोजना के परीक्षणों के लिए स्थिरता मॉडल तैयार किए गए।

बारहमासी फसल परीक्षण में अवशिष्ट प्रभाव को संभालने के लिए एक सांख्यिकीय विधि को मानकीकृत किया गया। आंवला के ऑस्मोटिक निर्जलीकरण को प्रभावित करने वाले कारकों के अनुकूलन के लिए बॉक्स–बेनकेन डिजाइन (बीबीडी) का उपयोग करते हुए दूसरे क्रम के आरएसएम का निर्माण किया गया।

कम्प्युटर अनुप्रयोग

चीकू और फ्रेंचबीन की खेती के मोबाइल ऐप को क्षेत्रीय भाषाओं में विकसित किया गया और फलों और सब्जियों के मुख्य मोबाइल ऐप के साथ जोड़ा गया। इन ऐप में बुवाई से लेकर कटाई और फसल प्रबंधन संबंधी समाधान के साथ–साथ विभिन्न सुविधाएँ भी शामिल हैं। फसल–संरक्षण प्रणाली को फलों और सब्जियों की फसलों के कीट प्रबंधन के लिए गतिशील मॉड्यूल के रूप में विकसित किया गया। इसे MySQL डेटाबेस के साथ वेब–आधारित इंटरफेस का उपयोग करके डिजाइन किया गया है।

कृषि विस्तार अनुसंधान

भाकृअनुप–भा.बा.अनु.सं. द्वारा जारी की गई चयनित सब्जियों, जैसे बैंगन (अर्का आनंद) और मिर्च के संकर (अर्का हरिता, अर्का मेघना, अर्का श्वेता और अर्का ख्याति) और औषधीय फसल म्यूकुना (अर्का शुभ्रा और अर्का धन्वंतरि) के प्रसार और स्वीकृति का अध्ययन किया गया। एपीएमसी परिवेश के बाहर उपयुक्त विस्तार पद्धतियों और रणनीतियों की पहचान की गई। आम में फसल क्षेत्र के आकलन, फसल निगरानी और सटीक बाग प्रबंधन के लिए मानक प्रोटोकॉल विकसित किए गए।

राजभाषा कार्यान्वयन

संस्थान के राजभाषा कक्ष द्वारा उक्त अवधि के दौरान मुख्यालय में हिंदी पखवाड़ा एवं हिन्दी कार्यशालाएँ आदि आयोजित की गईं। संस्थान के क्षेत्रीय केन्द्रों द्वारा हिंदी सप्ताह आयोजित किया गया। इसके अतिरिक्त मूल रूप से हिंदी में कार्य करने वाले कर्मचारियों को हिन्दी प्रोत्साहन योजना के तहत पुरस्कार प्रदान किया गया।

वर्ष 2022 में भा.कृ.अनु.प.–भा.बा.अनु.स., बेंगलूरु में किए गए अनुसंधान कार्य का उपरोक्त सारांश, बागवानी फसलों के क्षेत्र में विविध और समग्र उपलब्धियों को सामने रखता है।

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2. Executive Summary

This chapter enumerates the salient achievements of ICAR-IIHR in the year 2022.

CROP GENETIC RESOURCES

ICAR-IIHR is recognized by the National Active Germplasm Site (NAGS) as the nodal centre for the management of several horticultural plant genetic resources in the country. A total of 1042 germplasm were collected, out of the total 12,564 viable germplasm, fruit crops contributed 1,988, vegetables 9,553, flower crops 848, medicinal crops 80 and mushrooms 95. Out of the 1,854 germplasm characterized, fruits crops were 323, vegetable crops 1,347, flower crops 177 and medicinal crops 7. Four wild species each in guava and papaya, 25 edible fruits of Western Ghats, 10 downy/powdery mildew disease tolerant lines, 213 pomegranate USDA collections and 109 *jamun* genotypes were conserved in the field gene bank. In vegetable crops, a total of 915 germplasm were collected, 1,347 were characterized and 12 were registered with ICAR-NBPGR. The institute also collected 848 flower and medicinal crops germplasm, characterized 177 and registered 4 with ICAR-NBPGR. A total of 249 different fruit crops, including underutilized fruit crops, are being conserved at ICAR-IIHR. The Avocado accession-22 was found to the special with high average fruit weight, pulp recovery, peel thickness, TSS, fat content and yield.

Among vegetable crops, four exotic collections each of brinjal, chilli and bell pepper were collected from World Vegetable Centre, Taiwan; six wild accessions of *Abelmoschus caillei*, *A. angulosus* var. *grandiflorus*, *A. mezorensis*, *A. tuberculatus*, *A. moschatus* and *A. tetraphyllus* var. *tetraphyllus* are being maintained and utilized to develop pre-breeding lines. Onion accession LSR/18/37, a landrace collected from Chitradurga, Karnataka was found to be highly resistant to onion anthracnose disease.

In flower crops, in rose (326), marigold (75), tuberose (40), gladiolus (84), chrysanthemum (122) and China aster (28) germplasm have been conserved, and IC numbers for 37 germplasm of China aster were received. In medicinal crops, *Eclipta alba* (155), *Bacopa monnieri* (82), *Mucuna pruriens* (85), *Coleus forskohlii* (45), *Andrographis paniculata* (54), *Aloe vera* (37), *Centella asiatica* (27), *Gymnema sylvestre* (53) and *Piper betle* (109) germplasm were conserved in the field gene bank.

The collected germplasm were also characterized. Among vegetable crops, brinjal germplasm IC-362395 performed better for yield; chilli accessions AVPP 1609-085, AVPP 2003 and AVPP 2007 were found to be superior in yield; Okra accession IIHR-1676 recorded high yield with no incidence of YVMV; watermelon accession IIHR-82 showed 100 per cent plant survival against gummy stem blight; bitter gourd accessions IIHR-26 and IIHR-88 recorded zero incidence against fruit fly; ridge gourd line IIHR-45 recorded highest yield, while, accessions IIHR-35, IIHR-37, IIHR-101, IIHR-114 and IIHR-147 were found to be resistant to ToLCNDV, and IIHR-DMR-18-65-2 and IIHR-209 (sponge gourd) were found resistant to fruit fly incidence; French bean accessions IIHR-31 and IIHR-79 showed high level of tolerance to rust; garden pea accessions IIHR-13-10, IIHR-13-6, IIHR-13-7, IIHR-13-22, IIHR-13-26 and IIHR-132 were tolerant to powdery mildew; nine accessions of curry leaves had intense flavour and accessions BRR18/15 and LSR18/9 were found rich in calcium and LSR/18/06-A in Fe content; drumstick accessions IIHR-D-134 (41.84 t/ha), IIHR-D-137 (37.39 t/ha) recorded higher yield; carrot accession No. 88 was found to be highly resistant to root knot nematode. Bitter gourd line IIHR-144-1 (INGR22161) and chrysanthemum line IIHR4-8 (22182), IIHR2-16 (22180) and IIHR2-13 (22181) have been registered with ICAR-NBPGR, New Delhi for their unique traits.

Rose germplasm 'Knock Out' was found to be immune to black spot disease and 'Carefree Beauty' and 'Crifty Duty' were found highly resistant to black spot disease; marigold genotypes Arka Madhu, Pusa Arpita, IC-250-332, IC-250-323 were found to be moderately resistant to *Alternaria* blight disease. Among medicinal crops, *Gudmar* accessions IIHR-GS-18 and IIHR-GS-42 had high leaf area; Brahmi germplasm IIHR-BM-23, IIHR-BM-18, IIHR-BM-16 and IC-324777 were found to be desirable for growth and yield.

CROP IMPROVEMENT

The finding of the crop improvement studies are given here. Forty interspecific hybrid progenies of guava were found resistant to both nematode (*Meloidogyne incognita*) and wilt (*Fusarium oxysporum* f.sp. *psidii*); backcrossing of custard variety Arka Sahan with *A. squamosa* cv. Balanagar was done to develop self-fruitful population; *in vitro* route of ovule parthenogenesis was used for induction of doubled haploids in papaya cv. Arka Prabhath; mutation breeding was initiated in pomegranate to create variability for nodal blight resistance; avocado line IC0626510 was found to be promising for fruit quality traits. At CHES, Bhubaneswar, tamarind germplasm CHES-B-TM-3 (IC-

639464) exhibited better quality attributes in terms of pod weight, pulp content, fibre content, TSS, acidity, TSS acid ratio and sugar content.

In vegetable crops, 21 tolerant BC_1F_2 tomato progenies having resistance to *Tuta absoluta* and 88 F_3 lines showing less defoliation due to foliar diseases and fruit cracking were selected. Arka Avinash, a high yielding bacterial wilt resistant brinjal variety, has been Gazette Notified, and individual plants selections from IIHR-104 x Arka Keshav-2-5, IIHR-104 x Arka Neelakant-4-3 and IIHR-586 X Arka Nidhi-1-5 were found promising for yield and bacterial wilt resistance. Two high yielding chilli hybrids Arka Swetha and Arka Khyati were Gazette notified, and F_1 hybrids LCVH24, LCVH25, LCVH26, LCVH29, LCVH43 and Arka Gagan were found to be resistant to *Phytophthora* root rot; okra advance breeding lines viz., IIHR-385-11-5, IIHR-386-1-1-26 and RIL-1 (IIHR-285-1 x AC-1685 F_7) were found free from YVMV. Pole type Dolichos var. Arka Pradhan was recommended for *kharif* and *rabi* season during by AICRP on Vegetable Crops. Cluster Bean line IIHR-CB-22-1-1 with high yield, green long stringless pods, higher nutrients and amino acids, has identified for release by ITMC. Ridge gourd inbred line IIHR-RV-23-4 was found superior for fruit length and yield. Bitter gourd line IIHR-148-6 for yield, IIHR-148-10, IIHR-IP-19-142-2 and IIHR-184-4 were found promising, while, IIHR-IP-PDGY-3 was found resistant to powdery mildew. Pumpkin butternut lines BN-8-2, BN-2-3-1 and BN-23 had high yield potential. Summer squash SARY-4 x SQ-14 and SQ-14 x SQGL-2 recorded high number of fruits/plant and yield. Ash gourd advanced breeding lines AG-6-7-1-28-10, AG-27-1-20, AG-3-54-39-55 and AG-1-52-15-25 recorded high fruit yield. A total of 18 advance breeding lines of curry leaf were selected based on superior fresh leaf yield.

The garden rose lines IIHRR-9-13, IIHRR-4-15-12 and IIHRR-4-4-2 were suited for landscape, IIHRP-7 was rich in anthocyanin and antioxidants, IIHRR-3-7-12 and Arka Nishkant were resistant to black spot disease. French marigold lines IIHR-FM-13 and IIHR-FM-411 were floriferous. Tuberose line IIHR-17-23SP-08 was identified for release by ITMC as Arka Keerthi for garland purpose, high yield, field resistant to root knot nematode and *Alternaria* leaf blight. In Gladiolus advanced breeding lines *viz*., IIHR-15-1-99, IIHR-15-1-48 and IIHR-15-1-212 were identified for cut flower purpose, hybrid selections *viz*., 15-1-99, 15-5-180, 15-5-247 and 15-1-35 were found to be highly resistant to *Fusarium* wilt disease.

Three Chrysanthemum lines *viz.*, IIHR-4-8, IIHR-2-16 and IIHR2-13 were identified for release by the ITMC as Arka Anirudh, Arka Dhaval and Arka Manohar, respectively, for pot culture and bedding, and genotypes Arka Pink Star, Marigold, Pusa Anmol and Ajay showed photo-insensitive reaction. In China aster, 9 lines for cut flower and 10 lines for bedding and pot culture were found promising. Gerbera lines AV-35, AV-47, AV-21, Y-10 and AV-53 were found to be promising for protected cultivation, while, Red Double and Pink Double were identified for open cultivation. Crossandra mutant 2 was selected for medium sized flowers, higher yield and higher shelf life, while, mutant 3 for pot culture. *Centella asiatica* polyploid genotype IIHR-CA-28 recorded higher mean fresh biomass yield. Elite Kalmegh selections AP Sel. 3 and Sel. 1 and Sel. 2 registered higher leaf andrographolide content. Bhringaraj Sel. 43 had higher dry biomass and wedelolactone content.

CROP PRODUCTION

Polyembryony studies in mango revealed that the zygotic embryo growth was suppressed in the embryo sac of polyembryonic kernels during 9 to 12 days after anthesis by the vigorous nucellar embryos; leaf volatile profile is an effective biomarker to distinguish zygotic and nucellar seedlings; spraying of triacontanol (3-5 ppm) at panicle initiation, pea, and marble stage of fruit growth improved panicle size, fruit retention, yield and fruit quality. In guava var. Arka Kiran, the fruits and pruned material removed more nutrients per tree under high density planting. Drip irrigation at 60% evaporation replenishment during both vegetative and reproductive phases, recorded higher benefit cost ratio (3.63). Custard apple plants sprayed with GA_3 (200 ppm) registered the highest fruit yield. Guava air layered plants recorded better plant height, canopy spread, number of shoots, and productivity in summer and rainy season crops. In dragon fruit, single pole trellis system was found to be better for growth and yield compare to continuous pyramid stands, and 'T' stands. Nutrient level of 450 N: 275 P_2O_5: 650 K_2O g/pillar resulted in highest fruit yield, biomass yield and pulp recovery. In Crimson Seedless grapes, 30 cane load and 11-13 leaves, yielded good quality bunches, while, in vars. Gulabi and Bengaluru Blue, spraying ethrel improved berry colour. Seeds of papaya var. Arka Prabhath primed with Arka Microbial Consortium and sown in media comprising Arka Fermented cocopeat + compost was found to be superior in growth. The soil application of 100 g lime twice in a year recorded significantly higher plant canopy volume and collar girth. A fruit-based multistorey system (mango + dragon fruit + pineapple) has been developed at CHES, Bhubaneswar.

Bi-weekly application of NPK (kg/ha) (25:40:50 and 100:60:10) through water soluble fertilizers recorded

higher yield in pole type dolichos bean and musk melon, respectively. Rose variety Arka Savi performed better on rootstocks *R. multiflora*, Dr. Huey and Natal Briar. Rose rootstocks were screened for salinity and bicarbonate toxicity. Leaf analysis of tuberose at different stages (45 days to 180 days after planting) revealed nutrient concentrations order of K > N > Ca > Mg > P, spindle shaped bulbs from sectioned mother bulbs planted in Arka Fermented cocopeat + soil + FYM (1:1:1 v/v) along with application of 150:75:125 kg ha^{-1} NPK produced bulbs in short propagation cycle of four months. Crossandra crop performed very well with wick irrigation compared to irrigation with drippers. Fertilizer dose of 400:200:200 kg NPK/ha/year to *Rosa multiflora* rootstock improved plant height and number of primary branches. In gerbera, aggregate wick system on soil beds was found most desirable in increasing higher yield and superior quality flowers. Vertical farming was attempted for Gerbera, Lilium and Gypsophila. Manipulation of photoperiod in cut chrysanthemum achieved better flower quality and extended the blooming period in different cultivars. Pot herb production of oregan, mandukaparani and pepper mint was standardized. In *Centella asiatica*, Arka Fermented Cocopeat + Vermicompost (1:1 v/v) with the weekly application of Jeevamrutha (50 ml/pot) improved vegetative growth and dry weight of leaves, and yield of asiaticoside was found highest (460 g/ plant) in 75% field capacity. In mushrooms, biphasic spawn technology, and post-harvest mushroom calcium fortification process was standardized in elm oyster mushroom (*Hypsizygus ulmarius*).

Fertigation modules were developed for high density guava planting. In pomegranate, the liquid formulation of the isolate TPA 13 recorded significantly higher plant height, root length, root biomass and nutrient uptake. *Bacillus amyloliquefaciens* P-72 applied at the rate of 5 kg /ha as a suspension (20 g/l) on the seventh day of transplantation followed by another application on the 30^{th} day, improved the marketable yield levels of tomato by 28.26% over uninoculated plants when irrigated at 40% of Pan Evaporation (PE). Different isolates of methylotrophic bacteria were prolifed for hormones through LC-MS. A bio-organic manure production methodology was standardized. Pesticide residues were estimated in red chilli, grapes, brinjal and tomato.

CROP PROTECTION

Optimum temperature and relative humidity were worked out in forecasting models for blossom blight and powdery mildew in mango. Incidence of mango hoppers (*Idioscopus nitidulus*) and thrips (*Scirtothrips dorsalis*) were observed in January-March and August-September 2022. Management of mango fruit borer (*Citripestis eutraphera*) has been worked out, and varieties were screened for fruit fly and stone weevil. Different botanicals and entomopathogens were evaluated against tea mosquito bug in guava. Integrated modules for management of root knot nematodes in guava cv. Arka Kiran was developed. In mango, a total of 43 accessions were screened, for incidence of fruit fly varieties, Prior, Salem, K-o-22, Goakodur, Jawahar, Maya and Amrapali recorded nil incidence under exposed condition, the genotypes were also screened for Anthracnose disease. Survey and incidence of viral disease in tomato indicated 10 to 50 *per cent* viral incidence. Viruses associated with tomato were characterized. Integrated management modules for root knot nematodes in brinjal and cucumber, and *Phytophthora* blight in sweet pepper were standardized. The level of phenolics, antioxidant potential, peroxidase and allantoinase in the rust resistant lines Arka Bold, Arka Anoop, Arka Sukomal and IIHR-79 increased significantly after natural infection, while, the level decreased in rust susceptible lines. Genome editing of recessive resistance eIF4 genes in chilli was carried out for potyvirus resistance. Viruses infecting Lilium and Gladiolus were characterized. Bio-control bacteria (*Bacillus pumilus*) IIHR Bp-2 significantly reduced root knot nematode population in Gladiolus cv. Arka Aayush. Root exudates of marigold suppressed egg hatching and high mortality of juveniles of *M. incognita* was recorded under *in vitro* conditions. In marigold, genotypes Arka Madhu, Pusa Arpita, IC-250-332, IC-250-323, CGFM-1 and KAU-M2 were found to be moderately resistant to *Alternaria* blight disease.

CROP UTILIZATION & FARM MECHANIZATION

The ethylene action inhibitor 1- Methylcyclopropene (1-MCP) enhanced the storage life of custard apple and delayed fruit ripening without adversely affecting colour and firmness of the custard apple fruits. Pre-storage treatment of Alphonso mangoes with 100 µM melatonin helped in alleviation of chilling injury till 4 weeks during storage at 8°C. Papaya fruits pre-treated with ethylene inhibitor 1-MCP (500 ppb) was found to be effective in extending shelf-life for 2 weeks under ambient conditions and for 3 weeks at low temperature storage (15°C). Germinated millet flours of foxtail and little millet were incorporated into ready to serve (RTS) beverages of mango, pineapple and pomegranate to obtain organoleptically acceptable beverages. Processes for preparation of Ready-to-Serve (RTS) from dragon fruit and wood apple beverages with improved sensory qualities was standardized. Preparation of wine from pineapple were standardized. Probiotic beverage preparation was standardized from kiwi fruit. Fruit coating of capsicum fruits with sodium alginate and

Soy lecithin extended storage life up to 8 days under ambient conditions and up to 3 weeks at low temperature (8°C). A probiotic beverage was developed from carrot. The process for Ready to Use (RTU) Soup mix from pumpkin powder was standardized. Remote controlled multipurpose prime mover was designed and developed.

ECONOMICS, STATISTICS AND COMPUTER APPLICATION RESEARCH

ECONOMICS

The economic feasibility of the fruit and vegetable vending van was assessed. During the time period 2008-09 to 2021-22, 102 licences were issued for seeds, planting materials and advanced breeding lines. This realised an IP license fees of Rs.2.27 crores. A total of six licenses amounting to Rs. 18.61 lakhs in fruit crops, 65 licenses amounting to Rs. 1.95 crores in vegetable crops and 19 licenses amounting to Rs. 19.0 lakhs flower crops were obtained by the various companies throughout India from 2008-09 to 2021-22. The hybrid seed production of different varieties indicated that tomato, chilli and okra were the three major hybrids produced and sold at ICAR-IIHR. The crop-wise area spread of hybrid seeds and open pollinated varieties of ICAR-IIHR was estimated.

STATISTICS

Stability models were constructed for Gerbera, Aster and Mandarin AICRP experiments. A statistical method to handle residual effect in perennial crop experiment over years was standardised. Second order RSM using Box-Behnken Design (BBD) was constructed for optimization of factors influencing osmotic dehydration of *aonla*.

COMPUTER APPLICATION

Mobile app for sapota and French bean cultivation were developed in regional languages and were integrated with main mobile app for fruits and vegetables. These apps include various feature from sowing to harvesting and crop management solutions as well. The crop protection system was developed as dynamic module for pest management of fruits and vegetable crops. It is designed using web-based interface with MySQL database.

AGRICULTURAL EXTENSION AND OUT REACH

The spread and acceptance of selected ICAR-IIHR released vegetable crops such as brinjal (Arka Anand) and chilli hybrids (Arka Haritha, Arka Meghana, Arka Sweta and Arka Khyati) and medicinal crop *Mucuna* (Arka Shubhra and Arka Dhanvantari) were studied. Extension methodologies and strategies suitable for post APMC environment were identified. Standard protocols were developed for the assessment of cropped area, crop monitoring and precision orchards management in mango.

OFFICIAL LANGUAGE IMPLEMENTATION

The official language implementation unit of the Institute carried out various activities such as Hindi work shops, Hindi fortnight celebration at main campus and regional stations. Staff members working in Hindi were also awarded under Hindi incentive scheme.

The above abstract of the research work carried out at ICAR-IIHR in 2022, brings out the diverse and holistic accomplishments in the field of horticultural crops.

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3.1. CROP GENETIC RESOURCES

3.1.1. GERMPLASM EXPLORATION & AUGMENTATION

FRUIT CROPS

Crop	Germplasm collected during 2022	Areas explored/ Source Institute	Total viable germplasm as on 31.12. 2022	No. of germplasm characterized during the year 2022	No. of germplasm registered with NBPGR
Mango	8	Kerala	779	9	-
Guava	-	-	74	-	-
Pomegranate	-	-	269	11	-
Sapota	-	-	52	-	-
Annona	-	-	24	12	3
Pummelo	-	-	35	-	-
Rose apple	10	West Bengal	3	10	-
Annona muricata	-	-	3	-	1
Carissa macrocarpa	-	-	3	-	1
Tamarind	28	Chhattisgarh	80	-	-
Grapes	-	-	20	10	-
Wood apple	18	Karnataka	16	18	-
Bael	-	-	119	-	-
Garcinia	-	-	32	-	-
Dragon fruit	-	-	6	-	-
Avacado	-	-	10	-	-

VEGETABLE CROPS

Crop	Germplasm collected during 2022	Areas explored/ Source Institute	Total viable germplasm as on 31.12.2022	No. of germplasm characterized during the year 2022	No. of germplasm registered with NBPGR
Tomato	54	Tomato Genetics Resource Center, USA; World Vegetable Center (WVC), Taiwan	700	-	-
Chilli	5	Karnataka, Odisha	2010	15	6
Brinjal	2	Uttar Pradesh, Karnataka	361	-	-
Bell pepper	9	WVC, Taiwan	79	4	-

Okra	38	IARI, New Delhi, Haryana, Maharastra	1704	8	2
French Bean	42	Uttar Pradesh	276	234	-
Cowpea	4	Karnataka	263	259	-
Garden Pea	450	NBPGR, New Delhi	512	62	-
Dolichos Bean	-	-	276	-	-
Vegetable Soybean	-	-	88	-	-
Cluster Bean	-	-	50	3	-
Muskmelon	29	NBPGR, New Delhi	113	61	-
Ridge gourd	180	WVC, Taiwan; New Delhi, Odisha	324	191	-
Bitter gourd	-	-	147	-	1
Bottle gourd	02	Karnataka	158	-	3
Ash gourd	-	-	73	43	-
Pumpkin	-	-	124	-	
Summer squash	13		110	13	-
Gherkin	-	-	-	79	-
Carrot	5	NBPGR, New Delhi	180	96	-
Radish	5	Uttar Pradesh, Tamil Nadu	180	79	-
Drumstick	-	-	232	-	-
Onion	45	Karnataka	110	100	-
Curry leaf	32	Karnataka	160	100	-

FLOWER AND MEDICINAL CROPS

Crop	**Germplasm collected during 2022**	**Areas explored/ Source Institute**	**Total viable germplasm as on 31.12.2022**	**No. of germplasm characterized during the year 2022**	**No. of germplasm registered with NBPGR**
Rose	4	Tamil Nadu, New Delhi	326	46	-
Marigold	10	West Bengal, Punjab	75	20	-
Tuberose	2	West Bengal	40	10	1
Gladiolus	6	Uttar Pradesh	84	10	-
Carnation	-	-	50	-	-
Centella asiatica	-	-	27	-	-
Gymnema sylvestre	10	Karnataka, Tamil Nadu	53	7	-

Chrysanthemum	12	West Bengal, Himachal Pradesh, Uttar Pradesh	122	51	3
China aster	-	-	28	28	-
Crossandra	-	-	20	5	-

MUSHROOM

Crop	Germplasm collected during 2022	Areas explored/ Source Institute	Total viable germplasm as on 31.12.2022	No. of germplasm characterized during the year 2022	No. of germplasm registered with NBPGR
Mushroom	2	Karnataka	95	-	-

CHES - CHETTALLI

Crop	Germplasm collected during 2022	Areas explored/ Source Institute	Total viable germplasm as on 31.12.2022	No of Germplasm characterized during the year 2022	No. of germplasm registered with NBPGR
FRUIT CROPS					
Wild fruits	6	Karnataka	-	6	-
Avocado	1	Tamil Nadu	180	15	-
Citrus	11	-	35	11	-
Rambutan	-	-	10	180 seedlings	-
Malabar tamarind	-	-	40	28	-
Kokum	-	-	30	-	-
Longon	-	-	15	13 seedlings	-
Other fruit crops	-	-	130	-	-
VEGETABLE CROPS					
Teasel gourd	-	-	42	-	-

CHES - BHUBANESWAR

Crop	Germplasm collected during 2022	Areas explored/ Source Institute	Total viable germplasm as on 31.12.2022	No. of germplasm characterized during the year 2022	No. of germplasm registered with NBPGR
FRUIT CROPS					
Tamarind	23	Odisha, West Bengal	23	-	-
Jamun	10	Odisha	-	-	

VEGETABLE CROPS					
Chilli	-	-	140	-	-
Brinjal	-	-	42	-	-
Legume vegetables	-	-	164	-	-
Amaranthus	-	-	285	-	-
Pointed gourd	-	-	61	-	-
Edible leafy vegetables other than amaranthus	-	-	26	-	-
Underutilized cucurbit (*Solena*)	-	-	06	-	-
Drumstick	-	-	86	-	-
Winged bean	11	New Delhi	11	-	-

3.1.2. GERMPLASM CONSERVATION AND DOMESTICATION

FRUIT CROPS

Germplasm of mango (779), pummelo (35), guava (74), papaya (54), grapes (20), sweet tamarind (28), *annona* (13), jackfruit (7), pomegranate (269), sapota (53), *jamun* (108) and underutilized fruit crops (45) are being maintained.

AT CHES - BHUBANESWAR

Germplasm of mango (103), pineapple (17), jackfruit (24), tamarind (41), *bael* (12), custard apple (3), dragon fruit (06) and underutilized fruit crops (24) such as wax apple, rose apple, tamarind, *jamun*, longan, rambutan, egg fruit, avocado, *karonda*, star gooseberry, star apple, Barbados cherry, carambola, *kokum etc* are being maintained.

Tamarind germplasm block at CHES, Bhubaneswar

VEGETABLE CROPS

Germplasm collected from various regions of the country and through NBPGR, New Delhi during the year were conserved by the respective crop curators. Five variable genetic stocks of chilli landrace Kuchinda collected from farmers' field and one *Solanum sisymbrifolium* accession collected from Odisha state, four exotic collections (*viz*., EC1099160, EC1099161, EC1099162 and EC1099163) of brinjal, four collections of chilli and bell pepper each collected from World Vegetable Center, Taiwan are being conserved after evaluation. Six wild accessions of *Abelmoschus caillei*, *A. angulosus* var. *grandiflorus*, *A. mezorensis*, *A. tuberculatus*, *A. moschatus* and *A. tetraphyllus* var. *tetraphyllus* are being maintained and are being utilized to develop pre-breeding lines. A total of 230 French bean, 259 cowpea and 62 garden pea accessions were rejuvenated, characterized and conserved at gene bank (-20 ºC) during *kharif*, 2022.

Among vegetables, germplasm of chilli (140), brinjal (42), legume vegetable (175), amaranthus (285), drumstick (86), edible leafy vegetables (26), pointed gourd (61), underutilized cucurbits (Solena-6) are being maintained at Bhubaneswar.

FLOWER AND MEDICINAL CROPS

Rose: The germplasm blocks have been revived with fresh multiplication. A total of 14 species and 54 fragrant genotypes are being maintained.

Marigold: Germplasm collection consists of three species; a set of 20 genotypes have been multiplied and conserved at seed gene bank.

Tuberose: A total of 40 germplasm were conserved in the field gene bank and IC numbers were obtained for ten germplasm.

Gladiolus: A total of 84 germplasm were conserved in cold room, multiplied and maintained in the field gene bank and IC numbers were obtained for 4 germplasm.

Chrysanthemum: A total of 122 germplasm have been conserved and multiplied in field gene bank; a total of 8 germplasm received IC number.

China aster: A total of 28 germplasm have been conserved in cold room, multiplied and maintained. A total of 37 lines received IC number.

Medicinal crops: 155 germplasm accessions in *Eclipta alba*, 82 in *Bacopa monnieri*, 85 in *Mucuna pruriens*, 45 in *Coleus forskohlii*, 54 in *Andrographis paniculata* and 37 in *Aloe vera* are being maintained.

***Centella asiatica* and *Gymnema sylvestre*:** A total of 28 accessions of *Centella asiatica* and 53 accessions of *Gymnema sylvestre* are being conserved in the field gene bank.

Betelvine: A total of 109 accessions of *Piper betle* were maintained in the field gene bank.

MUSHROOM

Two wild mushrooms were collected, isolates were tissue cultured, purified, spawn was made and presently under fruiting trial for culture validation.

Wild mushroom collected from IIHR campus

Wild mushroom collected from Bengaluru

CHES - CHETTALLI

Six indigenous fruit crops of Kodagu district *viz*., ammeannu, kotteannu, Indian plum, paaleannu, kokkarchiannu and huliannu were collected and conserved. Twenty avocado accessions were transplanted in the main field for evaluation and characterization.

3.1.3. GERMPLASM CHARACTERIZATION

FRUIT CROPS

The underutilized fruit crops *viz*., soursop, carambola, *bilimbi*, *karonda*, rough lemon, rangpur lime, West Indian cherry, Surinam cherry and *aonla* accessions were characterized for tree and fruit characters.

Mango: Out of 9 accessions characterized for fruit traits, the fruit weight was ranged from 113.92 g (Shafi) to 335.60 g (Gola Neknoor), total soluble solids 11.88 ºBrix (Isaloor) to 21.12 ºBrix (Sharma seln.) and pulp content 48.19% (Isaloor) to 77.57% (Sharma seln.)

Grape: Ten rootstock genotypes were characterized for vegetative and reproductive characters based on Bioversity International descriptor.

***Annona*:** About 12 varieties of *Annona squamosa* were characterized as per the DUS descriptor.

Sweet tamarind: A total of 28 accessions were characterized for biochemical parameters and 80 accessions were molecular characterized, indicating significant genetic variations.

VEGETABLE CROPS

Brinjal: Five hundred accessions received from ICAR-NBPGR, New Delhi were characterized along with three check varieties. Among them, the high yielding accessions were IC-362395 (0.83 kg/ plant), IC-99702-X (0.71kg/ plant), IC-137761-X (0.66 kg/ plant), IC-362380 (0.65 kg/ plant) and IC-136438 (0.51 kg/ plant).

Chilli: One hundred and three germplasm lines were characterized for total carotenoids (ranged between 0.08-0.5% on dry weight basis), colour value (ranged 21.2 - 230.7 ASTA), vitamin 'C' content (ranged from 80-490 mg/ 100 g fresh weight) and total chlorophyll content (ranged from 0.0073- 0.117 mg/ g fresh weight). Two hundred and fifty chilli accessions were screened for *Thrips parvispinus* under field conditions and further, 17 selected tolerant accessions are being evaluated under controlled conditions releasing larvae of *T. parvispinus* at vegetative stage of the plant.

Chilli accession IHR-4395 showing resistance to *T. parvispinus* at vegetative, flowering & fruiting stages

Four chilli germplasm lines received from World Vegetable Centre, Taiwan were evaluated during the period. Among the lines evaluated, AVPP 1609-085 yielded maximum (33 q dry chilli yield/acre) followed by AVPP 2003 and AVPP 2007 (31q dry yield/acre each) and AVPP 2008 (30 q dry yield/acre). AVPP 2003 fruits were solitary, pendent, light green turn red, 10-11cm long and 0.9-1cm wide; AVPP 2007 fruits were thick, solitary, pendent, green turn red, 11-12 cm long and 1.5-1.6 cm wide; AVPP 2008 fruits erect, clusters, green turn red, 6-7 cm long and 0.6-0.8 cm wide; and AVPP 1609-085 fruits were borne erect, solitary, light green turn red, 9-10 cm long and 0.8-1.0 cm wide.

AVPP 2003 (fruits solitary, pendent, light green turn red)

AVPP 2007 (fruits thick, solitary, pendent, green turn red)

AVPP 2008 (fruits erect, clusters, green turn red)

AVPP 1609-085 (fruits erect, solitary, light green turn red)

Bell pepper: Four germplasm lines received from World Vegetable Centre, Taiwan were evaluated for yield and fruit quality traits under protected cultivation. Among them, AVPP 2030 yielded maximum (734.8 g/plant) followed by AVPP 2029 (715.9 g/plant). AVPP 2030 fruits are dark green, blocky and drooping with 3-4 lobes, whereas of AVPP 2029 fruits are green, blocky and drooping with 3-4 lobes.

Okra: Ninety-three old accessions were characterized for eight economic traits; among them three were found to be early flowering, 42 days after sowing (IC602395, IC620574 and IC620573); fruit length ranged between 12.5 and 16.4 cm; fruit diameter ranged between 1.45 and 1.60 cm; individual fruit weight ranged between 10 and 20 g); and yield ranged between 159 to 670 g/ plant. IC621452 was found to be found to be dwarf (37-40 cm) with shorter intermodal length. Fruits of four accessions were dark green. None of the accessions showed YVMV symptoms under natural field conditions even after pruning at 120 after sowing. Fourteen new accessions were in observation row trail during summer 2022, among them IIHR-1676 yielded maximum (538 g/ plant), dark green fruits, five ribs with no incidence of YVMV; followed by IIHR-1678 (386 g/plant) and purple colour fruits.

IC-620573 (yield 650 g/plant)

IIHR-1676 (yield 538 g/plant)

IIHR-1678 (Yield 386 g/plant)

Watermelon: Out of eighty-one germplasm lines evaluated in gummy stem blight (GSB) disease sick plot during *kharif* 2022, 24 accessions showed resistance with 60-100% plant survival. IIHR-82 (*Citrullus amarus*) showed 100 per cent plant survival and fruits were white fleshed with 3 to 4° Brix TSS. Twenty-four accessions were morphologically characterized; fruit length ranged from 8.15 (IIHR-530) to 14.3 cm (IIHR-530), fruit circumference ranged from 31 (IIHR-540) to 45.5 cm (IIHR-537), fruit width varied from 8.85 (IIHR-530) to 12.8 cm (IIHR-512), rind thickness ranged from 0.15 (IIHR-520) to 0.65 cm (IIHR-539), TSS ranged from 2.75 (IIHR-537) to 5 °Brix (IIHR-513) and fruit weight ranged from 0.25 (IIHR-516) to 1.10 kg (IIHR-537).

IIHR 82 (*Citrullus amarus*) showing cent per cent survival in GSB sick plot during *kharif* 2022

Bitter gourd: Sixty-four germplasm lines were characterized for fruit characters *viz*., fruit colour, ridge type, fruit length and peduncle length. Fruit length ranged from 6.5 - 24.5 cm; fruit diameter ranged from 2.2 - 4.8 cm; peduncle length ranged from 5.2-14.0 cm; fruit colour varied from green, dark green and creamy white; and ridge type recorded was either discontinuous or continuous. Thirty-five germplasm lines of bitter gourd were screened for fruit fly resistance in observational row trail under natural epiphytotic conditions without any pesticide spray during *kharif* 2022. Fruit fly incidence ranged from 0 to 40% among the lines; and IIHR-26 and IIHR-88 recorded zero incidence, whereas 11 lines each recorded resistance and moderate resistance to fruit fly. Resistance in these lines has to be confirmed through artificial screening conditions.

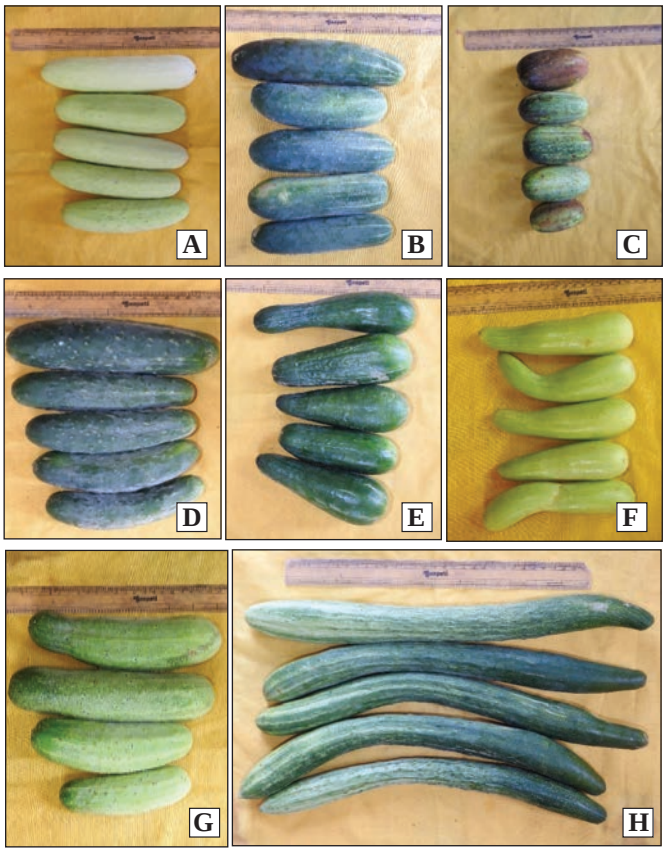
Ridge gourd: One hundred thirty one lines were characterized for fruit length, fruit girth, peduncle length, fruit number, fruit weight, fruit colour, fruit shape, ridge type and fruit yield during summer, 2022. Fruit length ranged from 7.85 (IIHR-81) to 36.35 cm (IIHR-101), fruit girth ranged from 9.90 (IIHR-81) to 21.45 cm (IIHR-160). Yield ranged from 0.2 - 27.5 t/ha. Fruit colour varied from light green, green to dark green and fruit shape varied from oblong to elongate. Ridge type varied from discontinuous to continuous. Highest yield was recorded by IIHR-45 (27.5 t/ha) followed by IIHR-55 (23.9 t/ha) and IIHR-28 (23.8 t/ha). A total of 131 germplasm lines were evaluated for yield, yield parameters and ToLCNDV resistance during summer, 2022. Out of these, five lines *viz*., IIHR-35, IIHR-37, IIHR-101, IIHR-114 and IIHR-147 were found resistant to ToLCNDV (with VI=1). Twenty eight germplasm lines and advanced breeding lines were evaluated for yield, yield parameters and downy mildew reaction during *kharif*, 2022. Out of these, six lines *viz*., IIHR-155-1, IIHR-61-1, IIHR-18-4-4, IIHR-18-4-3, IIHR-18-65-1, IIHR-18-65-2 were moderately resistant. Thirty two germplasm lines of ridge gourd were screened for fruit fly resistance in observational row trial under natural epiphytotic conditions without any pesticide spray during *kharif*, 2022. Fruit fly incidence ranged from 0-100% among these lines and IIHR-209-1 (sponge gourd) recorded zero incidence, whereas IIHR-DMR-18-65-2 and IIHR-209 (sponge gourd) were resistant. Resistance in these lines has to be confirmed through artificial screening conditions.

Fruit diversity of bitter gourd and ridge gourd germplasm

Ash gourd: Forty three germplasm accessions collected from ICAR-NBPGR, New Delhi were characterized. Among the evaluated accessions, maximum fruit yield per plant was recorded in IIHRAG-73 (36.40 kg/plant) followed by IIHRAG-61(33.12 kg/plant). Fruit length and circumference of the fruit varied from 12.38 cm (IIHRAG-78) to 32.22 cm (IIHRAG-75) and 28.31 cm (IIHRAG-78) to 68.50 cm (IIHRAG-63), respectively. Average fruit weight ranged from 0.5 kg (IIHRAG-78) to 6.9 kg (IIHRAG-61). Number of fruits per plant varied from 3.20 (IIHRAG-60) to 7.80 (IIHRAG-78).

Ash gourd fruit shape variability

Cucumber: One hundred forty seven germplasm lines were characterized as per the minimal descriptor of NBPGR, New Delhi for 44 traits. The node at which the first female flower appeared ranged from 2.33 (IC344358) to 12.67 (IC332429); and recorded one gynoecious (IC753493), three androecious and 143 monoecious accessions. Fruit colour at the marketable stage varied from cream, light green, green, dark green and brown; flesh colour varied from white, green and yellow. Fruit length at the marketable stage ranged from 7.1 cm (IC 354806) to 35.2 cm (IC 076297), fruit breadth and fruit shape showed significant variation. The number of fruits per plant and yield per plant (g) ranged from 0.75 (IC317485) to 19.80 (IC354806) and 200 g (IC317485) to 4980 g (IC523692), respectively. The fruit length ranged from 15.2 to 50.3 cm, number of seeds/pod ranged between 10 and 23.



Fruit variability in cucumber germplasm, A. IC523673, B. IC523695, C. IC354775, D. IC523687, E. IC635242, F. IC635243, G. IC421743, H. IC076297

One hundred and fourteen cucumber accessions were screened for downy mildew resistance under natural epiphytic conditions at ICAR-IIHR, Bengaluru during late *kharif* 2022 in augmented block design along with five checks. Among the accessions screened, the lowest PDI at 75 days after sowing and minimum AUDPC were recorded in IC572024 (42.22 & 1028.87, respectively).

Cucumber genotypes showing moderate resistance (IC572024) and highly susceptible (EC1041433) reaction to downy mildew resistance under natural epiphytic conditions

Onion: One hundred germplasm lines were screened for resistance to onion anthracnose caused by *Colletotrichum gloeosporioides* under natural field conditions during *kharif*, 2022. Out of them only LSR/18/37, a landrace collected from Chitradurga, Karnataka was found highly resistant (PDI-4.4). Besides, six populations, namely, Phule Samarth (PDI-15), Arka Kalyan (PDI-19), Kumpta local (PDI-31), LSR/18/61(PDI-31.5), Sangam selection (PDI-36) and Arka Kirthiman (PDI-36.5) showed moderate level of resistance under natural epiphytotic conditions.

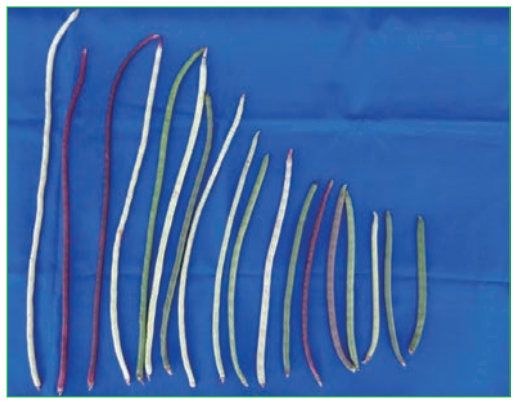
Incidence of onion anthracnose under natural field conditions during *kharif*, 2022 at ICAR-IIHR

French bean: Two hundred thirty four accessions were characterized during the summer and *kharif*, 2022. Among them, 133 accessions had green coloured pods, 60 accessions had light green coloured pods, 13 accessions had dark green coloured pods, three accessions (IIHR-234, IIHR-252, IIHR-296) were having purple pods, three accessions (IIHR-17, IIHR-51, IIHR-96) with yellow pods and remaining 18 accessions were having green pods with purple stripes. A total of 95 accessions were categorized as string less pods. Based on the mean performance, pod yield and yield attributing traits such as days to flowering (33.5-52.0 days), ten pod weight (32.6-82.5 g), pod length (8.1-33.1 cm) and green pod yield per plant (46.4-187 g/plant) were observed. During *kharif*, 2022, two accessions *viz*., IIHR-31 and IIHR-79 showed high level of tolerance to rust after spore suspension spray at flowering stage. Sixteen accessions were found to be field tolerant to viruses.

Cowpea: Sixty-seven germplasm accessions were characterized for pod yield and yield attributing traits

during the summer, 2022. Among them, 46 accessions were characterized as light green coloured pods, 11 accessions as green coloured pods, seven accessions as dark green coloured pods and three accessions (KVTSA-36-3, TSA-74 and TSA-50) were characterized as purple pods. Pod yield and attributing traits such as days to flowering (earliness), an average 10 pod weight, number of fruits/plant and pod yield/plant ranged from 67-95 days, 32-186 g, 3.0-71.5 pods/plant and 15.6-779.4 g /plant, respectively. Among the test entries, eight accessions such as KVTSA-38B, TSA-73, KVTSA-37, KVTSA-28, KVTSA-32, TSA-3-2, TSA-24 and TSA-52 were showing field tolerance to cowpea aphid-borne mosaic virus disease.

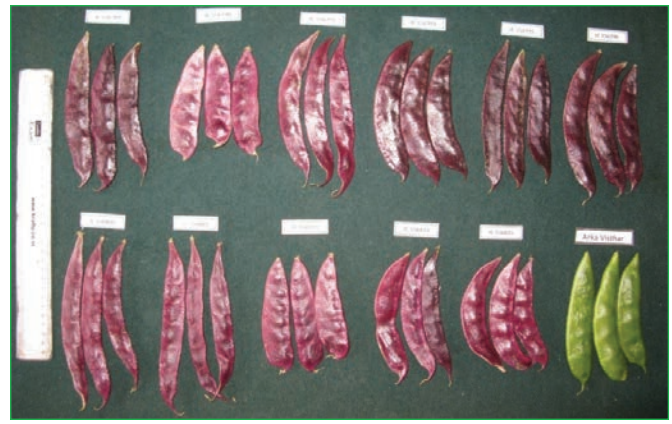
Flower (vexillum) colour variability in cowpea germplasm



Pod colour and shape variability in cowpea germplasm

Garden Pea: Fifty accessions were evaluated for pod yield and yield attributing traits during *rabi*, 2021-22. Six accessions (IIHR-13-1, IIHR-132, IIHR-231, IIHR-530, IIHR-576 and IIHR-685) have Afila type of canopy; 30 accessions had green coloured pods, 15 accessions were light green coloured pods and five accessions (IIHR-1 IP3, IIHR-13-3, IIHR-530, IIHR-576 and IIHR-768) were dark green coloured pods. Pod yield attributing traits such as days to flowering, pod length, number of seeds/pod, plant height and pod yield/plant was ranged from 28-52 days, 3.7-10.1cm, 3.5-8.5, 39.5-179 cm and 3.7-128 g, respectively. Nine accessions (IIHR-13-6, IIHR-13-10, IIHR-13-19, IIHR-13-22, IIHR-476, IIHR-576, IIHR-579, IIHR-582, IIHR-685, IIHR-698 and IIHR-709) were found tolerant to rust disease and six accessions (IIHR-13-10, IIHR-13-6, IIHR-13-7, IIHR-13-22, IIHR-13-26, IIHR-132) were tolerant to powdery mildew disease. Zinc content, ranged from 27.3 to 70 ppm on dry weight basis. Iron content at green pea stage in the germplasm ranged from 61.5-162.2 ppm and highest was recorded in IIHR-576 (162.2 ppm) followed by IIHR-698 (159.7 ppm).

Dolichos bean: Thirty-four purple coloured germplasm accessions were evaluated during the period. Fruit length ranged from 7.34 cm (IIHR-B-DB-65) to 17.3 cm (IC556786) and individual fruit weight ranged between 3.2 and 10.7 g in BRR/18/26 and IC556783, respectively. Anthocyanin content in the fruit ranged from 4.17 (IC556718 and BRR/18/25) to 137.77 mg/100 g (IC 556862) on dry weight basis.



Pumpkin: Twenty-one pumpkin and butternut accessions were characterized for vegetative, fruiting and yield characters as per NBPGR descriptors. Significant differences were observed among the accessions. All accessions had prostrate growth habit with fruits of oval, cylindrical, pyriform, flat round and globular in shape with varied fruit length (9.5 to 28 cm), fruit circumference (36-71 cm), average fruit weight (0.67-6.89 kg), flesh thickness (1.2 to 4.3 cm), TSS (3.7-10.2 °Brix) and yield (1.0 to 6.89 kg/plant). VS-1 had very small fruits with average weight of 0.67 kg and produced 7-8 fruits/plant with deep orange flesh colour.

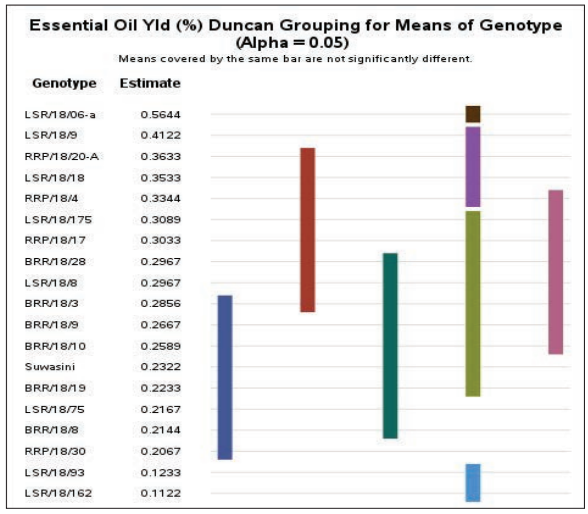
VS-1

LG-1

Curry leaf: One hundred germplasm lines were evaluated for fresh leaf yield, leaf size, leaf colour leaf texture and leaf fragrance. The leaf yield varied from 2.5 to 18.6 kg/plant/year. The accessions *viz*., LSR/18/06-a, LSR/18/75, LSR/18/8, LSR/18/9, RRP/18/55, RRP/18/20-a, BRR/19/26, BRR/19/09, BRR/19/16, BRR/18/31, RRP/18/14, BRR/18/27, BRR/19/22, BRR/18/2, BRR/18/11, BRR/19/23, RRP/18/4 and BRR/18/14 showed significantly higher fresh leaf yield/ plant as compared to the check variety Suwasini (14.37 kg/ plant/year). Nine accessions *viz*., LSR/18/75, LSR/18/8, LSR/18/9, BRR/19/26, BRR/19/09, BRR/19/16, BRR/19/22, BRR/19/23 and LSR/18/06-a have intense flavour as compared to Suwasini.

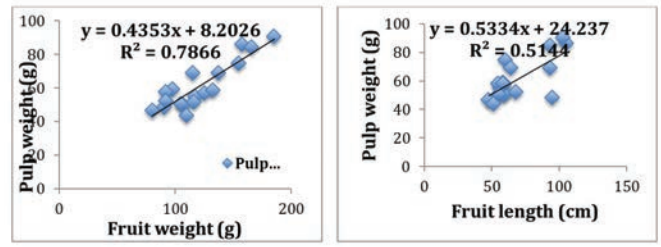
Variability of curry leaf germplasm for leaf size, leaf colour, leaf texture and fragrance

Fifty curry leaf germplasm lines were evaluated for fresh leaf essential oil yield through hydro-distillation. The essential oil yield varied from 0.11 to 0.56 per cent and maximum oil yield observed in LSR/18/06-a. Biochemical profiling of leaf essential oil showed the compounds such as trans-caryophyllene, valencene, gamma-terpinene and alpha-humulene are responsible for characteristic intense fragrance in curry leaves. Nutritional profiling of curry leaf germplasm indicated that BRR18/15 (7.0%) and LSR18/9 (6.9%) are rich in calcium; and LSR/18/06–A is rich in Fe (649.8 ppm) content.



Per cent leaf essential oil yield in curry leaf germplasm

Drumstick: One hundred fifty-five accessions were assessed for pod yield and tree yield ranged from 10.7-26.2 kg. Pod quality evaluation of drumstick accessions revealed that the fruit width is highly correlated with pulp content and has linear relation as compared to fruit length. Larger pods had higher number of seeds per pod and seed weight. Two peak flowering was observed and none of the accessions showed year the round flowering. Pod length ranged from 47.8-105.5 cm, pod girth from 4.93-6.95 cm, pod weight from 80.55-185.50 g, number of pods/tree from 78 -164, number of seeds/pod from 15-27 and pulp weight from 43.7 -902 g. Among the high yielding accessions, IIHR-D-8 was of purple fruit types with yield potential of 25.25 t/ha and all other accessions were of green pod types. The accessions IIHR-D-134 (41.84 t/ha), IIHR-D-137 (37.39 t/ha) had higher yield than commercial check PKM-1 (19.06 t/ha).



Correlation of fruit weight and fruit length with pulp weight among drumstick accessions

Radish: Among 52 accessions evaluated for root characters, maximum root weight was observed in IIHR-71 (459.0 g) followed by IIHR-81 (348.0 g), IIHR-66 (325.3 g) and IIHR-63 (268.0 g) in comparison with check variety Pusa Chetki (113.1 g). Highest root length was observed in IIHR-71 (23.73 cm) followed by IIHR-81(22.66 cm) and IIHR-82 (21.16 cm) compared to Pusa Chetki (11.5 cm). Among 25 accessions profiled for root biochemical characters**,** IIHR-9, IIHR-15, IIHR-16, IIHR-17, IIHR-32, IIHR-33, IIHR-35, IIHR-61, IIHR-73 and IIHR-75 had less pungency due to <2.0 mg/100 g isothiocyanates compared to Arka Nishant (3.50 mg/100 g). High TSS was observed in IIHR-15 (3.45 °Brix) and high vitamin C was found in IIHR-9 (20 mg/100 g). Among 65 accessions characterized in polyhouse at 39-42 °C, 19 lines were found heat tolerant with higher root yield compared to Pusa Chetki. Photosynthetic rate, stomatal conductance and transpiration rate were higher in heat tolerant accessions compared to check Pusa Chetki. Among 48 accessions evaluated in open field condition (36 °C), 20 accessions have been identified promising out of which IC347787, IC433540, IIHR -77, IIHR-78 and IIHR-81 were found to be superior for early rooting and higher yield compared to check Pusa Chetki.

Carrot: Among ninety six accessions evaluated, IIHR-110, IIHR-109, IIHR-206, AS9 and AS10 were found superior for high root weight (>150 g), root length (15-20 cm) and self core. High TSS was found in IIHR-6 (17 °Brix). AS9 and AS10 carrot lines recorded high marketable yield 55.45 and 53.65 t /ha, respectively and were found early (90 days) compared to Early Nantes (120 days). Among 32 lines tested for total carotenoids, IIHR-200A (22.82 mg/100 g) was found superior with high TSS (17 °Brix). Twenty three carrot accessions were screened forroot knot nematodes resistance through artificial inoculation and among them Acc. 88 was found to be highly resistant; five lines *viz.*, AS 9-2, IIHR-200A, IIHR-128, IIHR-15 and Acc.113 were reported as resistant.

Acc. 88 (RKNR)

Arka Suraj (RKNS)

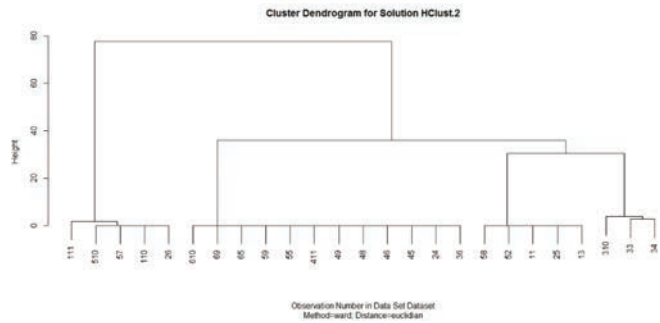
Artificial screening for powdery mildew resulted in identification of moderately resistant carrot accessions *viz*., IIHR60 (PDI 12.59) and IIHR61 (PDI 14.07) compared to Arka Suraj (PDI 40.74).

IIHR-36 (PMS) IIHR-60 (PMR) IIHR-61 (PMR)

Reaction of carrot genotypes to powdery mildew resistance (*Erysiphe* sp.)

FLOWER AND MEDICINAL CROPS

Rose: Based on sensory evaluation for fragrance, 46 genotypes were classified into major five core groups. Twelve red flower genotypes and six of pink flower genotypes were found to be distinct, while, remaining collection though were collected from different locations having different names were found to be the duplicates.



Identification of distinct groups in fragrant rose germplasm of pink colour group based on morphological characters

The existing germplasm was screened for black spot disease (BSD) (*Diplocarpon rosae*) under field conditions during peak disease incidence. The germplasm 'Knock Out' was found to be immune (0 PDI), while 'Carefree Beauty' and 'Crifty Duty' were found to be highly resistant (1-5 PDI).

Marigold: Twenty French marigold collections were characterized for morphometric characters. Among the germplasm characterised, wide range was recorded for plant spread (22.5-91.67 cm^2), number of primary (5.8-23.3) and secondary branches (11.29-70) and total number of flowers per plant (44.1-414.9).

Representation of diversity in French marigold collection

Out of sixty four germplasm screened, for *Alternaria* blight disease, the genotypes Arka Madhu, Pusa Arpita, IC250332 and IC250323, were found to be moderately resistant.

Jasmine: Forty-two accessions belonging to four commercially cultivated species *viz., Jasminum sambac, J. auriculatum, J. grandiflorum, J. multiflorum* and six other lesser-known species (*J. rigidum, J. nitidum, J. flexile, J. malabaricum, J. humile* and *J. calophyllum*)

were characterized based on the morphological descriptors.

Tuberose: Ten germplasm were characterized as per standard descriptors.

Gladiolus: Ten germplasm were characterized as per standard descriptors.

Chrysanthemum: A total of 51 named genotypes were characterized for 77 traits as per DUS test guidelines.

China aster: A total of 28 named genotypes for 21 traits were characterized as per DUS test guidelines.

MEDICINAL CROPS

***Gudmar* (*Gymnema sylvestre*):** A total of 35 accessions were characterized for 13 morphological traits. Variability was recorded for leaf length (3.42 to 7.90 cm) and leaf width (1.92 to 5.23 cm). The highest leaf area was recorded in IIHR-GS-18 (25.85 cm^2) followed by IIHR-GS-42 (24.34 cm^2).

***Brahmi* (*Bacopa monnieri*):** Eighty two germplasm accessions were characterized for 16 morphological traits as per DUS test. The germplasm IIHR BM 23 followed by IIHR BM 18, IIHR BM 16 and IC324777, were identified as desirable genotypes for growth and yield parameters. The accessions IC565503 showed yellowish-green leaf colour and IIHR BM-2, IIHR BM-19, IIHR BM-9, IIHR BM-16 and IC565508 genotypes exhibited cuneate leaf shape.

CHES - CHETTALLI

FRUIT CROPS

Longan: Out of 37 longan seedlings characterized for plant growth parameters, maximum plant height was recorded in R1P1 (7.0 m), canopy spread E-W (8.6 m), N-S (8.4 m) and trunk circumference (127.3 m) in R11P1.

Fruting in Longan Accession R1P1

Out of 13 seedlings characterized for fruit and yield traits, maximum fruit weight (7.7 g), fruit length (2.18 cm), pulp weight (5.46 g) was recorded in seedling R2P6 which was on par with R2P5, R2P1 and R1P1, however, maximum TSS (21.58 ^oBrix), number of panicles/plant (350) and yield/plant (80 kg) were recorded in seedling R1P1, while, maximum number of fruits per panicle was recorded in R12P1 (71.67).

Malabar tamarind: Out of 28 accessions characterized for fruit and yield characters, maximum fruit weight (125.74 g), rind weight (86.79 g) and pulp weight (26.07 g) were recorded in accession GG-20; maximum rind thickness in GG-1 (13.83 mm), rind TSS in GG-8 (15.2 ^oBrix), number of fruits/plant in GG-7 (5700 fruits) and yield in GG-7 (460 kg/plant) was observed.

Accession GG-7

Wild fruits: The six different native fruits of Coorg region *viz*., *ammeannu*, *kotteannu*, Indian plum, *paaleannu*, *kokkarchiannu* and *huliannu* were characterized for leaf and fruit characters. The average fruit weight of *ammeannu*, *kotteannu*, Indian plum, *paaleannu*, *kokkarchiannu* and *huliannu* was 0.9, 0.97, 2.85, 46.19, 0.65 and 3.74 g, respectively. The *paaleannu* is mainly consumed for deworming.

Ceylonbox wood (*Canthium dicoccum*)

Wild jujube (*Ziziphus rugosa* Lam.)

Indian Plum (*Flacourtia Indica* Merr.)

***Paalehannu* (*Chrysophyllum lanceolatum*)**

***Huliannu* (*Rourea minor*)**

***Kokkarchiannu* (*Scutia myrtina*)**

Avocado: Out of 15 accessions characterized for fruit traits, Acc. 22 was found to be special with high average fruit weight (236 g), pulp recovery (50.14%), peel thickness (>2 mm), TSS (9.4 ºBrix), fat content (21-23%) and yield (40 kg/ plant).

Accession-22

Coorg mandarin: Out of 11 good yielding accessions which were characterized for fruit traits, maximum fruit weight (166.7 g), fruit length (7.4 cm), fruit diameter (5.6 cm) and juice content (69.3 ml) was recorded in CM-1, however, minimum number seeds and high TSS was recorded in genotypes CM-6 and CM-5, respectively.

Accession CM-6

3.1.4. EVALUATION OF GERMPLASM FOR YIELD AND QUALITY

FRUIT CROPS

Rose apple: Based on *in situ* evaluation, one superior tree of seedling origin (SJ-8) from Agrahara Taluk, Devanahalli was identified for yield and fruit characters, which annually yielded around 600 kg/tree, fruit weight (40 to 80 g), pulp thickness (7 mm) and pulp recovery (>85%). Fruit quality was good with TSS (14 ºBrix), acidity (0.06%) and Vitamin C (7.5 mg/100 g) and shelf-life (3 days) at room temperature. The average content of total phenols (31.12 mg/100 g fresh weight), total favonoids (10.67 mg/100 g fresh weight), anti-oxidants (FRAP 40.64 mg/100 g fresh weight, DPPH 112.95 mg/100 g fresh weight), vitamin C (7 mg/100 g fresh weight), protein (540 mg/100g fresh weight), total sugars (reducing- 22.93 and non reducing 82.33 mg/100 g fresh weight) was recorded. Nutrient content in pulp was estimated as K (2.38%), Ca (0.24%), Fe (35.42 ppm), Zn (7.63 ppm) and Mn (3.08 ppm).

Superior Rose apple seedling selection SJ-8 from farmer's field

Out of ten accessions (AS/DP 1-10) evaluated for fruit quality traits, fruit weight ranged from 13.88 (AS/DP-9) to 38.32 g (AS/DP-5), maximum fruit length was recorded in AS/DP-7 (4.76 cm) and fruit width in AS/DP (5.12 cm), pulp thickness in AS/DP-2 (0.63 mm). The average pulp recovery (83%) was recorded in AS/DP-2 (87%) and TSS in AS/DP-1 (13 °Brix). Fruit length/breadth ratio ranged from 0.79 (*Golap* type) to 1.34 (*Malai* type). AS/DP-9 was rich in total carotenoids (2.58 mg/100 g fresh weight) and lycopene (1.25 mg/100 g fresh weight), while, AS/DP-6 in total proteins (1259.38 mg/100 g fresh weight), total sugars (99.09 mg/100 g fresh weight) and non reducing sugars (65.70 mg/100 g fresh weight).

Rose apple types *Golap* and *Malai* collected from 24 Parganas

Wood apple: Twenty accessions were evaluated. Variability was observed for fruit weight (128 g - 440 g), fruit length (6.4 - 10.25 cm), fruit width (6.4 - 9.4 cm), number of seeds/fruit (111-550) and pulp recovery (40-67%). Fruit colour was grey green group (RHS 197 to grey brown group 199A) and pulp colour ranged from greyed orange group (RHS 175A) to brown (RHS 200C). Fruit weight of >300 g was recorded in seven genotypes pulp recovery >55% in DB-3. All the18 accessions were good yielders with >100 fruits/tree.

Two accessions (CHWA-10 and CHWA-1) recorded higher total phenols (>105 mg/100 g pulp). The accession CHWA-11 was rich in flavonoids (28.25 mg/100 g), whereas, highest antioxidant activity was observed in S-2 (152.12 mg DPPH/100 g) and D-13 (88.1 mg FRAP/100 g). Seeds contained 3.72 % N, 0.45% P, 0.24% Ca, 0.35% Mg, 0.18% S, 46.62 ppm

Zn and 18.46 ppm Cu. Wood apple pulp was rich in K (0.85%), Fe (43.85 ppm) and Mn (40.66 ppm). Crude fibre in fruit samples varied from 4 to 7%.

***Aonla*:** Among the varieties, NA-7 recorded maximum yield (75 kg/tree) with bold fruits (> 60 g), high pulp recovery (90%). The Anand-2 variety recorded maximum Vitamin C content (507.69 mg/100 g fresh weight).

Jackfruit: Out of four major jackfruit species *viz.*, *Artocarpus heterophyllus*, *A. lakoocha*, *A. hirsutus*, *A. camansi* assessed for nutritional quality for vegetable purpose, *A. heterophyllus* recorded higher amount of dietary fibre, ash, starch, polyphenolics and antioxidant potential, while, *A. lakoocha* recorded high amount of vitamin C and titratable acidity.

Tamarind: Fifty three germplasm accessions were evaluated at CHES, Bhubaneswar for their physical and biochemical parameters of fruit quality. Variability was observed with respect to pod length (7.48-17.68 cm), fruit weight (6.40-23.19 g), pulp content (36.9-53.68%), moisture content (10.78-18.39%), total soluble solids (66.32-81.1 ºBrix), acidity (6.10-18.75%), and total sugars (23.92-41.67%).

The concentrations of total phenols and total flavonoids per 100 g fresh weight were 97.21-195.11 mg GAE, and 31.50-283.04 mg QE, respectively. Anti-oxidant capacity measured in terms of FRAP and DPPH varied between 10.62-19.37 mM Fe(II)/100 g fresh weight and 54.85-83.98%, respectively.

Tamarind germplasm block at CHES, Bhubaneswar

Promising sweet type tamarind germplasm collected from Koraput, Odisha

***Jamun*:** A total of 54 germplasm accessions were evaluated for vegetative growth, 65 germplasm for yield, quality and biochemical characters were evaluated at ICAR-IIHR, and 26 germplasm accessions at CHES (ICAR-IIHR) for physical and biochemical parameters of fruit quality were evalauated.

VEGETABLE CROPS

Moringa: About 83 germplasm were characterized for leaf nutrient to assess the variability among the germplasm.

Amaranthus: Morphological, nutritional characterization and response to white rust was carried out for 19 selected advanced breeding lines of amaranthus. The fresh foliage yield varied from 7.81t/ha (IIHR-B-AM-45-6-2) to 29.6t/ha (IIHR-B-AM-286-17-2-8). Accessions namely, IIHR-B-AM-8-13-5-2, IIHR-B-AM39-16-3, IIHR-B-AM45-6-2, IIHR-B-AM65-17-3-8, IIHR-B-AM231-13-2-15, IIHR-B-AM248-3-2, IIHR-B-AM258-11-1-8, IIHR-B-AM269-4-7, IIHR-B-AM276-3-9-4, IIHR-B-AM286-17-2-8, IIHR-B-AM287-3, IIHR-B-AM293-8 showed 100% field resistance to white rust. Nutrient and anti-nutritional composition of advanced breeding lines of amaranthus were analysed. Total N, P, Ca, Fe and Zn in the leaves varied between 2.91-4.4, 0.51-0.60, 1.6-2.4% and 831.13-1168.48 and 133.85-206.29 ppm, respectively. Similarly; total phenols, FRAP antioxidant activity, total flavonoids, DPPH anti-oxidant activity, and nitrates ranged between 568.62-1220, 559.83-1531.17, 352-1284, 347-1397, 2.43-20.82 mg/100g dry weight, respectively.

FLOWER AND MEDICINAL CROPS

Rose: Out of 46 fragrant genotypes evaluated for yield and phytochemical characters, variation was observed for anthocyanins (87.80-1900 mg/100 g dry weight), antioxidant activity (5572-34100 mg/100 g dry weight) and total phenol content (4800-11900 mg/100 g dry weight), and for flower and yield traits, variation was observed for flower diameter (1.2 -10 cm), number of flowers/plant/month (80-280) and flower weight/plant/month (0.5-1.25 kg).

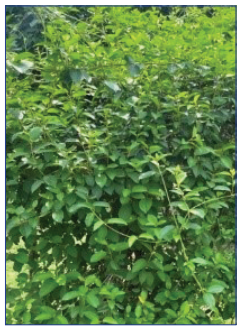
Tuberose: Tuberose line IIHR-4 (INGR22056) was registered with ICAR-NBPGR, New Delhi for novel traits.

Chrysanthemum: Out of 20 germplasm accessions evaluated for yield and flower quality, variety Arka Yellow Gold recorded high loose flower yield. Three genetic stocks *viz.*, IIHR4-8 (INGR22182), IIHR2-16 (INGR22180) and IIHR2-13 (INGR22181) were found promising for pot culture and bedding and have been registered with ICAR-NBPGR, New Delhi for their novel traits.

China aster: A total of 28 germplasm were evaluated for yield and quality traits. In white flower colour group, cultivars Phule Ganesh White and Arka Archana recorded high loose flower yield, and pink colour group, Arka Kamini and Arka Advika found promising for cut flower. In violet colour group, Arka Nirali with novel flower as found promising for cut flower. All the Matsumoto series varieties showed dwarf plant stature.

MEDICINAL CROPS

***Gudmar* (*Gymnema sylvestre*):** Out of 35 accessions evaluated for fresh leaf yield/plant, the variation was observed for mean fresh leaf yield/plant (0.09 kg to 1.76 kg). IIHR-GS-27 recorded the maximum yield (1.76 kg) followed by IIHR-GS-9 (1.74 kg), maximum gymnemagenin content was estimated in IIHR-GS-44 (1.954%) followed by IIHR-GS-37 (1.720%) and IIHR-GS-19 (1.688%). The accessions IIHR-GS-9 (12.38 kg/ha), IIHR-GS-25 (10.83 kg/ha) and, IIHR-GS-37 (9.40 kg/ha) were found promising based on the higher gymnemagenin yield/hectare.



IIHR-GS-27 (High leaf yield/ plant)

IIHR GS44 (High gymnemagenin content)

IIHR-GS-9 (High gymnemagenin yield/ha)

***Brahmi* (*Bacopa monnieri*):** Germplasm accessions were evaluated for growth and yield parameters, the accessions IIHRBM-23, IIHRBM-18, IIHRBM-16 and IC324777 recorded better growth and produced higher biomass (18 to 20 t/ha).

The chemical analysis for different triterpenoid saponins showed that Bacoside A3 content was highest in IC343108 (1.00%), IIHRBM-5 (0.99%) and Bacopaside content in IIHRBM-30 (1.81%), IC554588 (1.66%), and Jujubogenin content in IC321278 (0.79%), IC284992 (0.77%), and Bacopasaponin C content (1.04%) in JU20/34 and IIHR BM 21 (0.81%). The total triterpenoid saponin (Bacoside A) was highest in IC554588 (3.49%) followed by IIHR BM 30 (3.404%), IIHR BM-21 (3.38%) and IC343108 (3.33%). Studies on correlation indicated that number of primary branches and fresh herb yield have significant and positive association with herb yield.

Molecular analysis revealed that IIHR BM-31 and IC468878 are the most diverse genotypes. Genotypes IIHR BM-30, IC565466 and IC554586 grouped together in cluster analysis based on morphological, biochemical and molecular levels showing high degree of similarity.

3.2. CROP IMPROVEMENT

FRUIT CROPS

Mango: Hybridization was carried out in 8 different combinations Alphonso x *Mangifera camptosperma*, Alphonso x Pedda Neelum, Amrapali x Pedda Neeelum, Amrapali x *Mangifera odorata*, Amrapali x *M.camptosperma*, Mallika x Pedda Neelum, Alphonso x Vanraj, Amrapali x *Mangifera odorata* and raised 72 F1 progenies in polybags.

Evaluated 101 mango hybrids for fruit quality parameters of which 5 F1 progenies (R1P2, R1P57, R1P62, R3P11 and R12P3) have been selected for further evaluation.

Quality traits of selected mango hybrids

Sl. No.	Name	Fruit weight (g)	Fruit length (cm)	Fruit width (cm)	Fruit thickness (cm)	TSS (°B)	Skin (g)	Stone (g)	Pulp (%)	Peel colour	Pulp colour
1.	R1P2	295.43	11.68	7.40	6.38	20.72	49.08	34.18	71.82	Yellow green	Orange group 24 A
2.	R1P57	269.17	9.70	8.20	6.53	18.10	48.40	35.77	68.73	Yellow	Yellow orange 23 A
3.	R1P62	232.05	10.35	6.55	6.00	23.00	39.05	36.70	67.36	Yellow green with red tinge	Orange group 24 A
4.	R3P11	253.80	9.88	7.23	6.20	20.90	38.65	38.20	69.72	Yellow green	Orange group 24 A
5.	R12P3	336.20	10.77	7.17	6.70	20.70	46.10	31.60	76.89	Yellow	Orange group 24 A

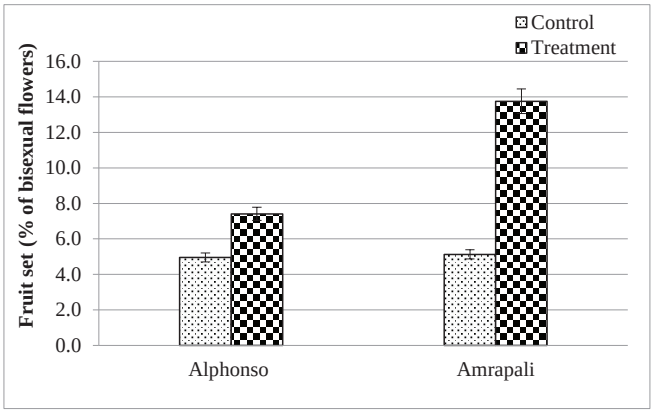
		Crop DNA FingerPrint Database										
		Barcode Representation										
	Mango											
	SSR											
Sl. no	**Variety**	**11588**	**18463**	**8095**	**333**	**99**	**21478**	**88**	**16400**	**80**	**81**	
1	**Arka Uday (Big fruit)**											
2	**Arka Uday (Original)**											

Molecular Barcode generated for mango genotype/ hybrid/ variety using Crop DNA Fingerprint database

Identification of promising mango clone: Fruit quality traits of selected mango clone (Arka Udaya big fruit) as given below;

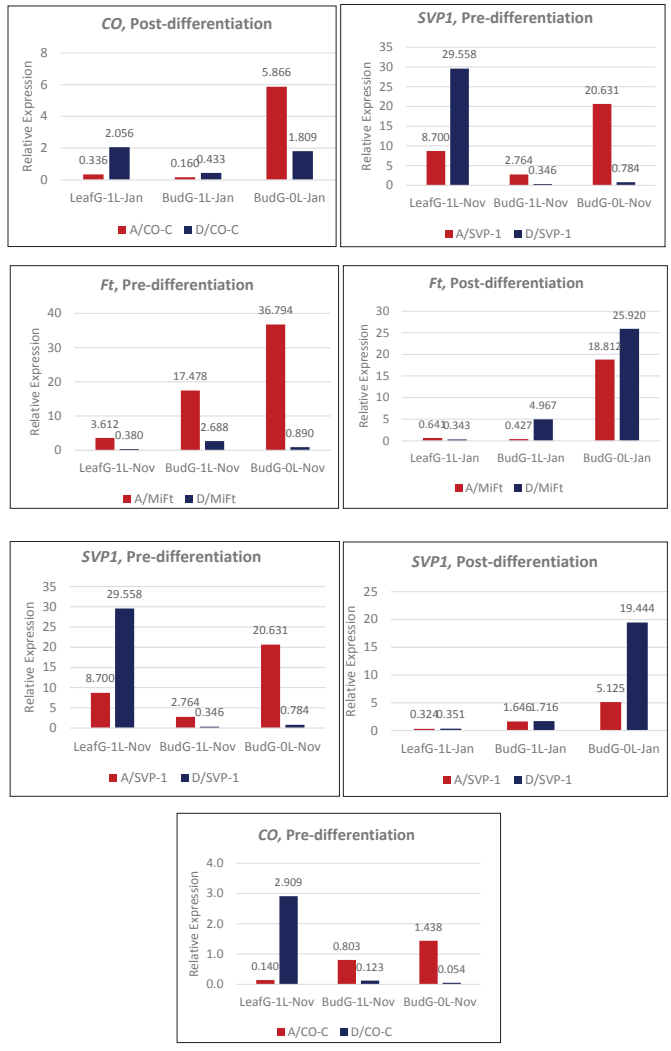
- Fruit Size : Medium (350-400 g)
- TSS: 24-25 °Brix
- Fruit shape: Oblong
- Pulp: Orange 24 A
- Pulp content : > 75%
- Keeping quality: 8-10 days
- Pulp traits: Amrapali
- Regular and cluster bearing

Fruit set



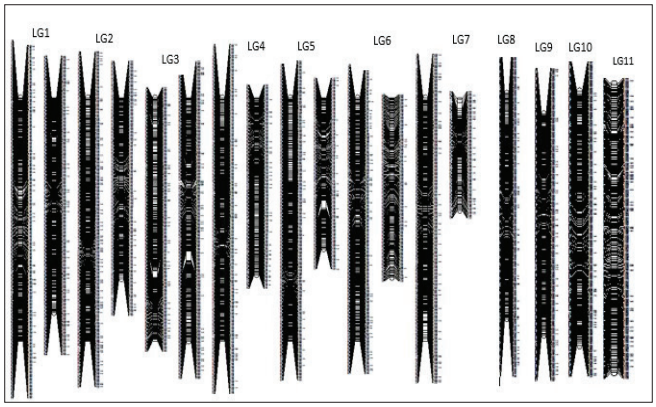
Spray of a mixture of minerals, hormones and amino acids was done at flower initiation, 50% flower opening and complete bloom stage. The second spray was given after fruit set. There was an increase in fruit set and retention in both Amrapali and Alphonso. Fruit set was calculated as per cent of bisexual flowers per panicle.

Expression of flowering genes: The last quarter of 2021 received unseasonal heavy rains (592.1 mm), resulting in very low flowering of only <10 and <16% in Amrapali and Dashehari, respectively. Since the bud of G0L receives no signal from leaf, it demonstrated complete vegetative development. Compared to Dashehari, the regular bearer Amrapali showed early expression of all flowering inducers and the repressor gene *SVP1*. The gene expression of G0L bud was opposite to that of G1L bud for all genes (except *SOC*). In buds of both Amrapali and Dashehari, the inducer *CO* and the induced flowering signal *Ft* followed the same trend. Compared to the flowering inducers, expression of *SVP1* was much higher, explaining the vegetative growth of both varieties this year. When *SVP1* expression is high, *Ft* and *SOC* are repressed in leaf and G1L bud. *LFY* and *AP1* expression in G1L leaf and bud decreased post-differentiation, in both varieties; correlating with *Ft* expression .



Banana

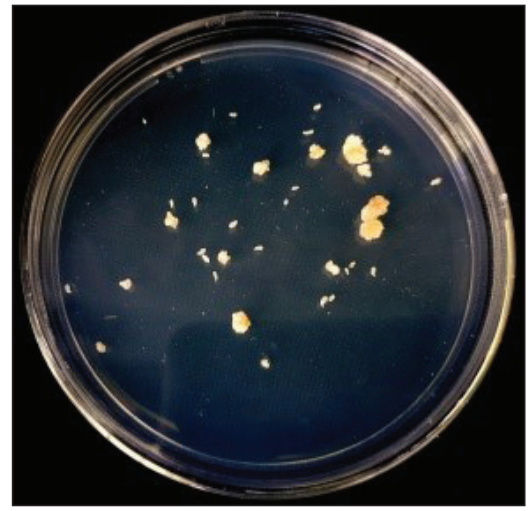
High-density linkage map construction: Genotyping by Sequencing (GBS) analysis was performed for 94 banana F_1 progenies generated by crossing *'Bee HeeKela'* and *'Bemethiya'*. The raw reads generated were filtered using trimmomatic tool. The filtered reads were aligned to the reference genome, DH Pahang V2.0 using burrow wheelers algorithm. A total of 4,32,338 SNPs were obtained after alignment with reference. Furthermore, the SNPs were filtered based on the criteria; missing genotypes, minor allele frequency and Hardy Weinberg equilibrium after which a total of 30,421 high quality SNPs were obtained. The 30,421 SNPs were imported to JoinMap V5.0 software for linkage map construction. A high-density linkage map was constructed at LOD of 11 using Kosambi mapping function and the maps were drawn using ML (maximum likelihood) mapping. Out of 30,421 SNPs, 6894 SNPs formed 11 linkage groups spanning a total distance of 2268.55 cM.



Linkage map of banana with 11 linkage groups

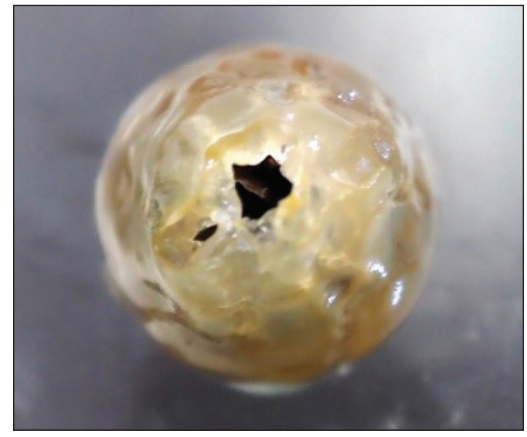
Papaya

Exploitation of doubled haploid technology: Doubled haploid (DH) technology is a non-conventional biotechnological, plant tissue culture method to develop 100% homozygous and non-segregating pure-lines in cross-pollinated crops in heterosis breeding. This project is the first of its kind to attempt DH technology in fruit crops with a special reference to papaya. Sterile irradiated pollen induced gynogenesis and ovule culture was attempted in var. Arka Prabhath. Pollen was collected and irradiated to different doses of radioactive ^{60}Co isotope and then used for pollinating receptive female and emasculated hermaphrodite flowers. Immature fruits of Arka Prabhath were harvested and surface sterilized. Immature ovules were isolated and cultured on various modified MS medium with different supplementations of cytokinins and auxins. Callus induction and shoot induction responses were recorded.



Callus induction from unfertilized ovules pollinated with pollen irradiated with average 50 Gy gamma on MS medium containing 0.1 mg/L NAA and 1.0 mg-/L BAP

Re-initiation of shoot buds from organogenic callus (MS medium+2-3 mg/L BAP+0.2 mg/L NAA)



Somatic embryo-dome-like growth on immature ovule on modified MS medium

Enhanced shoot bud induction response will be attempted by adjusting various *ex planta* and *in vitro* parameters.

Breeding for PRSV tolerance: The evaluation of intergeneric progenies (F_2/ three way cross) for PRSV resistance/ tolerance indicated that 120 seedlings in the combination involving F_1 (Arka Prabhath x *Vasconcellea cundinamarcensis*) x Red Lady did not express PRSV symptoms at the end of challenge inoculation period out of total 2721 seedlings inoculated for PRSV. In the combination involving F_1 (Arka Prabhath x *Vasconcellea cauliflora*) x Red Lady, 302 seedlings did not express PRSV symptoms at the end of challenge inoculation out of 3,330 seedlings inoculated for PRSV. All those seedlings were field planted for further evaluation.

Evaluation of back cross progenies **(**BC_1F_2 progenies of Arka Prabhath x *V. parviflora* x Arka Prabhath) was done for fruit traits such as fruit weight (800 to 1200 g), pulp thickness (2.74 to 3.30 cm, total soluble solids (11 to 12.4 ºBrix), fruit cavity per cent (25 to 40), pulp colour (yellow orange to orange red) and PRSV tolerance. Three progenies each in yellow and red pulp were selected for further advancing.

Evaluation of F_1 intergeneric progenies: The F_1 intergeneric progenies (Arka Prabhath x *V. cauliflora*; 100 Nos.) and (Red Lady x *V. cauliflora*: 54 Nos.) were field planted for further evaluation.

Guava

Breeding for nematode and wilt tolerance: Screening of interspecific hybrid progenies for nematode (*Meloidogyne incognita*) and wilt (*Fusarium oxysporum* f. sp. *psidii*) resulted in identification of 40 interspecific hybrid progenies (10 in Arka Poorna x *Psidium cattleianum* var. *lucidium*, 16 in Arka Poorna x *P. cattleianum* var. *cattleianum*, 12 each in H 12-5 x *P. cattleianum* var. *lucidium* and H 12-5 x *P. cattleianum* var. *cattleianum*) found to be resistant to both wilt and nematode after challenge inoculation. These progenies are being multiplied vegetatively for further evaluation of horticultural traits.

Interspecific hybrid progenies of guava (Arka Poorna x *P. cattleianum* & H 12-5 x P. *cattleianum*)

In another set of progenies, out of 150 interspecific progenies of Arka Poorna x *P. cattleianum* var. *cattleianum* screened for nematode (*Meloidogyne incognita*) by challenge inoculation, 17 progenies did not developed root galls. These resistant progenies are being screened for wilt pathogen (*Fusarium oxysporum* f. sp. *psidii*).

In order to overcome the graft incompatibility existing between *P. guajava* as scion and *P. cattleianum* as rootstock, two methods of grafting (approach and soft wood) were attempted using growth regulators. It has resulted in very low success rate (4 to 10%).

Mutagenesis in guava for wilt resistant rootstock: Four mutants of purple guava (*P. guajava*) were shortlisted after repeated inoculation with *Fusarium oxysporum* f.sp. *psidii* culture under pot conditions, the plants were further subjected to screening using nematodes (*Meloidogyne incognita*).

Induced parthenogenesis in guava - Arka Poorna for haploid production: The induction of parthenogenetic haploids of Arka Poorna x Arka Poorna (Irradiated Vs Normal pollens) and Arka Poorna x *P. cattleianum* (Irradiated Vs Normal pollens) resulted in 1.2 and 0.2 percent fruit set after pollination of Arka Poorna female parent with normal pollens collected from Arka Poorna x *P. cattleianum*, respectively, whereas no fruit set was observed using irradiated pollens (150, 200 and 250 Gy).

***Annona*:** Backcrossing of Arka Sahan with *A. squamosa* cv. Balanagar (BC_1F_1) with the objective to develop self fruitful population was carried out and evaluated about 1600 progenies for self fruitfulness. Sixty three progenies were found to be self fruitful. Six progenies (1/1, 10/3, 13/1, 7-4/5, 7-7/11 and 7-11/7) were promising and stable for self fruitfulness. A progeny 10/3 has been isolated for self fruitfulness, similar to Arka Sahan traits that produced 37 fruits per tree with an average fruit weight of 324.25 g and having TSS of 30.0 °Brix. Other progenies were found similar to Balanagar or intermediate between Balanagar and Arka Sahan for various traits. Progeny row trial was initiated in field with all six progenies for secondary selection.

Seven-year-old interspecific hybrid progenies (500 No.) of *Annona* involving crosses between Atemoya and custard apple were evaluated for self fruitfulness. Inter-specific hybrids were found to be non stable for yield and self fruitfulness.

Self fruitfulness in 10/3 progeny

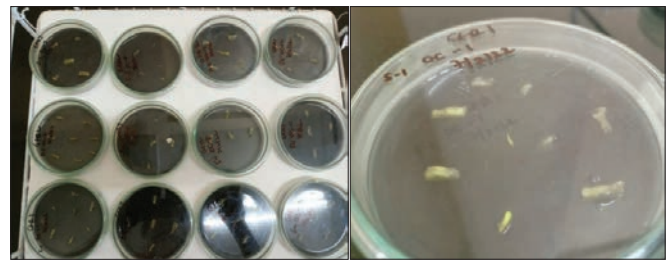
Grape: In grape rootstock breeding, hybridization between Dogridge and 110R was taken up in order to broaden the genetic base of Dogridge and its further improvement. Fifty five hybrid progenies were field established, thereby hybridization were taken up during April, 2022 second fortnight due to favourable climate (mean maximum temperature of 35.2 ºC and minimum of 19.1 ºC and rainfall of 54.7 mm) that favoured modification of vegetative shoot mersitem to floral meristems. About 658 seeds were kept for stratification (4 ºC for 90 days). During optimized pruning timing of flowering in Dogridge, September II fortnight and October I fortnight pruning, hybridization was carried out between Dogridge and 110R, out of 57 inflorescence crossed 25 fruit bunches were developed.

Out of M_1 and hybrid progenies of Dogridge, twenty seven progenies were well established in the field, of which fifteen hybrid progenies were multiplied through macro propagation and twelve hybrid progenies were multiplied through *in vitro* propagation for sodicity screening.

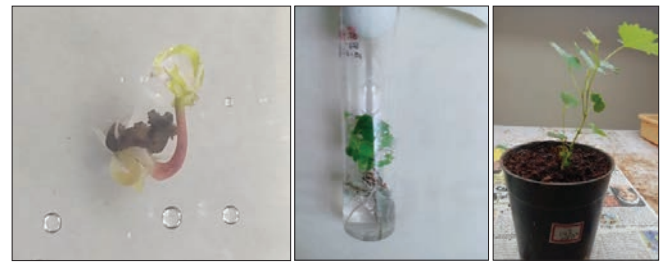
In grape scion breeding program, hybridization of Red Globe as female parent and Bianca as male parent was taken up. Three hundred and ninety hybrid progenies were screened (at field level) at nursery stage of which four progenies were found tolerant to downy mildew. Embryo rescue was carried out in Flame Seedless x Bianca cross and the tolerant progeny was established in the field.

Embryo rescued Flame Seedless x Bianca plant

Hybrid embryo rescue from distant hybridization: A total of 768 embryos from Flame Seedless x Bianca cross, immature seeds without ovule and immature seeds with ovule from berries harvested at 40, 41, 42, 45, 48 and 49 days after crossing were inoculated on different media (WPM, MS Gamborgs B5 vitamins, ER medium with hormones) for rescuing the embryos. The viable cultures were sub-cultured on MS and WPM medium for further studies. Embryos develeoped on WPM media and further germinated on half-strength MS with 0.5 mg /L GA_3. The well developed plantlets were transfered to hardening medium containing autoclaved Arka Fermented Cocopeat with FYM and covered with polythene cover to maintain the humidity. After new leaves were observed the plants were gradually acclimatized by making holes in the polythene cover. Once established, the plantlets were transferred to field.



Embryo inoculation **Embryo development**



Germination **Plantlet** **Hardened plant**

Pomegranate: In order to create variability in nodal blight resistance, mutation breeding was initiated. A total of 6,864 mutants cv. Bhagwa were developed and screening is underway for nodal blight disease.

The USDA collection 99A, which was identified as resistant source to nodal blight in pomegranate, has not flowered in Bengaluru conditions. Hence, cold treatment along with grafting trial was initiated. Grafting success was highest in 200 h of cold treatment with 4 to 6 mm thick semi-hard wood cuttings.

Towards achieving the objective of developing of wilt tolerance/ resistance in pomegranate, screening of Nana population of OP and clonal propagules were initiated. Inspite of poor (18%) seed germination, 20 OP Nana progenies were developed. Both OP Nana progenies and clonal population are under artificial screening for wilt. In order to introgress wilt resistance into cv. Bhagwa, it's hybridization with Nana (selected) was taken up.

Mutant population of pomegranate cv. Bhagwa and disease development upon artificial screening

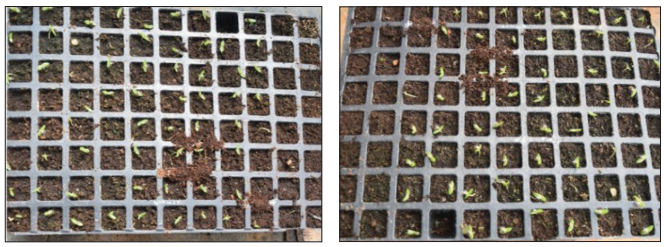
Dragon fruit (*Hylocereus* sp.)

Standardization of LD_{50} value for gamma radiation: Mutation was induced in pre-soaked red dragon fruit seeds using gamma radiation to fix the optimal dosage (LD_{50}). Dose levels ranging from 100-3,500 Gy were

used and gamma ray dosage of 3,250 Gy was fixed as LD_{50} dose. With the LD_{50} dose mass scale population were raised for 3,000 to 3,500 Gy, and the germinated seedlings were maintained for further studies.

Germination per cent of dragon fruit seeds treated with gamma radiation

Treatment	No. of seeds treated	Germination (%)
Control	1,000	71.23
3,000 Gy	1,000	51.23
3,250 Gy	1,000	50.45
3,500 Gy	1,000	48.23



Control 3,000 Gy

3,250 Gy 3,500 Gy

Dragon fruit seed germination treated with different dosage levels of gamma radiation

Promising lines of under-utilized fruit crops

Avocado line (IC0626510): A promising seedling selection was developed by individual plant selection from seeds collected from avocado grown in Madikeri (12.4208º 75.739, 1182 m above MSL) by random selection in 2012. It is a promising genotype with large sized green fruits weighing about 243 g. Mean fruit length was 9.15 cm and fruit diameter was 8.23 cm with pulp recovery >70%. Mean seed weight was 68 g with TSS 4.8 °Brix. Fruit colour is light green and flesh colour is creamy white. It is late bearing with pear shaped fruits and thin skin. Fruit shape is obovate, dark green with creamish white flesh colour. It is suitable for fresh fruit purpose.

Bilimbi (*Averrhoa bilimbi*): Promising genotype (IC0645571) was identified with bold fruits (> 20 g; 6 cm x 2 cm), ellipsoidal, elongated, green colour. Fruit quality was good with TSS (> 3.5 °Brix), acidity (1.2%), pulp recovery (> 98%), 6 seeds/fruit and mean yield of > 40 kg/tree.

Wood apple (*Feronia limonia*): Promising genotype (IC0645572) was identified with medium to large fruits (300 g), round to oval in shape (8 x 8 cm), grey green (RHS 197B) pulp colour (grey orange 177A). The fruit quality was good with TSS (> 15 °Brix), acidity of 3.4 %, shell thickness (3 mm) and pulp rwecovery (> 60%). The average number of seeds/fruit was 465 and seed hardness was 50.6 N. The tree yield (20 yrs old) was > 600 fruits.

Macadamia nut (*Macadamia integrifolia*): A Promising line (IC0647056) with medium size fruit (> 12 g), nut weight (8 g), and kernel weight (3 g) was identified. The yield from mature tree of 12-yr-old was 20-22 kg.

Bael (*Aegle marmelos*): IC0647057 is a promising line, dwarf (4 m) and thornless with individual fruit weight of above 1 kg and high total sugars (25 g/100 g). Similarly, fruits of another promising line, IC0647058 contained higher carotenoid (14.96 mg/g) while fruits of line IC0647059, contained high antioxidant (150.93 mg FRAP/100 g), total flavonoids (74.63 mg/100 g) with less seed content.

Hog plum (*Spondia spinnata*): Promising line (IC0647060) is a tall tree and with yield potential of > 200 kg/tree (15-yr-old tree). Fruits are big (7 x 6 cm), weighing >150 g with high pulp recovery (>90%). Immature fruits are sour, used for pickle purpose and ripe fruits are sweet which can be utilized for fresh as well as processed products.

Immature and Ripe fruits

Sapota

Evaluation of elite lines: Ten selected elite lines, namely, PKM-1 x KP /III-20-9, PKM-1 x KP / III-20-8, EMS 0.5 / III-23-5 CB x PKM-1 / III-4-11, CB x PKM-1 / III-14-11, CB x PKM-1 / III-13-5, CB x PKM-1 / III-14-22, CB x PKM-1 / III-13-9, CB x PKM-1 / III-11-21, PKM-1 x CB/ III-16-18 and three check varieties, Cricket Ball, PKM-1 and IIHR-63 were evaluated for growth characteristics. There was significant difference in their plant height and stem girth.

Evaluation of progenies : The growth data of 312 progenies of Cricket Ball x PKM-1, 50 progenies of PKM-1 x Cricket Ball, 5 progenies of PKM-1 x Kalipatti

were recorded. The average plant height was highest in cv. Cricket Ball (465 cm), while it was lowest in PKM-1 (387 cm). The progenies of PKM-1 x Cricket Ball, recorded highest plant height as compared to progenies of Cricket Ball x PKM-1 and PKM-1 x Kalipatti. The plant height ranged from 95 cm to 590 cm in Cricket Ball x PKM-1 while it was 120 to 495 in PKM-1 x Cricket Ball and 115 to 360 cm in PKM-1 x Kalipatti. The plant girth ranged from 2.2 to 23.9 cm in Cricket Ball x PKM-1 while it was 2.9 cm to 23.9 in PKM-1 x Cricket Ball and 4.1 cm to 11.8 cm in PKM-1 x Kalipatti. The tree volume ranged from 0.16 m^3 to 63.19 m^3 Cricket Ball x PKM-1 while it was 0.28 to 54.81 m^3 in PKM-1, x Cricket Ball and 0.26 to 17.76 m^3 in PKM-1 x Kalipatti.

Jamun

Evaluation of elite lines: Nine selected genotypes namely, Seedless *jamun*, Round the Year, PGR-9, PGR-8, BRH- 2, Selection - 45, Collection - 2, Kaveripattanam - 4 and Hirehalli were planted for evaluation along with two check varieties Dhoopdal and Konkan Bahaduli in a row trial. Three was significant difference in their growth parameters.

Evaluation of mutants: Mutant population (387) of *jamun* were evaluated for growth characters. There was lot of variation for morphological characters. Plant height ranged from 300 to 630 cm. The stem girth ranged from 5.0 to 26.2 cm. Mutants II-1-1, II-1-7, II-1-10, II-1-16, II-1-17, II-1-18, II-1-19, II-1-20, II-2-15, II-2-19, II-2-20, II-4-20, II-5-19, II-8-20, II-9-17, II-9-20, II-10-20, II-13-2, II-17-18 and II-20-1 produced flowering and II-1-1, II-1-18, II-1-19, II-2-19, II-4-20 and II-5-19 produced fruiting. Average fruit weight was highest in II-1-19 (13.71 g) followed by II-4-20 (11.32 g) and lowest in II-5-19 (7.32 g). Average fruit length was highest in II-1-19 (2.51 cm) followed by II-4-20 (3.42 cm) and lowest in II-5-19 (2.52 cm). Average fruit width was highest in II-1-19 (2.37 cm) followed by II-4-20 (2.18 cm) and lowest in II-5-19 (1.58 cm). Average TSS was highest in II-4-20 (12.67 °Brix) followed by II-1-1 (11.97 °Brix) and lowest in II-5-19 (9.57 °Brix).

Pummelo

Evaluation of half-sibs and hybrids: Evaluation of 245 pummelo hybrids from 4 different cross combinations and 240 pummelo half-sibs for less bitterness, thin skin and precocity in bearing were carried out. During the reporting period, a total of 65 hybrids and 49 half- sibs were characterized for fruit quality traits of which 2 hybrids (R17P9 & R26P9). Half-sibs (R44P15 & R38P4) have been selected for further evaluation.

Quality traits of pummelo hybrids

Sl. No.	Traits	Mean	Range	Standard Deviation (SD)
1.	Fruit weight (g)	1283	610.6 - 2622	404.6
2.	Fruit diameter (mm)	149	106.2 - 196.6	19.30
3.	Fruit length (mm)	137.7	106.6 - 183.2	17.51
4.	Rind thickness (mm)	19.56	9.2 - 41.80	5.66
5.	No. of segments	13.02	9.6 - 18.60	1.78
6.	TSS (°Brix)	8.78	6.8 - 10.88	0.90
7.	Acidity (%)	1.41	0.6 - 2.44	0.36

Quality traits of Pummelo half-sibs

Sl. No.	Traits	Mean	Range	Standard Deviation (SD)
1.	Fruit weight (g)	1379	492.2 - 2563	466.2
2.	Fruit diameter (mm)	156.5	101.3 - 201.7	22.20
3.	Fruit length (mm)	143.1	112.3 – 180.0	19.56
4.	Rind thickness (mm)	20.53	12.67 - 31.67	4.47
5.	No. of segments	13.18	10 - 19	1.67
6.	TSS (°Brix)	8.471	6.33 - 10.23	0.87
9.	Acidity (%)	1.317	0.64 - 2.19	0.38

Fruits of promising pummelo hybrids

Fruits of promising pummelo half-sibs

Evaluation of mutant populations: A total of 600 progenies are being maintained for primary evaluation (vegetative traits).

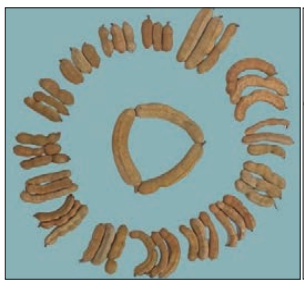
CHES - CHETTALLI

Improvement of Coorg mandarin and avocado: The large population of avocado seedlings were raised by irradiating avocado seeds with 75 Gy (LD_{50}). More than 600 seedlings were transplanted to main field for evaluation for yield and quality traits. Six hundred open-pollinated Hass seedling population were also planted for evaluation and characterization.

The large population of Coorg mandarin seedlings were raised by irradiating seeds with 100, 150 and 200 Gy and 500 mutated seedlings were transplanted for evaluation of yield and quality traits.

CHES - BHUBANESWAR

Promising germplasm of tamarind identified: Sixteen germplasm accessions of tamarind were evaluated for quality traits. Pod weight range from 7.64 - 22.17 g; pod length 67.03 - 118.27 mm; pod width 14.13 - 26.22 mm; pulp content 31.17- 52.44%; shell content 6.40 - 8.22%; seed No. 5.66 - 8.12; fibre content 4.48 - 6.87%, TSS 31.37 - 67.84 °Brix; acidity 6.45 - 11.32%; ascorbic acid 1.63 -5.52 mg; total sugars 21.42-37.33% and TSS/ acid ratio 4.46-9.58. Among the evaluated germplasm, CHES-B-TM-3 (IC639464) exhibited better quality attributes in terms of pod weight (21.18 ± 3.45g), pulp content (51.87 ± 4.62%), fibre content (4.57± 0.74%), TSS (68.34 ± 3.86 °Brix), acidity (6.74 ± 0.67%), TSS/ acid ratio (9.89 ±1.47) and sugar content (35.4 ± 2.37%). In addition, CHES-B-TM-3 has also demonstrated precocious bearing and spreading growth habit.



Tamarind germplasm

Promising germplasm (CHES-B-TM-3)

Promising genotypes of jackfruit identified: *In situ* evaluation of jackfruit germplasm for flake quality (large size with firm texture) was carried out in Kandhamal considered as one of the potential districts for jackfruit diversity in Odisha. Two germplasm accessions were found to be promising in terms of flake quality and consequently custodian farmers were identified. Identified genotypes were heavy bearers with > 120 medium sized fruits (6.0-8.0 kg). The average number of flakes varied between 142-166 with light pink to deep yellow in colour having firm texture. The average weight of the flake ranged from 22-34 g. Flake content and edible part were more than 40 and 30%, respectively. TSS was ~ 20 ºBrix and total carotenoids content was 2.18 µg /g.

Sh. Pankaj Sahoo, Kandhmal

VEGETABLE CROPS

Tomato

Pre-breeding for *Tuta absoluta* resistance: The early backcross generation derived from previously developed interspecific hybrid between *S. lycopersicum* and *S. pennelli* was used for developing *T. absoluta* resistance in tomato. Screening for *Tuta* resistance was carried out using the mass inoculation method in the net house. A total of 282 BC_1F_2 progenies generated by self-pollination of 49 BC_1F_1 plants were screened and a total of 21 tolerant BC_1F_2 progenies were identified. The recurrent parent 38-7 was used along with the backcross progenies to assess the resistance in the backcross progenies. Parallelly, as many as 71 BC_2F_1 families were advanced to BC_2F_2 generation for further studies on *T. absoluta* resistance.

Backcross progenies (BC_1F_2) derived from interspecific hybrid (*S. lycopersicum* x *S. pennelli*) showing differential response to *Tuta absoluta*

Breeding tomato suitable for protected cultivation: Ninety-six advance generation lines were evaluated during summer, 2022 for their suitability under protected cultivation. This set included lines selected during *kharif*, 2021 and additional lines. There was high incidence of bacterial wilt during evaluation. A total of 24 lines showing BW resistance were selected. The average fruit set without artificial pollination was highest in tomato lines IIHR20-3-2 and IIHR20-3-3.

Advanced tomato lines IIHR20-3-3 and IIHR41-5-1 showing resistance response to bacterial wilt

Breeding variety suitable for varied market segments: Two hundred and fifty F_3 families selected from 25 F_2 families were evaluated during *kharif*, 2022. The selections focused on field tolerance to foliar diseases and fruit cracking during rainy season. The trial witnessed incidence of late blight, early blight and mildew. A total of 88 F_3 lines showing less defoliation due to foliar diseases and fruit cracking were selected. Further, these selections were made for different fresh market segments such as square round/oval, round, flat and green shoulder segments. This set of selected lines included 54 oval, 10 flat, 10 green shoulder and 14 round fruited lines.

F_3 plants showing differential response to foliar diseases during *kharif*, 2022

Brinjal

Evaluation of interspecific grafts for yield and bacterial wilt resistance: Two advanced breeding lines *viz*., IIHR-766/ POBL-2 and VMG-6 grafted on *S.mammosum* and were raised in bacterial wilt sick plot during 2021 and have yielded 5.25 kg /plant and 4.75 kg/ plant, respectively during 2022. Eight elite lines *viz*., POBL-2, IIHR-438-2, IIHR-586, Muktakeshi, Sel-4, Arka Harshitha, VMG-6 and Black Star grafted on *S. torvum* yielded 3.35 to 4.45 kg/ plant during 2022.

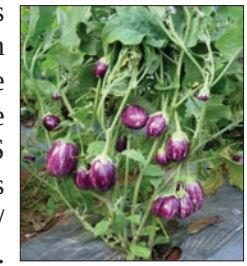
Breeding for bacterial wilt resistance in varied market segments: For big round segment fourteen F_8 individual plant selections were evaluated for yield and BWR, of which three populations *viz*., IIHR-104 x Arka Keshav-2-5 (3.5 kg/plant), IIHR-104 x Arka Neelakant-4-3 (3.25 kg/plant) and IIHR-586 x Arka Nidhi-1-5 (2.92 kg/plant) were found to be promising for yield and BWR, whereas check varieties *viz*., Kusuma and Black Star have completely succumbed to bacterial wilt.

IIHR-104 x A. Keshav-2-5

IIHR-104 x A. Neelakant-4-3

IIHR-586 x A. Nidhi-1-5

For Manjarigota segment, 10 IPSs derived from a cross between IIHR438-2 x 2BMG-1 were evaluated for yield and resistance to bacterial wilt, of which one IPS *viz*., IIHR438-2 x 2 BMG-1-4 was found promising for yield (2.40 kg/ pt) and resistance to bacterial wilt. Plants were tall, spreading with dark green stem and foliage, purple flowers, fleshy green calyx, fruits borne in clusters, dark purple in colour with white stripes and glossy, oval in shape with average fruit weight of 90-100 g. The check variety, MEBH-10 completely succumbed to bacterial wilt.



IIHR438-2X2BMG-1-4

One hundred sixty-five RILs of Arka Neelanchal Shyama x CARI-1 developed through single seed descent method were screened for *Ralstonia solanacearum* Bhubaneswar isolate through artificial challenge inoculation followed by sick plot screening at CHES,

Bhubaneswar; and through BSA-QTLseq of resistant and susceptible bulks, a major QTL on chromosome 8 (20 to 60 Mb) was identified which conferred resistance to bacterial wilt disease.

Screening RILs for bacterial wilt resistance and BSA-QTL seq in brinjal.

Evaluation of elite lines/ varieties and new F_1 hybrids for yield and fruit quality: Eight elite lines/ varieties *viz*., Arka Anand (F_1), Arka Harshitha, Arka Unnathi, VMG-6, MGSel-4, IIHR-766 (POBL-2), Arka Neelachal Shyama and Arka Neelanchala Yodha (B-BR 54) were raised for demonstration during National Horticultural Fair-2022. Out of which Arka Anand (6.33 kg/plant) followed by POBL-2 (4.79 kg/plant) and Arka Unnathi (4.13 kg/plant) have superior performance. Of nine new hybrids evaluated for yield and bacterial wilt resistance in an observation row trial, VMG-6 x Muktakeshi (6.40 kg/plant), Muktakeshi x Pant Rituraj (6.28 kg/plant), Kusuma x Black beauty (5.38 kg/plant) and IIHR-766 x Muktakeshi (5.33 kg/plant) were found to be promising for yield and BWR disease. The average fruit weight ranged from 102 to 180 g, with attractive shiny colour and oblong to round shape.

VMG-6 x Muktakeshi

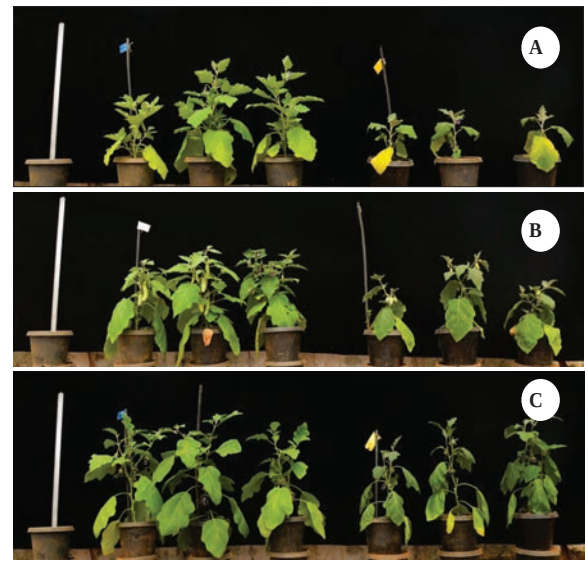
Muktakeshi x Pant Rituraj

Kusuma x Black Beauty

IIHR-766 x Muktakeshi

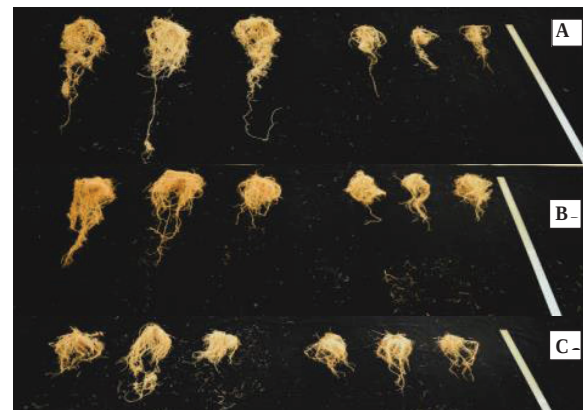
Evaluation of brinjal genotypes for resistance to root knot nematodes (RKN): About 126 brinjal genotypes were screened for resistance to RKN, of which Arka Harshitha and POBL-2 have showed highly resistant & susceptible reaction, respectively. Using these contrast lines F_2 and backcross populations were developed to study inheritance of resistance and molecular markers for validation.

Characterization of salinity stress contrasts for understanding stress tolerance: Total of 20 salinity stress tolerance contrasts were shortlisted from *in vitro* screening and characterized for salinity stress. Under salinity stress condition, overall plant growth affected under stress conditions. Utkal Anushree and Sharapova bottle brinjal had least growth under salinity stress conditions whereas Mattugulla Oblong, IIHR-766 and Arka Harshitha had least reduction in growth under salinity stress condition. Overall shoot growth and photosynthesis of susceptible genotypes reduced by 45 and 63% compared to tolerant genotypes under stress conditions.



Representative plant phenotype of salinity stress tolerance contrast under control and stress conditions. (A). Utkal Anushree, (B) Arka Harshitha and (C) Mattigulla Oblong

Overall root growth of susceptible genotypes under saline condition was 63% lesser compared to the tolerant genotypes. Root length decreased by 54%, root fresh weight decreased by 55% and root dry weight decreased by 60% compared to tolerant types under the stress conditions.



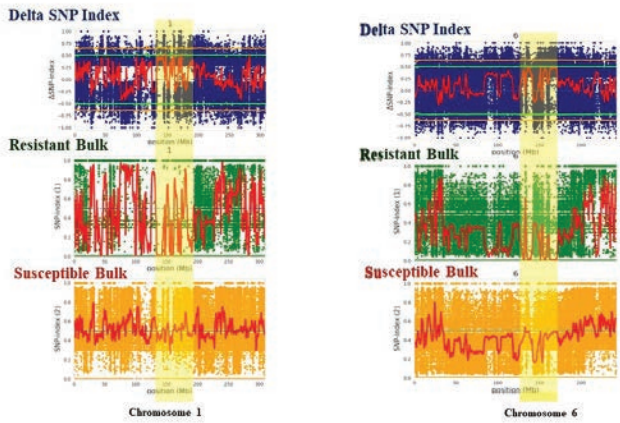
Representative plant phenotype of salinity stress tolerance contrast under control and stress conditions. (A). Utkal Anushree, (B) Arka Harshitha and (C) Mattigulla Oblong

From the overall experiment Arka Harshitha, Mattigulla Oblong and IIHR-766 were shortlisted as salinity tolerant genotypes, while Utkal Anushree and Sharapova bottle brinjal were shortlisted as salinity susceptible genotypes.

Chilli

Breeding for chilli leaf curl virus disease resistance: Multi-location trials of ten chilli F_1 hybrids having resistance to ChLCV-*ChiRai* isolate were evaluated at CTRI-RS-Kandukur-Andhra Pradesh, CHES-Bhubaneswar-Odisha, SKNAU-Jobner-Rajasthan and NIASM-Baramati-Maharashtra during *kharif*, 2022 to study their performance for yield and reaction to the varied isolates/ begomoviruses.

Using BSA-QTLSeq approach, two QTLs conferring resistance to Chilli leaf curl virus - *ChiRai* isolate (NCBI No. MK16145 of DNA-A and MK172892 of beta-satellite) located on chromosome 1 (133.5 to 191 Mb) and chromosome 6 (130 to 185.3 Mb) were identified in the F_2 populations derived from IHR4615 and IHR2451, resistant and susceptible parents, respectively.



QTL regions conferring resistance to chilli leaf curl virus – *ChiRai* isolate

Breeding for *Phytophthora* root rot disease resistance: F_1 hybrids were reconfirmed for *Phytophthora* root rot resistance through artificial challenge inoculation and in sick plot evaluation during the period. Among the F_1 hybrids evaluated, LCVH24, LCVH25, LCVH26, LCVH29, LCVH43 and Arka Gagan showed high resistance.

Screening Chilli F_1 hybrids for *Phytophthora* root rot resistance during 2022

Variety/ Hybrid	Challenge inoculation (Aug-Sept. 2022)	Challenge inoculation (Sept-Oct. 2022)	Sick plot screening (July- Oct. 2022)*
% Resistance to PRR			
H 24	89.31	90.19	88.22
H 25	85.10	88.88	88.45
H 26	89.77	87.30	83.93
H 29	92.89	92.18	93.13
H 43	96.61	84.37	89.38
Arka Gagan	94.07	91.54	95.12
Arka Mohini (SC)	0.00	0.00	0.00
Arka Harita	-	58.33	58.69

Reaction of H24 (Arka Nihira) to *Phytophthora* root rot (artificial challenge inoculation)

Reaction of H29 (Arka Dhriti) to *Phytophthora* root rot (artificial challenge inoculation)

H24 (Arka Nihira): Suitable for dual thick market segment, high yielding (fresh 30-35 and dry 7.5-8 t/ha), fruit solitary, pendent, fruit length 9-10 cm and width 1.5-1.7 cm, fruits dark green turns dark red (110-120 ASTA value) on maturity, medium pungent (35,000-40,000 SHU), fresh to dry recovery (30-32%) and having combined resistance to *Phytophtora* root rot and chilli leaf curl virus (ChLCV) *Rai* - isolate.

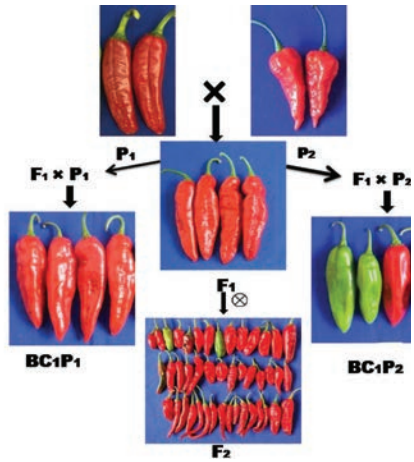
H29 (Arka Dhriti): Suitable for dual medium market segment, high yielding (fresh 30-35 and dry 7.5-8 t/ha), fruit solitary pendent, fruit length 7-8 cm and width 1.0-1.2 cm, fruits green turns dark red (80-90 ASTA value) on maturity, highly pungent (80,000-90,000 SHU), fresh to dry recovery (30-32%) and having combined resistance to *Phytophtora* root rot and chilli leaf curl virus (ChLCV) *Rai* - isolate.

H 24 (Arka Nihira) suitable for dual (dry and green) thick market segment

H 29 (Arka Dhriti) suitable for dual (dry and green) medium market segment

Breeding for moisture stress tolerance: Eighty-seven F_2 populations derived from 88 F_1 combinations were advanced and best performed IPS based on yield were advanced to F_3 generation and their yield ranged from 85-185 g per plant.

Introgression of pungency genes: Interspecific (F_2 and backcross) populations of IHR 4604 (*Capsicum annuum*) x IHR 4500 (*C. chinense*) were developed, wherein IHR 4604 fruits are dark red with high colour value (>200 ASTA) and IHR 4500 is highly pungent (>2,50,000 SHU) and high in capsinoids (400.05 µg/ g). Generation mean analysis showed that among gene effects, dominance and additive x additive type of gene interaction was predominant for capsaicin, dihydrocapsaicin, total capsaicinoids, capsiate, dihydrocapsiate and total capsiates. Additive and additive x additive type of gene interactions were predominant for nordihydrocapsaicin. Dominant and dominance x dominance effect with complementary type of epistasis was predominant for capsaicin and total capsaicinoids.



Inter-specific populations developed for high colour and pungency

Development of markers for pungency: Sequencing of partial gene of *Capsicum annuum acyl-transferase* gene (*Catf2*) (GenBank: AB206920.1) showed 5 bp short InDel region from 719 to 723 bp differentiating IHR 4604 (non-pungent) and IHR 4550 (highly pungent) genotypes and further InDel marker (MAPS-F2/R2) was developed. Phenotypic variance (PVE) explained by the InDel marker (MAPS F2/R2) was found to be 67.88% in an interspecific F_2 population.

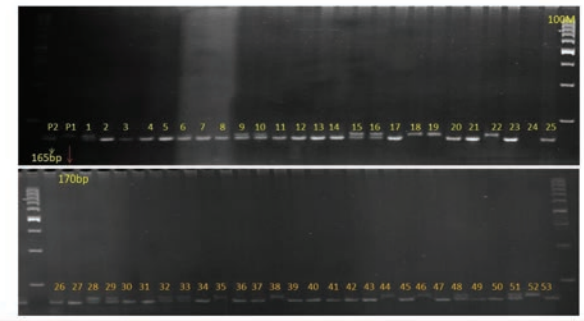
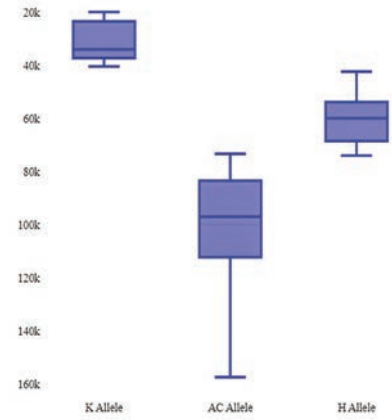


Fig. Gel profile (6% PAGE) of InDel marker (MAPS-F2/R2) in F2 population of IHR 4604 x IHR 4550 cross



Box plots for total capsaicinoids content values grouped by alleles

Exploring combined resistant rootstocks in chill for protected cultivation: Developed combined resistant chilli lines against *Phytophthora* root rot, bacterial wilt and root knot nematodes resistant recombinant inbred lines *viz*., ACRIL70, ACRIL90 & ACRIL48 were used as root stocks and commercial bell pepper *cv*. Indra was used as scion, to study the graft compatibility, yield and fruit quality under protected cultivation during summer, 2022. Among three rootstocks used in the study, ACRIL70 was found to be superior.

Performance of Indra grafted on multiple disease resistant rootstock in RKN sick polyhouse

Seed priming in chilli for abiotic stress tolerance: Primed (both chemo-priming and bio-priming) seedlings exhibited better performance over unprimed, under heat stress. qPCR studies revealed high level of HSF2 expression in primed seedlings compared to control

under heat stress. Further, tolerant (IIHR 3014) genotype exhibited higher level of HSF2 expression compared to susceptible (IIHR 4601) genotype.

Nitrogen and Phosphorus use under stress: The analysis of various mineral nutrient content in the shoot and leaf samples in 15 chilli genotypes grown under two water regimes, 100 and 50% field capacity indicated diverse genotypic response. The N content in general increased under deficit water stress among all the genotypes except Arka Meghana and Arka Lohit. In general, increased leaf N content was observed among the hybrids and cultivars. The highest increase in leaf N content was observed in the genotypes, Arka Harita and Arka Khyati. Significant increase in shoot and leaf K content was observed under deficit water stress (50% FC). Genotypes, IIHR 3241 recorded the highest K content in both shoot and leaf. Significant reductions in leaf Zn contents were observed under deficit water stress compared to control, whereas, shoot Zn contents did differ significantly. The genotypes exhibited differential response for fruit colour. The genotypes, IIHR 4501 and 3529 showed highest fruit colour. Overall, the pungency was higher under 50 % FC compared to 100% FC. The genotypes, IIHR 4550 followed by IIHR 4501 and IIHR 3529 exhibited the highest pungency.

Protray cavity size and water use efficiency: The seedlings of the genotype, IIHR 4501 were raised in different cavity number protrays with PGPR, *Bacillus amyloliquefaciens* treatment. Subsequently, the seedlings were transplanted to containers and maintained at 100 and 50% FC. Significant differences in various morphological and physiological parameters were observed among the treatments. The shoot fresh weight was highest in plants raised in 72 cavity protray with PGPR at 100% FC followed by 98 cavity protray with PGPR at 100% FC. The shoot and leaf dry weights were higher in 72 cavity protray with PGPR at 100% FC. Overall, the treatment with PGPR and 100% FC caused increase in root volume. The higher photosynthesis rate, stomatal conductance and transpiration rates were observed in the plants raised in 72 and 98 cavity protrays with PGPR at 100% FC. The highest water potential and lowest RWC were observed under 50% FC. Increase in WUE was observed under deficit water stress (50% FC). Higher WUE was observed in 72 cavity protray with PGPR at 100% FC followed by 50 cavity without PGPR at 50% FC.

Bell pepper

Breeding for root knot nematode resistance: Eleven capsicum lines and one F_1 hybrid [Arka Mohini (S) x CM334 (R)] were evaluated along with chilli resistant check, CM334 for nematode resistance adopting Taylor and Sasser (1978) scale. Among the lines evaluated, resistant chilli accession CM 334 showed gall index (GI) of 2.33; both F_1 (AM x CM 334) and bell pepper accession AVPP 9814 showed GI of 2.67 and AVPP 1360 showed GI of 3.33 indicating tolerance, whereas, all other accessions were found to be susceptible.

Capsicum accessions showing tolerant reaction to *M. incognita*

Development of genetic stocks: Through reverse genetics, developed three genetic stocks from commercial hybrids in capsicum *viz*., IIHR BP008-1-3-3 (green, oblong fruit of Indra segment, 3-4 lobes), IIHR BP028-2-2-3 (dark green conical fruit with pointed tips) and IIHR BP054-2-1-3 (blocky, green to chocolate colour fruit).

IIHR BP 008-1-3-3 **IIHR BP 028-2-2-3** **IIHR BP 054-2-1-3**

Okra

Breeding for yield and quality parameters: Twenty advanced breeding lines ($F_{5:6}$ generation) along with commercial check were evaluated in RBD with three replications during summer, 2022. Among them IIHR-386-1-1-26 (26 t/ha) was found significantly superior followed by IIHR-385-1-1-5 (21.56 t/ha). IIHR- 386-1-1-26 was also found to be superior with respect to fruit weight and dark green fruit colour. These lines were also resistant to YVMV disease under natural field conditions.

IIHR-386-1-1-26 **IIHR-385-1-1-5**

Evaluation of advanced breeding lines for YVMV resistance: Three lines *viz*., IIHR-385-11-5, IIHR-386-1-1-26 and RIL-1 (IIHR-285-1 x AC-1685 F_7) were artificially screened in the polyhouse using virulent

whiteflies during *kharif*, 2022. All the three lines were found to be free from YVMV, whereas susceptible check AC-1685 showed 100 per cent susceptibility, which was confirmed in the ratoon crop and also PCR testing.

Hybrid 155

Hybrid 73

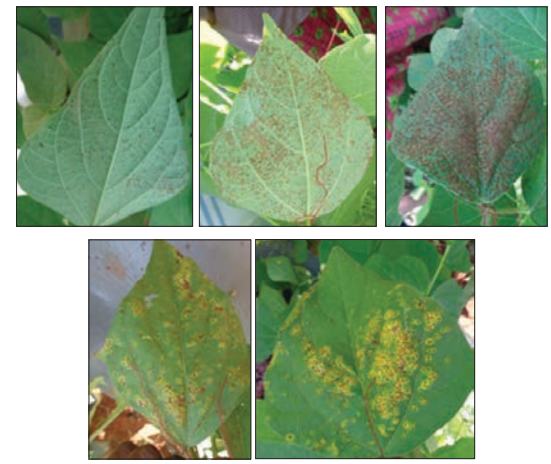
Breeding for YVMV resistance: Five RIL's of F_8 populations evaluated for yield, fruit quality and resistance to YVMV disease during summer, 2022. Among them RIL-1 (of IIHR-285-1 X AC-1685) found promising for yield (24 t/ha), YVMV disease resistance and fruit quality (dark green and smooth with five ridges). Seven BIL's of BC_1F_4 families and BC_2F_1 were evaluated for yield, quality and resistance to YVMV disease. Among them, five BIL families were found promising and are advanced. Further, *Abelmoschus tetraphyllus* var. *tetraphyllus*, *A. moschatus*, IIHR-385-1-5 and IIHR-386-1-1-26 were found to have combined tolerance to YVMV and ELCV diseases.

Reaction of okra advanced breeding lines to YVMV

Sl. No.	Line No.	Incidence of YVMV (%)	PCR results	Visual observation in the polyhouse after inoculating with virulent whiteflies	Characteristics selected for registration
1.	IIHR-385-1-1-5	0	Negative	Free from symptoms	Resistant to YVMV at hotspot area of Villupuram, TN and at IIHR under artificial inoculation condition
2.	IIHR-386-1-1-26	0	Negative	Free from symptoms	Resistant to YVMV at hotspot area of Villupuram, TN and at IIHR under artificial condition
3.	RIL- 1 (IIHR-285-1 x AC- 1685 F_7)	0	Negative	Free from symptoms	Resistant to YVMV at hotspot area of Villupuram, TN and at IIHR under artificial condition
4.	AC -1685 (SC)	100	Positive	Yellow mosaic symptoms	Highly susceptible to YVMV at Villupuram, TN & IIHR under artificial inoculation condition

French bean: Advanced breeding lines of pole bean, derived from the cross Arka Sukumol × Arka Arjun were advanced to F_6 generation and were screened for rust disease resistance by spraying with rust spore solution during *kharif*. 2022. A total of 97 rust tolerant single plants were selected from F_6 progenies for varied pod quality. Twenty-nine selections for dark green round, three for dark green flat, 26 for green round, 16 for green oval, five for green flat, two for light green round and 16 for light green flat pods. The crosses involving rust-resistant lines *viz*., IIHR-31 and IIHR-79 with superior pod quality genotypes *viz*., Arka Sukumol, Arka Arjun and Arka Sharath was attempted and rust-resistant individual plants were advanced to F_3 generation, selecting through artificial challenge inoculation. The identified resistant progenies were backcrossed with Arka Sukumol, Arka Arjun and Arka Sharath to improve the pod quality.

Development of F_1 hybrids for yield, quality and tolerance to YVMV: A total of 85 F_1 hybrids were developed and evaluated under observational row trial along with popular check varieties Radhika and Arka Nikita. Among them, H-155 found to be promising with highest fruit yield (28.28 t/ha and dark green), followed by H-104 (26.99 t/ha and green) and H-73 (20 t/ha and purple fruit); whereas, Radhika and Arka Nikita yielded 23.45 and 24.24 t/ha, respectively. Fifteen promising hybrids were selected for yield and fruit quality for further evaluation at hotspot areas.



Severity of rust disease under artificial screening in advanced progenies of French bean.

Breeding pole type French bean resistant/tolerance to virus: The F_3 generation of the crosses Arka Arjun x Raikia, Raikia x Arka Arjun and Raikia x Arka Sukomal were sown during *rabi* and were evaluated. Among the progenies, 22 individuals were observed as resistant, 243 were highly tolerant and 5 were susceptible to common bean mosaic virus at 45 days after sowing. Forty-one individuals were identified for earliness trait.

Garden pea: Hybridization between rust resistant accession IIHR-13-11 and high temperature tolerant lines such as Arka Chaitra, Arka Tapas and Arka Uttam was attempted during *rabi*, 2021-22, and three F_1 populations were evaluated during summer, 2022 and seeds were collected for further evaluation.

Dolichos bean: Pole Dolichos variety Arka Pradhan was recommended during 40th Annual Group meeting of AICRP Vegetable Crops held during 15th to 17th June, 2022 for Zone-IV comprising of UP, Bihar, Jharkhand and Punjab. Arka Pradhan is developed through Pedigree method of selection from F_7 generation involving (IC 556824 IPS-2 x Arka Swagath). The salient features are; photo-insensitive pole dolichos variety suitable for *kharif* and *rabi*, pods are green in colour, smooth and shiny with undulating surface. The green pod yield is 33-35 t/ ha in 120 days of crop duration.

Cluster bean

Development of variety for yield and fruit quality: IIHRCB 22-1-1 is identified for release by ITMC during summer, 2022. It is developed through pure line selection from the germplasm material collected from Tamil Nadu. Plants are tall (90-110 cm), erect, having single stem with dark green trifoliate leaves, pink-white flowers in racemose inflorescence. It has green long stringless pods (10-14 cm) borne in cluster at each node. The pods are soft with slow maturing seeds and tender green pods showed significantly higher potassium, calcium, total phenols, antioxidants and amino acids compared to check Pusa Navbahar. It has an yield potential of 20-25 t/ha and yield advantage of 26.68% over Pusa Navbahar. ICAR-NBPGR, New Delhi has provided IC number for the line as IC0646505.

Evaluation of accessions for powdery mildew disease resistance: Cluster bean accessions, IIHR CB 22-1-1 and IIHR CB 26-2-1 were found to be moderately susceptible, whereas, Pusa Navbahar is grouped as susceptible to powdery mildew disease.

Molecular confirmation of mutants: Two SSR markers differentiating mutants in cluster bean were identified, *i.e.* ct_SSR_149 and ct_SSR_151 which shows a 5-15 bp difference between parental line and mutants.

Ridge gourd

Breeding for ToLCNDV resistance: Pooled analysis data of six advanced inbred lines *viz*., IIHR-RV-20-3, IIHR-RV-28-1, IIHR-RV-23-4, IIHR-RV-5-4, IIHR-RV-55-9 and IIHR-RV-57-6 over two summer seasons of 2021 and 2022, has been recorded on 10 yield parameters and ToLCNDV incidence. Significant differences were observed for four of the 11 traits studied. All the six advanced inbred lines screened were having moderate resistance to ToLCNDV disease (VI ranged from 26 to 31) with a mean yield range of 11.78-17.67 t/ ha. IIHR-28-1 had least incidence with VI of 26.35 and 14.57 t/ ha fruit yield. Among the moderately resistant inbred lines, highest mean fruit length and yield were recorded by IIHR RV-23-4 (16.1 cm and 17.67 t/ha, respectively) with VI of 30.67.

Fruits of IIHR RV 23-4 and IIHR RV 28-1 ridge gourd

Breeding for downy mildew resistance: Seven downy mildew disease susceptible varieties and advanced breeding lines *viz*., Arka Prasan, Arka Sumeet, Arka Sujat, IIHR RGIP-18-13, IIHR RGIP-18-50, IIHR RGIP-18-55, IIHR-6-1-1 were crossed with four downy mildew disease resistant lines *viz*., IIHR DMR 18-4-3, IIHR DMR-18-4-4, IIHR DMR 18-65-1 and IIHR DMR-18-65-2. Out of the 24 crosses, evaluated for the downy

mildew disease resistance during *kharif*, 2022 under natural epiphytotic conditions, seven crosses showed moderate resistance to downy mildew disease. All these crosses were backcrossed with respective female parents for transferring the disease resistance trait.

Transferring male sterility: Nine back cross populations *viz*., IIHR-37-4*ms*BC_4, IIHR-22-4*ms*BC_5, IIHR-26-4*ms*BC_5, IIHR-34-2*ms*BC_5, IIHR-5-1-2*ms*BC_6, IIHR-6-4*ms*BC_6, IIHR-23-5*ms*BC_6, IIHR-49-3*ms*BC_6 and IIHR-70-1*ms*BC_6 were raised for maintenance of male sterility in different genetic background. All of the BC_6 progenies were 100% male sterile indicating the maintenance of sterility. In all the 10 backcross populations, IP's having the fruits similar to their male parent were selected and were backcrossed with respective male parents to advance the generation. Fruit length ranged from 12.14-46.33 cm in the advanced backcross populations. Using six *ms* lines, fifty-four F_1 crosses were attempted and seeds were collected for further evaluation.

Breeding for andromonoecy: Two BC_3F_2 populations were raised and were segregated in 3:1 ratio of monoecious and andromonoecious plants indicating recessive gene control of andromonoecy (AM). AM plants with longest fruits were selected and backcrossed with respective monoecious parents to advance the populations. Other sets of BC_5F_1 and BC_1F_1 populations were raised, which were monoecious due to dominant gene action of monoecy were also advanced through selfing.

Bitter gourd

Registration of genetic stock resistance to powdery mildew: IIHR-144-1 (INGR22161), is a bitter gourd powdery mildew resistant line which has been registered with NBPGR, New Delhi. It belongs to *Momordica charantia* var. *muricata*, fruits are dark green, small, with discontinuous ridges; leaves deeply lobed; yield 8.8 t/ha and resistant to powdery mildew (PDI = 1.67 under natural screening and 4.28 under artificial screening).

Arka Harit (HS) (left) and IIHR-144-1(R) (right)

Fruits of IIHR-144-1

Breeding for high yield and quality: Thirty nine advanced breeding lines were evaluated for yield and fruit quality. IIHR-148-6 (34 t/ha) recorded highest yield, followed by IIHR 148-10 (32.9 t/ha) in dark green fruit segment; IIHR IP-19-142-2 recorded 28.9 t/ha in the green long fruit segment; IIHR-184-4 recorded 22.7 t/ha in creamy white fruit segment; IIHR-147-5 recorded highest yield of 16.4 t/ha in the *muricata* segment. Out of these, only one line IIHR-IP-PDGY-3 (27.9 t/ha) was resistant and four other lines were moderately resistant to powdery mildew disease.

IIHR IP-148-6

IIHR IP-184-4

IIHR IP-147-5

Breeding for Gynoecy: In order to transfer the gynoecy, one F_1, four BC_1F_1, twelve BC_1F_2, four BC_2F_1, four BC_3F_2 and nine BC_4F_1 populations of varied fruit quality traits such as, fruit colour (green/ dark green/ very dark green), fruit length (long/ medium long), fruit ridge type (continuous/ discontinuous), number of tubercles (less/ many), tubercular prominence (prominent/ non-prominent), white tip (present/ absent) were raised. Progeny of all the F_1 crosses were monoecious indicating the recessive gene nature of gynoecy.

Breeding for powdery mildew disease resistance: Three hundred and fifty four resistant individual plant selections (IPS) of F_6 generation, 38 IPS of BC_2F_5 generation and 16 of bi-parental cross progenies of susceptible x resistant crosses of varied fruit quality traits, such as fruit colour (green/ dark green/ very dark green), fruit length (long/ medium long), fruit ridge type (continuous/ discontinuous) were raised for further evaluation for powdery mildew disease resistance during *rabi*, 2022. Populations were phenotyped under field conditions using 0-9 scale. Out of these, two resistant IPS of each progeny showing resistance to powdery mildew disease in different genetic backgrounds were advanced for further evaluation.

Ash gourd: Evaluated eleven advanced breeding lines for fruit yield and nutritional quality of which AG-6-7-1-28-10, AG-27-1-20, AG-3-54-39-55 and AG-1-52-15-

AG-27-1-20

AG-3-54-39-55

AG-1-52-15-25

25 recorded higher fruit yield. AG- 6-53-13 recorded high DPPH, FRAP antioxidant activity and vitamin C content. AG-1-73-10 recorded higher N, Cu, Zn and Mn content. AG-3-19-16 recorded higher K, Ca and Mg and AG-3-25-9 recorded higher P and Fe.

Pumpkin

Evaluation of butternut hybrids for yield and quality: Nine butternut F_1s were evaluated for 14 traits in RBD with three replications. Among the traits, yield per plant and node to female flower initiation recorded wider variations. Significant variations were observed for node to female flower initiation (7.10 to 12.03), fruit length (6.90 to 41.23 cm), fruit weight (0.80 to 2.43 kg) and number of fruits per plant (2.97 to 5.90). BN-23 x BN-20 (48.09 t/ha) followed by BN-15 x BN-21 (41.49 t/ha) recorded higher yield. These high yielding populations had long straight neck with tan and dark green with greenish stripes, respectively.

Ten elite butternut lines were evaluated for twelve quantitative traits. Among the elite lines, BN-6 and BN-8-2 recorded higher number of fruits/plant (7.10 and 8.20, respectively). BN-8-2 (51.13 t/ha), BN-2-3-1 (56.97 t/ha) and BN-23 (48.40 t/ha) recorded higher yield potential over the check Arka Chandan (36.37 t/ha).

BN-15 x BN-21 (Long neck)

BN-2-3-1

BN-8-2

Breeding pumpkin for high carotene content: Eighteen advanced breeding lines suitable for varied market segments were evaluated for yield and quality. Four hybrid combinations *viz*., Ambili x A. Chandan-4 (59.90 t/ha), Swarna x A. Suryamukhi-4 (57.05 t/ha), Kashi Harit x A. Chandan -2 (52.25 t/ha), Kashi Harit x A. Chandan-5 (54.05 t/ha) recorded higher yield with yellowish-orange to orange flesh. Arka Chandan selection, ACM-1 had an yield potential of 46.43 t/ha with 6.48 fruits/plant, smaller fruit size (0.94-1.13 kg) and deep-orange flesh colour.

Kashi Harit x A. Chandan-2

Interspecific and intraspecific breeding for biotic stress tolerance and quality: Interspecific and intraspecific crosses of *C. pepo* x *C. moschata* (SQ-15 x BN-1) and *C. moschata* x *C.moschata* (Kashi Harit x Arka Chandan-2-1-1 and Kashi Harit x Arka Chandan-2-1-2-1) showed tolerance to ToLCNDV disease incidence.

Summer squash

Evaluation of summer squash hybrids for yield and quality: Among nine segregating populations of summer squash evaluated for growth, flowering, fruiting and yield traits, SARY-4 x SQ-14 recorded higher number of fruits per plant (> 6 fruits) and yield (> 60.0 t/ha). followed by SQ-14 x SQGL-2.

SQGYL-1 x SQ-14

Among the ten elite summer squash lines evaluated for yield and quality, the highest variation was found for node to male and female flower and fruit yield per plant. SQ-6 (59.64 t/ha), SQ-2-5 (57.50 t/ha) and SQ-15 (55.69 t/ha) recorded higher yield and SQ-2-5 exhibited deep orange flesh colour.

SQ-2-5

SQ-2

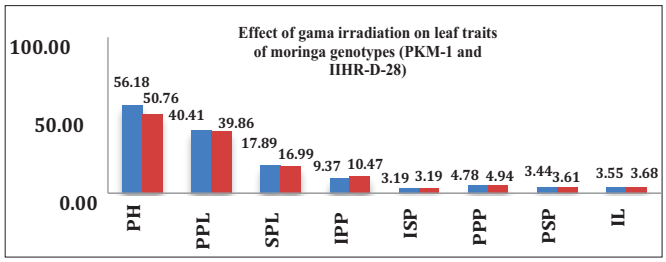
Drumstick

Identification of stable genotypes for high leaf yield and quality: The yield stability was estimated among thirteen promising accessions. Leaves were harvested in three seasons and two and half-month-old shoots after pruning, to assess its yield and nutritional stability. The pooled analysis estimated for whole leaf yield/ plant and edible leaf yield/ plant were highly significant.

Assessment of genotypes for mineral content: Nine accessions were assessed for mineral content and their genotypic stability across three seasons. High calcium content was observed in accessions namely, IIHR-D-55, IIHR-D-120, IIHR-D-109 and PKM-2 which had > 2.0 mg /100 g. Higher Fe content was observed in PKM-1 (154.4 ppm/100 g) and PKM-2 (198.9 ppm/100 g).

Selection for high leaf yielding accessions suitable for ultra high density planting: High leaf yielding accession IIHR-D-28 along with check variety PKM-1 was evaluated under ultra high density planting spaced at 30 x 30 cm accommodating nine plants/m^2. IIHR-D-28 recorded 56.8 whole leaves/plant as compared to PKM-1 (39.6), accounting to 43.1 % greater leaf production. The edible leaves produced/$meter^2$/area were 2.03 kg in IIHR-D-28 and 1.33 kg in PKM-1, accounting to 52.2% higher yield.

Evaluation of M_1 mutant population of drumstick: Two moringa genotypes (PKM-1 and IIHR-D-28) were irradiated with five doses of gamma rays (100, 150, 200, 250 and 300 Gy) and assessed for their leaf traits. None of the traits showed significant difference for main effect genotypes with dose A; however main effect gamma irradiation dose (B) found significant for plant height (PH), internode for primary pinnae (IPP) and internode length for leaf (IL). The interaction effect had significance for plant height, internode for primary pinnae, pair of primary pinnae and pairs of secondary pinnae.



Curry leaf: Fifteen advanced breeding lines of curry leaf were selected based on superior fresh leaf yield/ plant, leaf size, leaf colour, leaf texture and leaf fragrance over the check variety Suwasini. They were evaluated under high density planting of 60 x 30 cm.

FLOWER AND MEDICINAL CROPS

Rose

Breeding garden roses: Among 13 garden roses evaluated, IIHRR-9-13, IIHRR-4-15-12 and IIHRR-4-4-2 were found to be well suited for landscape being environment friendly roses, valued in terms carbon sequestration to an extent of 7.1-8.4 kg/plant/year CO_2 sequestered.

IIHRR-4-4-2

IIHRR-9-13

IIHRR-4-15-12

Fragrant roses for value addition: Advanced rose breeding line IIHRP-7 was found to be the richest source of anthocyanin (1868.19 mg/100g DW) and antioxidants (19,091 mg/100g DW) having potential for development of natural food colour with nutraceutical value.

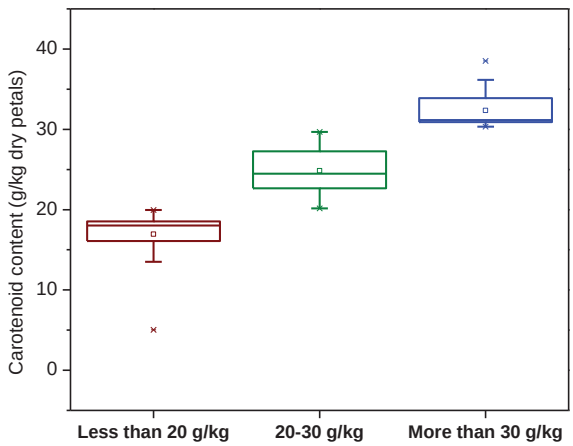
Advanced breeding line of rose IHRP-7

Fragrant genotypes comprising of clonal selections and progeny selections were evaluated with commercial varieties. Among the red group of fragrant genotypes, IIHRRF 17 (11.4 kg) and in pink group of fragrant genotypes IIHRRF 5-10 (13.1 kg/year) recorded highest yield/plant/year.

Resistance breeding for biotic stress: Among the advanced lines screened under field condition against black spot disease (*Diplocarpon rosae*), IIHRR 3-7-12 and Arka Nishkant were found to be resistant (6-10 PDI), whereas, IIHR 9-13, IIHRs-1 and IIHR 4-15-12 were found to be moderately resistant. Among the fragrant breeding lines screened under field condition, ten lines (IIHRR 1-10, IIHRR 1-11, IIHRR 5-7, IIHRR 5-9, IIHRR 5-10, IIHRR 6-4, IIHRR 8-3, IIHRR 9-2, IIHRR 9-3 and IIHRR 9-13) were found to be resistant with least disease incidence (1-10 PDI).

Marigold

Breeding for enhanced carotenoids content: Among 88 pre-breeding lines of orange marigold, total carotenoid content varied between 5.03 to 38.5 g/kg dry petal weight with average of 24.3 g/kg dry petal. Out of 88 lines evaluated for carotenoids, 14 lines recorded more than 30 g/kg, 54 lines recorded between 20-30 g/kg and 18 lines recorded less than 20 g/kg of dry petal. These lines can be effectively utilized in further breeding programme to develop carotenoid rich marigold varieties.



Inbred lines for hybrid seed production: To advance F_1 hybrid development in marigold, attempts have been made for diversification of male sterile lines. Pollen parents were selected based on their suitability for hybrid seed production. Maintenance of inbred lines depends upon selfing in case of purelines and intercrossing in case of genetic male sterile lines. Accordingly, from multiple inbred lines developed under heterosis breeding program, twelve selected and stabilised lines with distinct features were evaluated over a period of two years and were found to be consistent in seed production ability.

French marigold for novelty: Among the lines evaluated, IIHR- FM-13 and IIHR- FM-411, were found to be superior in terms of floriferousness. The flowers of IIHR FM -13 recorded multiple hues and shades of orange colours (RHS colour chart: orange group 23A, N24A, 34A), easy to maintain, spreading growth, more number of flowers/plant (400-420) and long flowering duration (130-140 days).

French marigold selection IIHR FM-13

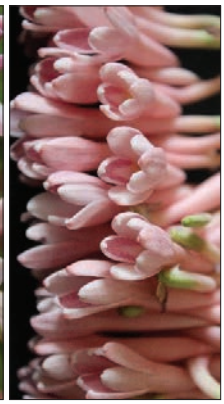
Tuberose

Breeding for garland purpose: ITMC identified for release one tuberose line IIHR 17 23SP 08 as Arka Keerthi which was developed through the seedling selection from GK-TC-4. The variety Arka Keerthi is suitable for garland purpose with single type flower, flower buds have green tinge on the tip with more number of flower buds per unit (kg), and flowers are medium in size with matured bud weight (1.29 g). It produces 8.40 number of spikes and bulbs (8.94) per clump per year. It yields 18.80 tonnes of loose flower/ha/year and have field resistant to root knot nematode and *Alterneria* leaf blight.

Tuberose variety Arka Keerthi

Breeding for novel flower colour: Novel flower colour lines IIHR 20-1-24 (IC0642159) and IIHR-20-2-10 (IC0642162) with high colour intensity was found to be promising. The flower buds are pink (RHS colour chart: Red purple group, 68D, Fan 2) with pink florets (Red purple group, 65C, Fan 2) along with pink colour (Red purple 63A, Fan 2) spots/punctuations present on

abaxial sides of the tepals, flowers are fragrant, produces 48 flowers/spike and 6 spikes/plant/year. The pink line IIHR-20-2-10 (IC-0642162) with drooping florets are promising with pink flower buds (RHS colour chart: Red Purple group 69C, Fan 2) and pink florets (Red group, 38B, Fan 1) on adaxial side and Red purple, 70C, Fan 2 on abaxial side.


IIHR 20-1-24 IIHR-20-2-10

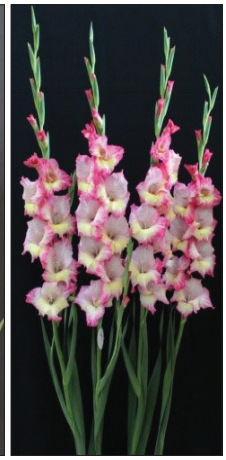
Breeding of double type: Hybridization was carried out in eight different cross combination using single type as seed parent and double type as pollen parent. A total of 25 double types progenies were selected for flowering and yield parameters.

Breeding for biotic stress resistance: Out of 61lines/ genotypes screened under field condition for *Alternaria* leaf blight disease, 3 genotypes were found to be resistant and 8 were moderately resistant.

Gladiolus

Breeding for cut flower: Hybrid selections IIHR-15-1-99, IIHR-15-1-48 and IIHR-15-1-212 were found to be promising for cut flower purpose. IIHR-15-1-99 (RHS colour: Red purple 73A, red 53A blotch having white yellow 5D on lower lip) florets are thick, frilled, attractive and arranged in *zig zag* pattern on spikes with 5 florets open at a time and produces 2 spikes/plant. IIHR-15-1-48 (RHS colour: Red 53B middle, having red 53A margin) florets are thick, wavy and arranged in *zig zag* pattern on spikes with 5 florets open at a time and produces 2.50 spikes/plant. IIHR-15-1-212 (RHS colour: Red purple 67B, red purple 67A hairy streaks with yellow 2C blotch) florets are attractive with frills and arranged in double row pattern on spikes, produces 2.60 spikes/plant.





IIHR-15-1-99 IIHR-15-1-48 IIHR-15-1-212

Evaluation of hybrid progenies: Out of 122 hybrid progenies from six different cross combinations evaluated for growth and flower yield, 28 progenies were selected based on the flower colour, arrangement and yield for further evaluation.

Flower colour variation in hybrid progenies

Screening for *Fusarium* wilt disease: Seventeen hybrid selections were screened for *Fusarium* wilt disease under field condition, the lines *viz*., 15-1-48, 15-1-154, 15-1-215, 15-1-238 and 15-1-172 were found to be immune without any disease. The hybrid selections namely 15-1-339, 15-1-93 and 15-1-36 were found to be resistant and 15-1-99, 15-5-180, 15-5-247 and 15-1-35 were highly resistant.

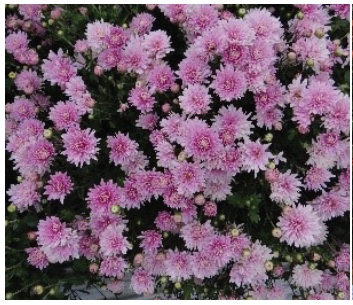
Marker Assisted selection in gladiolus for *Fusarium* wilt resistance: Twenty-four *Fusarium* wilt resistance linked RGA based markers were used to screen 21 genotypes as well as their derived population and aimed at assessing their usefulness. Four RGA primer pairs (GhRGA10, GhRGA23, GhRGA41 and GhRGA55), were found polymorphic and among these primers, GhRGA10 and GhRGA23 are able to differentiate the resistant progenies.

Chrysanthemum

Breeding for pot culture and bedding: ITMC identified for release three chrysanthemum lines *viz*., IIHR4-8,

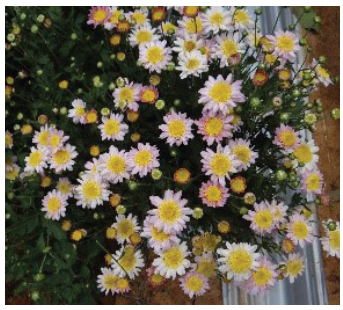
IIHR2-16 and IIHR2-13 as Arka Anirudh, Arka Dhaval and Arka Manohar, respectively, for pot culture and bedding.

Out of 10 half-sib lines evaluated for bedding, IIHR5-11, IIHR9-9, IIHR2-11B and IIHR2-42 were found promising for unique flower colour, flower form and floriferousness.



IIHR5-11

IIHR9-9

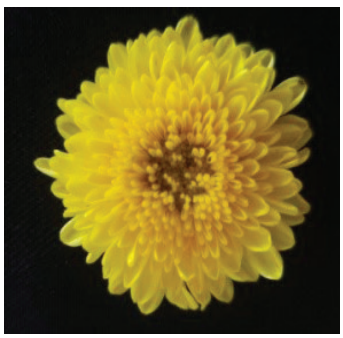


IIHR2-11B

IIHR2-42

Breeding for photo insensitivity: Out of 20 genotypes evaluated for photo-insensitivity under different photoperiods, the genotypes Arka Pink Star, Marigold, Pusa Anmol and Ajay showed photo-insensitive reaction. The genotypes namely Kargil, Arka Kirti and Rekha also showed tendency to photo-insensitivity.

Mutation breeding: Natural mutants (bud sports) were observed in genotype the HYCD14 (yellow mutant) and Candor Pink (white mutant) and successfully isolated under *in vitro* conditions. Two induced mutants from variety Arka Kirti and three mutants from variety Candoor Pink at 15 Gy gamma irradiation dose were observed and cultured *in vitro* for regeneration.



Natural mutant

HYDCD 14 (Parent)

Induced mutants at 15 Gy dose

Arka Kirti (Parent)

Candoor Pink (Parent)

Induced mutants at 15 Gy dose

Breeding for biotic stress: Out of 180 genotypes/ lines screened under natural field condition against chrysanthemum white rust disease (*Puccinia horiana* Henn.), 77 genotypes were highly resistant (PDI 1-10%), 27 resistant (PDI 11-20%), 38 moderately resistant (PDI 21-40%), 20 were susceptible (PDI 41-60%) and 18 were highly susceptible (PDI >61%).

China aster

Breeding for cut flower flower: Out of 36 F_7 erect type lines evaluated for cut flower traits, pink flowered lines (15-41-3, 15-41-5 and 15-57-2A), purple/violet (15-32-1A, 15-41-5A and 15-41-7) and white (15-42-3, 15-52-1B and 15-57-7) were found promising for attractive unique flower colour, long sturdy flower stalk, more number of ray florets and vase life.

Breeding for loose flower: Out of 47 F_7 lines with checks across the flower colour and growth habits evaluated for loose flower yield, 10 F_7 lines recorded more than 50 flowers per plant and high loose flower yield (>100 g/plant).

Breeding for bedding and pot culture: Out of 24 F_7 spreading type lines evaluated for bedding purpose, pink flowered lines (15-2-1, 15-16-4, 15-19-2, 15-30-1 and 15-57-2), purple/violet (15-14-3 and 15-27-1) and white (15-14-2, 15-15-1 and 15-16-3) were found promising for early flowering, attractive flower colour and floriferousness.

Gerbera

Breeding for protected condition: Forty-five segregating lines were evaluated and five lines (AV-35, AV-47, AV-21, Y-10 and AV-53) were found promising for protected cultivation with highest stalk length and flower diameter. The identified lines were multiplied through tissue culture for further evaluation.

AV-35 AV-47 AV-21 Y-10 AV-53

Breeding for open condition: Fifty-five segregating lines of gerbera were evaluated and two lines *viz.*, Red Double and Pink Double were identified for open cultivation with better stalk length, flower diameter and number of flowers/plant/year. Their performance was better compared to other lines in second year also.

Red Double Pink Double

Evaluation for potted plants: Sixteen varieties were evaluated for pot culture. The half-sib population was developed from 16 varieties and are under evaluation for characters suitable for potted plants.

Evaluation of potted gerbera

Crossandra: Fifteen mutants were evaluated for qualitative and quantitative economical characters. Three mutants have been identified and planted in replicated trial for further identification through VTIC based on the flower yield, shelf life, and flower size. Based on the economical characters, 2 mutants were selected. Mutant 2 was selected for medium sized flowers, higher yield and higher shelf life, while, Mutant 3 was selected for pot culture.

Mutant 2 Mutant 3

Dahlia: Different types of dahlia like exhibition type, garden display, potted type and loose flower type were evaluated for flowering and yield parameters. Out of 210 segregating lines of loose flower type evaluated, 4 lines such as IIHR-1 (purple), IIHR-2 (yellow), IIHR-3 (purplish white) and IIHR-4 (red) were found suitable for loose flower with good shelf life (3 days). The segregating lines were shortlisted for vigour, plant height, plant spread, number of flowers, flower weight, flower type etc. The selected lines were multiplied through tubers.

MEDICINAL CROPS

***Mandukaparni* (*Centella asiatica*):** Evaluation of polyploid genotype IIHR-CA-28 along with check Arka Prabhavi and other elite lines over two different harvests revealed that IIHR-CA-28 recorded significantly higher mean fresh biomass yield (14.06 t/ha) than check Arka Prabhavi (8.89 t/ha), however, average asiaticoside content (3.31%) and total triterpenoid content (5.67%)

was on par with check Arka Prabhavi (3.35% asiaticoside and 5.92% total triterpenoid).

Kalmegh (*Andrographis paniculate* Nees)

Evaluation of promising selections: The elite selections AP Sel 3 and Sel 1 and Sel 2 registered higher leaf andrographolide content consistently ranged 5.10% to 5.40% which was higher than checks (3.15% to 3.52%). Higher dry biomass yield was recorded in selections (3.8 to 4.32 t/ha) compared to the checks CIM Megha and Anand Kalmegh (2.34 to 3.13 t/ha).

Evaluation of segregating population: 10 advance selections-based biomass yield and total andrographolide content were evaluated for yield attributing traits. High variability was observed for plant height, number of branches, days to flowering and leaf yield/plant. All the lines exhibited higher number of branches and greater vegetative growth compared to check. The yield ranged from 3 to 4 t/ha and leaf andrographilide content from 4.5 to 5.5%.

***Brahmi*:** Ten elite lines were characterised as per DUS traits and were evaluated for yield and bacoside content with check CIM Jagruti. Total biomass yield growth and yield attributes were recorded over three harvests in the selected lines.

On the basis of three harvests in selected lines, fresh biomass yield ranged 27 to 48 t/ha and dry biomass 15 to 27.5 t/ha, highest biomass was recorded in BM09 (48 t/ha) followed by BM05 (43 t/ha) compared to check CIM Jagruti (37 t/ha).

Bacoside content in 10 lines were estimated over three seasons (summer, rainy and winter) where mean bacoside content was highest in BM 08 (3.49%) and BM 05 (3.20%). The selection BM05 followed by BM09 and BM 08 were found to be superior in terms of biomass yield and bacoside yield.

Bhringaraj (*Eclipta alba*)

Evaluation of promising selections: Seven selections were evaluated for yield and wedelolactone content. Dry biomass yield ranged 34 to 72 g/plant. Sel. 43 found promising with higher dry biomass (72 g/plant) followed by Sel. 58-1 (54 g/plant) and 59-2 (50 g/plant), however, Sel. 43 recorded higher wedelolactone content (0.64%).

Salacia chinensis

Characterization of *Salacia chinensis* L.: Morphol ogical characterization of different *Salacia* accessions was done.

Chemical profiling of *Salacia chinensis* L.: Chemical profiling of *Salacia chinensis* was done for total phenols, FRAP antioxidant activity, DPPH antioxidant activity, total flavonoids and total carotinoids

Standardization of tissue culture protocol: *In vitro* protocol for propagation of *Salacia chinensis* have been standerdised. Shoot tips as explants was cultured in MS-medium supplemented with different concentrations of BAP and NAA. Shooting response was higher in combination of BAP and NAA, MS Media+ 1.5 mg BAP+ 1 mg NAA, MS Media+ 1.5 mg BAP+ 0.02 mg NAA, MS Media+ 0.5 mg BAP + 0.5% activated charcoal, MS Media+ 1 mg BAP+ 1 mg NAA+ 0.5% activated charcoal.

Propagation techniques for multiplication: Seeds of *Salacia* sp. soaked in GA_3 (500 ppm) and sowed in cocopeat showed highest germination (≥70%). However, rooting was not occurred in air layering and in different types of cuttings tried.

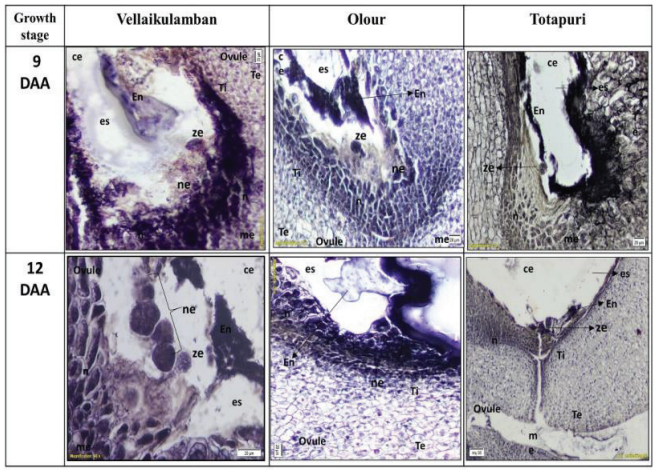
DNA was extracted from different *Salacia* species (*Salacia fruiticosa*, *Salacia beddomei*, *Salacia malabarica*, *Salacia wayanadica* and *Salacia chinensis*) using C-TAB method.

3.3 CROP PRODUCTION

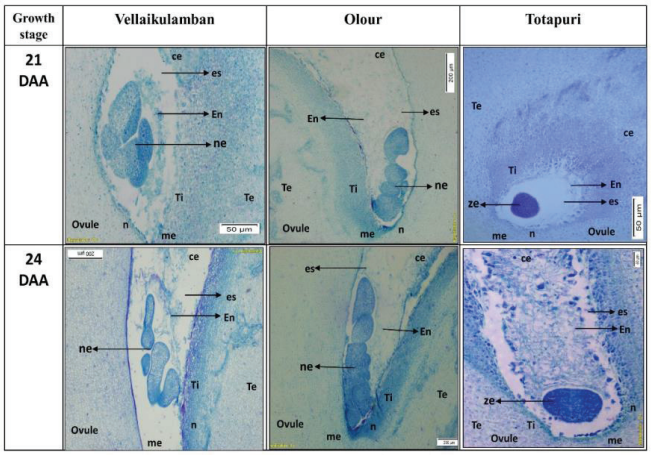
FRUIT CROPS

Mango

Studies on polyembryony: The multi-disciplinary investigations over the previous three years were concluded with the inference that the zygotic embryo growth was suppressed in the embryo sac of polyembryonic kernels during 9 to 12 days after anthesis by the vigorous nucellar embryos. Though some SSR markers exhibited polymorphism and reproducibility in differentiating the multiple seedlings and embryo's origin, leaf volatile profile is a more reliable biomarker to distinguish mango genotypes as well as zygotic seedling from nucellar ones. This study while resolving ambiguity regarding discrimination of nucellar and zygotic seedlings, gave clear indication that the multiple nucellar seedlings tend to be more vigorous than the single zygotic seedling that often emerges last from a polyembryonic mango seed being positioned farthest from the funicular end in the anti clockwise direction; and confirmed the adventive embryogenesis process in mango through histo-chemical approach while documenting the expression of polyembryony in open pollinated seeds of 21 polyembryonic genotypes of *Mangifera indica* and two of its related species namely *M. zeylanica* and *M. odorata*, ruling out any xenic effect in this regard with controlled crosses.



Developmental changes during 9 to 12 DAA, in the embryo sac of polyembryonic and monoembryonic mango cultivars with Hematoxyline & Orange - G stains



Developmental changes from 21 DAA to 24 DAA, in the embryo sac of polyembryonic and monoembryonic mango cultivars with toluidine blue stain

(DAA – Days after anthesis; ze - zygotic embryo with suspensor; ne- nucellus embryo; n – nucellus; es- embryo sac; me - micropylar end; ce- chalazal end; Ti- inner integument; Te- Outer integument)

High density planting system: The plant height, girth and canopy spread were significantly influenced by different HDP systems (5 m x 2.5 m, 5 m x 3.75 m and 5 m x 5 m) in Arka Udaya hybrid, but were similar in Arka Suprabhath mango hybrid. Different drip-fertigation levels (55:14:51, 73:18:68 (RDF) and 91:22:85 g N: P_2O_5: K_2O per plant) did not influence growth parameters in both hybrids. Recyclable pruned biomass varied between 184-366 and 144-277 kg per ha in Arka Udaya and Aka Suprabhath, respectively. Leaf nutrient status was found optimum in both hybrids. In Arka Udaya, the N accumulation in leaf varied from 1.57-1.93 % among HDP systems and 1.63-2.04% drip-fertigation levels. The P accumulation in leaf biomass was in optimum range (0.166-0.195 %) among treatments. The stem P concentration ranged from 0.201 to 0.259% among HDP systems and 0.224-0.243% among fertigation treatments. In Arka Suprabhath, the leaf N concentration ranged from 1.75-1.88% and 1.73-1.91% among HDP systems and fertigation levels, respectively. The N concentration in stem was 1.24-1.54% among HDP systems and 1.28-1.46% among fertigation levels.

Influence of PGR: Efficacy of NAA (10, 20, and 30ppm), GA_3 (25, 50, and 75ppm), and triacontanol (1, 3, and 5ppm) were evaluated for improving fruit retention, yield, and quality of Banganpalli at CHES (ICAR-IIHR), Bhubaneswar. Application of triacontanol (3-5ppm) at panicle initiation, pea, and marble stage of fruit growth brought out a significant improvement over control in terms of panicle size, fruit retention, yield, and fruit quality. Plants sprayed with 5ppm triacontanol produced the largest panicle (length: 28.74cm, width: 17.68cm) and recorded the maximum value for fruit retention (55.67, 36.81, 28.64, and 22.36 % at 15, 45, and 105 days after pea stage, respectively), number of fruits (96.75/tree), yield (36.27kg/tree), and TSS (19.71°B).

Fruit retention in Banganpalli influenced by application of triacontanol

Annona

Rootstock Studies: Growth and fruit quality parameters of Arka Sahan were unaffected on seven different rootstocks during the sixth orchard year while fruit yield was highest on *Annona muricata* and least on *A. reticulata* that tend to have less tree spread.

Organic matter recycling: The work on organic matter recycling in Arka Sahan hybrid of Annona was initiated to study the feasibility of supplementing inorganic fertilizers and making annona production system self-sustainable. The nutrient removal pattern in Arka Sahan hybrid of Annona indicated that the nutrient removal per plant was 221 g N, 12.5 g P, 105 g K, 115 g Ca and 32 g Mg.

Influence of PGR on custard apple: At CHES, Bhubaneswar, efficacy of NAA (50, 100, and 150 ppm), BR (0.1, 0.3, and 0.5 ppm), and GA_3 (100, 150, and 200ppm) was evaluated for fruit set, yield, and quality of custard apple var. Arka Neelachal Vikram. Three sprays of 150-200 ppm GA_3 during flowering (April to June) at the monthly interval were found effective for improving fruit set (May flowering: 5.25-5.68%, June flowering: 9.15-9.71%) over the control (May: 3.24%, June: 6.96%). Plants sprayed with 200 ppm GA_3 registered the highest fruit yield (22.45 kg/tree) followed by 150ppm GA_3 (21.30 kg/tree), whereas, the lowest yield was recorded under control (15.17 kg/tree). With respect to fruit quality, GA_3-treated plants produced better quality fruits in terms of pulp content (71.75-72.41%), and TSS (22.45-22.71°Brix).

Influence of defoliation on off-season flowering in custard apple: At CHES, Bhubaneswar**, e**thephon (200, 400, 800, and 1200 ppm), potassium iodide (KI) (1, 2, and 3%), NAA (250, 500, 750, and 1000 ppm), and urea (5, 10, and 15%) were sprayed to induce defoliation in custard apple. Though the application of KI (1-3%), urea (5-15%), and ethephon (1200 ppm) was effective in inducing defoliation, the new shoots that emerged after defoliation could not maintain their growth and abscised with the onset of the natural period of leaf shedding (December–January). New flush on manually defoliated plants followed a similar phenomenon of abscission during winter. Hence both chemical and manual defoliation were ineffective for inducing off-season flowering in custard apple in eastern tropical region.

Off-season flush in custard apple after application of defoliants

Shedding of off-season flush with the onset of winter

Guava

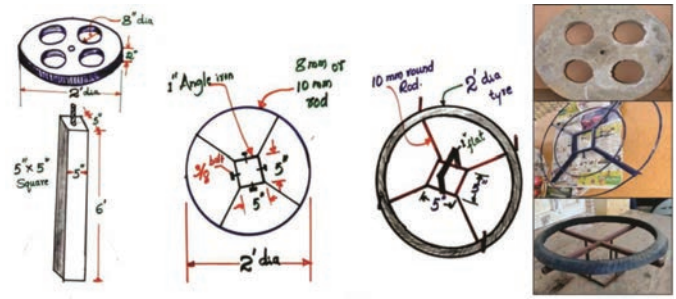
Evaluation of guava hybrid Arka Poorna propagules: The approach grafts and air layers of Arka Poorna in response to mineral and organic nutrient sources with 50,75 and 100% recommended dose of fertilizers + 2.5 kg FYM + 150 g AMC and 100% RDF through either organic manures or inorganic fertilizers showed that air layered plants had better plant height (142.95 cm), canopy spread [105.89 cm (N-S) & 101.13 cm (E-W)] and number of shoots (14.16) and productivity of 32.11 t/ha in summer season and 72.0 t/ha in rainy season crops.

Sapota

Fruit Based cropping system : The growth performance of intercropped acid lime var. Balaji at different planting geometries in sapota was similar in terms of plant height; canopy spread (E-W & N-S) and stem girth.

Dragon fruit

Training systems: Four year study on different trellis systems indicated that single pole system showed better performance in terms of growth and yield when comparatively other trellis systems such as continuous pyramid stands, and 'T' stands. Further, single pole system made-up of cement pole with cement ring is durable and highly suitable for dragon fruit cultivation.



Diagrammatic representation of single pole training system

Nutrient management: Based on 2-year results on nutrient requirement for dragon fruit, nutrient level of 450 N: 275 P_2O_5:650 K_2O g per pillar resulted in highest fruit yield (41.6 kg/pillar), biomass yield (61.0 kg/pillar) and pulp recovery (80.0 percent) for red pulp cultivar and higher fruit yield of 26.9 kg per pillar in white pulp cultivar. From the experiment it is observed that the treatment combination of 450 N: 275 P_2O_5: 650 K_2O g/ pillar is ideal for better yield of dragon fruit. For red pulp dragon fruit cultivar, drip irrigation replenishing 40% ER was better in terms of number of fruits and yield.

A view of the experimental plot on standardization of irrigation in dragon fruit

Influence of calcium on fruit quality: Influence of calcium on fruit quality of dragon fruit was assessed at CHES (ICAR-IIHR), Bhubaneswar. Soil application of Ca @ 400g/plant/year exhibited the maximal acquisition of N, K, Ca, Zn and B in the fruit pulp of dragon fruit. The same treatment significantly improved fruit yield, fruit weight and fruit firmness in dragon fruit. Soluble solid contents, reducing sugars, protein, betacyanin, total phenol, total flavonoid and FRAP activity also enhanced with the application of Ca @ 400g/hill/year. Significant correlation between the pulp calcium content and fruit quality parameters provides decisive evidences of beneficial effect of calcium nutrition in enhancing quality yield in dragon fruit under acidic soil condition.

Influence of crop load on fruit quality: Influence of crop load on fruit quality of red-fleshed dragon fruit (*S. monacanthus*) was assessed at CHES (ICAR-IIHR), Bhubaneswar. Two, three, four and five fruits/plant of dragon fruit was retained in each flush. Fruit weight exhibited declining trend with the increase in the number of fruits/plant. The proportion of large fruits (> 280g) and medium size fruit (250-280g) was increased by ~ 20% when less number of fruits were retained. However the proportion of small fruits (<250g) increased to about 65% when more than three fruits were retained. TSS, betacyanin content and protein content was also relatively higher when 2-3 fruit were retained

Grapes

Source sink relationship in coloured grapes: Three coloured grape varieties viz., Red Globe, Crimson Seedless and Fantasy Seedless were evaluated to study the source sink relationship to optimize yield and quality for 3rd year. Three cane regulation treatments (20, 30 and 40 canes per vine) were imposed after back pruning. While three leaf regulation treatments (10, 12 and 14 leaves per cane) were imposed after forward pruning. With less number of canes, Crimson Seedless recorded maximum cane diameter of 9.14 mm in vines with 20 canes and was significantly different among other cane loads of 30 (8.28 mm) and 40 (6.87mm). Maximum leaf area (3425 cm^2) was recorded in vines with 20 canes with 15 leaves in Crimson Seedless. With increase in cane load, there was gradual reduction in total leaf area. In all the canopy manipulations, maximum light penetration (62-80%) at bunch zone was in Red Globe indicating its sparse canopy. In Crimson Seedless minimum (34%) light penetration was observed in fruit zone indicating very denser canopy with 40 canes and 15 leaves. Fantasy Seedless was moderately vigorous with light penetration ranging from 40% to 56 % depending on the cane and leaf load. Due to heavy incidence of downy mildew in Red Globe and Fantasy Seedless (continuous rains during flowering and berry development stages), yield and quality parameters were recorded only in Crimson Seedless grapes. Among different cane and leaf regulation treatments, average berry weight (5.50 g) was maximum in vines having 30 canes, 15 leaves while it was least (3.57 g) in vines having 40 canes and 11 leaves and also in vines with 20 canes and 11 leaves (4.07 g). Highest TSS (16.4 ^oBrix) was recorded with vines having 30 canes and 13 leaves while it was least (14 to 14.8 ^oBrix) in vines with less leaves irrespective of cane load. Maximum berry diameter (17.63 mm) in vines with 30 canes and 13 leaves while it was least (14.2 mm) in vines having 20 canes and 11 leaves. Since, results were vitiated by unusual rains, the experiment will be repeated for one more year and conclusions will be derived.

Overcoming problem of uneven ripening in Gulabi and Bengaluru Blue grapes: To overcome the problem of uneven ripening, a field experiment was initiated during 2019 and continued for three consecutive years till 2022. Three levels of crop load (by thinning excess bunches) viz., 40 bunches, 50 bunches and 60 bunches per vine were retained. The bunches were treated with two concentrations of ethrel (150 ppm and 300 ppm) at veraison (berry softening) stage. Totally six treatment combinations were evaluated along with control (no bunch thinning and ethrel application). Based on three years research, it was concluded that retaining 50 bunches per vine and treating bunches with 300 ppm of

ethrel at veraison stage (berry softening) was identified as best practice to produce bunches having uniform colour (measured as anthocyanins) and high TSS. The same practice can be recommended to grape growers of Cumbum valley of Tamil Nadu to overcome the problem of uneven ripening in grape variety Gulabi. But, no significant difference was observed with respect to either bunch thinning or ethrel application in Bengaluru Blue grapes.

Bunch thinning and ethrel application in Gulabi grapes

Without bunch thinning and ethrel application in Gulabi Grapes

Papaya

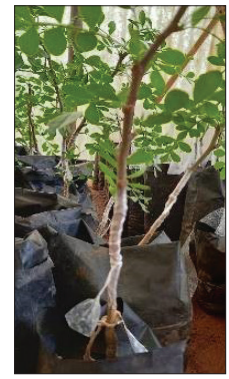
Management of papaya (var. Arka Prabhath) rhizosphere for quality fruit production: The nursery trial with two factors viz., substrate and seed priming showed that seeds primed with Arka microbial consortium and sown in media comprising Arka Fermented cocopeat + compost in equal proportion by volume are superior in growth parameters like plant height, root length, number of leaves and stem girth. The chlorophyll content was higher in plants raised in Arka Fermented cocopeat + compost. However, it was significantly on par with control (soil+sand+compost in 1:1:1 ratio). The enzyme activity (protease and amylase) was found higher in seeds primed in Arka Microbial consortium. However, the hormone levels (GA3 and IAA) were higher in seeds primed with Arka Actinoplus treated seeds. There was zero nematode count in the substrate before sowing and also in roots and substrate after 65 days of sowing. Collar rot was observed in Control substrate (6.67 to 7.89%) and also to a tune of 5.36 % in AFC+compost media. Based on the results of nursery trial, seedlings were raised in media comprising Arka Fermented cocopeat + compost in equal proportion by volume and transplanted in main field with eight treatments imposing Arka microbial consortium, Arka Actinoplus, *Trichoderma*, AM Fungi, *Bacillus*, *Azospirillum* and phosphate solubilizing bacteria along with control.

MINOR FRUITS

Standardization of propagation of some of the underutilized fruits using seed and vegetative propagation: In wood apple, germination percentage up to an extent of 95% was obtained from GA3 (100 ppm) treatment for 24 hrs. In Bael, 74% seed germination was obtained without any seed treatment. In Rose apple, seed germination of >75% was obtained without any seed treatment and polyembryony was observed in all the investigated samples and number of seedlings ranged from 2 to 9/seed. In Hog plum, mechanical scarification with sand paper followed by treatment in GA_3 100 ppm for 48 hrs resulted in 42% germination whereas no germination was observed in control. In Loquat, seed treatment with GA_3 100 ppm for 24 hrs resulted in 89.4% germination whereas water soaking for 24 hrs resulted in 82.75 % and control (75.67%). In Surinam cherry water soaking of seeds overnight before sowing resulted in >95% germination.

Vegetative propagation in wood apple: Softwood grafting was successful (80%) using own seedlings as rootstocks done during March, April, and October months. In rose apple air layering was successful (75%) in August while grafting was successful (< 60%) in November using own seedlings

Wood apple seedlings



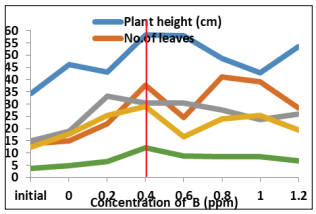
Wood apple grafts

Rose apple polyembronic single seed producing 9 seedlings

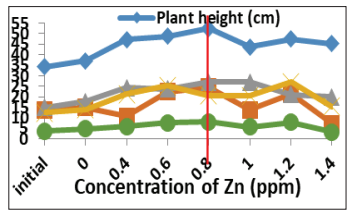
Rose apple air layered plant

Delineation of soil critical level of boron and zinc for avocado: Sand culture experiments were conducted to delineate soil critical levels of B and Zn for avocado adopting Arka Supreme grafted plants. Hoagland solution was used as nutrient source and different levels of B (0, 0.2, 0.4, 0.6, 0.8, 1.0 and 1.2 ppm) and Zn (0, 0.4, 0.6, 0.8, 1.0, 1.2 and 1.4 ppm) were applied. Based

on the growth response (plant height, number of leaves, total dry matter yield), soil critical level of B and Zn were found to be 0.4 ppm and 0.8 ppm, respectively.



Effect of different levels of boron on plant growth parameters



Effect of different levels of zinc on plant growth parameters

Polyembryonic behaviour in rose apple : Polyembryonic behaviour of rose apple (*Syzygium jambos*) was studied at CHES (ICAR-IIHR), Bhubaneswar. Frequency of occurrence of polyembryonic seeds varied between 45.85 – 54.62%. Intensity of occurrence of multiple seedlings was 46.7%. Occurrence of duplets was common (31.6%), whereas the occurrence of triplets, quadruplets and quintuplets was 9.6%, 3.9% and 0.52%, respectively. Embryos were mainly arranged at micropylar region which were characterized by asynchronous developments. Moreover, their biomass partitioning significantly varied with morphotypes. Embryo to seedling conversion rate was more than 53%. It was evident that the seedling biomass decreased with the increase in the intensity of multiple seedlings. Molecular characterization of seedlings gave an indication of predominance of apomictic seedlings.

Quintuplets in rose apple

Canopy architecture management in pomegranate and guava: Pre-experimental soil fertility status indicated that the soil is slightly acidic with low organic carbon (OC) content (0.33%) and available P, and high available K in pomegranate. In guava, the initial soil status showed the soil is acidic with 0.65% OC and higher availability of NPK.

Pomegranate variety Bhagwa was planted at spacing of 4m x 3m and 4m x 1.5 m. Guava variety Arka Poorna was planted at 3 m x 2 m and 3 m x 1m spacing. Training system for both crops was installed and plants are being suitably pruned to establish the framework.

Propagation of fruit crops by advance methods: A new initiative on refinement of propagation techniques for rapid multiplication of fruit crops (Papaya, Guava, Avocado, Mango, Grape, Rambutan and Mangosteen), through Semi Sterile Tissue Culture (SSTC) technique was planned.

Natural Farming in horticutlure based cropping system: A new multidisciplinary project on Evaluation and demonstration of Natural Farming approaches in horticulture-based cropping system was initiated involving fruit crops (mango, annona and guava), vegetable crop (tomato) and flower crop (marigold) in comparison with, modern farming and organic farming.

Fruit-based multistorey system: A fruit-based multistorey system (mango + dragon fruit + pineapple) has been developed at CHES (ICAR-IIHR), Bhubaneswar with an aim to enhance system profitability. Under partial shade condition (40000 – 50000 lux) dragon fruit and pineapple were selected as intercrops in low density mango. Crops were arranged according to height so that solar energy could be used effectively. Dragon fruit occupied about 35% area whereas pineapple occupied 15%. The profitability of the system was about three times more (Rs. 952 ha^{-1} day^{-1}) than sole mango cultivation. Relative economic efficiency was also >300% than sole mango cultivation.

Mango + dragon fruit + pineapple multistorey system

Standardisation of secondary nutrient application in fruit crops: New experiment on assessment of secondary nutrient requirement was initiated in mango (cv. Raspuri and Arka Udaya), papaya (cv. Arka Surya), guava (cv. Arka Kiran) and annona (Arka Sahan hybrid) to standardise the source and dose of secondary nutrients both for soil application and foliar spray.

In guava, the leaf nutrient concentrations were on par across the treatments and foliar spray of 0.5% Ca and 0.5% Mg alternatively during fruiting stage at monthly intervals along with RDF+FYM application showed relatively higher values of Ca (2.78%), Mg (0.49%)

and the S (0.23%). Soil application of 100 g dolomite twice in a year showed higher photosynthesis (14.49 µ mol m^{-2} s^{-1}) stomatal conductance (0.20mol m^{-2} s^{-1}) and transpiration rate (4.12mmol m^{-2} s^{1}).

In papaya, soil application of 100 g lime twice in a year recorded significantly higher plant canopy volume (5.73 m^3) and collar girth (21.2 cm) as compared to no application of secondary nutrients (4.03 m^3 and 19.5 cm, respectively. Foliar spray of 0.50% Ca during fruiting stage at monthly intervals in papaya although recorded lower number of flowers (12.13/plant), set the fruits from a lower height (0.78m) with higher fruit set percentage (92.38) and resulted in more number of fruits (16.75/plant). Incidentally the treatment also recorded lower PRSV disease scoring (2.13 with incidence of the disease in 11-25% range).

VEGETABLE CROPS

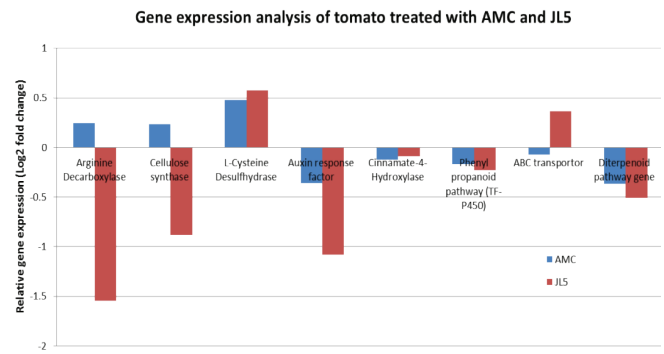
Dolichos: In pole type dolichos bean (Arka Vistar), bi-weekly application of fertilizer (25:40:50kg N:P_2O_5:K_2O ha^{-1}) through water soluble fertilizers resulted in significantly higher yield (46.61 t/ha) than other treatments except weekly application of same amount of fertilizers (46.17 t/ha). All the fertigation treatments recorded higher yields to the tune of 6.64 to 44.0 per cent than the soil application of fertilizers (32.36 t/ha). The maximum fertilizer use efficiency recorded with bi-weekly application of 75 per cent fertilizer dose through water soluble fertilizers (453.57 kg/kg). The minimum value for the FUE recorded with T_1 (281.39kg/kg).

In bush type dolichos bean (Arka Amogh), bi-weekly application of 100% fertilizer dose of N:P_2O_5:K_2O (25:40:50 kg/ha) through water soluble fertilizers recorded higher yield (23.81 t/ha) than other treatments followed by weekly application of same amount of water soluble fertilizers (23.66 t/ha). Application of 75% of the fertilizer dose through fertigation using water soluble fertilizers at weekly and bi-weekly intervals also produced higher yields (21.60 and 23.08 t/ha). All the fertigation treatments, where water soluble fertilizers or in combination with common fertilizers was applied recorded higher yields to the tune of 3.18 to 20.19 per cent than the soil application of fertilizers (19.81 t/ha). The maximum fertilizer use efficiency recorded with bi-weekly application of 75 per cent fertilizer dose through water soluble fertilizers (267.59 kg/kg), while soil application of normal fertilizers recorded the minimum (172.26 kg/kg).

Musk melon: In musk melon cv. Arka Siri, bi-weekly application of 100% fertilizer dose of NPK (100:60:10 kg/ha) through water soluble fertilizers resulted in significantly higher fruit yield (35.40t/ ha) followed by application of same amount of fertilizers on weekly basis (35.19 t/ ha). The fertigation treatments produced higher yields to the tune of 3.06 to 46.17 per cent than soil application of nutrients (24.13 t/ha). Biweekly or weekly application of 75% fertilizer dose of NPK through water soluble fertilizers resulted in higher fertilizer use efficiency (170.74 kg/kg) and (165.54 kg/kg) than other treatments.

Tomato

Functional annotation and gene expression analysis in tomato treated with beneficial microbes: The functional annotation of differentially expressed genes (DEGs) in tomato treated with AMC (Arka Microbial Consortium) and JL5 (*Trichoderma* sp.) was carried out. The DEGs were found to be involved in various molecular function, cellular components and biological processes. More than 500 genes that are involved in intrinsic and integral component of membrane were upregulated in AMC signifying its interaction with the tomato plants. The gene expression analysis of tomato treated with AMC and JL5 was conducted using qPCR. Genes involved in plant growth and development, signalling and stress response like arginine decarboxylase, cellulose synthase and L-Cysteine desulfhydrase were upregulated in AMC treatment whereas downregulated in JL5 treated plants. ABC transporters involved in plant growth were found upregulated in JL5 treatment. The results suggest that AMC treatment had up-regulated the expression of growth related genes compared to JL5.



Gene expression analysis in tomato using qPCR

Okra

Identification of long non-coding RNAs in Okra: Comprehensive okra transcriptome was used to identify 57675 putative long non- coding RNAs (lncRNA) from pooled okra transcriptome data comprising 13 different parts. The length of lncRNA ranged from 211 to 4234bp. We have further classified these lncRNA based on its length as, small lncRNA (200- 950nts), medium lncRNA (950-3000nts) and large lncRNA (>3000nts) which accounted for 50761, 6860 and 54 lncRNAs respectively.

Randomly 53 lncRNAs were selected from the identified lncRNAs of comprehensive okra transcriptome and its amplification was inspected by polymerase chain reaction (PCR). A total of 1281 TFs were identified from the comprehensive okra transcriptome which were distributed in 51 transcriptional factor families.

Gene expression analysis of okra treated with *F. oxysporum*: In order to understand the effect of beneficial microorganisms on Fusarium wilt disease in molecular level, expression of genes like PR3 and PR10, which are involved in disease tolerance, were examined. Relative expression of the PR (PR3 and PR10) genes were analyzed in GJ16B, AMC and JL5 treatments and the control plants at three different intervals (control, 1 and 4 DPI) through RT-qPCR analysis. JL5 treated plants before inoculation with pathogen had the highest PR10 gene expression of 1.9 fold, which again increased on 1 DPI to 2.0 fold. Except GJ16B, all the treatments showed up regulated PR10 gene expression during 1 DPI and the expression was down regulated on 4 DPI (Fig. 9). All treatments showed down regulation of PR3 gene on 1 DPI but an upregulation on 4 DPI except pathogen control (Fig. 10). The expression analysis signifies that the PR10 genes act during early stages of infection (1 DPI) whereas PR3 genes were activated during later stages of infection (4 DPI).

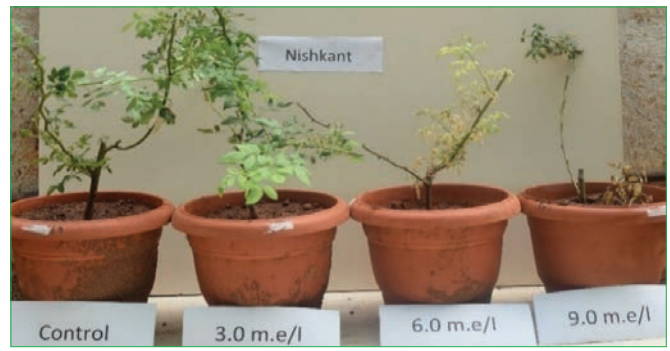
FLOWER AND MEDICINAL CROPS

Rose

Screening of budded rootstocks and varieties with institute developed rose varieties: Budding of ICAR-IIHR developed rose varieties for field conditions viz., Arka Parimala, Arka Savi and Arka Sukanya was done on *R.indica, R.multiflora*, Natal Briar and Dr. Huey for screening for salt tolerance under field conditions. Four salinity treatments viz., control, 2.5, 5.0 and 7.5 dS m^{-1} were given and the performance of different rootstock scion combinations was studied.

Among the three rose varieties that were budded on three rootstocks, Arka Savi performed better on all the rootstocks in the order of *R. multiflora*, Dr. Huey and Natal Briar. Slight salinity injury symptoms like scorching at leaf margins at high salinity levels were seen when Arka Savi was budded on Natal Briar and Dr. Huey. While Arka Sukanya and Arka Parimala performed better on *R. multiflora* at high levels of salinity, but their growth and flowering was affected when budded on Natal Briar and Dr. Huey rootstocks. Similarly chloride accumulation was less when they were budded on *R.multiflora* than on Natal Briar and Dr. Huey. Effect of salinity on physiological parameters of rose varieties budded on different rootstocks was also studied. Relative water content (RWC%) decreased with increase in salinity. It was about 57.14% in rose variety Arka Savi when it was budded on *R.multiflora* at T3 (7.5dS m^{-1}) salinity level, 42.9% in variety Arka Parimala and 29.41% in Arka Sukanya. Proline content increased with increase in salinity levels. It was more in all the three rose varieties when they were budded on Dr. Huey rootstock than on *R.multiflora*. Trehalose contents also increased with increase in salinity levels and it was more in Arka Savi when budded either on *R.multiflora* or Dr. Huey.

Experiments on amelioration measures for bicarbonate toxicity: A pot culture experiment was conducted to find out suitable amelioration measure for tolerating bicarbonate toxicity in irrigation water. Rose variety Nishkant which is highly sensitive for salinity and alkalinity has been selected for this experiment. Four alkalinity levels viz., 0,3.0,6.0 and 9.0 me/L were imposed. Three amendments *viz*., FYM and gypsum each at the rate of 20,40 and 60g /5 kg soil and Phosphoric acid @ 0.2,0.4 and 0.6 ml/L were applied in all salinity levels. Among all the treatments, application of phosphoric acid seems to be reducing the ill effects of bicarbonate toxicity.

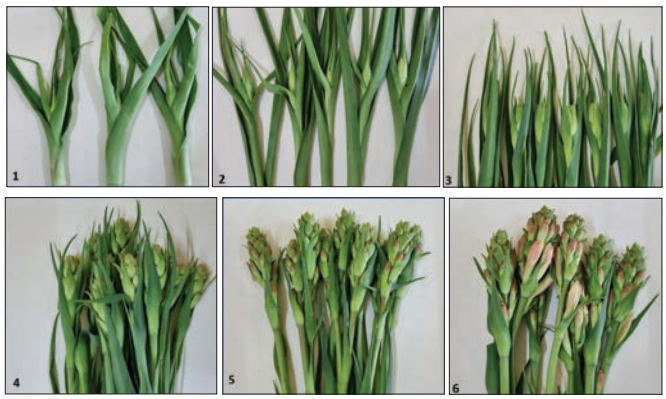


Bicarbonate toxicity in Rose variety Nishkant

Effect of different amendments on alleviating bicarbonate toxicity

Tuberose

Nutrient accumulation: Different stages of tuberose (Arka Prajwal) were analysed for leaf nutrient concentration starting from 45 days to 180 days after planting. Leaf analysis results showed macronutrients were in the order of K > N > Ca > Mg > P and micronutrients were in Fe > Zn > Mn > Cu.



Different tuberose (Arka prajwal) stages analysed for leaf nutrients concentration

Aster

Nutrient accumulation: Leaf nutrient concentrations analysed in the first season of Aster (ArkaKamini) showed macronutrients were in order K > N > Ca > Mg > P > S and micronutrients were in order Fe > B > Zn > Mn > Cu in leaf concentrations.

Identification of micronutrients constraints in flower crops in farmers' fields: Fifty flower growing fields soil and leaf samples were analysed for soil and plant nutrient status comprising rose and chrysanthemum crops. Soil data showed more than 50% soils were low in organic carbon status and with pH above 7.5. However, micronutrient contents were in optimum range only. Flower crops showed micronutrient deficiencies in different growth stages.

Potassium and Iron deficiency in Rose

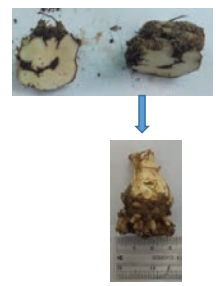
Magnesium Deficiency in Chrysanthemum

Boron Deficiency in Crossandra

Wick Irrigation in Crossandra: New irrigation method called Wick irrigation was tried in Crossandra variety Arka Chenna. The crop performed very well in wick irrigation compared to irrigation with drippers. The characters like plant height (cm), flower diameter (cm), flower weight (g/100 flowers) and yield/plant/month (g) was significantly higher in wick irrigation than the control, while, there was 50% saving of water in wick irrigation

Wick irrigation in Crossandra

Rapid multiplication of quality planting material in vegetatively propagated flower crops: In tuberose var Arka Prajwal, plantable size, spindle shaped bulbs (31.00 g bulb weight) were obtained from sectioned mother bulbs weighing 40 to 50 g when planted on the substrate combination of Arka Fermented cocopeat + soil + FYM (1:1:1 v/v) along with application of 150:75:125 kg/ha NPK in a short propagation cycle of four months (Fig. 1). In genotype IIHR-4, whole mother bulbs planted on conventional soil media along with application of 150:75:125 kg/ha NPK recorded the production of spindle shaped bulbs (30.17 g bulb weight) in a rapid propagation cycle of four months (Fig 2).



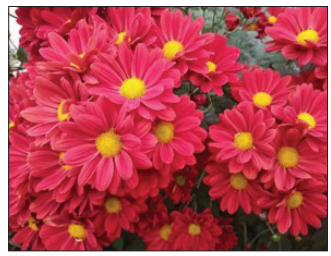
Sectioned mother bulbs of Arka Prajwal and spindle shaped planting stock

Whole mother bulbs of IIHR-4 and spindle shaped planting stock

Enhancing propagation efficiency and quality planting material production in vegetatively propagated flower crops (Rose): In establishment of rose rootstock mother block and nutrient scheduling experiment, significant differences were observed for plant height (36.72 cm) and number of primary branches (5.8) for *Rosa multiflora* rootstock with the application of 400:200:200 kg NPK/ha/year compared to Natar blair. Whereas, plant spread in N-S and E-W was maximum (194.68 cm and 18.84 cm) in *Rosa multiflora* rootstock supplied with nutrients @ 450:150:525 kg NPK/ha/year. Similarly, in establishment of rose scion block and nutrient scheduling experiment, significantly highest plant height (43.68 cm) and plant spread (E-W) 40.96 cm was recorded in Arka Savi with nutrient scheduling of 300:100:350 kg NPK/ha/year compared to Arka Swadesh.

Influence of photoperiod manipulation on growth and flowering of cut chrysanthemum: In second year, significantly better flower quality parameters were recorded in photoperiodic module T_1 : Long days (16 hours light, 8 hours dark) upto crop age 4-5 weeks + short days (8 hours light, 16 hours shade) after 5 weeks upto flower bud initiation across the different varieties of chrysanthemum which was on par with T_2 : long days (15 h light, 9 h dark) upto crop age of 4-5 weeks + short days (9 h light,15 h shade) after 5 weeks upto flower bud initiation.


Arctic Queen


Harley Red


Candor Pink


Dante Purple


Feeling Green Dark


Champagne Orange


Champagne Yellow


IIHR 5-14


General view of the experimental plot

Chrysanthemum varieties under photoperiodic module

Determination of appropriate hydroponic system for Gerbera cultivation: The feasibility of hydroponic system as an alternative planting system to protected soil-based conventional cultivation of Gerbera was assessed for second year experiment. Aggregate Wick system on soil beds was most desirable concerning the performance of the gerbera resulting in higher yield and superior quality flowers. With respect to soil-less system, aggregate wick system with pots on ground exhibited maximum plant height, number of leaves, leaf length and width and produced maximum number of flowers and better vase life.


Aggregate Wick system with pots and growbags on ground


Nutrient Film Technique with wick Pots on NFT Bench


Hydroponic production of Gerbera in different soil-less substrates

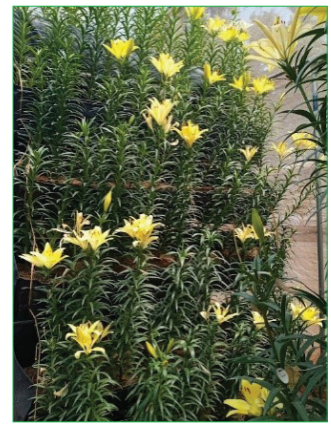
Soilless substrate for hydroponic Gerbera production: In 2nd year, significantly better vegetative growth and yield per plant in Gerbera cv. Arka Nesara was registered with the soilless substrate comprising cocopeat + rice husk +

FYM (1:1:1) substantiating that the quality as well as the proportion of growing substrates greatly matters when gerbera was grown hydroponically.

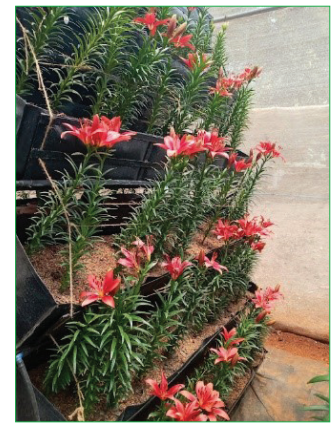
Standardization of orientation of vertical farming system for quality flower production of Gerbera: Vertical farming models with vertically stacked pots placed in different orientations were tested for commercial cultivation of Gerbera. Maximum plant height, number of leaves per plant, petiole length, leaf length and leaf breadth were observed in vertical system facing east which was on par with vertical system facing west. Utilization of Vertically stacked pots for vertical farming have increased the utilization of unit area available in polyhouse to an extent of 5 folds. This provides immediate solution for farming in urban and peri urban areas where arable land is a limitation and provides consistent income to gerbera growers by using minimal farm inputs.

Vertical farming of Gerbera in vertically stacked wick pots

Vertical farming system for commercial cultivation of Lilium: Performance evaluation of Lilium cvs. was carried out in vertical farming structures against control (Conventional farming - in horizontally placed growbags for *Lilium*). In conventional farming, water requirement for *Lilium* is 5 L/sqm/day whereas in vertical farming water requirement is 952 ml/sq.m/day. There is an increase in planting density 6 times (36 plants in horizontal farming Vs 198 plants in vertical farming) and reduction of water requirement by 4 times. No significant difference was observed in growth, flowering and productivity amongst the plants kept in lower and upper bags in vertical layers as well as control. Thus, vertical farming approach which efficiently utilizes the available land and water resources could be the superior alternative to cultivate Lilium without compromising yield and produce quality. The vertical farming requirements for commercial cultivation of Lilium have been standardized for two seasons.



***Lilium* cv. Scipione in Vertical farming**



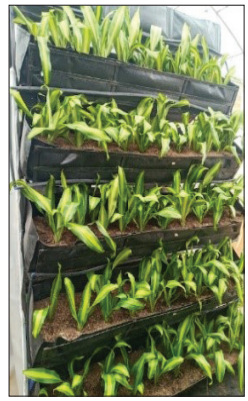
Lilium cv. Corleone in Vertical farming

Vertical farming for commercial cultivation of Gypsophila: The trial was initiated with objectives to increase the planting density of *Gypsophila paniculata* (Baby's breath), a popular high value cut filler crop in naturally ventilated polyhouse through Vertical farming by adopting soil-less cultivation practices. Performance evaluation of *Gypsophila* cv. Fortuna is in progress in vertical farming structures in comparison with control (Conventional farming - in horizontally placed growbags).

Evaluation of *Gypsophila* cv. Fortuna in Vertical farming structures

Utilization of vertical structures for propagation of *Draceana deremensis*: The suitability of vertical structures for the nursery production of rooted cuttings of ornamental cut foliage plants like *Draceana deremensis* was studied. To save the space required for nursery production, the growbags were kept vertically in tiers which are about 6 feet long and 1 feet wide. Prior to planting of unrooted cuttings, the propagation substrate was irrigated thoroughly. The available water in the propagation substrate was sufficient to supply the moisture required by the cutting to remain turgid once the roots emerge. The unrooted cuttings were then directly

planted on the soilless media in the growbags of the vertical structures. To provide the moisture needed to keep propagation environment humid, the vertical structures were kept covered with tailor made tarpaulin materials with provision of zip. Acting like a greenhouse, the cover was used to warm the substrate prior to planting of cuttings. As moisture loss was controlled it created the ideal humidity for rooting of cuttings. 98 % rooting was observed in cuttings of *Draceana* placed in all vertical tiers in a period of 30 days.



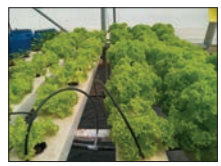
***Dracaena massangeana* propagated in vertical structures**

Propagation of *Crossandra infundibuliformis* in vertical structures: Terminal cuttings of 10-15 cm length of five varieties were planted in seedling pro-trays filled with sterilized cocopeat with 50 cells. 3 numbers of 50 celled pro-trays could be accommodated in 1 vertical tier thereby 150 cuttings could be propagated in each grow bags. 1500 numbers of unrooted cuttings could be easily accommodated in 1 vertical structure for rooting. To provide the moisture needed to keep the propagation environments humid, the vertical structures were kept covered with tailor made tarpaulin materials with provision of zip. 99% rooting could be observed in crossandra cuttings irrespective of the varieties kept in all vertical tiers in a period of 45 days.

Propagation of Crossandra in vertical structures

Comparison of growth and yield characteristics of lettuce grown in different hydroponic systems: Evaluation of Lettuce var. Locarno grown in DFT, NFT, NFT with wick Pots on NFT Bench, Aeroponics, Low cost Aeroponics set up, Vertical NFT, Aquaponics, Tower system and vertical structures with drip system was done in comparison with soil cultivation. The nutrient and water required for hydroponic production system for Lettuce grown in different hydroponic systems have been standardized for two seasons.

Deep Flow Technique

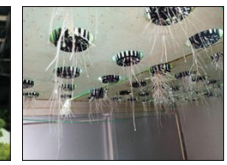


Nutrient Film Technique (NFT)

Vertical NFT

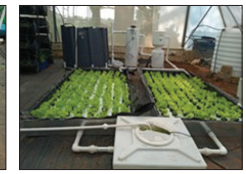
NFT with Wick pots

Aeroponic system



Root growth observed in Aeroponics

Low Cost Aeroponic set up



Recirculated Aquaponics System

Hydroponic Tower system

Evaluation of lettuce grown in different hydroponic systems

MEDICINAL CROPS

Potted herb production of pepper mint (*Mentha piperita*): In Pepper mint, plant growth parameters like plant height (22.82 cm), number of primary branches (4.83), number of secondary branches (21.83), plant spread (2893 cm^2), and yield parameters like number of leaves/plant (133), fresh weigh (28 g/plant) and dry weight (9.5 g/plant) were recorded maximum in the pooled mean of three seasons in the plants grown in 6" plastic pots by using the substrate combination of soil+sand+FYM (1:1:1 v/v) along with the weekly application of nutrient solution of 160:30:180 ppm NPK/plant (Arka Poshak Ras).

Mentha piperita

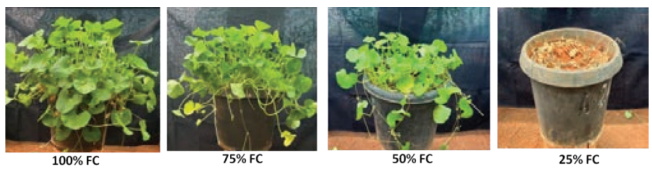
Oregano (*Origanum vulgare*) potted herb production: In Oregano, plant growth parameters like plant height (15.25 cm), number of primary branches (16.95), plant spread (486.16 cm^2), and yield parameters like number of leaves/plant (153.7), fresh weigh (22.17 g/plant) and dry weight (6.65 g/plant) were recorded maximum in the plants grown in 6" plastic pots by using the substrate combination of Arka Fermented Cocopeat (AFC) + Vermicompost (1:1 v/v) with the weekly application of Jeevamrutha @ 50 ml/pot.

Oregano (*Origanum vulgare*)

Mandukaparni (*Centella asiatica*) potted herb production: In Mandukaparni, plant growth parameters (plant height, lateral branches, plant spread, number of leaves, leaf length, leaf width, yield parameters like number of leaves/plant (153.7), fresh weigh (10.68 g/ plant) and dry weight (1.19 g/plant) were recorded maximum in the plants grown in 6" plastic pots by using the substrate combination of Arka Fermented Cocopeat (AFC) + Vermicompost (1:1 v/v) with the weekly application of Jeevamrutha @ 50 ml/pot.

Mandukaparni (*Centella asiatica*)

Effect of water stress on active metabolite yield in *Centella asiatica*: Arka Prabhavi variety of *Centella asiatica* was exposed to 100%, 75%, 50%, 25% and 10% field capacity under polyhouse conditions to study the yield of active metabolites. Experimental results showed that plants exposed to 100% FC gave the highest fresh and dry biomass yield and plants exposed to 50% FC gave the highest asiaticoside and total triterpene per cent. The yield of asiaticoside (g/pot) was found to be highest in 75% FC with 460 g asiaticoside per plant. Hence, it is appropriate to grow *Centella* either at 100% FC or 75% FC to get optimum biomass and active ingredient content.



Growth of *Centella asiatica* plants exposed to different field capacity

Hydroponic cultivation of spear mint and brahmi: Cultivation of spear mint in hydroponic system recorded 60% more oil yield than field grown spear mint three months after planting whereas field grown spear mint recorded 54% more biomass yield than the hydroponic system. In an effort to compare the fresh biomass yield of brahmi and spearmint cultivated via organic and inorganic method using hydroponics, it was found that organically grown brahmi and spear mint has reported 36 and 51% increase in biomass yield respectively over the inorganically grown crop.

MUSHROOM

Biphasic spawn technology: The spawn production increased from 4500 kg /tissue cultured petri dish in traditional grain spawn method to 90000 kg /tissue cultured petri dish in biphasic spawn production technology which is an increase of 1700 %.

Production of *Macrocybe gigantean*

SOIL HEALTH MANAGEMENT

Development of fertigation modules for high density guava planting: To develop fertigation modules for high density planting in guava, a field experiment was initiated on a 4-year-old guava orchard during 2021-22. The planting distance ranged from 3 x 2.5 m (1,333 plants/ha) to 2 x 1.5 m (3,333 plants/ha) with four fertigation modules *viz.,* T1: Recommendation arrived based on 4 years drip experiment (400 : 80 : 275 N : P : K g/tree at 3 x 2.5 m plant density and 240 : 50 : 170 N : P : K g/tree at 2 x 1.5 m plant density); T2: 25% dose lower than T1 (205 : 40 : 160 N : P : K g/tree at 3 x 2.5 m plant density and 120 : 20 : 100 N : P : K g/tree at 2 x 1.5 m plant density); T3: 25% dose higher than T1 (340 : 70 : 260 N : P : K g/tree at 3 x 2.5 m plant density and 210 : 40 : 160 N : P : K g/tree at 2 x 1.5 m plant density) and T4: 50% dose higher than T1 (410 : 80 : 200 N : P : K g/tree at 3 x 2.5 m plant density and 250: 50: 100 N : P : K g/tree at 2 x 1.5 m plant density). An uniform dose of FarmYard Manure (FYM), secondary and micronutrients and the microbial inoculant Arka Actino Plus were given uniformly to all the plants. The N, P and K fertilizers were provided in the form of urea, DAP and muriate of potash through drip fertigation.

After an year of imposing the fertigation modules, *i.e.* at the end of fifth year of planting, plant growth parameters were recorded. By the end of fifth year, both plant density and fertigation modules had significant effect on growth parameters of guava. The mean plant height at the end of fifth year was higher by 0.12 cm in 2 x 1.5 m plant density as compared to 3 x 2.5 m plant density. At this age of trees, the height of the plants ranged from 2.10 to 2.48 m with a mean value of 2.2 m in 3 x 2.5 m plant density and 2.05 to 2.65 m with an average value of 2.32 m in 2 x 1.5 m plant density plots. The stem girth of the plants ranged from 4.85 to 5.95 cm in 3 x 2.5 m plant density and from 4.49 to 5.50 cm in 2 x 1.5 m plant density plots. The mean stem girth was higher by 0.60 cm (12%) in 3 x 2.5 m plant density over 2 x 1.5 m plant density. The mean canopy spread irrespective of fertigation modules was more in 3 x 2.5 m spacing (N-S = 2.68 m, E-W = 2.53 m) than 2 x 1.5 m spacing (N-S = 2.21 m, E-W = 2.19 m). On an average, canopy spread was higher by 0.41 m (18%) in 3 x 2.5 m as compared to 2 x 1.5 m plant density. The land utilization index (LUI) has crossed 75% in 3 x 2.5 m plant density and over 100% in 2 x 1.5 m plant density plots. The LUI was maximum with 410 : 80 : 200 N : P : kg/tree at 3 x 2.5 m plant density and 250: 50: 100 N : P : K g/tree at 2 x 1.5 m plant density (T4) in both the plant densities. The canopy has overlapped, judicious pruning of canopies was done after every fruiting season to sustain productivity through higher light interception and promotion of new shoots.

The overall mean fruit yield was 1.66-fold higher under 2 x 1.5 m (41.5 t/ha) plant density plots over 3 x 2.5 m plant density plots. In both the plant densities, the highest fruit yields were obtained with 410: 80: 200 g N: P: K at 3 x 2.5 m plant density and 250 : 50 : 100 g N : P : K at 2 x 1.5 m plant density (T4) but it was statistically at par with 340 : 70 : 260 g N : P : K at 3 x 2.5 m plant density and 210 : 40 : 160 g N : P : K at 2 x 1.5 m plant density (T3). Significant differences in total dry weight removed from the tree were observed between two plant densities at every nutrient removal event. Average removed dry weight (kg) for 3 x 2.5 m plant density and 2 x 1.5 m plant density trees, respectively were 4.14 and 2.49 (harvested fruits), 5.21 and 3.04 (pruning), 1.2 and 0.60 (leaf fall). When we estimated the total nutrient content, guava trees allocated more N, P, K and Mg to leaf fall and Ca, S, Fe, Mn, Zn Cu and B to pruned material but less N, P, K, Mg, Fe, Mn and B in harvested fruits. The nutrient removal in g/ton of fresh fruit of guava under high density planting is as follows *viz.,* N-4.6, P-0.50, K-4.50, Ca-1.32, Mg-1.30, S-1.45, Fe-0.0066, Mn-0.0007, Zn-0.0024, Cu-0.0009 and B-0.0010.

Evaluation of liquid Actinobacterial formulation on pomegranate: Five elite isolates of Actinobacteria of Pomegranate origin from the arid and semi-arid regions of Karnataka, Maharashtra, Jammu & Kashmir, Uttarakhand and Himachal Pradesh were selected based on their growth promoting abilities, salt tolerance and biocontrol activity. Liquid formulations of these five strains were evaluated individually and in a consortia mode (two Nos.) on pomegranate (Bhagwa) in pots with Arka Actino-Plus as a check. The liquid formulation of the isolate TPA 13 recorded significantly higher plant height (143.75 cm), root length (36.75 cm), root biomass (71.98 g), nutrient uptake (1067.70, 81.58, 487.1 NPK mg/plant) compared to the standard check, plant height (103.30 cm), root length (20.25 cm), root biomass (38.78 g), nutrient uptake (579.11, 40.07, 2667.6 NPK mg/plant).

Microbial management under deficit stress irrigation in tomato: A bacterial strain *Bacillus amyloliquefaciens* strain P-72, which is an osmotolerant aerobic endospore forming bacterium was isolated from finger millet rhizosphere on 25% mannitol supplemented nutrient agar (-2.92 MPa osmotic potential). Under *in vitro* osmotically stressed conditions, this bacterium solubilizes tricalcium phosphate (25.53 ppm) and zinc phosphate (25.7 ppm). It also produces IAA (223.7 ng/ml) and GA_3 (287.2 ng/ml) under osmotically stressed conditions, besides releasing ammoniacal nitrogen into the growth medium. It produces the cytokinins Z- Zeatin; DHZR- Dihydrozeatin riboside; ZR- Zeatin riboside; iP- Isopentynyl adenine; and iPA- Isopentenyl

adenoside under normal conditions, but the cytokinin IP was not detected under osmotic stress conditions. This bacterium has the ability to promote plant growth and improve yields under deficit irrigation conditions. Under pot culture conditions *B. amyloliquefaciens* strain P-72 inoculation significantly improved plant height, root length, shoot and root dry weights and marketable fruit yields when plants were watered at 25 and 50% WHC. Inoculation also resulted in significantly higher levels of photosynthetic rate (P_N), transpiration rate (E), internal leaf CO_2 (C_i), stomatal conductance (g_s) and internal leaf temperature, compared to the uninoculated plants. *B. amyloliquefaciens*, inoculation effects were more pronounced on root dry matter content, which points out to the ability of the bacterium to stimulate the proliferation of lateral roots, thereby aiding the uptake of water and essential nutrients from the soil under deficit irrigation conditions. Based on the encouraging results it was further evaluated under rain-out shelter for two seasons and field conditions for its ability to promote tomato growth and yield under deficit irrigation conditions. The data revealed that under rainout shelter conditions the increase in marketable yields was 23.60% over the uninoculated control when plants were irrigated at 40% of the PE, while under field conditions, *Bacillus amyloliquefaciens* P-72 applied at the rate of 5 kg /ha as a suspension (20 g/l) on the seventh day of transplantation followed by another application on the 30th day, improved the marketable yield levels of tomato by 28.26% over uninoculated plants when irrigated at 40% of Pan Evaporation (PE). The cumulative water savings (L/plant) under ROS conditions was 55.15 and 55.3 % under field conditions (mean of two seasons each).

Effect of *Bacillus amyloliquefaciens* strain P-72 on tomato yield parameters under ROS and field conditions (pooled data of two seasons under ROS and field conditions each)

Treatment	Fruit yield (kg/ plant)		No. of fruits / plant		Avg. fruit weight (g)	
	ROS	Field	ROS	Field	ROS	Field
Treated Control (80% ET)	7.82^{a}	5.98^{a}	120^{a}	87.85^{a}	65.38^{a}	68.03^{a}
Un-treated Control (80% ET)	7.43^{a}	4.93^{b}	111^{b}	79.85^{b}	65.99^{a}	63.13^{ab}
Treated Stress (40% ET)	5.92^{b}	4.22^{c}	119^{a}	74.90^{b}	52.53^{b}	58.50^{bc}
Un-Treated Stress (40% ET)	5.69^{b}	3.29^{d}	124^{a}	61.30^{c}	44.36^{c}	54.83^{c}
CD(0.05)	0.65	0.37	6.48	7.63	6.15	6.31
CV (%)	7.22	5.98	4.08	7.77	8.04	7.69

ROS- Rain Out Shelter

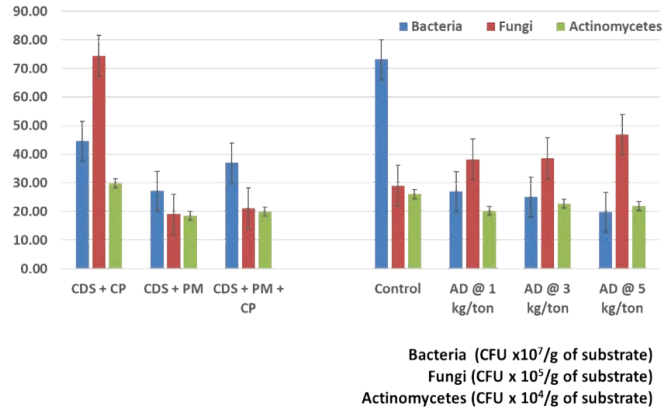
Plant growth hormones and metabolite Profiles of Methylotrophic bacteria : Seventy one methylotophic bacterial isolates that were previously isolated from the phylloplane of different horticultural crops were profiled for their ability to produce different growth hormones by LC-MS. It was observed that the isolates produced plant growth hormones and metabolites *viz.*, Salicylic acid (208.46 to 17622 ng/ml) , Indole Acetic Acid (2.44 to 955.14 ng/ml), Indole Butyric Acid (0.13 to 473 ng/ml), Jasmonic acid (0.11 to 13.56 ng/ml), Benzene Adenine 0.4 to 2.02 ng/ml), abscicic Acid (0.004 to 0.05 ng/ml), GA_3 (0.2 to 0.8 ng/ml), GA_4 (2.0 to 10.3 ng/ml), GA_7 (0.03 to 25.0 ng/ml), Epibrassinolide (9.0 to 38.8 ng/ml), ACC (0.5 to 1.98 ng/ml), cis jasmonate (0.4 to 2.8 ng/ml), Zeatin (0.16 to 89.6 ng/ml), methyl jasmonate (0.07 to 11.05 ng/ml) and trans zeatin riboside (0.1 to 0.4 ng/ml). Based on their LC-MS profiles the isolates having multiple traits are evaluated for their suitability for foliar bioinoculant production for enhancing the yield of horticultural crops.

Standardization of bio-organic manure production methodology: The methodology for production of bio-organic manure using bio-methanated cattle dung slurry, coir pith, poultry manure and Arka Decomposer was standardized. Bio-methanated cattle dung slurry (CDS), coir pith (CP) and poultry manure (PM) were collected from different sources and characterized for various physical, chemical and biological properties. Bio-organic manures were prepared using three different combinations of bio-methanated cattle dung slurry (CDS), coir pith (CP) and poultry manure (PM) (S1 - Biomethanated cattle dung slurry + Coir pith (1:1 v/v); S2 - Biomethanated cattle dung slurry + Poultry manure (1:1 v/v) and S3 - Biomethanated cattle dung slurry + Coir pith + Poultry manure (1:1:1 v/v) and four levels of Arka Decomposer (0, 1.0, 3.0 & 5.0 kg of Arka Decomposer (AD)/tonne of feedstock.

Raw materials collected from different sources

Experimental set up for standardization of bio-organic manure production methodology

Characterization of bio-organic manures: The initial substrates and the final bio-organic manure products were characterized for different chemical and biological properties. Among the substrate combinations, the highest pH and EC value are recorded with the CDS+PM, followed by CDS+PM+CP and the lowest pH and EC was recorded with CDS+CP. However, the pH and EC of initial and final products were not influenced by Arka Decomposer and found to be non-significant. In all the combination, there was a reduction in carbon (C) content in 45-days-old samples compared to initial samples. The N content increased in all the samples and the values increased to a higher level in CDS+CP+PM combination. Less carbon and low CN ratio. was also recorded with CDS+PM combination. High C and wider CN ratio was observed in the mixer of CDS and CP. There was also significant improvement in the content of other major (P, K, Ca, Mg and S) and micronutrients (Fe, Mn, Zn and Cu) in all the combinations and the highest values were recorded with CDS+PM followed by CDS+CP+PM and CDS+CP. Irrespective of substrate combinations, the micronutrient contents increased in 45th day samples compared to initial substate. Irrespective of nutrients, the lower content was recorded with CDS+CP substrate combination. The effect of decomposer levels and interaction on nutrient contents in initial and final products found to be non-significant. However, application of 1.0 kg of Arka Decomposer/ ton of feedstock found to hasten the decomposition rate. The counts of bacteria, fungi and actinomycetes were also enumerated in the final products (45-days-old bio-organic manure) and found to be highest in CDS+CP, followed by CDS+CP+PM and CDS+PM. The counts of fungi found to increase with increasing levels of Arka Decomposer. The substrate combinations cow dung slurry (CDS) + poultry manure (PM) + coir pith (CP) (1:1:1 v/v ratio) found to be perfect with respect to pH, electrical conductivity, CN ratio, macro-and micro-nutrients content and microbial counts. Therefore, the combination CDS+PM+CP was taken for further enrichment with rock phosphate and Arka microbial consortium for bio-enriched organic manure production.



Effect of different cattle dung slurry-based combinations and Arka Decomposer levels on microbial counts (cfu/g) in 45-day-old bio-organic manure samples

PESTICIDE RESIDUE STUDIES

Estimation of pesticide residues in red chilli and its processed product : In the experiment on the estimation of pesticide residues in the market sample of chilli, and its processed products, the dynamics of 13 pesticides, which were present in the fresh sample were studied. Fresh red chilli samples were dried in a solar dryer at 45□C. On the basis of the levels of pesticides in the fresh sample as well as processed product, i.e. red chilli powder, the processing factors were determined for each pesticide The pprocessing factor is important to calculate MRL of a pesticide in the processed commodity.

Processing factor for pesticides in chilli powder

Pesticide	Processing factor
Buprofezin	0.01
Flusilazole	<0.011*
Ethion	0.02
Bifenthrin	>1.00*
Cyfluthrin	3.14
Cypermethrin	0.63
Methamidophos	2.20
Acephate	0.91
Thiamethoxam	3.73
Carbendazim	4.08
Acetamiprid	3.77
Tebuconazole	3.45
Diafenthiuron	<0.11*

*Based on LOQ at 20 ppb

Dynamics of pesticides during the processing of grapes to raisins: During the processing of grapes, the dynamics of six pesticides, *viz*. deltamethrin, cyhalothrin, carbendazim, flupyram, metalaxil and tebuconazole were studied There were three treatments, which included washing and drying of grapes (T_1), washing followed by boiling for 5 min and drying (T_2), and washing followed by dipping in oleate + K_2CO_3 solution for one minute and drying (T_3). The drying process was carried out in a hot air oven at 40 ^{0}C. On the basis of the levels of pesticides in the fresh samples as well as processed product, the processing factors were determined for each of the pesticides.

Fate of pesticides during dehydration of grapes to raisin in hot-air oven

Pesticide/ raisins	Processing Factor		
	Raisins (no treatment)	Raisins (boiling)	Raisins (Olecic acid + K_2CO_3)
Deltamethrin	< 0.4*	< 0.4	< 0.4
Cyhalothrin	1.35	1.88	0.94
Carbendazim	< 0.04**	< 0.04	< 0.04
Flupyram	0.18	0.45	(0.36
Metalaxyl	< 0.32**	< 0.32	< 0.32
Tebuconazole	< 0.51**	< 0.51	< 0.51

Processing factors are in parenthesis
*Based on LOQ at 10 ppb
*Based on LOQ at 20 ppb

Residue and persistence study of tetraniliprole, its metabolite and thiacloprid in brinjal fruits and soil after application of a formulation containing tetraniliprole 120 g/L + thiacloprid 360 g/L SC on brinjal crop as foliar spray: The initial residues of tetraniliprole on brinjal fruits after the 3rd spray from treatments at the recommended and double the recommended doses were 0.192 mg/kg, 0.445 mg/kg respectively. The residues of tetraniliprole dissipated with a half-life of 2.6 days and 4.1 days from treatments at recommended and double the recommended doses, respectively. The initial residues of thiacloprid on brinjal fruits after the 3rd spray from treatments for the recommended and double the recommended doses were 0.508 mg/kg and 1.188 mg/kg, respectively. The residues of thiacloprid in brinjal fruits was found below the LOQ after 21 days in both the treatments. Thiacloprid residues dissipated with a half-life value of 3.8 and 3.9 days from treatments at recommended and double the recommended doses, respectively.

Persistence and residue studies of haloxyfop 10.8% EC on onion bulb: The initial residues of haloxyfop acid in spring onion at 0 day from treatments at the recommended dose (105 g a.i./ha) and double the recommended dose (210 g a.i./ha) were 0.104 mg/kg and 0.100 mg/kg, respectively. Residues of haloxyfop-methyl from all sampling days were below LOQ (0.02 mg/kg). At harvest (74 days after transplanting), residues of both haloxyfop-methyl and haloxyfop acid in onion bulb and soil were below the LOQ.

Residue and persistence study of fluoxapiprolin and its metabolites in grape berries and soil after application of fluoxapiprolin 20 g/l sc as foliar spray: Initial residues of fluoxapiprolin in grapes after its 3rd spray given at 50 days before harvest of grape berries, from treatments at recommended (X) and double the recommended (2X) doses were 0.468 mg/kg and 0.539 mg/kg, respectively, which persisted up to 21 days. The residues of fluoxapiprolin dissipated with the half-life of 5.1 and 5.6 days from treatments at X and 2X doses, respectively. Residues of fluoxapiprolin and its metabolites at harvest after last application were below LOQ (0.01 mg/kg) in grapes sprayed with fluoxapiprolin at both the doses.

Residue and persistence study of fluoxapiprolin, fluopicolide and their metabolites in grape berries and soil after application of a formulation of fluoxapiprolin 30 g/L +fluopicolide 200 g/L SC: Initial residues of fluoxapiprolin in grapes after its 3rd spray given at 50 days before harvest of crop, from treatments at recommended (X) and double the recommended (2X) doses were 0.174 and 0.370 mg/kg, respectively, which persisted up to 7 days. The residues of fluoxapiprolin dissipated with a half-life of 2.4 and 2.2 days from treatments at X and 2X doses, respectively. Residues of fluoxapiprolin and its metabolites at harvest after last application were below LOQ (0.01 mg/kg) in grapes at both the doses.

Similarly, initial residues of fluopicolide in grapes were 5.80 mg/kg and 4.70 mg/kg, respectively resulting from treatment at X and 2X doses, respectively. Residues of fluopicolide and its metabolite 2,6-dichlorobenzamide persisted up to 50 days in grapes from both the treatments. Fluopicolide residues dissipated with a half-life value of 6.85 and 9.61 days from treatments at recommended and double the recommended doses, respectively

Residue and persistence study of tetraniliprole and spirotetramat and their metabolites in tomato fruits and soil after application of a formulation of tetraniliprole 120 g/L + spirotetramat 240 g/L SC as a foliar spray: The initial residues of tetraniliprole after third application on tomato from treatments at recommended and 1.25 times the recommended dose were 0.631 and 0.744 mg/kg, respectively, whereas for spirotetramat, it was 0.303 mg/kg and 0.519 mg/kg, respectively. Spirotetramat and tetraniliprole persisted up to 28 days in tomato fruits. Tetraniliprole dissipated with the half-life of 6.3 and 6.8 days in the recommended

and 1.25 times the recommended dose treatments, respectively. Spirotetramat dissipated with half-life of 6.5 and 9.4 days in the recommended and 1.25 times the recommended dose treatments, respectively.

Uptake of soil applied chlorpyrifos in carrot root as well as shoot was seen up to 39 days of application, carbofuran persisted for 12 to 15 days, the residues of carbendazim were found only on the sample of carrot at 6th day after application but it was readily taken up by carrot shoots where it persisted for about 20 days. The biofertilizer treatment or genotypic variation did not affect the uptake of these pesticides from the soil to the shorter root.

Biofortification of mushroom: Mushroom samples were treated with UVB light to enhance Vitamin D_2 content were stored at 4 deg C and at room temperature for 6 months. Periodic evaluation of these samples showed that the Vitamin D_2 (ergocalciferol) content in treated mushrooms remained constant till 6 months of storage both at low and ambient temperatures.

3.4. CROP PROTECTION

FRUIT CROPS

Integrated Disease Management (IDM) module for blight and wilt diseases in pomegranate: Percentage mortality was calculated upon treatment application. Foliar spray of AMC (without BM) and foliar spray *Bacillus subtilis* (with BM) showed zero per cent mortality and was on par with standard check. Similarly, nematode population were accounted subsequent to nine different treatment. Among all the treatments, Module 3 with soil application of *B. pumilus*, *B. subtilis*, *P. putida* and calcium silicate combined with foliar spray of *B. pumilus* and calcium silicate application recorded the least nematode population in soil (63.0 per 250 cc soil) followed by other treatments (75.7 to per 117.0 per 250 cc soil). Maximum nematode population was observed in control (154.3 per 250 cc soil).

In the objective **"**Identification of bioagents for suppression of blight and wilt pathogens in pomegranate", lowest mortality was recorded in *B. pumilus* and *B. subtilis* application. Similarly, nematode population was recorded. Combined application of all bioagents in soil recorded the lowest nematode population in soil (75.7 per 250 cc soil) followed by application of *B. pumilus* (84.3 per 250 cc soil). It was followed by other treatments with biocontrol agents *viz.*, *Trichoderma harzianum* >*Bacillus subtilis* > *Pseudomonas putida* >Actinoplus >AMC> (93.0 to 127.7 per 250 cc soil). Maximum nematode population was observed in untreated control (168.0 per 250 cc soil).

Effect of weather parameters on mango hoppers (*Idioscopus nitidulus*) and thrips, *Scirtothrips dorsalis*: Weekly observations were recorded on hopper population in a mango orchard (cv. Totapuri) maintained free from pesticide applications. Data on population was correlated with different weather parameters *viz*., temperature, relative humidity, wind speed and rainfall and also the crop phenology. There were two peaks of hopper population. First peak was observed during January – March coinciding with flowering period and a minor second peak during August-September. Correlation and regression models developed indicated that crop phenology (phenology index) had significant effect on pest build up compared to weather parameters. Regression model (polynomial) explained 61% variability in thrips population due to temperature. Maximum temperature had significant positive effect (r = 0.67) on thrips, while other weather factors had non significant negative effect except for wind speed. Regression model (polynomial) explained 61% variability in thrips population due to temperature. Phenology index also positively correlated (r = 0.43). However, correlation was weak compared to hoppers.

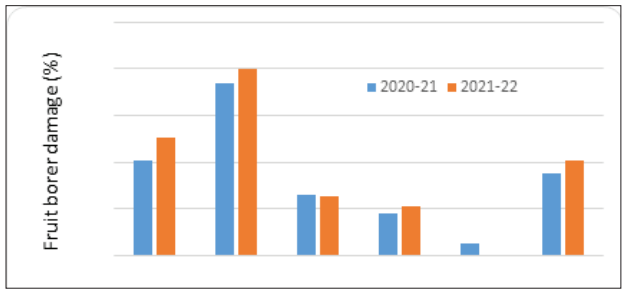
Correlation of weather parameters and incidence of anthracnose and powdery mildew: Consecutively for the third year, the incidence of blossom blight and powdery mildew in mango were recorded to arrive at a forewarning model. The powdery mildew incidence progressed faster in Lazzat Baksh (early flowering genotype) during January and reached the maximum PDI of 81% while in the mid-flowering variety Alphonso, it initiated only in January first week and reached peak with PDI of 85 by February third week. In the late flowering variety, Neelum with its early vegetative flush, the incidence of powdery mildew was noticed. The blossom blight incidence was also noticed in Lazzat Baksh and Alphonso with maximum PDI values of 12 and 15, respectively during February. The incidence of leaf anthracnose was also noticed during *kharif* in all the three varieties during September and October though the incidence was less than in 10% of the trees. The multiple regression analysis carried out to understand the relation between weather parameters and disease incidence revealed that, minimum temperature and maximum relative humidity were positively correlated with anthracnose while minimum temperature, maximum humidity and number of rainy days were positively correlated with powdery mildew. Besides, the weather parameters, the powdery mildew incidence was earlier in trees with new vegetative flush compared to other trees.

Alternative to dichlorovos for use in fruit fly traps: Among seven insecticides evaluated, thiamethoxam 25 WG, spinetoram 11.7 SC and spinosad 45 SC were more

effective than dichlorovos, while, deltamethrin 2.8 EC was at par in effecting mortality of fruit flies trapped in methyl eugenol traps. The mean weekly catches of fruit fly adults was more than 300 with thiamethoxam, spinetoram and spinosad while traps with deltamethrin treated lures attracted 254.5 flies. These can be considered for use in fruit fly traps.

Evaluation of insecticides to find an alternative to dichlorovos for use in stem borer management: Among five insecticides evaluated, imidacloprid 17.8 SL @ 5 ml/L was found to be the most effective chemical resulting in 100% mortality of larvae of stem borer, *Batocera rufomaculata* in mango which was followed profenofos 50 EC (10 ml/L), which resulted in 66.66 % mortality.

Varietal preference of mango fruit borer (*Citripestis eutraphera*): Observations were recorded on six major cultivars of mango on the extent of fruit borer damage revelead that there was an increase in the extent of fruit borer damage on different varieties indicating the increased severity of borer over the years. This warrants continuous monitoring of borer infestation. The infestation ranged from lowest (0.0) in Neelam to highest (20.05%) in Totapuri. Alphonso, Banganapalli and Mallika had 12.56, 6.40 and 5.24 per cent damage, respectively.



Varietal preference of mango fruit borer, *Citripestis eutraphera*

Mango fruit borer, *Citripestis eutraphera* on different varieties

Mango

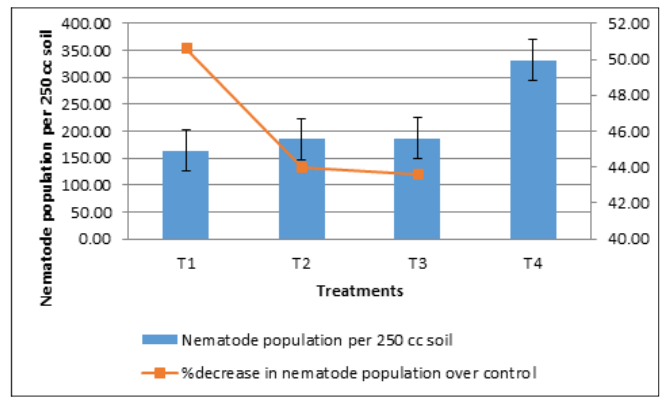
Screening for anthracnose : During the summer season of 2022, fruits of 43 mango genotypes were screened for resistance to *Colletotrichum gloeosporioides*. The genotypes *viz*., Ratul, TSR Naati 1, HY-87, PKR Green Baneshan, Aamai, Tripura collection, Tommy Atkinson, Panchasari, Pusa Arunima, TSR Naati 6-13, Palamanakullapalli, K. Ravindranatha Naati 3, GSR Naati2, *M. zeylanica* and Mylapuri expressed rotting symptoms by 5th day after inoculation with *C. gloeosporioides* preceded by pin prick. The least average lesion diameter was recorded in the genotype Nuha with 1.81 cm, while, in genotypes, *viz*. Hara Bhara, Maya, Mahammada Vakaldad, Surtha Culcuta, Jeerige and Amrapali, it ranged from 2.19 -2.47 cm. The highly susceptible genotypes were Jambu Kesar, Kartha Colamban and Zarda with 5.56, 6.07 and 6.48 cm average lesion diameter, respectively, *The genotypes viz.* H- 85, TSR Naati 6-13, TSR Naati-3 and GSR Naati2 were expressing infection with average lesion diameter of 1.21 to 1.85 cm when inoculated without pinprick, indicating that they were susceptible when injury preceded the infection and can tolerate the natural infection compared to other genotypes.

Screening for fruit fly and stone weevil: A total of 43 accessions were screened for disease incidence (%) of fruit fly, varieties Prior, Salem, K-O-22, Goakodur, Jawahar, Maya and Amrapali shown (0%) incidence under exposed condition. Under unexposed condition, all the varieties shown <20% incidence of fruit fly. Under unexposed condition, the Maya and Amrapali varieties shown 0% stone weevil infestation.

Guava

Evaluation of entomopathogens and botanicals against tea mosquito bug: Lambda cyhalothrin @ 0.6 mL/L was found to be superior with 0.11 mean No. of dried shoots/plant. Among the entomopathogens and botanical evaluated, *Beauveria bassiana* (NBAIR) 5 g/L was found to be superior with 0.78 mean No. of dried shoots/plant followed by *M. anisopliae* (IIHR) @ 5 g/L (3.56/plant) and *B. bassiana* (IIHR) @ 10 g/L (4.33/ plant).

Evaluation of management modules for nematodes in guava cv. Arka Kiran: Integrated module with pre-planting application of Fluopyram @ 0.5 mL/plant and *B. amyloliquefaciens* IIHR Ba-2 enriched FYM followed by post planting application of bioagent enriched neem



cake suspension at quarterly intervals @ 2 L /plant recorded the maximum reduction on soil nematode population (-50.64 %), which was followed by chemical module with application of Fluopyram @ 0.5 mL/plant at quarterly intervals.

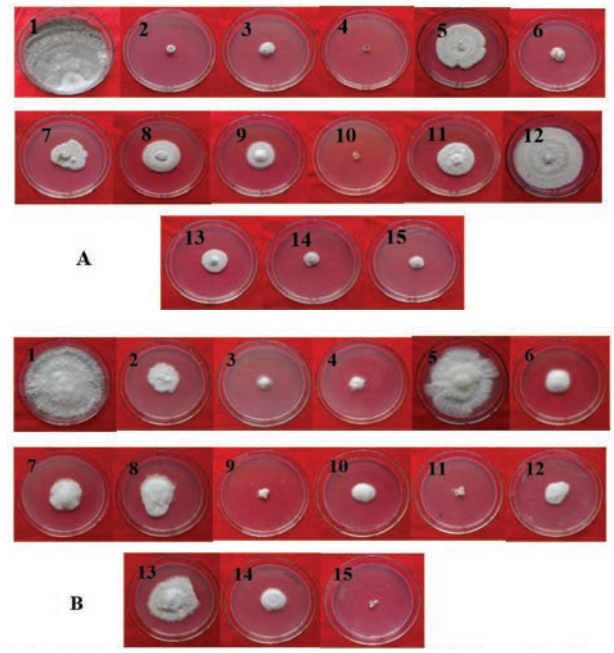
[T1 – Pre-planting application of Fluopyram @ 0.5 mL per plant and *B. amyloliquefaciens* enriched FYM followed by post planting application of bioagent enriched neem cake suspension at quarterly intervals @ 2 L/plant; T2 – Pre and post planting application of chemical nematicides; T3 – Pre and post planting application of bioagents ; T4 – untreated control].

Mechanism of action of nematode resistant guava *Psidium cattleianum*: Phenolic profiling was done in the roots both with and without nematode inoculation. Para hydroxy benzoic acid and trans-Cinnamic acid were elevated in their concentration in inoculated control compared to uninoculated control. Whereas benzoic acid and vanillic acid are lower in concentration in inoculated than uninoculated control. Flavanoid compounds like Umbelliferone and apigenin were higher in inoculated plants compared to uninoculated control. These compounds might play a significant role in resistance mechanism exhibited by *P. cattleianum* against *M. incognita.*

Grapes

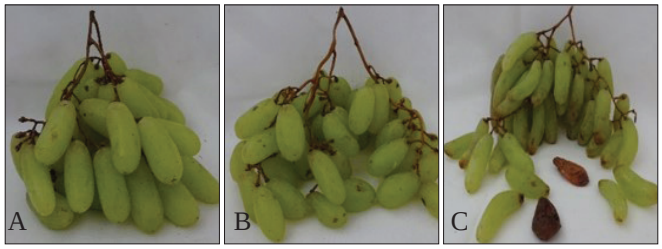
Bioefficacy of volatile organic compounds (VOC) from endophytes isolated from grapes for the management of postharvest pathogens: Based on the screening of endophytes isolated from grapes against three pathogens *viz*., *Colletotrichum gloeosporioides*, *Penicillium citrinum* and *Alternaria alternata*, few isolates were shortlisted. The bioefficacy of these endophytes producing VOCs on test pathogens were determined *in vitro* by measuring the growth of test organisms with double petri dish dual-culture. The maximum (90.07%) growth inhibition of *A. alternata* was recorded with IIHR-GSPB02 which was significantly higher compared to IIHR-GAIB02 (89.73%), IIHR-GLIB01 (84.263%) and rest of the isolates. The maximum growth inhibition (75-100%) in case of *C. gloeosporioides* was recorded with IIHR-MIFY01 (87.38%) followed by IIHR-GCFB01 (85.66%), IIHR-GSPB03 (85.171%) and IIHR-GLIB01 (78.59%). All antagonists inhibited *P. citrinum* by 84.20 to 100 %. This screening showed that 5 isolates *viz*., IIHR-GIFY01, IIHR-MIFY01, IIHR_ GSPB02, IIHR-GLIB01 and IIHR-GAIB02 inhibited all the test pathogens.

After exposure of grape fruits to volatiles from selected endophytes for 48 h, and incubated at 20 °C for 7 days and two parameters *viz*., decay incidence rate and physiological loss in weight were recorded to assess the efficacy. In the treatment without exposure of volatiles of antagonists, there was weight loss up to 9.02-9.75 per cent and decay incidence rate of 14-20% which were inoculated with *A. alternata*, *C. gloeosporioides* or *P. citrinum*. Among different antagonists, volatiles produced by IIHR-MIFY01 (*H. opuntiae*) and IIHR-GSPB02 (*B. amyloliquefaciens*) were highly effective in reducing the incidence (0-1.14%) of postharvest diseases and weight loss percentage (3.46-5.13%) compared to control where fruits were not exposed to volatiles. The VOCs were analysed from the pure culture of IIHR-GIFY01 (*H. opuntiae*), IIHR-MIFY01 (*H. opuntiae*), IIHR-GSPB02 (*B. amyloliquefaciens*), IIHR-GLIB01 (*B. velezensis*), IIHR-GAIB02 (*B. paralicheniformis*) by GC-MS. A total of thirteen compounds from IIHR-GIFY01, eleven from IIHR-MIFY0 1, eight from IIHR-GLIB01, seven from IIHR-GSPB02, IIHR-GAIB02. These compounds fell into classes of esters, alcohols, alkenes, alkanes, alkynes, organic acids, ketones, aldehydes, benzenes, and amines. The most abundant compounds in the VOC profile of antagonists were aceticacid, 2-phenylether ester, oleic acid and styrene.



Double Petri dish culture assay for bioactivity of VOCs produced by antagonists.

A – against *Alternaria alternata* B. against *Colletotrichum gloesporioides*. A_1- *A. alternata*, B_1- *C. gloeosporiodes.* 2-IIHR-GSPB02, 3- IIHR-GLIB01, 4- IIHR-GAIB02, 5-IIHR-GIPB03, 6-IIHR_GAIB01, 7- IIHR-GAPB01, 8- IIHR-GSTB02, 9- IIHR-GSPB03, 10- IIHR-GIPB04, 11- IIHR-GCFB01, 12- IIHR-GAPB02, 13- IIHR-GLFB02, 14- IIHR-GIFY01, 15-IIHR-MIFY01.



Control of post-harvest pathogens of grapes by the VOCs of antagonists

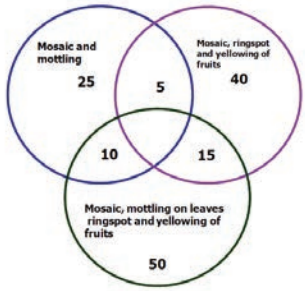
A- Bunches exposed to volatiles of *Hanseniaspora opuntiae*
B. Bunches exposed to *Bacillus amyloliquefaciens*
C - Control

VEGETABLE CROPS

Tomato

Evaluation of essential oils against *Phthorimaea absoluta*: *Ocimum basilium* and *Mentha piperita* essential oils (EO) were found to have significant mortality effect on *Phthorimaea absoluta*. The *M. piperita* EO showed highest mortality (100%) of *P. absoluta* with LC_{50} 1.78 µl/ml due to alloaromadendrene (27.99%), levomenthol (18.31%) and santolina triene (9.78%). The *O. basilicum* EO also had significant mortality (90%) effect with LC_{50} 3.58 µl/ml due to humulene (32.31%), alpha farnesense (27.22%), estragole (19.24%) and 4-cerene (10.61%). Among binary compounds, levomenthol showed highest mortality (100%) having LC_{50} 13.18 µl/ml followed by alpha-pinene (100%) with LC_{50} 16.10 µl/ml, 4-cerene (95%) with LC_{50} 38.20 µl/ml and alpha-phellandrene (90%) having LC_{50} 46.83 µl/ml. The observed toxicity in all compounds was due to significant changes in the activity of esterases, glutathione S transferase and acetylcholine esterases over the time. Thus *O. basilium* and *M. piperita* EOs would provide an additional approach for the management of *P. absoluta* over synthetic insecticides

Survey and incidence of viral disease of tomato: The roving survey was carried out in Karnataka, Andhra Pradesh, and Maharashtra. Total 75 tomato samples showing mosaic and mottling. The per cent viral incidence on tomato is ranged from 10 to 50 in surveyed locations.



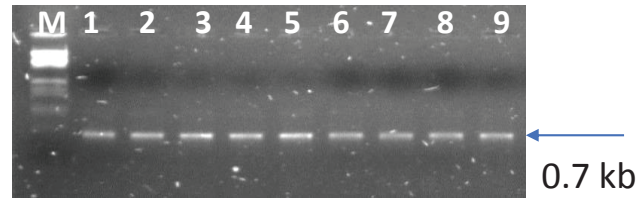
Types of symptoms showing the tomato plants infected with viral disease under natural condition

Biological characterization of viruses associated with tomato: The virus infecting tomato plants collected during surveyed was maintained indicator host plants such as datura, tobacco and cucumber by mechanical inoculation. These viruses were used for further characterization and screening of tomato genotypes.

Molecular characterization viruses associated with tomato

Cucumber mosaic virus: The total RNA of nine CMV infected tomato fruits from the three different states was isolated using RNeasy Plant Mini kit (Qiagen, Valencia, CA). The quality of the RNA was checked on 1% agarose gel and quantified by Nanodrop(R) (Thermo Fisher Scientific, USA). CMV cDNA synthesis was synthesized using coat protein gene specific reverse primer. Initially, 5 µg total RNA with reverse primer specific *Cp* gene of CMV (20 pmol/µl) were taken separately and incubated at 72 °C for 5 min. Then 4 µl of 5X RT buffer, 0.2 µl ribonuclease inhibitor (40 U/µl) (Fermentas, Germany), 2 µl of dNTPs (10 mM) and 1 µ1 M-MLV-RT (200 U/µl) (Fermentas, Germany) were added to make up the reaction volume of 25µl. Subsequently, the reaction was carried at 42 °C for 60 min, followed by incubation at 75 °C for 5 min. PCR amplification was performed using coat protein gene specific reverse primers of CMV in a GeneAmp PCR system 9700 (PE Applied Biosystems, Foster City, CA).

DNA amplification was performed with 35 cycles of denaturation for 1 min at 94 °C, primer annealing for 45 s at 57 °C and primer extension for 1 min 30 s at 72°C, with an initial denaturation at 94°C for 3 min and a final extension for 15 min at 72 °C. The PCR reactions



PCR amplification coat protein gene of CMV using specific primers

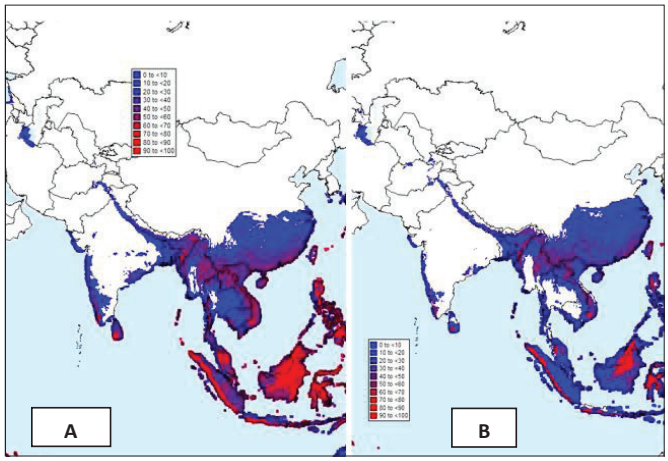
M: 1 Kb Marker, Lane 1 Positive samples of CMV, Lane 2 to 9 tomato fruit samples

were carried out in a Gene Amp PCR system 9700 (PE Applied Biosystems, Foster City, CA) thermocycler. All amplifications were performed in volumes of 25 µL containing PCR mix containing 2 µL DNA template, 1.5 U *Taq* DNA polymerase, 25 mM $Mgcl_2$, 2 mM dNTPs and 25 pmol of each primer was taken in a PCR tube. PCR

products were electrophoresed (1 h at 80 Volts) in 0.8% agarose gels stained with ethidium bromide (10mg/mL) in Tris-borate-EDTA buffer (pH 8). Gels were visualized in a Gel documentation unit (Alpha Innotech, USA). The resulted PCR amplicon ~ 700 bp was amplified in tomato samples collected from three states.

Capsicum

Potential distribution of *Phytophthora capsici* CLIMEX simulation: The potential distribution of *Phytophthora capsici* L. causal agent of *Phytophthora* blight, an emerging disease of sweet pepper in India was investigated under current and climate change (+2 °C) scenario based on laboratory studies and CLIMEX simulation. Western Ghats and adjoining plains in Karnataka and Kerala, Western and Eastern Himalayan regions, hills in Odisha and Andaman and Nicobar islands were found highly favorable for *P. capsici* establishment under current and climate change (+2 °C) scenario.



Predicted distribution of *Phytophthora capsici* in India estimated by CLIMEX modeling. A: Current climate; B: Climate change scenario (+ 2 ºC)

Integrated management of schedule of *Phytophthora* blight, an emerging of sweet pepper: Integrated management schedule was developed with interventions *viz*., i) Seed treatment with *Trichoderma harzianum* Th-2 + *Bacillus subtilis* BS-2 at 10 g/kg seed ii) Application of neem cake and farmyard manure enriched with bioagents to planting bed @1kg/100 kg, iii) Raised bed planting (90-100 cm wide and 15-22 cm height) with silver-black reflective mulch film (30-100 µ), iv) Irrigation regulation and soil drainage management v) Weeding and sanitation, vi) Protective foliar sprays of chlorothalonil 75% WP (2 g/L) or mancozeb 75% WP (2 g/L) in rotation at 15 day interval up to 40th standard meteorological week under Bengaluru conditions. Also, need based curative sprays and drenching with dimethomorph 50% WP (1 g/L) + chlorothalonil 75% WP (2g/L), in rotation with dimethomorph 50% WP (1 g/L) + mancozeb 75% WP (2 g/L) were found effective. Highest B: C ratio of 2.88 was recorded in hybrid Arka Athulya with integrated management interventions.

IDM plot with at 100 DAT. UP = Unprotected, IP = Improved practice and EP = Existing practice.

Screening capsicum for nematode resistance: Among the 13 capsicum lines screened for resistance to *M. incognita*, one accession, CM 334 was found to be resistant; three accessions, AM x CM 334 F1, 1360 and 9814 were found to be tolerant and rests were susceptible.

Brinjal

Evaluation of integrated management modules for root knot nematodes: Field trials were conducted in brinjal cv. Arka Anand grown where pre-planting incorporation of mucuna, application of fluensulfone @ 1 g/plant and bioagent (*Bacillus subtilis*) enriched FYM @ 5 t/ha before planting followed soil drenching of bioagents at monthly intervals (5 ml/L) recorded the lowest nematode population in soil (-89%) and gall index (-91.12%) and the highest yield (61.93 t/ha; +25.12%) compared to control (49.5 t/ha).

Growing velvet bean and marigold as rotational crops followed by brinjal for nematode management

Screening brinjal lines for nematode resistance: Among the 72 brinjal lines screened for resistance to root knot nematodes (RKN), line No. 1 revealed immune reaction; line No. 21 showed highly resistant reaction; line No. 74 showed resistant reaction and line No. 10 was moderately resistant to *M. incognita;* rest all were susceptible/ highly susceptible to RKN.

Cucumber

Evaluation of integrated management modules for root knot nematodes in cucumber, grown under protected conditions: To develop integrated management modules for managing nematodes in cucumber under protected conditions, field trials were conducted in cucumber cv. Chitra. Results revealed that pre-planting of Mucuna or marigold, application of bioagent (*Bacillus subtilis* IIHR Bs-2) enriched FYM @ 5 t/ha before planting, Fluopyram @ 500 mL/acre at 15 DAS followed by soil drenching of bioagents at monthly intervals (5 mL/L) recorded significantly lower nematode population in soil (80.17 to 83.35%) and gall index (81.04 to 84.91%) and higher yield (21.77 to 25.05%) compared to control.

Growing velvet bean and marigold as rotational crops followed by cucumber for nematode management in protected conditions

Okra

Screening for nematode resistance: Among the 17 accessions/ germplasm screened for resistance to root knot nematode, *Meloidogyne incognita*, one accession *A. mizorensis* was found to be resistant, four accessions (*A. tetraphyllus*, *A. angulosus* var. *grandiflorus, A. ficulneus* and *A. moschatus*) were moderately resistant and rest were susceptible.

Carrot

Screening for nematode resistance: Among 23 accessions screened for resistance to root knot nematodes (*M. incognita*) by artificial inoculation in pot trials, line No. 20 was found to be highly resistant; five lines *viz.*, 2, 13, 14, 18 and 19 were resistant; four lines *viz.*, 7, 16, 17 and 21 were moderately resistant and rest were susceptible.

Biochemical basis of rust (*Uromyces phaseoli* Reben Wint.) resistance in French bean: Biochemical changes take place during the rust infection was studied in both resistant (Arka Bold, Arka Anoop, Arka Sukomal and IIHR 79) and susceptible (Arka Komal and Arka Suvitha, US2) genotypes. The presence of high concentration of ureides (allantoin, uric acid, xanthine, and hypoxanthine) in susceptible French bean genotypes may be a predisposing factors for rust infection as the rust pathogen utilizes the ureides as nitrogen source for their multiplication. Under field conditions, the level of phenolics, antioxidant potential, peroxidase and allantoinase activities in the rust resistant lines Arka Bold, Arka Anoop, Arka Sukomal and IIHR-79 was increased significantly after natural infection, while the level was decreased in rust susceptible lines. Among the isozymes, esterase isozyme showed high level of polymorphism across the cultivars. The resistant genotypes IIHR-79, Arka Anoop and Arka Bold showed est-2 isoform at near Rm (Relative mobility) value of 0.49. For peroxidase isozyme, genotype IIHR-79 showed specific isoform at near Rm value of 0.42. Native protein profiling showed wide variation across cultivars with high polymorphism. At Rm value of 0.045 expression of high molecular weight protein was noticed in resistant genotypes IIHR-79, Arka Anoop and Arka Bold. These can be used as biochemical markers for initial screening of rust resistance in French bean.

Genome editing of recessive resistance *eIF4* genes in chilli for potyvirus: Recessive resistance is conferred by recessive gene mutations that encode a host factor critical for viral infection. CRISPR/Cas9 genome editing of *eIF4E* gene of chilli was carried out by employing ythe agrobacterium mediated plant transformation. A total of 27 T_0 plantlets were obtained and of these two confirmed plants were transferred to the nethouse to obtain homozygous mutant plants.

CRISPR/Cas9 Genome editing for *eIF4E* gene in chilli

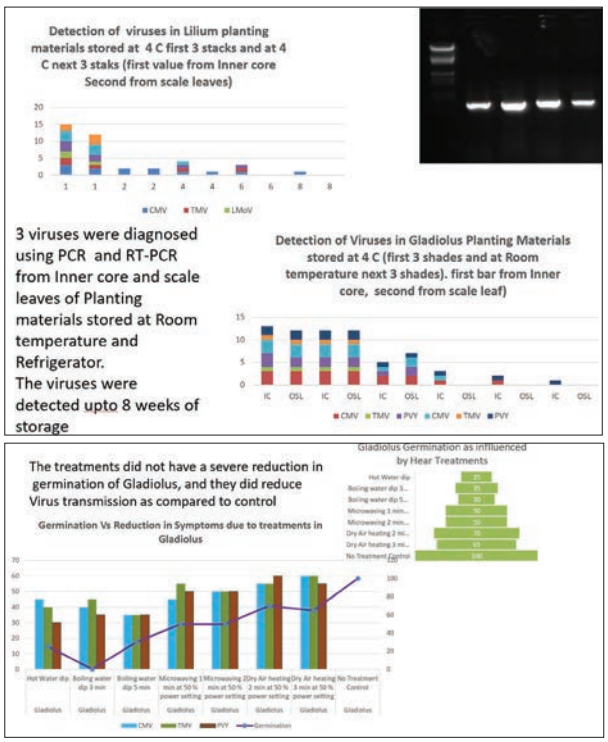
FLOWER AND MEDICINAL CROPS

Lilium and Gladiolus

Characterization of viruses of flower crops: Viral Diseases of lilium and gladiolus, CMV, PVX, PVY, TOSPO were detected by TEM from lilium by leaf dip and CMV, PVY, were detected by TEM from gladiolus by leaf dip. The combined RNA and DNA infection was detected by combined cDNA and DNA multiplex gel, in this protocol DNA and RNA were separately extracted and cDNA and DNA were co amplified. Tulip Virus (RNA) virus, and DNA virus begomovirus were PCR

amplified 4 separately. This protocol will help to make multiple viruses' detection possible in a low-cost manner. The amplified DNA fragments were sequenced and had high similarity with bitter gourd yellow vein virus, Tomato leaf curl New Delhi virus isolate Bangladesh (begomoviruses). RT-PCR Detection of CMV from various parts of Gladiolus, corm, leaf, stem, and roots was optimized. RT-PCR detection of CMV from lilium bulbs stored for 1, 2, 4, 6, 8, 10, 12 weeks at 4 ^{0}C. No reduction in virus content was noticed. Three viruses were diagnosed using PCR and RT-PCR from inner core and scale leaves of planting materials stored at room temperature and refrigerator.

The viruses were detected up to eight weeks of storage, the treatments had a severe reduction in germination of lilium. However, they did reduce virus transmission as compared to control, the treatments did not have a severe reduction in germination of gladiolus, and they did reduce virus transmission as compared to control. This protocol will help to make multiple viruses detection possible in a low-cost manner. The amplified DNA fragments were sequenced and had high similarity with bitter gourd yellow vein virus, Tomato leaf curl New Delhi virus isolate Bangladesh (begomoviruses).



Management of *F. oxysporum* wilt in gladiolus: Efficacy of bio-agents and fungicides at their respective dosages were tested in field against *F. oxysporum* wilt causing pathogen in gladiolus. Application of *Bacillus amyloliquefaciens* (0.5%) + Tebuconazole 25 EC (0.05%) was found to be most effective treatment with no incidence of corm rot after planting and disease severity of 10.45 per cent.

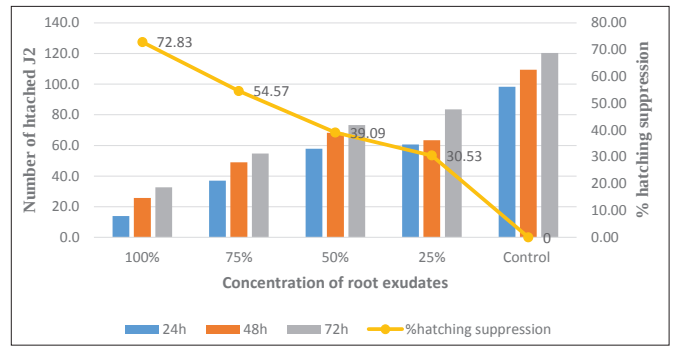
Biological control of root knot nematode in gladiolus cv. Arka Aayush: Treatment of Gladiolus cv. Arka Aayush with bio-control bacteria, *Bacillus pumilus* IIHR Bp-2 significantly reduced root knot nematode, *Meloidogyne incognita* population and increased flower and corm yield in all the test doses. Corm treatment with *Bacillus pumilus* 1% W.P. @ 5 g/L water followed by soil application of 5 tons of FYM enriched with 5 kg of *B. pumilus* recorded the highest spike yield (13.85 per m^2) and the lowest nematode population in soil (210.00 J2/250 cc soil) and roots (9.50 females/10 g root). It also yielded the maximum number of corms (1.78) and cormels (54.0).

Tuberose

Evaluation of new nematicides for management of root knot nematodes: Evaluation of novel nematicides on tuberose revealed that Fluopyram 34.48% SC @ 750 ml/ha was at par with dosage @ 500 ml/ha in recording significantly lower nematode population in soil (156.00 to 167.33/250 cc soil) and roots (8.00 to 9.33 /10 g roots) and higher yield (43.33 to 44.67 x 10^4 spikes and 36.97 to 37.87 tons of loose flower/ha) compared to other nematicides and untreated control. It was followed by fluensulfone 2% GR @ 3.3 kg a.i. / ha and carbofuran 3% G @ 3.3 kg a.i. / ha.

Marigold

Effect of marigold root exudates on *M. incognita*: Root exudates of marigold (IIHR 2-5) exhibited 30.53 to 72.83% suppression in egg hatching and 33.0 to 80.2% mortality of juveniles *in vitro* (Fig. 2, 3). Growing marigold (IIHR 2-5) in polyhouses for 45 and 90 days reduced 38.9 to 53.4 per cent decrease in initial nematode population.



Ovicidal action of marigold root exudate on *M. incognita*

Evaluation of marigold germplasm against blight disease caused by *Alternaria tagetica*: Marigold black spot caused by *A. tagetica* is a major disease that can decrease marigold production by 40%, resulting in serious economic losses. One hundred ninety marigold

germplasm was screened for their reaction against *Alternaria* blight disease. Among, 190 germplasm most of the varieties were susceptible or highly susceptible. Arka Madhu, Pusa Arpita, IC-250-332, IC-250-323, CGFM-1 and KAU-M2 were found to be moderately resistant.

Crossandra

Management of *Phytophthora nicotianae* causing root rot: Efficacy of bio-agents and fungicides at their respective dosages were tested in field against *Phytophthora nicotianae* causing root rot in crossandra seedlings planted in sick soil. The treatment (Arka Actino plus (0.5%) + Fosetyl Al (0.2%) was found to be most effective with disease severity of 12.34.

Chrysanthemum

Occurrence of *Phytophthora nicotianae* causing collar and root rot disease: The plants exhibiting collar rot and root rot disease symptoms were received from the local farmers in Karnataka. Based on initial micro-morphological observation it was identified as *Phytophthora* sp. Further the pure culture of pathogen was isolated and confirmed its identity through cultural, morphological and molecular amplification using ITS region. The fungal pathogen was identified as *Phytophthora nicotianae.*

The sequences of *Phytophthora nicotianae* submitted to NCBI.

Species	Isolate No.	DNA database accession		
		ITS rDNA	β-tubulin	Elongation factor 1α
Phytophthora nicotianae	PhN1	MZ396857	MZ502251	MZ447850
Phytophthora nicotianae	PhN2	MZ396871	MZ502252	MZ447851
Phytophthora nicotianae	PhN3	MZ411440	MZ502253	MZ447852
Phytophthora nicotianae	PhN4	MZ411441	MZ502254	MZ447853
Phytophthora nicotianae	PhN5	MZ411443	MZ502255	MZ447854

The collar rot and root rot symptoms on chrysanthemum

MEDICINAL CROPS

Bhringraj (*Eclipta alba*)

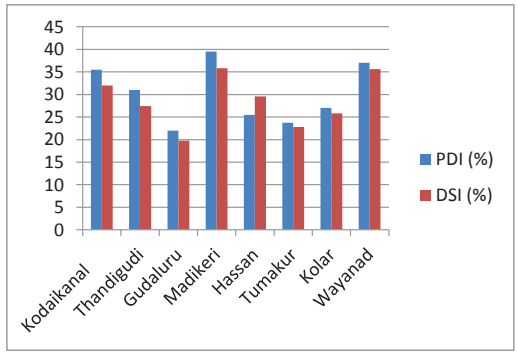
First report of *Plasmopara sphagneticolae* causing downy mildew: In the post monsoon period of 2022, severe downy growth was observed on the bhringraj (*Eclipta alba*) leaves grown at ICAR-IIHR, Bengaluru (13°08'00.4"N 77°29'39.5"E), Karnataka, India. Initial symptoms were damping off, thick white mycelial growth was observed on lower side of leaves. Mycelium is hyaline, aspetate, branched 5-15 µm in diameter. Sporangiophores are slender with monopodially branching at right angle with slight bulbous base. For molecular identification, COX 2 primers were used for PCR amplification. The sequences were submitted in gene bank with accession number OQ200475 and OQ200476, respectively.

Plasmopara sphagneticolae* causing downy mildew in *Bhringraj

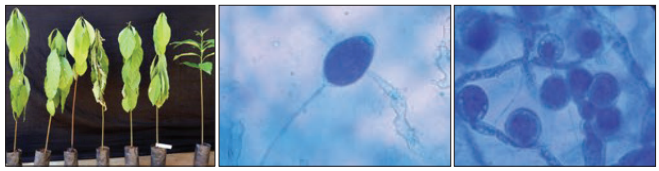
CHES-CHETTALLI

Survey and etiology of avocado wilt disease in India: The disease Incidence and severity of *Phytophthora* root rot of avocado was recorded during May to December 2022 in Karnataka, Kerala and Tamil Nadu states. The highest per cent disease incidence and severity was recorded in Madikeri district of Karnataka followed by

Wayanad district of Kerala. Out of 40 samples collected, almost all the samples have recovered *Phytophthora cinnamomi*, *Fusarium* and other organisms. Based on pathogencity test it is confirmed that *P. cinnamomi* is the prime casual agent of avocado root rot. Other organisms like *Fusarium* and *Cylindrocladium etc*., are associated with secondary infections and makes plants more prone to this disease. The symptoms that observed in farmers field include complete and sudden wilting of plants. Partial infected plants with chlorotic foliage and wilted, falling of leaves and rapid die back of branches. Feeder roots are completely rotten in wilted plants. It is concluded that *P. cinnamomi* restricted to feeder roots and absence of feeder roots prevents trees from absorbing moisture and plants will die even in the presence abundant moisture in the soil.



Per cent disease incidence (PDI) and disease severity index (DSI) of avocado root in India



Challenge inoculated avocado plants showing wilt symptoms, sporangia and chlamydospores of *Phytophthora cinnomomi*

Incidence of borers on avocado: Incidence of borers on avocado tree was recorded during September to December 2022. Severe incidence of shot hole borer, bark borer and sporadic incidence of stem borer was recorded. The shot hole borer incidence was observed on weak and *Phytophthara* root rot disease infested avocado trees. The shot hole borer damage can be seen from base up to the 200 cm height of the tree but maximum number of shot holes were recorded at 0 (tree base)-40 cm height. The size of the shot holes ranged from 1-2 mm. The shot hole borers make small round holes on the stem and branches. Pin holes are more conspicuous if the barks are removed. Frass ejected from the bored entry holes. The bark or trunk borer damage can be seen on the trunk from 10-20 cm height. Insect infestation recognizable from the exudation of brownish oozing frass produced by the larval feeding around the infested part. The larvae are often seen beneath the trees bark, inside the frass filled tunnels. Adults moths have translucent wings resembles wasps. The stem borer larvae bores the stem at 10-50 cm height near ground level horizontally up to the pith and then tunnels vertically and again horizontally for exit. The diameter of the holes made by the stem borer ranged from 3-5 mm. The larval excreta can be seen at the base of tree. The attacked tree gradually dries up with leaves turning yellow and drop-off prematurely.

Shot hole borer **Trunk/bark borer** **Stem borer**

Efficiency of pollinators on yield parameters of spine gourd, *Momordica dioica* : Significant difference was observed among the pollination treatments effects on yield parameters of spine gourd. Among the different pollination treatments, the yield parameters such as fruit weight ($F_{3, 53}$ = 65.847, P = <0.001; Mean=61.568 and 52.937), fruit length ($F_{3, 53}$ = 92.628, P = <0.001; Mean=8.573 and 7.557) and fruit diameter ($F_{3, 53}$ = 106.30, P = <0.001; Mean=3.978 and 3.504) was maximum in pollen augmentation and hand pollination treatments as compared to wind pollination and open pollination treatments. The study revealed both pollen augmentation and hand pollination resulted in higher fruit weight, length and diameter compared to open pollination.

Means of yield parameters for the different pollination treatment in spine gourd *Momordica dioica*

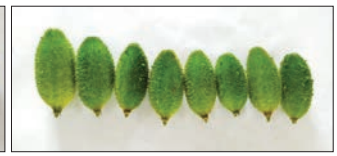
Treatments/Yield parameter	Fruit weight (g) ± S.E	Fruit length (cm) ± S.E	Fruit diameter (cm) ± S.E
1. Wind pollination (n=14)	0.881±0.04^{b}	2.043±0.04^{b}	0.809±0.02^{b}
2. Open Pollination (n=14)	2.182±0.96^{b}	2.493±0.28^{b}	0.988±0.13^{b}
3. Hand Pollination (n=14)	52.937±7.28^{a}	7.557±0.61^{a}	3.504±0.29^{a}
4. Pollen augmentation (n=15)	61.568±3.29^{a}	8.573±0.24^{a}	3.978±0.05^{a}
F value	65.847	92.628	106.30
df	3, 53	3, 53	3, 53
p	<0.001	<0.001	<0.001

Means followed by the same letter in superscript within column are not significantly different based on Tukey's post hoc test at 95% significant level.

Wind pollination/ Pollinators exclusion

Open pollination/Natural pollination

Hand pollination



Pollen augmentation/Hand cum open pollination

3.5. CROP UTILIZATION AND FARM MECHANIZATION

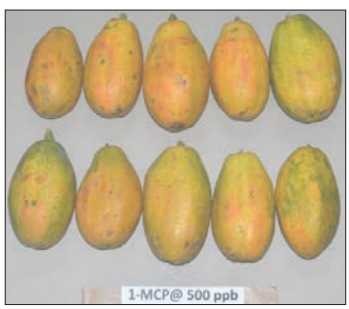
FRUIT CROPS

Post-harvest handling and storage

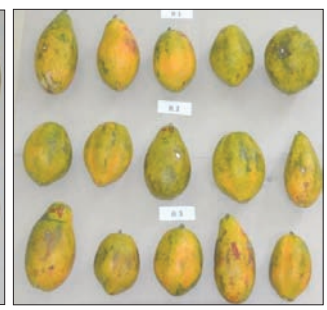
Custard apple: Effect of ethylene inhibitors and gamma irradiation on post harvest quality of custard apple was carried out. The ethylene action inhibitor 1-Methylcyclopropene (1-MCP) enhanced the storage-life of custard apple at ambient as well as low temperature storage; and delayed the fruit ripening without adversely affecting colour and firmness of the fruits. Gamma irradiation doses at 400-800 Gray effectively controlled fruit fly incidence. However, these doses caused severe blackening of the fruit surface.

Mango: Pre-storage treatment of Alphonso mangoes with 100 µM melatonin helped in alleviation of chilling injury till 4 weeks, during storage at 8 ºC.

Papaya: The effect of different ethylene inhibitors *viz*. Sodium nitroprusside (1 and 1.5 mM), salicylic acid (1.5, 3 and 6 mM) and 1-MCP (500 ppb) in extending the storage life of papaya fruits at ambient conditions and low temperature storage (15°C) was studied. Among all the pre-treatments, 1-MCP (500 ppb) was found to be significantly effective in extending the shelf-life for 2 weeks under ambient conditions and for 3 weeks at low temperature storage (15°C) followed by 4 days of storage at ambient conditions.



Fruits at 14 days storage at ambient conditions



21 days storage at 18 ºC + 4 days at ambient conditions

Antimicrobial activity of plant based extracts for potential use in edible coatings: Extracts from edible plant portions such as grape seed, pomegranate peel, *Hibiscus* petal, *Moringa* leaves and cactus were evaluated for their inhibitory activity against enteric pathogens. Among these, hexane extract from pomegranate peel showed superior level of antimicrobial property and inhibited *E. coli*, *Listeria monocytogenes*, *Salmonella enterica* and *Staphylococcus aureus.*

Value-added products from fruits

Fruit beverage fortification with millets: Value-addition of fruit beverages was achieved through fortification with sprouted millet flours. Germinated millet flours of foxtail (*Setaria italica*) and little millet (*Panicum sumatrense*) were incorporated into ready-to-serve (RTS) beverages of mango, pineapple, and pomegranate to obtain organoleptically acceptable beverage with six months shelf stability. Besides improving the polyphenol antioxidants, the fortification process significantly improved the iron level and its dialysability in the fruit beverages.

Fruit RTS beverages fortified with germinated foxtail millet flour

Fruit RTS beverages incorporated with germinated little millet flour

Fruit beverages

Dragon Fruit (*Kamalam*) RTS beverage: Process for preparation of Ready-to-serve (RTS) beverage from dragon fruit (*Kamalam* or *Pitaya*) was standardized. The product is a pink coloured clear beverage having typical dragon fruit flavour rich in antioxidants like ascorbic acid (85 mg/100 g), betalains (2.61 mg/100 mg) and polyphenols (292 mg gallic acid equivalent/100 g). The beverage was shelf stable for six months.

Dragon fruit RTS beverage

Wood apple RTS beverage: A ready-to-serve beverage from wood apple was standardized and evaluated for shelf life during six months under room temperature. This beverage was characterized with high excellent organoleptic quality (scored 8 on nine point Hedonic scale), pulp content, cloud stability and organoleptic qualities. There was significant antioxidant qualities as evident from ascorbic acid (69 mg/100 g), polyphenols (80 mg GAE/100 g) and flavonoids (14 mg Catechin equivalent/100 g). No microbial spoilage was detected during storage period.

Pineapple wine: Preparation of wine from pineapple was standardized. The preparation process can be completed in one month, and the shel-life of the beverage was six months at 10℃.

Kiwi fruit probiotic beverage: Probiotic beverage preparation was standardized from kiwi fruit. The process involved preparation of the base beverage with suitable flavour enhancement techniques followed by build up of 10^{-11} cells of probiotic *Lactobacillus* strain through partial fermentation. The beverage possessed good sensory qualities till 45 days during storage at 5 ℃.

Pineapple wine

Kiwi fruit probiotic beverage

Aonla probiotic beverage

Process required for aonla probiotic beverage preparation was improved through standardizing the additives for better sensory quality and shelf-life. The product harbored more than 10^{-10} CFU/mL probiotic cells obtained till 60 days storage.

Aonla probiotic beverage

VEGETABLE CROPS

Post-harvest handling and storage

Capsicum: A total of 17 edible coating formulations comprising of guar gum and sodium alginate (0.25-0.75% w/v), Soy Protein Isolate (1–3%, w/v), and soy lecithin (2–10% v/v) were developed and tested their efficacy over the various fruits and vegetables. Among all the combinations, the composite comprising sodium alginate (0.6% w/v) and soy lecithin (1% w/v) was found to be effective in providing good coatability over the fruit and vegetable surfaces. Application of these coatings over capsicum fruits extended their storage-life upto 8 days under ambient conditions and upto 3 weeks at low temperature (8 ℃).

Value-added products from vegetables

Probiotic beverage was developed from carrot. The beverage is characterized by very good sensory properties, more than 1 billion probiotic cells per mL during two months of shelf life at refrigerated storage. It was also proven that probiotic growth in carrot beverage improves its antioxidant capacity as well as bio accessibility of β-carotene.

Pumpkin powder based RTU soup mix

Process for Ready-to-use (RTU) soup mix from pumpkin powder was standardized. The product was rich in antioxidant carotenoids and organoleptic quality on par with a commercially available popular vegetable soup in India.

Pumpkin powder based RTU soup mix: Process for Ready-to-use (RTU) Soup mix from pumpkin powder was standardized. The product was rich in antioxidant carotenoids and organoleptic quality on par with a commercially available popular vegetable soup available in India.

Farm Mechanization

Development of biodegradable trays: Industrial trial for production of biodegradable trays from paddy straw powder was carried out. The trays possessed good finishing and strength characteristics. Cost of production of 125 x 70 x 45 mm sized 5 mm thick tray was Rs. 3.45/-.

Design and development of remote controlled multipurpose prime mover

Design and development of remote controlled multi-purpose prime mover was carried out. The remote controlled prime mover consists of (i) Permanent magnet DC motor (2 Nos. of each 250 W; 300 rpm), (ii) Lead acid battery (2 Nos. of 12 V connected in series, 32 Ah) and (iii) Pneumatic wheel (4 Nos.). All these components were mounted on a base frame having dimension of 520 x 750 x 370 mm with necessary fittings. The front two wheels are individually powered by DC motors and the rear wheels are powered by differential chain and pulley transmission system. The linear actuator has been fitted to the main frame and it is detachable, having stroke length of 200 mm. It is an electrical replacement for hydraulic. The prime mower is operated by a remote controlled unit. This prime mover and linear actuator can be used to attach seed drill, sprayer, fertilizer drill, pruner and harvesters.

Design and development of a target oriented fertilizer drill for orchard: The target oriented fertilizer drill for orchard was designed and developed. The machine consists of a fertilizer metering system, mechatronic system, power system and main frame. The fertilizer metering system includes a hopper to carry the fertilizer and a suitably designed screw auger to meter the required quantity of fertilizer. The mechatronic system consists of rotary encoder, stepper motor and proximity sensor. The ultrasonic proximity sensor detects the presence of the tree trunk and send the signal to the microcontroller. The rotary encoder mounted on the wheel axle of the prime mover, receives rotary drive from the wheel axle to measure the forward the speed of the machine. The signal received from the rotary speed encoder is transmitted to the microcontroller to actuate the stepper motor. The stepper motor further transmitted rotation to the screw auger to meter the required quantity of fertilizer. The above system was powered by two lead acid batteries of each 12 V, 24 Ah.

3.6. ECONOMICS, STATISTICS AND COMPUTER APPLICATION RESEARCH

ECONOMICS

Impact of ICAR-IIHR Fruits and Vegetables Vending Van

The Economics of the vending van:

Costs and returns: The value of the van is taken as the establishment costs and the average value of the van was

Rs 13,22,400/- and the present case it is uniform across four regions. The annual variable cost of operating machines varies with each of the HOPCOMS centre. The average annual costs of the four centres was about Rs. 42.44 lakhs, including the average procurement cost of Rs. 40.2 lakhs. The cost of procurement is the deciding factor for differences in the variable costs of HOPCOMS centres. On an average about 125 kg of fruits and 158 kgs of vegetables were handled by the vans in these four HOPCOMS and the total value of these crops for each van works out to Rs. 40.23 lakh/centre. The annual fixed costs were also worked out and these includes repair and maintenance costs, taxes and insurances and amortization costs including depreciation, which was Rs. 2,47,024/- year/van/centre.

Returns: The gross return realised by the different centres were estimated annually. The average gross return was Rs. 44.62 lakhs comprising of Rs. 26.82 from sale of fruits and Rs. 17.79 lakhs from sale of vegetables. The higher gross return was in Bengaluru HOPCOMS centre at Rs. 51.67 lakhs followed by Kalburgi HOPCOMS due to higher handling of FVs. The average net return was Rs. 4.41 lakh/year/centre and it was highest in Bengaluru HOPCOMS (Rs. 6.76 lakhs) followed by Kalburgi HOPCOMS (Rs. 4.1 lakhs). The higher net return in these centres were higher because of higher level of handling of fruits and vegetables.

Economic feasibility of vending van: The economic feasibility was estimated for the van considering 15 years of running and 8 per cent discount rate. The average NPV of IIHR-fruits and vegetables vending van was Rs. 24. 51 lakhs with BC ratio of 1.07 and IRR of 23 per cent per annum with a payback period of 3 years. Hence, the investment on mobile vending vans for the sale of fruits and vegetables was found to be economically feasible. Consumers were satisfied as they get relatively fresh produce with the minimum handling of produce with less damage.

The spread of the varieties by licensees / planting material producer:

ICAR-IIHR IP licenses: The number of licenses for sale of seeds and planting materials as well as the advance breeding lines was 102 from the time period from 2008-09 to 2021-22. This altogether realised IP license fees of around Rs. 2.27 crores. A total of six licenses amounting to Rs. 18.61 lakhs in fruit crops, 65 licenses amounting to Rs. 1.95 crores in vegetable crops and 19 licenses amounting to Rs. 19.0 lakhs in flower crops were purchased by various companies from India during 2008-09 to 2021-22. Regarding individual crop license, tomato crop hybrids and advanced breeding lines ranks first with the licenses fee of Rs. 73.47 lakhs from 20 licenses to different companies and accounts for nearly 32.29 per cent of the total license fees. This was followed by the chilli varieties and hybrids with a license fees of Rs. 38.56 lakhs and accounts for about 16.95 per cent of the total license fee. Okra realized a license fee of about Rs 34.89 lakhs from the sale of 21 licenses to private companies. These three crops *viz.,* tomato, chilli and okra together accounted for about 54.5 per cent of the total license fees realized by IIHR.

Impact of IIHR Seeds: The ICAR-IIHR has produced and sold nearly 1,93,638 kg seeds of major vegetable varieties and hybrids from 1984-85 to 2021-22, which includes 10,045.06 kg of hybrids seeds and 1,83,593.8 kg of open-pollinated seed varieties. There was a clear increase in seed production and sale from 2005-06 and later after 2007-08.

Growth of hybrid seeds sale: Emphasis for production and sale of hybrid seeds was accorded only after 2007-08 and major shift has happened after 2011-12 onwards and hence the sale of hybrid seeds was compared then and present production. The hybrid seed production of different varieties indicated that tomato, chilli and okra were the three major hybrids produced at IIHR and sold. Since 2011-12 there is an increased trend in the sale of all the hybrid seeds and especially in tomato and the trend was very prominent after 2018-19.

Crop-wise area spread of hybrid vegetable seeds: It is estimated that an area of 95,415 acres was cultivated with tomato hybrids of ICAR-IIHR, Bengaluru since inception. Chilli is the next crop which had higher area under IIHR hybrids with 17,000 acres. Since tomato and chillies were the two major hybrids which were grown in the farmer's field, year-wise spread of area was analysed. It was clear from the trend analysis that spread of tomato hybrids was faster than the chillies and it was observed that the tomato hybrids were introduced in more than 23 states of India including the north-eastern states of Assam, Arunachal Pradesh, Meghalaya *etc.*

Spread of open-pollinated (OP) varieties of ICAR-IIHR: A total of 1,83,593.8 kg of open-pollinated vegetable seed varieties were produced and sold since 1984-85 till 2021-22 and the maximum production was in 2015-16 due to the production of onion seeds. Tomatoes, amaranthus, chillies and brinjal were other major contributors of these total production. Analysis of growth of production of OP varieties revealed that during last one decade, the production of French bean varieties is increased by nearly 27 per cent followed in dolichols type (bush type), yard long bean (9.3%) and onion (9.3%). The year-wise spread of OP varieties of IIHR follows similar pattern of production of seeds.

The total spread of IIHR OP varieties was 87,102 acres including all the OP varieties sold from IIHR. Crop-wise spread indicated that spread was maximum in brinjal (13,788 acres), followed by amaranthus (13,408 acres), tomato (12,203 acres) and chillies (9,310 acres).

STATISTICS

a) Stability models in gerbera: Yield and associated traits of gerbera genotypes (16) were evaluated during three consecutive years (2019-2021) under polyhouse conditions to construct stability models, individually for 11 traits. Wricke's measure of ecovalence: (W_i) and Shukla's stability variance parameter (σ^2_i) were worked out as the measures of stability of genotypes over years. Results revealed that for vegetative characters (leaf length, breadth, No. of leaves, plant spread and No. of suckers/plant), least ecovalance (high stability) value (0.00009 to 0.57) was observed in Stanza and Kalina for plant characters. Stanza and Balance genotypes for leaf characters. Further, the results for flowering traits (flower stalk length, diameter, No. of flowers/plant, flower diameter, vase-life and days to bud burst) showed that least ecovalence (high stability) value (0.00005 to 0.074) for the genotypes Alcatraz and Susan over the period.

b) Statistical method to handle residual effect in perennial crop experiments over years: A circular change over design was adopted to estimate first order residual effects in mango Totapuri rootstock trial experiment conducted over the period 2011-18. Based on the results obtained, it was inferred that Olour rootstock treatment has least residual effect among eight different rootstock treatments evaluated for yield and yield attributing traits. As a statistical efficacy of the results obtained, it was noticed that Olour rootstock treatment has significant effect ($P<0.05$) as compared to other treatments and over all resulted in least error mean square.

c) Stability models in Aster

Yield and associated traits of aster erect type advanced breeding lines (37) were evaluated along with *Arka Kamini* (as check) for years 2020 and 2021 to construct stability indices, individually for seven traits. Wricke's measure of ecovalence: (W_i) and Shukla's stability variance parameter (σ^2_i) were worked out as the measures of stability. Results revealed that for plant characters (plant height, plant spread, No. of branches/plant) least ecovalance (high stability) value (0.0005 to 0.022) observed for 15-41-10 and 15-41-9. Also, the results for flowering traits (flower stalk length, No of flowers/plant, flower diameter and vase-life) showed that least ecovalence (high stability) value (0.0068 to 0.023) for the genotypes 15-31-1 and 15-40-2 over the years.

d) Stability models in Mandarin AICRP experiments: Stability models were constructed based on five AICRP(F) centers (Akola, Ludhiana, Nagpur, Sriganganagar and Tinsukia) experimental data of seven mandarin varieties (Mudkhed seedless, Nagpur seedless, Nagpur mandarin, Kinnow mandarin, Coorg mandarin, Khasi mandarin and Darjeeling mandarin) individually for five different traits (plant height, stem girth, canopy volume, fruit weight, No. of fruits/tree and fruit yield) for four successive years (2018-2021). Measures of stability were worked out. Based on the computed and tested measures of stability, the results revealed that for fruit weight, Mudkhed seedless, Nagpur mandarin, Kinnow mandarin and Coorg mandarin were found to be stable and ideal for all locations, whereas for fruit yield, Mudkhed seedless, Nagpur seedless, Nagpur mandarin, Kinnow mandarin, Coorg mandarin, and Darjeeling mandarin were found to be stable and ideal for all locations. In case of No. of fruits/tree, the results revealed that Nagpur seedless, Kinnow mandarin and Coorg mandarin were found to be stable and ideal for all locations. Further, based on the environmental indices values worked, it was identified that for fruit weight, Akola followed by Ludhiana and Nagpur as the best locations; for fruit yield Ludhiana followed by Akola, Sriganganagar and Nagpur as best locations and for No. of fruits/tree, Sriganganagar followed by Ludhiana and Akola as best locations, as they possessed least values of environmental indices.

e) Response Surface Models (RSM) in *Aonla* : Second order RSM using Box-Behnken Design (BBD) was constructed for optimization of factors influencing osmotic dehydration of *aonla* with the process responses as water loss percentage (WL%) and solids gain percentage (SG%). RSM results revealed that the optimum conditions predicted were 5.02% salt concentration, 54.8°C temperature and 60.64 min. process time to attain a desired effect of maximum water loss (6.42%) and minimum solid gain (1.09%) in osmotic dehydration of *aonla* in salt medium. In addition to high coefficient of determination values (0.90 and 0.94) for prediction of response factors, the models generated residuals were subjected for randomness and normality assumptions to ensure further validation of results.

COMPUTER APPLICATIONS

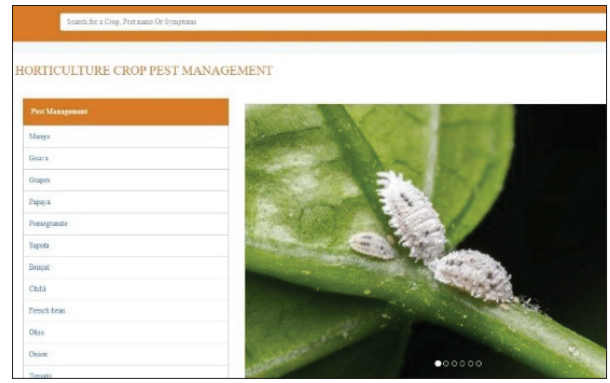
Mobile apps for Sapota and French bean cultivation in Regional Languages: Mobile app for sapota and french bean cultivation were developed in Regional languages and were integrated with main mobile app for fruits and vegetables. This app was developed in Tamil language for android phones, which could be

installed from Google play store and also from ICAR IIHR website. These apps include various features from sowing to harvesting and crop management solutions as well. The app features following aspects:

- Crop cultivation aspects
- Disease management
- Pest management
- FAQs
- Contact us

The production aspects *viz.*, soil type and climate, seasons, land preparation, fertilizers usage, drip system, mulching, spacing, irrigation, fertigation and foliar spray of nutrients are included. Crop nutrition, harvesting and varieties details were also provided. The disease and pest management feature includes various diseases such as rust, root rot complex, powdery mildew *etc.*, and Various pests affecting the crop *viz.* Red spider mites, stem fly, thrips and ants describing their symptoms and management for better crop management. Similarly, for sapota the popular varieties *viz.*, Cricket Ball, Kalipatti, Pala, Kirthibarti *etc.*, technology developed for packaging for transportation pest management *viz.*, Chiku moth, bud borer, soft green scale, seed borer and leaf miner are included. The infestation symptoms and its management for controlling the infestation are given under pest management modules. The query window for farmers to post queries specific to crop cultivation is available in the app to post the cultivation problems on sapota and French bean. This farmer's query can also be posted in regional language and replies can be conveyed through experts by Email. The IPM strategies in French bean and Sapota were also provided in the app. The app can be installed from Google play store and also available at IIHR main institute website.

Crop protection system: The crop protection system was developed as dynamic module for pest management of fruits and vegetable crops.It is designed using web-based interface with MySQL database. The PHP scripts are used to develop the dynamic modules of web application. The management and data storage of the database were processed under the php Myadmin system. The web interface provides the option to select the crop on fruits and vegetables. On selecting the crop, the pest affecting that crop is listed along with the image for the user to identify and the user can select from this list for displaying more information. The crop symptoms seen and control measure details were retrieved from the system along with the image of the pest, which enables user for pest identification. The search bar option is used to retrieve data either by providing crop name or pest name. The data edit form facilitates for updating the crop protection database system.



3.7. AGRICULTURAL EXTENSION AND OUT REACH

Organizational Capacity Assessment of Community-based Organizations – A Theoretical Orientation

Service organizations such as non-governmental organizations (NGOs), community-based organizations (CBOs), farmer producer organizations (FPOs) *etc.*, are established to cater to the various needs of their members such as producers, rural artisans, landless labours, women, youth, *etc.*, through welfare and development schemes. Such organizations need to be vibrant and rejuvenate themselves regularly according to the external needs, which requires a tool like Organizational Capacity Assessment (OCA) to have assessment among their stakeholders in order to understand the existing capacity and plan for the future. Thus, OCA is a self-assessment tool for organizations to identify gaps and required capacity building to measure progress against initial or target benchmarks.

Pact Inc. used the OCA tool developed in Ethiopia as its starting point. Pact has further developed versions of this tool (generically called OCAT) in Botswana, Madagascar, Angola and Zambia and is continuously applying and modifying this tool in other countries of the world (Anonymous, 2022a). South Africa, Ethiopia, Thailand, Lesotho, Vietnam, Ukraine, Kenya, Tanzania, Myanmar, South Sudan, Nigeria, Malawi, Namibia, Botswana, Swaziland, Nigeria, Madagascar, Afghanistan, Cyprus, USA, Ecuador, Bolivia, Rwanda, Sierra Leone, Laos, Cambodia, Mongolia, Sudan and Zambia were the countries, in which the OCA has been used. It is reported that the tool has been used by more than 150 facilitators for almost two decades. The following are the points to be understood by the researchers, faculty and students, while designing and adopting OCA tools in field situations:

1. Organizational capacity is complex and context-specific.Strengthening of organizational capacity needs long-term strategy, which can be attained through OCA.
2. OCA is a tool utilized to design the capacity development plan and improvement of the already existing plan.
3. It is a self-assessment tool to be utilized by the organization and its members.
4. This tool has been utilized by more than 150 facilitators for almost two decades in and around more than 30 countries.
5. Leaders, managers, officers of community-based organizations, financial, human resource, administrative and other staff members of such organizations can be the potential participants in OCA.
6. All types of civil society organizations, CBOs, government institutions, business place committees and women groups can engage this tool.
7. The key function of OCA is to provide a framework at which an individual of an organization value the organization's trajectory.
8. The OCA tools assesses technical capacity in seven domains such as governance, administration, human resource, financial management, aspirational management, programme management, project performance management.
9. The OCA is participatory in nature.
10. The OCA tool is easily adaptable.

The OCA tools give snapshots of institutional and technical capacity, allowing the administrators to identify challenges, evaluate progress and meet individual needs.

Assessment of Spread and Acceptance of selected Floriculture Technologies

Survey was conducted regarding spread of ICAR-IIHR mucuna varieties. The results indicated that more than 96.4% growers adopted mucuna variety Arka Shubra followed by Arka Dhanwantari (3.6%). Karnataka (85.6%) was largest grower of IIHR Mucuna varieties followed by Tamil Nadu (13.2%) and Telangana (1.2%). Total area under IIHR varieties was more than 700 acres. Experience of growers was up to 4 years (30%) and 5 to 15 years (70%). Majority have grown for seeds, green manuring, preparing medicines by themselves and few were marketing to private entrepreneurs. Almost all growers indicated itching is not there in IIHR varieties. Seed rate followed was 7 to 8 kg/acre, more than 70% of the crop was grown as mono crop followed by intercrop (30%). Pod size is good, 5 to 6 seeds per pod, yield obtained was 6 q / acre in dry land condition whereas 12 q/acre under irrigated condition. Price for produce varied from Rs 60/q to Rs 80/q. Constraints indicated by farmers were lack of support structure for obtaining higher yield, lack of awareness about improved mucuna cultivation practices, lack of demand for mucuna seeds, lack of localized marketing, lack of attractive price for mucuna seeds and lack of labour availability during harvest season.

Identification of extension methodologies and strategies suitable for post APMC environment and study on researchable issues and impact of new policy on horticultural crops

- Highest RBQ value correspond to the problems namely non-availability of cold storage facility in APMCs (1,494), followed by lack of training and guidance facility at APMCs (1437.97) and no proper canteen and refreshment at APMCs (1383.94).
- Among the non-APMC suppliers, large majority of the farmers (97.5%) avoided APMC for marketing of their produce because of high commission percentage in APMC, followed by 87.5% farmers expressed that they were not getting good price for their produce and number of middlemen were more in APMC. Only 12.5 percent of non-APMC farmers said that they have not chosen the APMC for marketing of their produce because of lack of knowledge about APMC working system.
- All the respondents (APMC suppliers) and majority (63.88%) of the non APMC suppliers together said that major advantages of new APMC act were 1) more opportunity / freedom to sell their produce and 2) multiple trading options provided under the Act as compared with earlier provisions.
- All the respondents said that the major disadvantage of the new policy is 1) only first quality (well-graded) produce were preferred by private companies like Reliance Fresh, More, Big Basket *etc*. but in APMC farmers can sell their whole produce. And all the respondents who are supplying to APMCs also expressed that *i*) exploitation by unknown is more and *ii*) no guarantee of the payment for their produce were the other major disadvantage of the new policy/ Act.
- The top 3 ranking constraints expressed by the farmers (both APMC suppliers and Non APMC suppliers) were seasonality of production, price fluctuation and lack of group approach in marketing of produce.
- Ninety percent of officer's / extension functionaries said that "development and popularization of E-marketing system" is the one of the best innovative marketing methods influenced by new marketing system followed by 86.67% respondents expressed that "farmer empowerment and FPO support to

market their produce using business approach rather than just creation of FPOs" is the innovative marketing approach influenced by new marketing system. Again 70 percent of the respondents said that "production and supply of seeds / planting materials of varieties largely suitable for export and processing" and "supply horticultural produce directly to consumers with tracking system in line on production, processing, transportation and marketing and export" were innovative marketing methods which needs to be adopted to suit the new and emerging marketing system of horticultural produce.

- In case of industry representatives, majority of them expressed that *i*) Farmers empowerment and FPO support to market their produce by helping business approach rather than just creation of FPOs *ii*) More cold storage for preservation of seasonal products and its wider publicity on advantages *iii*) Support to quality production of crops were the important marketing approaches/ innovative marketing methods for horticultural crops.

- The most important suggestions given by the farmers (both APMC suppliers and Non APMC suppliers), extension functionaries and industry representatives to improve functioning and efficiency of marketing in APMC system, cropping pattern, yield and quality, relevance of research outputs and extension programmes and methods in horticultural crops were *i*) Full payment should be made on day of sale itself *ii*) Breed better genetically potential varieties to adopt adverse weather condition, mainly rain and droughts *iii*) Focus on ground level requirements of varieties and technologies than focusing only research-oriented output *iv*) Increase efficient transportation with cold storage for better quality, price and demand for horticultural produce and 5) exclusive and improved package to enhance quality of the produce, based on cropping pattern.

Enriching Knowledge – Integrating Technology and Institutions for holistic village development in horticulture-based farming system - Farmers FIRST Project

- Introduction of new improved varieties in Ragi continued based on the farmers demand and to suit the existing production system. In order to overcome the technological gaps in adoption of suitable varieties, ML-365, MR-6 and MR-1 of *Ragi* crop was demonstrated. These varieties had special features like dwarf growth habit, high tillering capacity, blast and neck blast disease tolerance. Similarly, improved varieties of BRG series in Redgram (BRG 4 & BRG 5) were demonstrated as intercrop in *Ragi*. In Field bean, short duration, aroma rich, small and round seeded and viral disease resistant variety HA 4 of UAS, Bengaluru was introduced and also improved horsegram variety - PHG-9 was introduced as an intercrop with *Ragi*. Totally in 319 families with 420 acres was covered with improved varieties in field crops to through demonstration of new varieties under field crop module.

- Under horticulture crop module, ICAR-IIHR hybrids of tomato, chilli and brinjal were demonstrated in farmers' fields. In tomato, Arka Rakshak, Arka Samrat and Arka Abed hybrids were introduced. In chilli, leaf curl virus hybrids such as Arka Saanvi, Arka Harita, Arka Yashasvi and Arka Tejaswi of ICAR-IIHR were introduced. In brinjal Arka Anand and Arka Harshitha varieties were introduced in order to increase yield, production and productivity of horticultural crops. Totally in 47 farm families introduced the horticultural crops to take up demonstrations.

Development of standard protocols for assessment of cropped area, crop monitoring and precision orchards management in mango

Highlights of the study also include *i*) mapping and assessment of mango orchards ESA Sentinel *ii* MSI imagery and estimated area for mango cultivation in Kolar district was very close to the area assessed manually by the Department of Horticulture, Government of Karnataka during last year (2021-22) -12% of the total geographical area of district. 2) Total geographical area of the Kolar district was 398211.70 ha and projected area of the mango orchards was 47816.0 ha given by department and according to the analysis performed by remote sensing methods, the estimated area of the mango orchards is 42057.75 ha. *iii*) Majority of mango orchards area from Srinivaspura Taluk, contribute around 27,650 ha. as per department reports while 23,258 ha area was estimated area through data analysis under the project and *iv*) Web application at level-1 stage was developed to display the analysed outputs.

A study on spread, acceptance of ICAR-IIHR released selected vegetable hybrids in South India

The spread and acceptance of ICAR-IIHR released brinjal (Arka Anand) and chilli hybrids (Arka Haritha, Arka Meghana, Arka Sweta and Arka Khyati) were studied based on the hybrid seed distribution and also survey work carried out in South India (Tamil Nadu, Kerala, Andhra Pradesh, Telangana and Karnataka). Based on the survey, it was revealed that awareness of farmers towards selected ICAR-IIHR vegetable

hybrids (Arka Anand in brinjal and Arka Haritha, Arka Meghana, Arka Sweta and Arka Khyati in chilli) ranged from 1.22 – 7.85% in South India. To create awareness about ICAR-IIHR released brinjal and chilli hybrids at farmers field, during *kharif* and *rabi* seasons, more than 12 demonstrations and 10 scientist-farmers interaction meetings were conducted in four states (Tamil Nadu, Andhra Pradesh, Telangana and Karnataka). In case of brinjal (Arka Anand) the spread was 1.84% and 2.43 % spread was observed in case of chilli hybrids (Arka Haritha, Arka Meghana, Arka Sweta and Arka Khyati) in Southern states.

The reasons for spread and acceptance of brinjal hybrid (Arka Anand) are: (i) high yielding capacity, (ii) cluster and continuous bearing, (iii) good fruit quality, (iv) resistant to bacterial wilt, (iv) good field establishment and (vi) suitable for ratoon crop. The main reasons for non-adoption of brinjal hybrid (Arka Anand) in farmers field are (i) less market demand (colour and shape), (ii) less consumer preference, (iii) not aware of this hybrid, (iv) non availability of seeds at their locality, and (v) poor keeping quality. In case of chilli, based on the survey results, it was observed that 66.6 – 83.6% of the farmers are accepting ICAR-IIHR released chilli hybrids (Arka Haritha, Arka Meghana, Arka Sweta and Arka Khyati) because of its high pungency, high yielding potential combined with attractive dark green fruits suitable for green as well dry chilli market. The reasons for non-adoption are (i) availability of commercial private hybrids at door step, (ii) not aware of this hybrid, (iii) non availability of seeds at their location, (iv) no local consumer preference, and (v) more incidence of pest and diseases. Impact study on IIHR released brinjal and chilli hybrids were studied in farmers field. The economic benefit of brinjal hybrid 'Arka Anand' was compared with private hybrids and it was observed that 8.15% higher yield,14.3% less cost of production and higher C:B ratio of 1:2.68. In case of chilli hybrids (Arka Haritha, Arka Meghana, Arka Sweta and Arka Khyati) 9.43% higher yield, 13.8% less cost of production and higher C:B ratio of 1:3.57 was observed.

Feasibility, spread, acceptance and profitability of selected varieties / hybrids and technologies of ICAR-IIHR

Impact of institute's online seed portal was studied. More than 15,000 customer shopped through online seed portal, which was a satisfactory number. Through proportionate random sampling method, a total of 250 samples were selected across different crops and different states. The highest shoppers were from Karnataka (5,450 No.), followed by Kerala (3,373 No.), Andhra Pradesh (2,435 No.), *etc*. Crops that were purchased highest were tomato hybrid (868 No.), chilli hybrids (709 No.), seed kit (482 No.) *etc*. ICAR-IIHR website was the major source of information (46%) for the consumers followed by social media (17%). Determinants of seed purchase from the portal were trust (31%), followed by convenience (23%) and cost effectiveness (9%). Major suggestions were to provide option to include crop of choice in vegetable seed kit (32%), followed by choice to add additional seed quantity may be made (13%).

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4.1 FRUIT CROPS

Institute houses office of the Project Coordinators (Fruits), ICAR-All India Coordinated Research Project (AICRP) on Fruits besides it also takes up many of the trials of various other AICRPs. During the period of report, The ICAR-AICRP on Fruits organized its 9th Group Discussion from 8th to 11th March 2022 in virtual mode with the support of ICAR-IIHR and ICAR-NRCB. The event was inaugurated by Dr. Anand Kumar Singh, Deputy Director General (Horticultural Science) and was attended by several dignitaries Dr. Vikramaditya Pandey, ADG (Hort. Sci. - I), ICAR; Dr. B.K. Pandey, ADG (Hort. Sci. - II), ICAR, Dr. B.N.S. Murthy, Director, ICAR-IIHR, Dr. S. Uma, Director, ICAR-NRCB, Dr. Dilip K. Ghosh, Director, ICAR-CCRI, Dr. R.G. Somkuwar, Director, ICAR-NRCG, ICAR special invitees- Dr. B.M.C. Reddy, Former Vice Chancellor, Dr. Y.S.R. Horticultural University and Dr. A.K. Misra, former Project Coordinator (Subtropical Fruits) and over 200 scientists.

Mango

A total of 771 mango germplasm were collected and conserved in field gene bank. 574 germplasm were evaluated and characterized for various horticultural traits and 12 germplasms are actively used for breeding program at ICAR-IIHR. A total of 2771 hermaphrodite flowers of Amrapali were crossed with Vanraj and raised 7 F1 progenies to develop coloured mango varieties/ hybrids. A total of 1988 hermaphrodite flowers of Vellaikolumban were crossed with Terpentine and raised 10 F1 progenies. A total of 741 hermaphrodite flowers of Olur were crossed with Terpentine and raised 10 F1 progenies. Besides, the previously raised progenies are being maintained for further evaluation.

Guava

The total germplasm collection at ICAR- IIHR, Bengaluru Field Gene Bank stands at 74 accessions including four wild species. The main objective of this centre is to act as one of the National Active Germplasm Conservation Sites for guava. During this reported period, no accession has been received from the AICRP centres for conservation.

For management of tea mosquito bugs in guava, a trail was laid out in RBD with 4 replications, having 5 treatments (T1-B. bassiana W/P-5g/l, T2-B. bassiana W/P-10g/l, T3-B. bassiana W/P-12g/l, T4-Standard check (Lambda –cyhalothrin 5 EC) @ 0.5 ml/l) and T5-Unsprayed (control). Four sprays were applied, first spray at fruit setting and subsequent sprays at ten days interval for T1 to T3 whereas for T4 sprays were applied twice at 15 days interval. B. bassiana W/P-12g/l (T3) is the best formulation for the management of pest. The extent of damage by the pest in best treatment is 11.68 % and recorded highest B:C ratio (2.05).

4.2. VEGETABLE CROPS

AICRP (Vegetable Crops): PI Dr K Madhavi Reddy and 24 scientists are involved from the Division of Vegetable Crops, Division of Crop Protection, Division of Basic Sciences and Division of PHT&AE. About 100 trials have been conducted during 2022.

Under 'Collection, evaluation, conservation and utilization of germplasm' – trials were conducted in brinjal, chilli, paprika, drumstick, pumpkin, ridge gourd and bottle gourd crops. Varietal evaluation IET trials were conducted in brinjal long (10 entries), brinjal round (15 entries), tomato determinate (6 entries), cherry tomato (6 entries), chilli (12 entries), bell pepper (7 entries), cabbage (6 entries), Dolichos bean pole type (9 entries), cowpea bush (7 entries), cucumber (7 entries) garden pea early (9 entries), garden pea mid-season (10 entries), pea edible podded (7 entries), pumpkin (7 entries), bottle gourd (10 entries) and ridge gourd (6 entries) during the period.

Varietal evaluation AVT – I trials were conducted in brinjal long (11 entries), brinjal round (9 entries), tomato indeterminate (5 entries), chilli (13 entries), Dolichos bean pole type (7 entries) and watermelon (6 entries) during the period. Varietal evaluation AVT – II trials were conducted in brinjal long (9 entries), brinjal round (15 entries), tomato determinate (10 entries), chilli (6 entries), garden pea early (10 entries), garden pea mid season (7 entries), cowpea bush (6 entries), Dolichos bean pole type (8 entries), ridge gourd (7 entries), pumpkin (6 entries), bottle gourd (6 entries), and watermelon (6 entries) during the period.

Hybrid evaluation IET trials were conducted in brinjal round (6 entries), tomato determinate (6 entries), chilli (8 entries), cabbage (7 entries), broccoli (6 entries), bottle gourd (7 entries), bitter gourd (7 entries), carrot tropical (6 entries), carrot temperate (5 entries), cucumber (6 entries) and ridge gourd (7 entries) during the period. Hybrid evaluation AVT I trials were conducted in brinjal long (6 entries), brinjal round (6 entries), tomato determinate (7 entries), chilli (9 entries) and bitter gourd (9 entries) during the period. Hybrid evaluation AVT II trials were conducted in brinjal long (8 entries), brinjal round (7 entries), tomato determinate (8 entries), chilli (6 entries), pumpkin (6 entries), bottle gourd (7 entries), bitter gourd (9 entries) and ridge gourd (7 entries) during the period.

Under evaluation of biotic and abiotic stresses IET, okra YVMV varietal trial (10 entries), okra YVMV hybrid trial (9 entries), tomato ToLCV hybrid trial (7 entries), chilli LCV resistant (7 entries); under AVT I, tomato ToLCV trial (8 entries), okra YVMV trial (8 entries); and under AVT II, peas mid-season powdery mildew resistance trial (8 entries), tomato hybrid ToLCV resistance (8 entries), tomato variety ToLCV resistance (8 entries), okra YVMV resistance (13 entries) were evaluated during the period.

Under protected cultivation five trials were conducted on tomato, green capsicums, hybrd brinjal, cucumber and parthenocarpic brinjal. Under physiology, biochemistry and processing, two trials were conducted on biochemical estimation of antioxidant compounds in tomato, pumpkin, bitter gourd and musk melon genotypes under AVT II trials; and quality evaluation of cherry tomato lines. Under insect pest management there were eight trials, on nematode management five trials and on disease management seven trials were conducted. Under seed production trials two trials were conducted.

AICRP (Onion and Garlic) : *Kharif* trial RVIET-I, seven new entries were evaluated during *Kharif*, and none of the genotypes surpassed the check variety, Arka Kalyan. Red onion late *kharif* varietal trial involving seven new entries was evaluated and none of the genotypes surpassed the check variety Arka Kalyan, and under *rabi* six trails, *viz.*, RIET, RVAVT-I, RVAVT-II, RHyIET, RHyAVT-I and onion germplasm trials (white and red onion) involving 34 new entries in yield evaluation trials and 43 new germplasm were evaluated during rabi 2022.

4.3 FLOWER & MEDICINAL CROPS

Rose

Three garden roses and one fragrant rose genotypes were tested under AICRP program on testing of new varieties. Arka Sinchana with red flower, shining foliage; Arka Sharmeeli with multiple flower shades, and Arka Kinnari with attractive flower opening characters were found to be performing well under Bengaluru conditions. Maximum flower diameter was recorded in case of Arka Kinnari (11 cm), while minimum was recorded in case of Arka Sinchana (5.4 cm). Number of flowers produced per plant per month was maximum in case of Arka Sinchana (103), while minimum was recorded in case of Arka Kinnari (30).

Arka Sharmeeli

Arka Kinnari

Arka Sinchana

Marigold

Ten African and one French marigold genotypes were evaluated for yield and associated characters. Among theAfrican marigold, days to flower initiation ranged between 42-56 days, number of flower production was maximum with 61 fls/plant, while maximum flower

wt. recorded was 405 g/plant. Among the lines under testing, maximum range was noticed for shelf life (2.3-7.9 days), plant height (31.6-85.2 cm) and plant spread (23-51.7 cm).

Crossandra

In crossandra var. Arka Chenna, mother plants sprayed with 150 ppm GA_3 recorded minimum duration to reach 10 cm long shoots (23.60 days) during the second cutting cycle, whereas 300 ppm spray of GA_3 recorded minimum duration to reach 10 cm long shoots (53.60 days) during third cutting cycle for use as propagation material. The rooting percentage and survival of the rooted cuttings did not vary significantly with the PGR treatments.

Tuberose

Tuberose genotypes Bidhan Rajani-17, Bidhan Rajani-18, Bidhan Rajani-19, Bidhan Rajani-24 and Phule Rajat were tested for cut flower purpose along with checks Arka Vaibhav, Arka Suvasini and Kolkatta Double under Bengaluru conditions. Among the varieties tested, Phule Rajat, Bidhan Rajini-19 and Arka Vaibhav have performed better under Bengaluru conditions and produced highest number of spikes per plant (4.80, 4.73 and 4.47, respectively).

The dwarf tuberose genotypes Shyadhri Vaman, Pratap Rajani–7-1, Bidhan Pearl and Bidhan Rajani-19 with checks Arka Shringar, Phule Rajani and Bidhan Ujwal were tested for suitability as pot plant. Among the tuberose genotypes tested, Shayadri Vaman found promising with short upright spike (41.72 cm), highest number of florets per spike (51.65) and number of spikes per plant (3.50). Bidhan Rajani-19 also performed better with double florets, maximum flower diameter (5.09 cm) and highest number of spikes per plant (3.80).

Gladiolus

The gladiolus genotypes Pusa Manmohak, Pusa Sinduri, DFR GH-1, DFR GH-3, Arka Manorama, Arka Ranjini, Pratap Glad-1 and Punjab Glad-3 were tested for cut flower purpose. Among the gladiolus varieties tested for cut flower purpose Arka Ranjini was found promising with attractive violet colour, early flowering (65.33 days), more number of flowers open at a time (6.08) and highest number of spikes per plant (2.00). Pratap Glad-1 was also found promising with half white colour flower, maximum diameter of flower (14.06 cm) and number of spikes per plant (2.25).

Chrysanthemum

Influence of pinching and light manipulation on pot mum production: Pinching and light manipulation treatments were done for pot mum production of Variety: DFR C-3 in Production Cycle: C_2 (September-November: Artificial Long Days and Natural Short Days). Treatments differed significantly with respect to plant growth and flowering parameters. Plant height (26.40 cm) and plant spread (E-W : 13.73 cm and N-S: 14.53 cm) was maximum in P_1 : Single pinch (two weeks after planting), whereas least was observed in Control (P_7 : No pinch). Treatment P_6 : Double pinch (1st pinch four weeks after planting + 2nd pinch two weeks after first pinch) recorded maximum number of branches /plant (3.93 Nos.) and took maximum no. of days for flower budinitiation (83 days) and maximum number of days for full bloom (119.20 days). Flower diameter (5.17 cm) was observed maximum in P_1 : Single pinch (two weeks after planting). Duration of flowering (36.33 days), flower longevity on plant (16.16 days) and number of flowers per pot (104.56) was observed maximum in P_6 : Double pinch (1st pinch four weeks after planting + 2nd pinch two weeks after first pinch).

China aster

Three new varieties *viz*., Arka Advika, Arka Nirali and Arka Shubhi have been included for multi-location testing at 11 testing centres of AICRP on Floriculture.

Centella asiatica

Initial varietal trial of 2 varieties (Arka Divya and Arka Prabhavi) along with check variety Vallabh Medha is under testing at 5 centers of AICRP MAP and Betelvine.

Ashwagandha

Hybridization trial involving 6 parental lines is in progress.

Betelvine

Characterization: All the germplasm lines showed coriaceous orthotropic leaf texture except Maghai and IIHR BV 53 where it is membranacious. Plagiotropic leaf lamina shape showed elliptic, wide elliptic and ovate shape leaves. Clones differed for flower colourit varied either yellow and beige. Banavalli, Hirehalli Local, CARI 6 have produced dark green coloured orthotropic leaves. Germplasm lines had acuminate leaf apex except Banavalli, which recorded acute leaf apex. Leaf shape of germplasm was found to be elliptic, wide elliptic or ovate. The data on flowering revealed that IIHR BV 67, Sirugamani-1, IIHR BV 53 is profuse flowering among female clones. Among male clones, Dobbesepet Ambadi, Kapoori Bihar and CARI 6 are found to be profusely flowering.

Diversity analysis of germplasm with the mean data over three years formed five clusters. Cluster I consisted

of 11 genotypes, cluster II had 17 , cluster III with 1 and cluster IV with 18 and cluster 5 has 20 genotypes. Gender based grouping is observed as all male clones grouped in Cluster II. Cluster I had genotypes whose have been collected from Andaman island region showing grouping based on geographical origin. Genotypes in Cluster 4 and 5 comprised of female clones. Cluster III has single genotype IIHR BV 105 indicating it may be diverse accession from other germplasm.

Intra and interspecific hybridisation: Eight inter-varietal crosses were carried out. Fruit setting is recorded in all the crosses. The germination in crosses ranged from 32.14% (IIHR BV 33/IIHR BV58) to 88.42% (IIHR BV 59/IIHR BV1). Around 282 hybrid seedlings were raised from different crosses and are being established in the polybags under polyhouse. Four interspecific crosses between *P. betle* and *Phytophthora* resistant *P. colubrinum* was carried out. Fruit set was observed in only three crosses. Though the fruit set is observed in other crosses, very limited number of seeds/fruit, seed germination and the establishment of seedlings is noted in interspecific crosses.

Screening Interspecific hybrids against *Phytophthora nicotianae*: Over 13 interspecific hybrids developed through crossing betelvine with *Piper colubrinum* were screened *in vitro* for *Phytophthora* through artificial inoculation. The leaves were inoculated with two different inoculation methods [*i.e*., detached leaf (Pin prick at centre of leaf) and spore suspension method (soil drenching and zoospore suspension spray on leaf)] were assayed for their effectiveness for screening using *Phytophthora nicotianae* (GenBank ON358198) with 13 interspecific hybrids of betelvine. Phytophthora disease development was observed on leaf at 3rd, 5th and 7th dpi. Leaf was incubated in water after 7th dpi and microscopic observation was recorded accordingly for the confirmation of spore development.

Disease severity of 13 interspecific hybrids along with check variety IIHRBV170 was carried out through artificial inoculation. The Percent Disease Indexwas calculated using the formula (Wheeler, 1969), analysis was carried out using WASP-2. Among the interspecific hybrids used, IIHRPBIH9 shows significant resistance to phytophthora with the mean value of 4.46 per cent, as IIHRPBIH9 at initial days doesn't develop any symptoms. But 7dpi there was a trace amount of symptoms which was noticed to be 11.14 per cent. Hypersentive response (HR) and phenolic component was found to be the key effector to trigger the resistance. Further, it was noticed that under hypersensitive defence responses, the necrosis was observed to be at a trance amount as compared to susceptible check variety (IIHRBV170). The mean value of susceptible check was significantly higher with 69.70 per cent and it was noticed that there was a gradual increase in the trend of disease development as compared to IIHRPBIH9 interspecific hybrid.

Ploidy analysis by flow cytometry of Interspecific, intraspecific hybrids and germplasm of betelvine: Ploidy analysis of interspecific hybrids through flow cytometry showed that they differ in ploidy status. Among 13 interspecific hybrids tested, 3 showed diploid status, 6 are tetraploids and 4 are pentaploids. The confirmation ploidy status of the groups by cytological investigations is also required. Similarly 16 intra-specific hybrids were also analysed for assessing their ploidy status. Mixed ploidy is observed in these hybrids similar to interspecific hybrids. Out of 16 intervarietal hybrids, 10 were tetraploids, 1 pentaploid, 2 octoploid and 3 exhibited diploid status. The ploidy status of 34 germplasm was also assessed through flow cytometry. The presence of different ploidy levels were recorded. Germplasm consisted of 9 diploids, 12 triploids, 9 tetraploids, 1 pentaploid and 3 hexaploids. Higher variation of ploidy is noted among germplasm with the presence of triploidy and hexaploidy. The above results indicate the prevalence of mixed ploidy among germplasm, intra and interspecific hybrids.

CHES-BHUBANESWAR

FRUIT CROPS

Mango (Crop Production)

Effect of micro-nutrients on yield and quality of mango: The treatment consisting of RDF + 100 g zinc sulphate + 50 g copper sulphate + 50 g borax(Soil application) in basin after harvest + Foliar spray of 0.2% zinc sulphate + 0.1% copper sulphate + 0.1% boric acid (2 sprays at just before flowering and marble stage) produced highest yield (8.1 t/ha) with an increase of 119% over control.

Nutritional Survey in mango-Ten each mango orchards were selected on the basis of yield in Dhenkanal districts of Odisha. Macro- and micro-nutrient analysis of soil and leaf samples were carried out of each orchard. The soil nutritional profile will be worked out

VEGETABLE CROPS

Chilli (Crop Improvement)

37 entries consisting of IET-Chili/Hot pepper-10, AVT-I-chilli/hot pepper-14 and AVT-II-13 entries of hot pepper are being evaluated.

CHES-CHETTALLI

Evaluation of promising clones of Citrus- e) grapefruit

The seven grapefruit clones were evaluated for yield and quality traits. The maximum number of fruits was observed in Flame Seedless (147.67), which was on par with Marsh Seedless (135) and minimum was noticed in Red blush (69.33). The higher yield was recorded in Marsh Seedless (64.66) which was on par with Flame Seedless (61.12) and minimum was noticed in Red Blush (29.94).

Improving bearing potential of litchi through girdling of branches

The maximum flowering was observed in trees girdled with 2 mm 50 per cent branches (83.0%) which was on par 6 mm girdling of 25% branches (75.0%) followed by 6mm 50% PB (71.7%) and Girdling 2 mm 25% Primary branches (69%) . The maximum yield was recorded in 2 mm girdling of 50% branches (111.2 kg/tree) which was on par with 6 mm 25% branches (90.8 kg/tree) and minimum was observed in control (16.8 kg/tree).

Bearing in 50% branches girdled with 2 mm in variety Shahi

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5. Transfer of Technology

5.1. Training Programs

Date/s	No. of Trainings	No. of Participants
ICAR-IIHR, Bengaluru		
On-campus		
1st to 7th January; 30th June to 8th July; 12th to 21st October,2022	Online Entrepreneurial Training on 'Mushroom Spawn Production & Cultivation)	163
5th to 8th January, 2022	Special training programme for SMSs of KVKs of Assam Agricultural University, Johrat on “Improved Production Techniques in Horticulture”	17
11th to 13th January, 2022	Special Online Training for the Farmer’s of ATMA, Pakur, Jharkhand on “Horticulture Production Technologies of ICAR-IIHR” (online)	50
25th January, 2022	'Vegetable Grafting for Biotic and Abiotic Stress' for farmers of NEH region and 6 other selected states (online)	130
29th January, 2022	Online Virtual Orientation and Tour for students of The Professor Jayashankar Telangana State Agricultural University, Telangana State for UG Students	80
9th February, 2022	Online Orientation cum Virtual Tour for students of Kerala Agricultural University, College of Agriculture, Vellayani, Thiruvananthapuram	157
22nd to 23rd February, 2022	'Advances in Production Technologies of Papaya including seed production'	82
26th February, 2022	'Vertical Farming and Hydroponics in Horticulture'	34
5th March, 2022	One day offline training program on “Value-Addition in Flower Crops for Entrepreneurial Opportunities” in collaboration with Society for Promotion of Horticulture	20
5th March, 2022	'Vertical Farming and Hydroponics in Horticulture'	10
11th to 31st March, 2022	ICAR sponsored Winter School on 'Horticultural Biodiversity Conservation for Livelihood and Nutritional Security in the Era of Anthropocene and Climate Change'	25
29th March, 2022	Capacity Building Training Programme on “Cultivation and Propagation of ICAR-IIHR Varieties of Roses” under RKVY	60
3rd to 4th April, 2022	'Advances in Production Technologies of Papaya including Seed Production	38
21st to 23rd April, 2022	Training on 'Small Scale Wine Making from Grapes'	25
22nd April, 2022	Training on 'Mushroom Cultivation' for Harohallipalya Village	40
14th to17th June, 2022	BSF Personnel Training on 'Compost making, gardening, propagation and management of orchards’	05
18th June, 2022	Training on 'Mushroom Cultivation' for Ragavapura Village	20

25th June, 2022	Integrated Plant Protection Management for Capsicum under Polyhouse Cultivation	30
27th June to 2nd July, 2022	Special Training Programme on "Advances in Production and Management of Horticultural crops" for 3rd year students of SHUATS, Prayagaraj, Uttar Pradesh	20
25th to29th July, 2022	Hands on Training on 'Post Harvest Management & Value-Addition of Kiwifruit, Pineapple & other fruits of North East'	15
8-13th August, 2022	Training on 'Post Harvest Management & Value -Addition of Kiwifruit, Pineapple & other fruits of North East India'	15
20th August, 2022	Training programme (Hybrid Mode) on "Hydroponics and Vertical Farming in Horticultural Crops'	42
23rd to 30th August, 2022	Training program on "Food processing of Horticultural Crops" for officers of the Chief Food Technologist, Department of Horticulture and Soil Conservation, Manipur	09
06th to 08th September, 2022	KSCST Sponsored Capacity Building Training Programme on 'Post-Harvest Technology of Fruits & Vegetables for SC/ST Communities'	17
23rd & 24th September, 2022	Training Programme on 'Dissemination of Export Protocol in Mango including Pre and Post Harvest Practices' to the Officials of Vegetable and Fruit Promotion Council, Kerala	15
24th September, 2022	Interaction cum training workshop on 'Rose Cultivation'	34
7th to 21st October, 2022	Training Programme on 'Advances in Horticultural Production Technologies' for Assistant Directors Horticulture, Department of Horticulture, Bihar	12
7th to 21st November, 2022	Training Programme on 'Advances in Horticultural Production Technologies' for Assistant Director Horticulture, Department of Horticulture, Bihar	12
25th November, 2022	Farmers Training Programme on "Fruit Crop Based IFS and Varieties and Technologies of ICAR-IIHR, Bengaluru" in collaboration with Institute NICRA Team	48
05th to 07th December, 2022	Hands on Training Programme on 'Post-Harvest Management and Value-Addition of Fruits and Vegetables' for SC beneficiaries	14
6th to 20th December, 2022	Special Training Programme on 'Advances in Horticultural Production Technologies' for Assistant Director Horticulture, Department of Horticulture Bihar	09
20th December, 2022	Training and Entrepreneurship Development Programme on "Flowers and Foliage Drying Techniques for Production of Value-Added Dried Flower Products"	20
27th to 29th December, 2022	Interstate Training Programme on "Vertical Farming" for Horticulture Officers of Tamil Nadu	21
Off-campus		
14th February, 2022	Online Training Programme on "Cultivation of Arka Vertical Garden Structure in Kerala" State Horticulture Mission –Staff of State Horticulture Mission Kerala	30
21st February, 2022	'Mushroom Cultivation' Training at Karnataka State Akkamahadevi Women's University, Vijayapura	186

9th March, 2022	'Annona Cultivation', KVK, Raichur	125
24th March, 2022	Training Programme on "Varieties and Technologies of ICAR-IIHR Suitable for Meghalaya" at KVK, East Khasi District, Upper Shillong, Meghalaya	75
25th March, 2022	Training Programme on "Varieties and Technologies of ICAR-IIHR Suitable for Sikkim" under NEH Programme at NRCO Pakyong, Sikkim	120
26th March 2022	Training Programme on "Varieties and Technologies of ICAR-IIHR suitable for Sikkim" under NEH Programme at KVK, Namthang, Sikkim	65
23rd to 25th June 2022	Training Programme for Farmers of Meghalaya on 'Value-Addition of Kiwi Fruit and Pineapple'	15
18th July, 2022	Farmers Training Programme on 'New Varieties and Improved Technologies of ICAR-IIHR' and distribution of inputs under SCSP Programme at Hunsur	115
21st July, 2022	'Exotic Fruit Crops', KVK, Idukki, Kerala	225
21st July, 2022	Flower crops training, demonstration and input distribution program on at Channahally village, Devanahally (T) in collaboration with Dept of Horticulture, GOK under SCSP program.	60
12th August, 2022	Off campus 'Mushroom Cultivation' Training for the Selected Beneficiaries of Hunusuru Taluk, Mysore District	40
18th August, 2022	TSP training programme on " ICAR-IIHR Flower and Medicinal Crop Varieties and Technologies for Doubling Farmers Income" at HD Kote, Mysore	52
20th August, 2022	SCSP Training on "Integrated Crop Management in Cardamom" at ICAR-KVK, Idukki, Kerala	50
23rd August, 2022	Training Programme on 'New Varieties and Improved Technologies of ICAR-IIHR' and distribution of inputs under SCSP Programme at Raghavapura, Gundlupet Chamaraja Nagar	126
18th October, 2022	Training Programme on "Precision Farming of Vegetable Crops" at FFP Village Vasappana doddi, Kanakapura under FFP Project	14
15th November, 2022	Training Programme on 'Underutilized Fruits', KVK, Ambalavayal, Waynad, Kerala	76
16th November, 2022	Training on 'Mushroom Spawn Production and Cultivation at UAS, Raichur	55
20th November, 2022	'New Varieties and Improved Technologies of ICAR-IIHR' and distribution of inputs for the farmers of Mudhol taluk, Bagalkot district under SCSP Programmee	120
9th December, 2022	SCSP Farmers Training Programme on "New Varieties and Improved Technologies of ICAR-IIHR" at Anayadi, Kollam, Kerala	100
18th December, 2022	Farmers Training on "Total Quality Management in Protected Cultivation of Vegetable Crops with Holistic Package of ICAR-IIHR, Bengaluru" at Thungani Village, Kanakapura taluk, Ramangara district under SCSP Programme	12
22nd December, 2022	'Mushroom Cultivation' training at Nelahala, Sira for Gubbi and Sira farmer under SCSP program	30
26th December, 2022	'Mushroom Cultivation' training at Machur village, H. D. Kote farmers under TSP program.	65
CHES, Chettalli		
On-campus		
12th July, 2022	Training Programme on 'Scientific Cultivation of Avocado' to the farmers of Nilgiris District of Tamil Nadu	30

26th July to 17th August, 2022	21 days Horticulture Based Industrial (HBI) Training Programme to final year students of B.Sc. (Hort.) Fruit Science, College of Horticulture, Mudigere, Chikmagalur (Keladi Shivappa Nayaka University of Agricultural & Horticultural Sciences, Shivamogga)	12
4th August, 2022	Exposure Training on 'Horticultural Crops and Technologies' and Press Day Celebration at CHES (ICAR-IIHR), Chettalli to the Members and Families of Kushal Nagara Taluk Working Journalists Association	45
Off-campus		
20th September, 2022	Capacity Building Programme on 'Mushroom Cultivation' cum input distribution under TSP at Bommadi Hadi, Kodagu	100
8th November, 2022	Capacity Building Program on Sustainable 'Crop Production' and resources distribution under TSP at Valnur, Kodagu	110
KVK, Gonikoppal		
On-campus	KVK, Gonikoppal conducted 35 on campus training programmes	1340
Off-campus	KVK, Gonikoppal conducted 30 off campus training programmes	1310

Online webinars:

Dr. Jayaraghavendra Rao V.K, Principal Scientist (Agri. Extension) delivered the following online webinars:

- Leveraging Social Media For Agricultural Prosperity *ttps://youtu.be/FHOn823lj6Y,* on 23rd June, 2022 Agrinformn.com lecture series.
- Agri Nano Technology https://youtu.be/zu_gwb9IcCA, on 12th September, 2022, Agrinformn.com lecture series
- Rejuvenating Soils ttps://youtu.be/VpciAASLJKM, on 02nd August, 2022 Agrinformn.com lecture series.
- Start-Up Failure And Way Forward https://youtu.be/5Pl9NfI1W1k, on 18th August,2022 Agrinformn.com lecture series.
- Soilless Protected Cultivation Prospect https://youtu.be/gy1R4bixbMA, on18th October, 2022, Agrinformn.com lecture series.
- Start-Ups in Agriculture https://youtu.be/gG125sPLmvA, on 27th December, 2022, Agrinformn.com lecture series.
- Pm/Pert https://youtu.be/xq9NYJ1EEJ4, on 15-10-2022, Training programme on 'Planning, Monitoring and Evaluation of Agricultural Programmes and Projects', organised by EEI Hyderabad.
- Rawe Kaupla Livelihood https://youtu.be/H3RRXh3q3mY,
- Entrepreneurial Dynamics https://youtu.be/mHhj_8EDfKg, on 14th October, 2022 ACABC for refresher course on value addition opportunities conducted in collaboration with IIHR-MANAGE.
- Role of ICAR-IIHR in promoting FPOs, on 17th November, 2022 “Opportunities & Challenges in Promoting FPOs” in Horticulture Sector, MANAGE Training programme.

Dr. B. L. Manjunath, Nodal Officer, BPD/ABI, ICAR-IIHR orgnaised the following webinars:

- Novel Ideas of Insect Pest Management in Creating Entrepreneurial Opportunities on 10thMarch, 2022.
- Entrepreneurship Development Programme on “Business Opportunities in Horticulture for Self Employment” on 9th June, 2022.
- Entrepreneurship Development Programme on “Soilless Cultivation and Urban Gardening " on 6th September, 2022.
- Entrepreneurship Development Programme on “ICAR-IIHR Innovative Technologies in Vegetable Nursery Management” on 21st December 2022.

5.2. Demonstrations (Field Demonstrations, On-Farm Trials, Front Line Demonstrations etc.)

Following demonstrations were undertaken under NEH, TSP, SCP programmes of the institute and FFP

Sl. No	Description	Place	Number
	Front Line Demonstration of ICAR-IIHR varieties and hybrids in different states		
1.	Tomato hybrid - Arka Abhed	3 districts in Assam, 1 district of Meghalaya, 2 districts in Tripura, 10 villages in Sikkim, Kolar, Bengaluru Urban, Chamaraja Nagar and Mysuru districts of Karnataka	336
2.	Tomato hybrid - Arka Samrat	1 district in Meghalaya, 1 district in Tripura, 1 district in Assam , 38 villages in Sikkim, and 4 villages of Kanakapura taluk in Karnataka	292
3.	Tomato hybrid - Arka Rakshak	1 district in Meghalaya, 3 district in Assam, 10 villages of Sikkim , villages in Kolar, Bengaluru Urban and Rural, Chamaraja Nagar and Mysuru districts in Karnataka	327
4.	Tomato hybrid -Arka Apeksha and Arka Vishesh	Sonitpur district of Assam; Hosa Kote taluk in Bengaluru Urban and Kolar districts of Karntaka	34
5.	Chilli hybrid – Arka Meghana	15 villages in Dima Hasao, Goalpara, Bongaigaon and Haflong district Assam	40
6.	Chilli hybrid – Arka Haritha	15 villages in Dima Hasao and Darrang, Bongaigaon, districts in Assam, 39 villages in Sikkim, 2 villages in Kanakapura Taluk of karnataka	447
7.	Chilli hybrid – Arka Kyathi	1 district in Meghalaya and 11 villages of South Sikkim district	144
8.	Chilli hybrid – Arka Gagan	Dibrugarh district in Assam and 10 villages in South Sikkim district of Sikkim	142
9.	Chilli hybrid – Arka Sanvi	2 districts in Tripura, 10 villages in Sikkim and Hosadurga village of Kanakapura	143
10	Chilli hybrid – Arka Tejaswi	Kebbedoddi village in Ramanagara district, Karnataka	02
11.	Chilli hybrid –Arka Yashasvi	Kebbedoddi and Ramadurgadoddi villages in Ramanagara district, Karnataka	02
12.	Okra hybrid – Arka Nikitha	8 district in Assam, West Garo Hills district in Meghalaya and 39 villages in two districts of Sikkim	148
13	Okra hybrid – Arka Anamika	6 districts in Assam, 11 villages of 2 districts in Sikkim	86
14.	Brinjal hybrid - Arka Anand	1 district in Meghalaya, 11 villages in Sikkim, 2 villages in Kanakapura, Karnataka	51
15.	Brinjal hybrid - Arka Harshitha	Chikalegowdanadoddi in Ramanagara district, Kolar, Chikkaballapura and Chamaraja Nagar districts of Karnataka	20
16.	Improved Palak variety - Arka Anupama	Dibrugarh, Darrang, Bongaigaon districts of Assam and 10 villages of South Sikkim	27
17.	Improved Cowpea variety- Arka Garima	Goalpara district in Assam, West Garo Hills in Meghalaya, 39 villages in 2 districts of Sikkim	46
18.	Improved variety of Amaranthus - Arka Suguna	2 district in Assam, West Garo Hills of Meghalaya, 39 villages in 2 districts of Sikkim	52
19.	Improved Dolichos beans variety - Arka Sambhram	Dibrugarh in Assam, 11 villages in Sikkim	12

20.	Improved variety of Ridge gourd of Arka Prasan	4 districts of Assam, East and West Garo Hills in Meghalaya, 2 villages in Tripura, 15 villages of Dima Hasao and Darrang districts of Assam, 10 villages in South Sikkim districts	61
21.	Hybrid of Ridge gourd - Arka Vikram	5 districts in Assam, West Garo Hills in Meghalaya, 39 villages in East and South Sikkim districts	78
22.	Improved variety of Radish- Arka Nishanth	2 districts in Assam, 15 villages in Dima Hasao of Assam, 39 villages of South and East Sikkim districts	48
23.	Improved variety of China Aster- Arka Poornima	10 villages in East Sikkim district	36
24.	Improved variety of China Aster- Arka Archana	10 villages in East Sikkim district	48
25.	Improved variety of Tuberose - Arka Prajwal	10 villages in East Sikkim district	6
26.	Improved variety of Gladiolus-Arka Amar	10 villages in East Sikkim district	2
27.	Improved variety of Gladiolus - Arka Ayush	10 villages in East Sikkim district	2
28.	Vegetable hybrids of chilli, tomato and brinjal with mulching, drip, neem soap, AMC and Vegetable special	Raghavapura in Gundlupete taluk, Chamaraja Nagar districts of Karnataka	04
29.	Mulching, drip, water soluble fertilizers in selected vegetable crops	Kyalanur village in Kolar district, Karnataka	02
30.	Coconut seedlings, Vegetable seedlings, Neem soap, vegetable special, water soluble fertilizers,	5 villages in Kolar district, Karnataka	36
31.	Arka varieties of vegetable crops with other inputs	3 villages in Kolar district, Karnataka	06
32.	Tuberose variety - Arka Prajwal	4 villages in Chikkaballapura district of Karnataka	07
33.	Arka Onion detopper	Suntnoor Village, Kalaburagi (Dt.), Karnataka	33
35.	Arka tricycle and Arka vertical garden structure	CoE, Mulugu, Hyderabad, Telangana	
36.	Arka Onion detopper and Arka Tricycle	Agricultural Engineering Department, Chennai, Tamil Nadu	100
37.	ICAR-IIHR Onion detopper and grader to the onion growing farmers	Keelakari village, Perambalur (Dt.), Tamil Nadu	170
38.	ICAR-IIHR Onion detopper and grader to the onion growing farmers	Irur village, Perambalur (Dt.), Tamil Nadu	200
39.	ICAR-IIHR developed onion detopper	Dharapuram, Tamil Nadu State	1
40.	High yielding variety of Aswagandha–Arka Aswagandha	Andhra Pradesh	2

41.	High yielding non itchy varieties of Velvet bean	Karnataka	2
42.	China aster varieties - Arka Kamini and Arka Archana	Shakadadu, Sira, Tumakuru	2
43.	China aster varieties - Arka Kamini and Arka Poornima	Tammarasanahalli, Hesaraghatta Hobli, Bengaluru.	1
44.	China aster variety - Arka Kamini	Kaggallipalya, Gopalpura, Bengaluru	1
45.	Gladiolus varieties - Arka Amar and Arka Aayush, Arka Pratham, Arka Ranjini, Arka Gold (On Farm Trial)	UHS, Bagalkote, Karnataka	4
	At CHES, Chettalli		
	Demonstration of Nutrition Garden with 30 ICAR-IIHR vegetable hybrids/varieties		1
	At KVK, Gonikoppal		
	Front Line Demonstrations		12
	On-Farm Trials		5

Demonstrations taken under SCSP

Sl. No.	Title	Place	Period
1.	ICAR-IIHR tomato hybrids- Arka Samrat and Arka Abedh with holistic production technology	4 villages in Kanakapura, Ramanagara district; 2 villages in Gundlupete, Chamaraja Nagar district; 2 villages in Anekal, Bengaluru urban district and 3 villages in Gudibande in Chikkaballapura district	1st week of November, 2022
2.	ICAR-IIHR chilli hybrids - Arka Sanvi and Arka Gagan with holistic production technology	4 villages in Kanakapura, Ramanagara district; 2 villages in Gundlupete, Chamaraja Nagar; 2 villages in Anekal, Bengaluru urban district and 3 villages in Gudibande in Chikkaballapura district	3rd week of November, 2022
3.	ICAR-IIHR Brinjal hybrids – Arka Harshita with precision farming package	2 villages in Kanakapura, Ramanagara district	4th week of November ,2022
4.	Improved Mushroom Production Technology with permanent supporting structures for crop	1 village in Gundlupete taluk, Chamaraja Nagar district	3rd week of December,2022
5.	Precision farming of vegetable crops with IIHR technological products, mulching and crop support structures	3 villages in Kanakapura, Ramanagara district; 2 villages in Gundlupete, Chamaraja Nagar district; 2 villages in Anekal, Bengaluru urban district and 3 villages in Gudibande in Chikkaballapura district	2nd week of November, 2022
6.	IPM in vegetable crops	5 villages in Kanakapura, Ramanagara district; 2 villages in Gundlupete, Chamaraja Nagar and 2 villages in Gudibande in Chikkaballapura district	3rd week of November, 2022
7.	Good Post Harvest Management practices in field and horticultural crops	5 villages in Kanakapura, Ramanagara district; 2 villages in Chamaraja Nagar and Gundlupete taluk in Chamaraja Nagar district, 2 villages in Gudibande in Chikkaballapura district and 13 villages in Mudhol taluk, Bagalkot district	2nd week of November, 2022 (Bagalkot) and 2nd week of December, 2022 (Ramanagara)

5.3. Farmer–Scientist Interface Meetings

Place	Number of Meetings	No. of Participants
CHES, Chettalli		
	Field day on Nutrition Garden for the farmers of Kodagu district on 17th February, 2022	125
	One Day Workshop-cum-Field day on Avocado Cv. Arka Supreme and Spine gourd Cv. Arka Bharath on 2nd July, 2022	300
KVK, Gonikoppal	10	318

5.4. Exhibitions

Place	Number of Exhibitions
ICAR-IIHR, Bengaluru	Dr. R. B. Tiwari, Principal Scientist (Horticulture) participated in AAM Mahotsav and put up a stall about ICAR-IIHR technologies, organised by Directorate of Horticulture, Department of Agriculture, Govt of Bihar held at Gyan Bhavan, Gandhi Maidan, Patna Bihar from 24th -26th June 2022
	Dr.V.Sankar participated in the three-day *"Soya Mahakumbh"* at Devi Ahilya Vishwa Vidyalaya, Indore organised by ICAR-Indian Institute of Soybean Research, Indore, Madhya Pradesh from 29th to 31st May, 2022
	Dr.V.Sankar participated in "Expansion of Horticulture Value Chain in India – Potential and Opportunities", held at VAMNICOM, Pune, Maharashtra during 1st-2nd November,2022
CHES, Chettalli	Exhibition on ICAR-IIHR vegetable varieties and fruits at CHES, Chettalli on 17th February, 2022
	Exhibition on diversity of Avocado and Teasel gourd fruits on 2nd July, 2022
	Exhibition on Horticultural Crops and Technologies at Hotel Crystal Court, Madikeri during 2nd-3rd December, 2022
	CHES-Chettalli participated in Exhibition organized by ICAR-Krishi Vigyan Kendra, Gonikoppal as a part of one day Kisan Mela on 26th April, 2022
KVK, Gonikoppal	2
CHES- Bhuvaneswar	9

5.5. Media (TV, Radio, Newspaper, Webinars etc.)

Place	Scientist and Topic	Mode
CHES - Chettalli		
1	Dr. B.M. Muralidhara, Scientist (Fruit Science) delivered a talk in Dighvijaya TV programme Negila yogi on "Cultivation of Avocado" on 1St April, 2022	**TV Talk**
2	Dr. B.M. Muralidhara, Scientist delivered a talk in Dighvijaya TV programme Negila yogi on "Problems in cultivation of off-season litchi" on 1St April, 2022	**TV Talk**
3	Dr. B.M. Muralidhara, Scientist delivered a talk on "Cultivation of Litchi" and on 6th October, 2022.	**Radio Talk**

4	Dr. B.M. Muralidhara, Scientist delivered a talk on "Varieties of avocado and its cultivation" on 29th September, 2022	**Radio Talk**
5	Dr. S. Rajendiran, Senior Scientist (Soil Science) delivered a talk on "Supply of Mg and Zn to the soils of Coorg Mandarin on 12th October, 2022	**Radio Talk**
6	Dr. A.T. Rani, Scientist (Agri. Entomology) delivered a talk on "Insect pests of citrus and their management" on 3rd October, 2022	**Radio Talk**
7	Dr. A.T. Rani, Scientist delivered a talk on "Integrated management of fruit-fly in horticultural crops" on 11th October, 2022	**Radio Talk**
8	Mr. G.S. Madhu, Scientist (Plant Pathology) delivered a talk on "Avocado wilt management" on 10th October, 2022	**Radio Talk**
9	Mr. G.S. Madhu, Scientist delivered a talk on "Coorg Mandarin disease management" on 15th October, 2022	**Radio Talk**
KVK-Gonikoppal	Radio	9
	Newspaper articles	14
	Webinars	2
CHES-Bhubaneswar	All India Radio	3

Newspaper Clippings of National Symposium on Horticultural Crops of Humid Tropics for Nutritional and Livelihood Security-2022 held at Hotel Crystal Court, Madikeri during 02nd-03rd Dec., 2022.

Vijaya Karnataka(03/12/2022)

Vijaya Karnataka(03/12/2022)

Indian Express (03/12/2022)

Kannada Prabha (03/12/2022)

Vartha Bharathi (03/12/2022)

Times of India (03/12/2022)

Indian Express (03/12/2022)

Shakthi (03/12/2022)

Shakthi (03/12/2022)

Prajwani (03/12/2022)

5.6. Revenue Generation

ICAR-IIHR, Bengaluru

Technology commercialized and revenue generated during 1st January - 31st Dec, 2022

Sl. No.	Technology theme area	Technologies licensed
1.	Post Harvest Technology	Mango Fruit Bar, Mango Squash, Arka Mushroom Finger Millet Cookies, Arka Minimally Processed Onion, Arka Mushroom Rasam Powder, Arka Mushroom Groundnut Chutney Powder, Raw Mango Slice preservation in Brine Technology, Jackfruit Seed Powder and Mushroom Based biscuits/ Cookies (Arka Jackies), Crushed Tomato Technology, Osmotic Dehydration Technology of Mango, Arka Minimally Processed Onion + In a cluster (Shelf life extension of minimally processed cabbage+ fresh cut carrot + peeled garlic+ minimally processed coriander leaves+ fresh cut cucumber+ fresh cut capsicum+ fresh cut French beans+ fresh cut Radish), Sapota Wine and Banana Wine
2.	Farm Implements and Machinery	Solar Power Operated Tricycle Cart for Fresh Fruits and Vegetable Vending, Fruit and Vegetable Vending van, Arka Vertical Garden Model, Solar power Operated Tricycle Cart for Vending Ready to Harvest, Fresh Mushroom, Solar Power Integrated Outdoor Mushroom Growing Unit, Arka Power operated Watermelon Seed Extractor
3.	Seed and Planting Material	Chilli technologies IHR 4615, MS4 (IHR 3228/3229), IHR 4597 and CGMS line IHR 4392/4393), Avocado variety - Arka Supreme, Guava - Arka Kiran, Rose - Arka Savi, Ridgegourd - Arka Prasan, Black pepper- Arka Coorg Excel, Gerbera - Arka Red, Rose - Arka Parimala, Chilli- CGMS LINE MS3 (A&B lines) and Onion - Arka Kalyan
4.	Plant Health Management Technologies	Arka Microbial Consortium, Arka Decomposer, Arka Vegetable Special, Arka Sasya Poshak Ras,
5.	Biopesticides	*Trichoderma viride* 1.5% W. P., *Trichoderma harzianum* 1% W.P., *V. chlamydosporium* 1% W. P. and *Pseudomonas fluorescens* 1% W. P.,
6.	Biotechnology	Embryogenic cell suspensions for mass multiplication of banana (cv Elakki balle)

Total revenue through technology licensing: Rs. 1,13,17,169/- (Inclusive of tax)

Revenue Generated under Professional Service Function (CPC) during 2022

Type of service	No. of services	Total revenue generated in Rs. (Including GST)
Contract Service (Testing)	161	37,30,166
Contract Research (Paid up trial)	20	96,86,866
Consultancy service (Field visit)	21	3,56,135
Training	03	1,56,739
Total	205	**1,39,29,906**

ATIC-IIHR generated Rs.169.9 lakh revenue through sale of technology products and publications during 2022

A revenue of Rs. 5,07,000 was generated under RFS on 'Leaf Analysis Services to Horticultural Crop Growers' by analyzing soil (401 No.), water (60 No.) and plant (50 No.) samples.

A revenue of about Rs. 60,000 was generated through guiding MSc students for dissertation, about Rs. 75,000 through transfer of technology and Rs. 3,50,000 through training programmes of Post-Harvest Technology.

A revenue of Rs. 56,23,000 was generated through Phytosanitary testing, field inspections and Mushroom spawn and other related technologies.

SALE OF QUALITY SEEDS & PLANTING MATERIAL

ICAR-IIHR, Bengaluru

Vegetable Breeder Seed distributed

Crop	Variety	Quantity produced (Kg)	Quantity sold (Kg)
Bitter gourd	Arka Harit-BS	7.6	7.50
Brinjal	Arka Keshav-BS	1.2	0.05
Brinjal hybrid	Arka Anand Male & Female	0.05	0.05
Chilli	Arka Lohit-BS	1.20	1.20
Capsicum	Arka Gaurav-BS	0.385	-
Cowpea	Arka Samrudhi-BS	65.0	5
French bean (Bush type)	Arka Komal-BS, Arka Suvidha-BS	310.0	101.00
Okra	Arka Abhay-BS, Arka Anamika-BS	73.0	73.00
Pumpkin	Arka Chandan-BS, Arka Suryamukhi-BS	118.0	3.00
Radish	Arka Nishant	100.0	-
Roundmelon	Arka Tinda-BS	20.0	17.00
Tomato	Arka Vikas-BS	6.0	5.01
Tomato hybrid	Arka Samrat Male & Female	0.04	0.04
Veg. Amaranth	Arka Samraksha-BS, Arka Suguna-BS, Arka Varna-BS	42.0	3.50
	Total	**744.475**	**216.35**

Vegetable Seeds sold

Crop	Varieties	Quantity produced (kg)	Quantity sold (kg)
Bitter gourd	Arka Harit	1.6	1.54
Bottle gourd	Arka Bahar, Arka Nutan, Arka Shreyas	830.3	289.52
Brinjal	Arka Harshita,Arka Keshav, Arka Kusumakar, Arka Neelkanth, Arka Nidhi	237.8	74.38
Brinjal hybrid [F_1]	Arka Anand	62.90	19.81
Bush Squash	Patty Pan	14.15	3.19
Capsicum	Arka Gaurav, Arka Mohini	1.55	0.16
Capsicum hybrid [F_1]	Arka Athulya	1.2	0.59
Chilli	Arka Abhir, Arka Lohit, Arka Suphal	0.84	0.84
Chilli hybrid [F_1]	Arka Gagan, Arka Haritha , Arka Kyati, Arka Meghana, Arka Saanvi, Arka Swetha, Arka Tanvi, Arka Tejasvi, Arka Yashasvi	496.99	177.93
Coriander	Arka Isha	376.00	317.07
Cowpea	Arka Garima, Arka Samrudhi	814.00	750.65
Cucumber	Arka Veera	38.50	14.90

Dolichos (Bush type)	Arka Amogh, Arka Jay, Arka Sambhram, Arka Soumya	2,608.0	913.08
Dolichos (Pole type)	Arka Adarsh, Arka Bhavani, Arka Krishna, Arka Pradhan, Arka Swagath, Arka Visthar	2,570.0	726.20
French bean (Bush type)	Arka Anoop,Arka Arjun,Arka Komal,Arka Sharath,Arka Suvidha	13,185.0	2,783.51
French bean (Pole type)	Arka Sukomal	266.0	265.74
Garden pea	Arka Ajit,Arka Apoorva,Arka Chaitra,Arka Priya, Arka Uttam	524.55	55.55
Muskmelon	Arka Siri	57.92	45.53
Okra	Arka Abhay,Arka Anamika	2,076.07	1,202.31
Okra hybrid [F_1]	Arka Nikita	449.0	490.30
Onion	Arka Bheem [Synth], Arka Kalyan, Arka Ujjwal	33.41	33.41
Palak	Arka Anupama	3,103.0	1,275.95
Pumpkin	Arka Chandan, Arka Suryamukhi	289.019	258.60
Radish	Arka Nishant	250.0	250.0
Ridge gourd	Arka Prasan, Arka Sujat, Arka Sumeet	965.0	553.12
Ridge gourd hybrid [F_1]	Arka Vikram	343.0	253.35
Round melon	Arka Tinda	-	0.03
Tomato	Arka Abha, Arka Meghali, Arka Vikas	0.38	0.38
Tomato hybrid [F_1]	Arka Abhed , Arka Aditya, Arka Apeksha, Arka Rakshak, Arka Samrat, Arka Vishesh	605.9	360.40
Veg. Amaranth	Arka Samraksha, Arka Suguna, Arka Varna, Arka Arunima	5,373.0	1,215.98
Watermelon	Arka Manik, Arka Muthu, Arka Shyama	149.1	92.49
Watermelon hybrid [F_1]	Arka Akash	-	3.01
Yard long bean	Arka Mangala	5,397.8	1,240.65
	Total	**41,121.98**	**13,670.17**

Particulars	**Quantity Sold (Nos.)**
Vegetable Seed Kit (3 Arka Hybrids + 5 OP Arka Varieties)	9,567
Vegetable Seed Kit (8 OP Arka Varieties)	8,083

Fruits Planting Material Produced and sold

Sl. No.	Crop / Scion stick	Variety	Production (Nos.)	Sold (Nos.)
1	*Aonla*	NA-7	2,350	2,743
2	*Annona*	Arka Sahan, Balanagara	25,000	25,000
3	Annona scion sticks	Arka Sahan	1,500	1,500
4	Avocado plants	Arka Supreme	52	52
5	Banana plants	Yelakki, Red Banana	23,837	23,129
6	Curry leaf plants	Local	4,042	4,042
7	Dragon unrooted cuttings	Pink pulp, White pulp	42	42
8	Dragon cuttings	Pink pulp, White pulp	12,580	12,524
9	Drumstick plants	PKM-1	19,802	19,626
10	Mango plants	Arka Uday, Arka Suprabhath, Alphonso, Mallika,Raspuri, Totapuri, Kesar, Banganapalli, Dashehari,Amrapali,Langra, Arka Aruna, Arka Puneeth, Arka Anmol, Appemidi	43,677	43,677

11	Guava plants	Arka Kiran, Arka Mridula, Arka Rashmi, Arka Poorna	42,680	41,058
12	Papaya plants	Arka Prabhath, Arka Surya	46,100	45,529
13	Pepper plants	Panniyur-1	750	732
14	Pummelo plants	Arka Anantha, Arka Chandra	10,891	10,679
15	Sapota plants	Cricket Ball, Kalipatti	660	550
16	Tamarind plants	Lakshmana, PKM-1	1,950	1,921
17	Jack plants	Siddu,Shankara	11170	11,170
18	*Jamun*	Dupdal	4,297	4,297
19	Grapes rooted cuttings	-	450	425
20	Lime plants	Balaji	1,091	1,047
21	Minor fruit crops	Barbados cherry, Passion fruit seedlings, Malayan apple, Sour soup seedlings, Fig, Other foliage	2,483	2,331
		Total	**25,5404**	**25,2074**
1	Papaya seeds	Arka Prabhath, Arka Surya	18.675 kg	5.951 kg

Ornamental & Medicinal crops seed/planting material production & distribution in 2022

Sl.No.	Crop	Quantity Produced (Nos.)	Quantity sold (Nos.)
1	Aromatic plants	5000	4750
2	China aster plants	1100	1050
3	Crossandra cuttings	183000	182221
4	Gerbera plants	55500	55350
5	Gladiolus corms	106000	105985
6	Jasmine rooted cuttings	525	525
7	Marigold cuttings	438000	437105
8	Medicinal plants	40000	39992
9	Rose plants	61500	61305
10	China aster seeds	53	52.491
11	Marigold seeds	10	9.799
12	Medicinal seeds	3550	3537.773
13	Tuberose bulbs	460000	45890.46

Large scale demonstration of ICAR-IIHR vegetable varieties

Bottle gourd-Arka Shreyas plot in Kundur, Madhya

Coriander- Arka Isha plot in Hiriyur, Chitradurga

CHES, Chettalli - Revenue Receipt for the Year, 2022

Particulars	Revenue (Rs.)
Farm produce	19,40,849
License fee	5,71,273
Guest house rent	90,100
Interest on P loan and advance	4,094
Miscellaneous	1,03,200
Sale of tender paper	9,200
Total	**27,18,716**
Revolving fund	**55,39,928**
Grand Total	**82,58,644**

Agricultural Technology Information Centre (ATIC)
Planting materials Sold during Jan., 2022 to Dec., 2022

Sl. No.	Particulars	Amount (Rs.)
1.	Planting Materials	48,72,790
2.	Farm Produce	5,69,807
3.	Vegetable Seed Packets	12,430
4.	Others	2,37,060

Supply of Farm Machinery

Technology transferred	Name of Firm/ Organization	Amount (Rs.)
Arka Watermelon Seed Extractor – 2 Nos.	ICAR-IIAB, Ranchi	4,60,992
Power Operated Mango Grader - 5 Nos.	ICAR-IIAB, Ranchi	13,55,200
Solar Powered Outdoor Mushroom Growing Unit – 28 Nos.	ICAR-IIAB, Ranchi	36,49,563
Mushroom Spawn Machinery Set - 2 Nos.	ICAR-IIAB, Ranchi	30,91,000
Raw Jackfruit Peeler – 2 Nos.	ICAR-IIAB, Ranchi	34,7000
Supply of Arka Vertical Garden Model	ICAR-KVK, Kallakuruchi, Tamil Nadu	28,320
Supply of Arka Vertical Garden Model	Agriculture College & Research Institute, Tamil Nadu Agricultural University, Vazhavachanur, Tamil Nadu.	28,320

Sale of Mushroom Spawn and its Impact

Technology	Quantity/ Value
Oyster Mushroom Spawn (Gonikoppal)	1431.5 kg

On Farm Trials

Name of the Trial/Technology	Place	No. of Trials
Assessment of chilli hybrids for resistance to leaf curl disease and their suitability for coorg region	Chikkaluvara	05
The reigning pepper hybrid Panniyur-1 does not yield to its potential in higher altitudes	Boikeri	03
Assessment of paddy varieties for higher yield and blast resistance	Devarapura	05
Assessment of different plant growth promoting microbes for plant health management in black pepper	Devarapura	05
Assessment of performance of *Kadaknath* and *Giriraja* Poultry for high rainfall and hilly regions of Kodagu district	Cherandetti	05

Sale of Biofertilizers

Name of Product	Quantity/ Value
Arka Microbial Consortium (Gonikoppal)	13.65 tonnes

CHES-Bhubaneswar

Sale of Seed and Planting Material Production and Distribution

Crop/ Variety	Total Production
Fruit plants (Nos.)	45,331
Pine apple suckers (Nos.)	26,113
Rooted cuttings of Ivy gourd, spine gourd, pointed gourd (Nos.)	3,192
Seeds of brinjal, chilli, dolichos (Kgs)	94.2
Grafted brinjal (Nos.)	10,160
Vegetable Seeds (Tonnes)	4.9

Sale of Seed and Planting Material Production and Distribution: Rs. 22,81,707.00

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6.1 POST GRADUATE EDUCATION

The major activities of PG cell include offering Ph.D. in horticultural sciences as an outreach program of IARI, New Delhi, since the academic year 2014 and facilitating research guidance and course work for students of various universities as per MoU. ICAR-IIHR has MoU with reputed universities such as UAS, Bengaluru; TNAU, Coimbatore; JNKVV, Jabalpur; Acharya N.G. Ranga Agricultural University (ANGRAU), A.P; UHS, Bagalkot; Dr. Y.S.R Horticultural University, V.R. Gudem, AP; Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh; Kerala Agricultural University, Thrissur; Jain University, Bengaluru; Sam Higginbottom Institute of Agriculture, Technology & Sciences, Prayagraj; Graphic Era University, Uttarakhand; Siddaganga Institute of Technology, Tumakuru, Karnataka; Karnataka Science & Technology, Bengaluru; Bishop Hebar College (Autonomous), Trichy, Tamil Nadu; St. Joseph's College (Autonomous), Bengaluru; Kalinga Institute of Industrial Technology, Odisha; Sri Konda Laxman Telangana State Horticultural University, Telangana; Ashoka Trust for Research in Ecology & The Environment (ATREE) Karnataka; Presidency University, Bengaluru; Amrita School of Biotechnology, Amrita Vishwa Vidyapeetham, Kerala; During this period it has signed MoU with 11 more universities such as Dayananda Sagar University, Bengaluru; Sri Krishadevaraya University, Anantapuram; Sapthagiri College of Engineering, Bengaluru; Maharani Cluster University, Bengaluru; Lovely Professional University, Punjab; Acharya N.G. Ranga Agricultural University, Guntur; Mount Carmel College, Bengaluru; Odisha University of Agriculture and Technology, Odisha; RVSKVV, Gwalior; Alvas Collge, Moodbidri and College of Horticulture and Forestry, Pasighat, Arunachal Pradesh, for offering higher education in horticultural sciences. Scientists of the Institute have been recognized as Faculty/Guides for offering course work and to guide the students for research.

6.1.1. COURSES OFFERED FOR IARI-IIHR STUDENTS

A total of 59 courses were offered for IARI-IIHR Ph.D students during 2022-23 academic year: 34 in the I semester and 25 in the II semester, respectively, across 14 disciplines.

6.1.2. ALLOTMENT OF PG STUDENTS TO RESEARCH GUIDES

A total of 15 IARI-IIHR PhD students were allotted to scientists of the Institute for pursuing Ph.D. research work in Horticulture during the academic year 2022-23.

6.1.3. RECOGNITION OF FACULTY/GUIDE FROM ICAR-IIHR DURING 2022

Sl. No.	Name of the Scientist	Discipline	Faculty/Guide
1.	Dr. C. Mahadevaiah	Genetics and Plant Breeding	Faculty
2.	Dr. Deepa Samant	Fruit Science	Faculty
3.	Dr. Ayyagari V.V. Koundinya	Vegetable Science	Faculty
4.	Dr. S. Sriram	Plant Pathology	Guide
5.	Dr. K. V. Ravishankar	Plant Physiology	Guide
6.	Dr. Shamina Azeez	Biochemistry	Guide
7.	Dr. P. D. Kamala Jayanthi	Entomology	Guide
8.	Dr. Kundan Kishore	Fruit Science	Guide
9.	Dr. Basavaprabhu L Patil	Molecular Biology and Biotechnology	Guide
10.	Dr. T.R. Usharani	Molecular Biology and Biotechnology	Guide
11.	Dr. G. Sangeetha	Plant Pathology	Guide
12.	Dr. K.S. Shivashankara	Plant Physiology	Guide
13.	Dr. Smaranika Mishra	Vegetable Science	Guide

6.1.4. AWARD OF M.Sc. AND Ph.D. DEGREES

A. ICAR-IARI (outreach campus at ICAR-IIHR)Ph.D. Degrees awarded

Name of the Student	Discipline	Guide
Kaluram	Fruit Science	Dr. C. Vasugi
G.N. Kiran Kumar	Fruit Science	Dr. M.R. Dinesh
Arindam Das	Vegetable Science	Dr. T.S. Aghora
Siddharod Maragal	Vegetable Science	Dr. E.S. Rao
Swamini Bhoi	Vegetable Science	Dr. B. Varalakshmi
Manish Kumar	Vegetable Science	Dr. K. Madhavi Reddy
A.J. Sachin	Post Harvest Technology	Dr. D.V. Sudhakar Rao

B. SAUs/ Private institute M.Sc/Ph.D. Degrees awarded

Student	University	Degree	Guide
Amarnath, M	UHS, Bagalkot	Ph.D. (Biotechnology)	Dr. K.V. Ravishankar
Ankita Sahu	OUAT, Bhubaneswar	Ph.D. (Fruit Science and Horticulture Technology)	Dr. Kundan Kishore
Chandandeep Kaur	Jain University	Ph.D. (Microbiology)	Dr. G. Selvakumar
Neethu K. Chandran	Jain University	Ph.D. (Biotechnology)	Dr. S. Sriram
Vidya Srinivasa Murthy	Jain University	Ph.D. (Biotechnology)	Dr. K.V. Ravishankar
Sathyashree, R. B.	UAS, Bengaluru	M.Sc. (Agriculture) Plant Physiology	Dr. K. Bhanu Prakash
Jayalakshmi K.T.	UAS, Bengaluru	M.Sc. (Agriculture) Plant Physiology	Dr. R.H. Laxman
Logeshwaran, J.	UAS, Bengaluru	M.Sc. (Agriculture) Crop Physiology	Dr. K. S. Shivashankara
Lalthantluanga	UAS, Bengaluru	M.Sc. (Agriculture) Crop Physiology	Dr. K. S. Shivashankara
Shirisha. K.B.	UAS, Bengaluru	M.Sc. (Agriculture) in Crop Physiology	Dr. Prakash Patil
Soumen Shit	OUAT, Bhubaneswar	M.Sc. Ag (Fruit Science and Horticulture Technology)	Dr. G. C. Acharya
Sagarika Sahoo	OUAT, Bhubaneswar	M.Sc. Ag (Fruit Science and Horticulture Technology)	Dr. Kundan Kishore
Sasmita Bal	OUAT, Bhubaneswar	M.Sc. Ag (Fruit Science and Horticulture Technology)	Dr. Deepa Samant
Dolly Sahu	OUAT, Bhubaneswar	M.Sc. Ag (Fruit Science and Horticulture Technology)	Dr. Deepa Samant
Jeetesh Sahu	OUAT, Bhubaneswar	M.Sc. Ag (Vegetable science)	Dr. G. C. Acharya

6.2. TRAINING AND CAPACITY BUILDING OF ICAR-IIHR STAFF (HRD)

Capacity building program

One-day offline training program on 'Value Addition in flower crops for entrepreneurial opportunities', was organized by the Division of Flower and Medicinal Crops, ICAR-IIHR in association with Society for Promotion of Horticulture on 5th March, 2022. Training on preparation of value-added products from fresh flowers, dry flowers and foliage, processed flower products, essential oil extracction, edible products from flowers, extraction of figment and dyes pharmaceutical products, nutraceutical products was conducted. In addition, hands on training on these aspects including dry flowers products, preparation of Terrariums and Tray garden' was imparted. Around 20 participants including farmers, assistant professors, students from different states participated in the program.

SCIENTIFIC STAFF

- Dr. B. Varalakshmi attended online training program on "Use of Intellectual Property Rights (lPR) for Protection of Research and Innovation in Field of Veterinary, Agriculture and Horticulture" organized by Nanaji Deshmukh Veterinary Science University, Jabalpur, Madhya Pradesh during 23rd May to 6th June, 2022
- Dr. G. Sangeetha attended online training program on "Pest Risk Analysis" organized by National Institute of Plant Health Management, Hyderabad during 6th-10th June, 2022
- Dr. Shamina Azeez attended training program on National workshop cum webinar on "Genome Editing Basics to Applications in Agriculture, Pharma and Health Sectors" organized by Glostem on 27th June to 3th July, 2022
- Dr. P. Preethi attended online training program on "Spray, Freeze and Spray-Freeze Drying of Foods" organized by NIFTEM-T, Thanjavur on 8th July, 2022
- Dr. T. R. Usharani attended online training program on "Genetically Engineered (GE) Plants: Biosafety Considerations, Policies, Challenges and Detection Strategies" organized by ICAR- NBPGR, New Delhi on 19th – 25th July, 2022
- Dr. Priti Sonavane attended online training program on "Biosecurity and Biosafety: Policies, Diagnostics, Phyosanitary Treatments and Issue" organized by ICAR- NBPGR, New Delhi on 2nd and 11th August, 2022
- Dr. P. R. Ramesh attended online training program on "Capacity building programme (NICRA)" organized by CRIDA, Hyderabad on 13th -14th August, 2022
- Dr. M. D. Prathibha attended online training program on "Computational Genomics Proteomics" organized by Indian Institute of Information Technology, Design and Manufacturing, Jabalpur on 18th August -1st September, 2022
- Dr. M.D. Prathibha attended training program on "4th Centre for Advance Faculty Training (CAFT) on Genome Utilization and Editing of Plant for Useful Trait" organized by ICAR-NIPB, New Delhi on 30th November to 20th December, 2022
- Dr. M. D. Prathibha attended online training program on "QTL Analysis and Genome Wide Association Studies" organized by ICAR- IASRI, New Delhi on l5th-24th February, 2022
- Dr. K.S. Shivashankara attended training program on "Training of Vigilance Officer" organized by ICAR-NAARM, Hyderabad on 24th-26th August, 2022
- Mr. G.M. Sandeep Kumar, attended online and offline training program on "Gender Responsive Breeding and Seed Systems" organized by ICRISAT, Hyderabad during l2th to 17th September and 26th to 30th September 2022, respectively.
- Dr. Anuradha Sane attended training program on "Leadership and Organization Development for Women Scientists and Technologists" organized by Centre for Organization, Hyderabad during 12th-16th September, 2022
- Dr. S. Bhuvaneswari and Dr. P. D. Kamala Jayanthi attended training program on "Building Competencies for Personal Excellence" organized by Art of Living Center, Bengaluru during 5th-9th September, 2022
- Dr. R. Venkattakumar, Dr. R. Senthil Kumar and Mr. G.A. Atheequalla attended training program on "National Facilitators Development Program, MANAGE" organized by MANAGE, Hyderabad during 31st October - 5th November, 2022
- Dr. S. Ramachandran attended online training program on "Response Surface Methodology" organized by ICAR- NAARM, Hyderabad during 18th - 20th August, 2022
- Dr. P. Tejaswini attended training program on "Building Competencies for Personal Excellenc" organized by Art of Living Center, Bengaluru during 21st -25th November, 2022

- Dr. B. R. Raghu attended online training program on "Analysis of Multi-Environment Trials" organized by ICAR-NAARM, Hyderabad on 3rd- 8th November, 2022
- Dr. Anil Kumar Nair attended online training program on "Annual Training of Evaluation Committee Members of APEDA" on 14th February, 2022
- Dr. Pritee Singh attended online training program on "Data Visualization using R" organized by ICAR - NAARM, Hyderabad on 9th-11th March, 2022
- Dr. Shamina Azeez attended training program on "Hands-on Training Course in Proteomics" by C-CAMP organized by Glostem on 26th-28th September, 2022
- Dr. R.B. Tiwari attended training program on "Strengthening Capacities for Nutrition - Sensitive Agriculture and Food Systems for Mid-Senior Level (MSL)" organized by MANAGE, Hyderabad on 28th February- 4th March, 2022
- Dr. K.V. Ramesh attended training program on "Advances in Simulation Modeling and Climate Change Research" towards Knowledge based Agriculture organized by ICAR -HRM programme on 17th November - 7th December, 2022
- Dr. Shameena Azeez attended training on 'Analysis of Fruit & Vegetable Products', at the Referral Food Laboratory, Food Safety & Analytical Quality Control Laboratory, CSIR-CFTRI, Mysore, during 11th-12th April, 2022
- Dr. Shameena Azeez attended National workshop-cum-webinar on "Genome Editing – Basics to Applications in Agriculture, Pharma & Health Sectors", organized online by Glostem, during 27th June to 3rd July 2022
- Dr. Partha P. Choudhury attended training on "Laboratory Quality System Management and Internal Audit as per ISO/IEC 17025: 2017" at NIPHM, Hyderabad, during 07th-11th March, 2022
- Dr. M.D. Pratibha attended training on "Genome utilization and editing of plant for useful trait" conducted by NIPB, New Delhi, during 30th November to 20th December, 2022
- Dr. K.S. Shivashankara attended "Training of Vigilance officers" at ICAR-NAARM, Hyderabad from 24th-26thAugust, 2022
- Dr. K.V. Ramesh, attended Training Workshop on "Advances in Simulation Modelling and Climate Change Research towards Knowledge Based Agriculture" organized by Centre for Environment Science and Climate Resilient Agriculture, ICAR-IARI, during 17th November to 7th December, 2022
- Dr. G.R. Smitha attended one week training program "Analysis of Experimental Data" organized by ICAR-NAARM, Hyderabad during 17th-22nd January, 2022
- Dr. G.R. Smitha and Dr. S.A. Safeena attended National Workshop on "Post-harvest management and value addition of ornamentals" organised by the Department of Floriculture and Landscape Architecture, College of Horticulture, BUAT, Banda during 17th-18th February, 2022
- Dr. M.R. Rohini participated in the Online Training Programme on "Analysis of Experimental Data" organized by ICAR-NAARM, Hyderabad during 17th-22th January, 2022
- Dr. S.A. Safeena attended Capacity building programme on "Cultivation and Propagation of Marigold flower crop of ICAR- IIHR varieties" under RKVY Programme held at Model Nagarur on 09th March, 2022
- Dr. S.A. Safeena attended Online collaborative training program on "Urban farming for nutritional security and environmental sustainability" organized by UAS, Bengaluru and MANAGE, Hyderabad during 14th-16th June 2022
- Dr. S.A. Safeena attended Brainstorming Session on "One District One Product" organized by All India Co-ordinated Research Project on Floriculture on 6th August, 2022
- Dr. A. Carolin Rathinakumari attended online ICAR-HRD Training Programme on 'Emotional and Social Intelligence at Workplace' on virtual mode held organized by ICAR-IIWBR, Haryana during 13th-15th, December, 2022
- Dr. S. Vijay Rakesh Reddy attended the "Massive Open Online Course (MOOC) on Digital Assessment and Evaluation Technologies" offered by ICAR-NAARM, Hyderabad during 1st-30th September 2022
- Dr. S. Vijay Rakesh Reddy participated in two days virtual training on 'Statistical Methods in Food Processing' conducted by AFST(I), CFTRI, Mysore during 10th-11th October 2022
- Dr. S. Vijay Rakesh Reddy participated in a training program on 'Social Media for Agricultural Extension' from 16-20 May 2022 jointly organized by GKVK,

UAS, Bengaluru and MANAGE, Hyderabad.

- Dr. R. B. Tiwari, Principal Scientist (Horticulture) participate in training programme on "Role of Technology in Community Level Disaster Mitigation for Scientist & Technologist (Offline)" held at Centre for Disaster Management (CDM) Lal Bahadur Shastri National Academy of Administration, Mussoorie, Uttarakhand., during 25- 29th July, 2022
- Dr. R. B. Tiwari attended the training programme on "Strengthening Capacities for Nutrition - Sensitive Agriculture and Food Systems for Mid-Senior Level (MSL) organized by MANAGE, Hyderabad. during 28th February to 4th March, 2022
- Dr. R. B. Tiwari attended the National Facilitators Development Programme (NFDP) conducted by MANAGE, Hyderabad during 17th-22nd, January, 2022
- Dr. H.R. Ramya attended MANAGE training programme on “Research Priorities in Agricultural Extension" held during 24th- 25th February, 2022
- Dr. N. Loganadhan, attended training on “Honey bee Testing Protocol” at National Honey Testing Unit ,NDDB, Anand, Gujarat from 27-28th March, 2022
- Dr. N. Loganandhan. , Principal Scientist and Head KVK, Hirehalli attended the training programme on “Statistical & Socio Economic Methods and Impact Assessment for Technology Refinement in Agriculture” on 12-13th August 2022 at ICAR-Central Plantation Crops Research Institute, Kasaragod
- Dr. N. Loganandhan, ICAR-KVK, Hirehalli, Tumakuru participated in the Capacity Building Programme on Technology Demonstrations for Enhancing Resilience during 13th -14th August 2022 held at CRIDA, Hyderabad
- Dr. H.R. Ramya attended a seminar on 'Pulses and their Improvement for Food and Nutritional Security' on 10 th February, 2022 at ICAR-IIHR, Bengaluru
- Dr. G. Sangeetha attended online training on "Metagenomics Data Analysis" organized by ICAR-IASRI, New Delhi during 19th - 24th January, 2022
- Dr. Priti Sonavane, attended online short course on “Phytophthora: From Isolation to Functional Genomics” held at ICAR-IISR, Kozhikode, Kerala, from 02nd -11th March, 2022.
- Dr. Priti Sonavane, attended online DBT-sponsored Training on “Biosecurity and Biosafety: Policies, Diagnostics, Phytosanitary Treatments and Issues” organized by ICAR-NBPGR, New Delhi during August, 2nd -11th 2022
- Dr. S. Sriram attended the "Annual Technical Meet of Plant Pathology group of University of Horticultural Sciences" as an external expert at College of Horticulture, Mysore during 4th -5th April, 2022

TECHNICAL STAFF

- Dr. Lakshmipathi, Dr. A. N. Lokesha, Sanna Manjunatha, M. Venkatesh and Mr. L. Balakrishna, attended training program on "Motivation, Positive Thinking and Communication Skills for the Technical Officers" organized by ICAR-NAARM, Hyderabad on 13th-16th September, 2022
- Dr. A.N. Lokesha attended online training program on "Computer Applications for Technical Personnel of ICAR" organized by ICAR-IASRI, New Delhi on 15th-21st December, 2022
- Sri. K. N. Avinash and Sri. Nagaraj. E. Kodekal attended training program on "Selection, Adjustment, Operation and Maintenance of Agricultural Implements for field and Horticultural Crops" organized by ICAR-Central Institute of Agricultural Engineering, Nabibagh, Bhopal on 29th December, 2022 - 7th January, 2023
- Mr. Benecio Fernandes, Senior Technical Assistant (Computer lab) particapted in the "Cyber security training program" on 19th October 2022, conducted by ISEA, Ministry of Electronics and Information Technology (MeitY), GoI
- Smt. Lakshmi R, Senior Technical Assistant (Field/ Farm) participated in the training program on "Introduction to Natural farming, Principles and Practices " organized by MANAGE, Hyderabad from 17th to 19th October 2022
- Dr. Jyothi V. Divakara attended online training on "Emotional and Social Intelligence at Workplace" organized by ICAR- IIWBR, Karnal during 13th-15th December, 2022
- M. Malarvizhi, attended online training on "RNA world: Advance Bioinformatics for Deciphering Regulatory Molecules" organized by ICAR-IASRI, New Delhi during 03th-09th November, 2022
- Mr. Benecio Fernandes, Senior Technical Assistant (Computer), KVK Kodagu attended the programme on "Use of AI and ICT in Agriculture Information Access and Dissemination" on 14th March, 2022

- Sri. K.N.Jagadish, ACTO/SMS-Agril.Extn. participated in Training Programme on "FPOs and Sustainable Community Extension Model" through virtual mode organized by MANAGE, Hyderabad from 9th-11th March, 2022
- Mrs. Jyoti Appu Naik, Technical Officer-Computer attended virtual mode training programme on “Advances in Web and Mobile Application Development” from 2-6th August, 2002
- Dr. D. Somasekhar, SMS-Plant Breeding attended the training programme on “Production on Cocoponics/ soilless culture-A new method of growing vegetables and medicinal herbs in terrace/ roof top” at BESST-HORT,ICAR-IIHR, Bengaluru on 6th August, 2022
- Mr. Ramesh.P.R and Mr. Praveen Kumara from ICAR-KVK, Hirehalli, Tumakuru participated in the Capacity Building Programme on Technology Demonstrations for Enhancing Resilience during 13th -14th August 2022 held at CRIDA, Hyderabad
- Sri. P.R. Ramesh attended training program on National Workshop on 'Natural Farming and Orientation-cum-Training' by State Natural Farming Training Center, Gurukul, Kurukshetra, Haryana on 5th - 6th December, 2022

ADMINISTRATIVE STAFF

- Sri. S.M.A. Ahmed attended training program on Public Procurement (Basic) and Arbitration for Government Officers organized by Arun Jaitely National Institute of Financial Management (AJNIFM), Faridabad on 14th-19th November, 2022
- Mrs. Aachal Palewar attended training program on Public Procurement (Basic) organized by Arun Jaitley National Institute of Financial Management (AJNIFM), Faridabad on 12th - 17th December, 2022

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7. Awards and Recognitions

7.1. Awards

- Best All India Coordinated Research Project on Vegetable Crops Coordinating Center for the year 2021 is conferred to the Division of Vegetable Crops, ICAR-IIHR for their contribution in the field of Vegetable Science on 15th June 2022


ICAR-All India Coordinated Research Project
(Vegetable Crops)

40th Annual Group Meeting of AICRP on Vegetable Crops (Virtual Mode)

Best AICRP (Veg. Crops) Coordinating Centre-2021

Conferred on

ICAR-Indian Institute of Horticultural Research, Bengaluru

(15th June, 2022)

Director & Project Coordinator
AICRP on Vegetable Crops
ICAR-IIVR, Varanasi

- Dr. K. Madhavi Reddy received National Award for Excellence in Agricultural Research, 'Punjabrao Deshmukh Outstanding Women Scientist Award 2021' presented by Shri Narendra Singh Tomar, the honourable Union Minister of Agriculture & Farmers Welfare on 16th July 2022 in New Delhi

- Dr. M. Sankaran, Principal Scientist, Division of Fruit Crops received the following awards/recognition
  - ICAR-IIHR-Best Teacher award-2022
  - ICAR-National Fellow-2022, ICAR, New Delhi
  - Outstanding Fruit Scientist Award-2022 by Kalasalingam School of Agriculture and Horticulture, KARE, Krishnankoil, Tamil Nadu
- Dr. Kanupriya received 'Women Scientist Award-2022' from the Society for Scientific Development in Agriculture and Technology, Meerut, Uttar Pradesh, during the '7th International Conference on Global Research Initiatives for Sustainable Agriculture and Allied Sciences' organised at Birsa Agricultural University, Ranchi, Jharkhand from 21st-23rd November, 2022
- Dr. C. Vasugi recieved best presenter award (Agro-techniques) during IX Group Discussion of ICAR-AICRP on Fruits held in virtual mode from 8th-11th March, 2022
- Dr. P. C. Tripathi conferred 'Fellow of Society for Promotion of Oil Palm Research and Development', IIOPR, Pedavegi (AP) in December, 2022
- Dr. Kanupriya was awarded Best Oral presentation for 'Tamarind for improving rural livelihood security through sustainable integrated farming', in the International Web-Conference on Food Security through Sustainable Agriculture (FSSA), VAKSANA-2020, 21st-22nd September, 2022
- Dr. G.R. Smitha and Dr. T. Usha Bharathi received 'Horticultural Scientist Award-2022' from Dr. B. Vasantharaj David Foundation Excellence Awards -2022
- Dr. G.R. Smitha and Dr. T. Usha Bharathi received Best Poster Award under the category Horticultural Sciences 2022 for the paper entitled 'Standardization of container type, substrate and nutrition for potted plant production of China aster [*Callistephus chinensis* (L.) Ness.] var. Arka Archana' in 4th National Conference on 'Recent Advances in Applied Entomology and Environmental Sciences' organised at Chennai, Tamil Nadu on 1st October, 2022
- Dr. Safeena S.A. was conferred with 'Outstanding Woman Researcher Award' by 'Research Education Solutions (RES) registered as Micro Enterprise with MSME, Govt. of India)' during 'International Conference on Green Technology, Agriculture, Information Technology, Business Management and Social Sciences' jointly organized by 'Society for Ecological Sustainability (SES), Bhawanipatna, Odisha', M.S. Swaminathan School of Agriculture (MSSSoA) and Centurion University of Technology and Management (CUTM), Odisha, during 16th-17th July, 2022
- Dr. Rajiv Kumar was conferred 'Fellowship of the Indian Academy of Horticultural Sciences (IAHS)', New Delhi for significant contribution in the field of Horticulture (Floriculture) 2022 on 02nd December 2022

- Dr. P. Venkata Rami Reddy received 'Dr. Anand Prakash Award for excellence in Entomological research' by the Applied Zoologists Research Association (AZRA), Bhubaneswar

- Dr. R. Umamaheswari received 'AZRA Fellowship Award' during XVIII AZRA International Conference on "Advances in Applied Zoological Researches towards Food, Feed & Nutritional Security and Safer Environment organized by AZRA, Bhubaneswar, Odisha durinh 10th-11th November, 2022

- Dr. R. Umamaheswari received Best paper Award for oral presentation on 'Exploring host plant resistance and developing integrated nematode management strategies in brinjal (*Solanum melongena* L.) during International Conference on Innovative technologies and their application in higher education organized by Annamalai University, Chidambaram during 17th-19th October, 2022

- Drs. T.K. Radha, R. Umamaheshwari, S. Onkar Naik and A.N. Lokesh recieved best poster award for 'Biocontrol potential of entomopathogenic *Streptomyces* and its secondary metabolites on insects pests and nematodes' in 7th National conference on biological control: 75 years of Biological Control of Pests and Diseases in Agriculture: Challenges and the way forward' held during 15th-17th, December, 2022 at Yelahanka, Bengaluru

- Dr. B. R. Jayanthi Mala, received oral presentation award for paper on 'Olfactometer responses of ash weevil, *Myllocerus subfasciatus* to male aggregation pheromone 2-methyl-4-heptanol' during International Conference on 'Advances in Agricultural, Veterinary and allied Sciences for Improving Livelihood and Environmental Security (AAVASILES-2022)' during 28th-30th, September, 2022

- Dr. M. C. Keerthi, received 'Young Agricultural Scientist Award- 2022' from Dr. B. Vasantharaj David Foundation, Chennai on 01st October, 2022

- Dr. L.R. Varalakshmi received 'Reviewer Excellence Award' as reviewer of 'Legume Research' from the editors of ARCC journals in recognition of significant and outstanding contribution to the journal

- Dr. D. Kalaivanan, received 'Outstanding Researcher Award in Soil Science' for the contribution and achievement in the discipline of Agricultural Sciences from Venus International Foundations, Chennai during 8th Annual Science and Technology Meet (ASTM) held at Chennai on 02nd July, 2022

- Dr. D. Kalaivanan, received 'Distinguished Scientist Award in Soil Science 2022' for the contribution in soil science during the 'National Conference on Horticulture: Enhancing Productivity and Mitigating Major Challenges' jointly organized by the Department of Horticulture, Kalasalingam School of Agriculture and Horticulture, KARE with RVS Padmavathy College of Horticulture (TNAU) at Srivilliputtur, Tamil Nadu during 10th-11th November, 2022

- Dr. D. Kalaivanan, received first prize in oral presentation on 'Nutrient Scheduling and Substrate Effects on Growth, Yield and Quality of Chilli Hybrid Arka Meghana under Open and Polyhouse Soilless Culture' presented under the theme 'Novel Technologies in Horticulture and Agriculture Engineering' in the National Seminar on Empowerment of Rural Youth with Novel Agricultural Technologies (ERYNAT 2022) held at Agricultural College, Bapatla, AP during 28th-29th January, 2022, India

- Dr. T.K. Radha, was conferred 'Young Scientist Award- 2021' in the field of Agricultural Microbiology from the Society for Scientific Development in Agriculture & Technology, Merrut (U.P)

- Dr. T.K. Radha, received 'Young Agricultural Microbiologist Award 2022' for commendable contribution to Agricultural Microbiology from Dr. B. Vasanthraj David Foundation, Chennai

- Dr. R. Venkattakumar received the most attractive stall award in the 'International Agriculture and Horti Expo at Pragti Maidan' and during 17th-19th June, 2022

- Dr. R. Venkattakumar recieved second best stall award in the Government stalls category in Krishi Mela organized by UAS, GKVK, Bengaluru and during October, 2022

- Dr. R. Venkattakumar received second best stall award in the Government stalls category in Mega Kisan Mela and Agri Expo 2022 organized by Regional Centre, KIDU of CPCRI, Kasaragod during 17th-23rd November, 2022

- Dr. G.S. Madhu, received 'Best Oral Presentation award' for 'Survey, Symptomotology and Identification of Pathogens Associated with Avocado Root Rot Disease in India", in the 'National symposium on Horticultural Crops of Humid Tropics for Nutritional and Livelihood Security (NSHCHT)-2022' organized by CHES (ICAR-IIHR), Chettalli at Madikeri during 2nd-3rd December, 2022

- Dr. S. Rajendiran, recieved 'Global Scientist Award' for his contribution and recognition in the Field of Soil Science (Soil Chemistry/Fertility) in the 4th International Conference on Global Efforts on Agriculture, Forestry, Environment and Food Security (GAFEF-2022), at Institute of Forestry, Tribhuvan University, Pokhara Campus, Pokhara, Nepal during 17th-19th September, 2022

- Dr. S. Rajendiran, recieved 'Best Oral Presentation (1st Position)' in the 4th International Conference on Global Efforts on Agriculture, Forestry, Environment and Food Security (GAFEF-2022), at Institute of Forestry, Tribhuvan University, Pokhara Campus, Pokhara, Nepal during 17th-19th September, 2022

- Dr A.V.V. Koundinya was awarded the 'Best Oral Presentation Award' in 'National Seminar on Horticulture for Sustainable Development, Nutritional and Livelihood Security' from Uttara Banga Krishi Viswavidyalaya, Cooch Behar during 26th-27th May, 2022

- Dr. Deepa Samant received 'Best Oral Presentation Award' in the VII International Conference on 'Global Research Initiatives for Sustainable Agriculture and Allied Sciences' held at BAU, Ranchi, Jharkhand during 21st-23rd November, 2022

- Dr. Kundan Kishore was awarded 'Fellow of Society for Horticultural Research and Development (SHRD)' at 2nd Indian Horticulture Summit organized by NAU, Navsari during 27th-29th April, 2022

- Dr. Deepa Samant was conferred with 'Fellowship Award-2021' by the Hi-Tech Horticultural Society (HTHS), Meerut, Uttar Pradesh

- Dr. Deepa Samant received the 'Best Oral Presentation Award' in the IV International Conference on 'Innovative and Current Advances in Agriculture and Allied Sciences' held at Himachal Pradesh University, Shimla during 12th-14th June, 2022

- Miss Sipra Mohapatra and Dr. G. C. Acharya were awarded with 'Best Oral Presentation Award' in the 'National Seminar on Fruit Production in Eastern Tropical Region', at CHES (ICAR-IIHR), Bhubaneswar during 24th-26th March, 2022

- ICAR-IIHR participated in the exhibition in the International Agriculture and Horti Expo at Pragti Maidan during June 17th-19th, 2022, in which ICAR-IIHR bagged the most attractive stall award

- Dr. V. Sankar received Best oral presentation during National Symposium on "Horticultural Crops of Humid Tropics for Nutritional and Livelihood Security (NSHCHT)" & Exhibition-2022 was organized at Madikeri, in collaboration with the Society for Promotion of Horticulture (SPH), ICAR-IIHR, Bengaluru during 2nd-3rd December, 2022

- Dr. A. Carolin Rathinakumari was awarded Second Prize for the research paper entitled "Onion Detopping Machine: Bench work to start up" in International Conference on "Advances in Agriculture and Food System towards Sustainable Development Goals (AAFS - 2022)" held at UAS Bengaluru during August, 22th-24th, 2022

- Dr. S. Bhuvaneswari Principal Scientist, was awarded best oral presentation award for the research paper entitled " Design and Development of Motorized Raw Jackfruit peeler" by S.Bhuvaneswari and P.Srinivas in the International Symposium on India @2047: Agricultural Engineering perspective. Jointly organised by ISAE, New Delhi and TNAU, Coimbatore held at TNAU, Coimbatore from November, 9th-11th 2022

- Dr Vijay Rakesh Reddy S was conferred with Young Horticultural Scientist Award (Fruit Science-PHT) by Society for Horticultural Research and Development (SHRD) during 2nd Indian Horticulture Summit-2022 organized at Navsari Agricultural University, Navsari, Gujarat from 27th-29th, April, 2022

7.2. Recognition (ICAR Recognitions, Professional Societies, Member in Institute Management Committees/ Others, Member in Editorial Boards of Journals)

- Dr. M. Sankaran, Principal Scientist was recognized as Member, ARS Syllabus (Fruit Science) framing committee, ASRB, ICAR, New Delhi & Member, Academic Council, Acharya N.G.Ranga Agricultural University, Guntur, Andhra Pradesh

- Dr. M. Sankaran, Principal Scientist was recognized as Chairman, Poster evaluation committee for the Technical Session-I: Genetic Diversity, Conservation, Utilization and Improvement, in

the National Symposium on Horticultural Crops of Humid Tropics for Nutritional and Livelihood Security-2022, organized by IIHR-CHES, Chettali, on 2nd-3rd December,2022, at Madikeri, Coorg District

- Dr. K. Madhavi Reddy nominated as Selection Committee Member for NAAS Fellow & NAAS Young Scientist Award
- Dr. K. Madhavi Reddy nominated as member for 'National Committee Spices Quality & Safety (NCSQS)'
- Dr. K. Madhavi Reddy elected as Vice-President of Society for Promotion of Horticulture
- Dr. K. Madhavi Reddy nominated as Executive Council Member of Indian Society of Vegetable Science (ISVS), Varanasi
- Dr. K. Madhavi Reddy was nominated as IMC member of ICAR-CTRI, Rajamundry and ICAR-IISR, Calicut
- Dr. K. Madhavi Reddy nominated as Chairperson to finalize Score Card for objective evaluation of R&D Unit to accord R&D recognition by ICAR-IIHR
- Dr. K. Padmini served as member of BPD for Research and Development committee for deciding eligibility criteria for R&D recognition in BPD and Score Card R&D proceedings & Score Card
- Dr. P. C. Tripathi is nominated as Editor of Current Horticulture
- Dr. P. C. Tripathi is nominated as Member of IMC of ICAR-NRC Grapes, Pune from 2021 to 2024
- Dr. A. K. Jha is elected as Executive Council Member, Indian Society for Spices, ICAR-Indian Institute of Spices Research Kozhikode, Kerala (2020-22)
- Dr. G. Karunakaran, was nominated as committee member to visit and assess the nursery for the possibilities with regard to import of high-quality planting material of apple at Uttarakhand during 11th-12th March, 2022
- Dr. G. Karunakaran, was nominated as an expert by DA&FW, Ministry of Agriculture for import and production of commercially important quality planting material of High value horticultural crops
- Dr. G. Karunakaran, T. Sakthivel, P.V.R. Reddy, S. Sriram, and D. Kalaivannan, were nominated by ICAR-IIHR to assess the suitability of various agro climatic conditions in Coonoor and Valparai, Tamil Nadu for crop diversification in collaboration UPASI Scientist during 21st-25th March, 2022
- Dr. G. Karunakaran, T. Sakthivel and D. Kalaivannan, were nominated by ICAR-IIHR to assess the suitability of various agro climatic condition in Idukki, Kerala for crop diversification in collaboration UPASI Scientist during 17th-22nd July, 2022
- Dr. Anushma acted as Rapporteur for Theme-II: Crop Production, Cropping System Models And Natural Resource Management, in the National Symposium on Horticultural Crops of HumidTropics for Nutritional and Livelihood Security organised by, ICAR-IIHR, CHES, Chettalli, Karnataka during 2nd-3rd December, 2022
- Dr. Sujatha A. Nair was nominated as Section Editor of the Journal of Horticultural Sciences, Bengaluru
- Dr. G.R. Smitha served as Assistant Managing Editor of 'Medicinal Plants' Journal
- Dr. G.R. Smitha served as Section Editor - Open Access Journal of Medicinal and Aromatic Plants
- Dr. G.R. Smitha served as member in National Organizing Committee and as rapporteur in the National Conference on 'Underutilized Horticultural Genetic Resources: Conservation and Utilization (NCUHGR-2022)' organized by Andaman Science Association, Port Blair in collaboration with ICAR-Central Island Agricultural Research Institute, Port Blair and Department of Biotechnology, Government of India, New Delhi during 3rd-4th June, 2022
- Dr. S. A. Safeena served as Member of Poster evaluation committee – Theme IV- Processing and Value Addition, Socio-economic aspects and Marketing during National Symposium on Horticultural Crops of Humid Tropics for Nutritional and Livelihood Security (NSHCHT-2022) " held at CHES (ICAR-IIHR), Chettalli, Kodagu, Karnataka from 2nd-3rd December, 2022
- Dr. M.R. Rohini was Course Convener in ICAR-IIHR Sponsored Winter School on 'Horticultural Biodiversity Conservation for Livelihood and Nutritional Security in the Era of Anthropocene and Climate change' held at ICAR-IIHR, Bengaluru during 11th- 31st March, 2022
- Dr. K. Hima Bindu, acted as an expert for the selection of a Technical Consultant for Karnataka State Medicinal Plants Authority, Mallewaram, Bengaluru
- Dr. K. Hima Bindu acted as member core group formed by the Karnataka State Medicinal Plants to come up with a Vision Document for the state of Karnataka

- Dr. K. Hima Bindu acted as member, Executive Committee of Karnataka State Medicinal Plants Authority
- Dr. K. Hima Bindu acted as member, Oversight committee of Karnataka State Medicinal Plants Authority
- Dr. K. Hima Bindu acted as Associate Editor in the Editorial Board of the Journal of Horticultural Sciences, Bengaluru
- Dr. P.E. Rajasekharan was acted as Member, Editorial Board of IJBST Journal and Journal of Traditional knowledge
- Dr. P.E. Rajasekharan acted as Member of RAC for Central Sericultural Germplam Research Center (CSB), Hosur and Malabar Botanical Garden, Calicut
- Dr. Rajiv Kumar was nominated as Editor for the Journal of Horticultural Sciences, ICAR-IIHR, Bengaluru
- Dr. Rajiv Kumar acted as Member of the Editorial Board of the institute's official language magazine *'Bagwani'* 2022
- Dr. T. Usha Bharathi acted as Co chair of the session 'Environmental and Landscape Horticulture' in the 'National Symposium on Ornamental and Edible Horticulture: Emerging challenges and sustainable goals' organized by BCKV, Mohanpur, Nadia, West Bengal on 21st February, 2022
- Dr. S. Vageeshbabu Hanur served as BoS Panel member of KLE College, Bengaluru, under UGC-STRIDE Component, NSQF-Molecular Diagnostics
- Dr. B.L. Patil was selected for Fulbright-Nehru Academic & Professional Excellence Fellowship (2022-23), by United States-India Educational Foundation (USIEF), to visit University of California, Davis, USA, for 9 months
- Dr. M. Arivalagan, served as Jury member for oral presentation during International Conference on Biotechnology Trends and future Prospects (BTFP 2022), University of Agricultural Sciences, Bengaluru, 13th-15th September, 2022
- Dr. B.L. Patil, Editor of PLOS One, Associate Editor in Frontiers in Plant Science, Frontiers in Virology, Virus Research Newsletter (IVS), ICAR-IIHR Newsletter, ICAR-IIHR Annual Report
- Dr. B.L. Patil, Reviewer for Plant Disease, Virus Research, Molecular Plant Pathology, Viruses, Gene, Virus Genes, Plant Gene, VirusDisease, Virology Journal, Journal of General & Molecular Virology, Crop Protection, BMC Evolutionary Biology, BMC Plant Biology, Nature Protocols, BMCBiotechnology, Molecular Plant Microbe Interactions, PLoS One, Biotechnology & Bioengineering, Frontiers in Plant Science, GM Crops & Food Biotechnology in Agriculture, Journal of Plant Biochemistry & Biotechnology, Journal of Phytopathology, 3Biotech
- Dr. K.V. Ravishankar was member of organising committee of Global Okra Round Table (GORT) 2022 during 10th-12th October, 2022 at IARI, Pusa New Delhi
- Dr. K.V. Ravishankar has been appointed as member of Research Advisory Group meeting of Institute of Wood Science and Technology, Bengaluru and attended a meeting on 15th November, 2022
- Dr. Partha P. Choudhury, Alternate Member representing IIHR in FAD 27 (Pesticide Residue Analysis) of Bureau of Indian Standards
- Dr. Partha P. Choudhury, Member, FAD 27, Panel VI (For Honey), Food and Agriculture Division, Bureau of Indian Standards
- Dr. Partha P. Choudhury, Member, FAD 27, Panel IX (Single Pesticide Residue Analysis), Food and Agriculture Department, Bureau of Indian Standards
- Dr. Partha P. Choudhury, Member in the Editorial Board of *Weed* – a Journal of Asian-Pacific Weed Science Society, Australia
- Dr. K.S. Shivashankara, acted as Co-Chairman for the Session on Emerging Dynamics of thrips species in pepper, during Asian Solanaceous Round Table 2022 (ASRT-4) from at ICAR-IIHR, Hessarghatta, Bengaluru during 11th -13th May, 2022
- Dr. K.S. Shivashankara acted as Chairman for the technical session 1 during ConSept22: Harnessing Plant Physiology to improve productivity and Nutritional value held at Department of Crop Physiology, UAS, GKVK, Bengaluru on 24th September, 2022
- Dr. R. Umamaheswari served as Secretary of Association for Advancement of Pest management in Horticultural Sciences
- Dr. R. Umamaheswari served as Member in Editorial Boards of Archives of phytopathology and Plant Protection
- Dr.T.R. Rupa was elected as Councillor of Indian Society of Soil Science for biennium 2023-24

- Dr.T.R. Rupa served as Member, Editorial Board of Journal of Spices and Aromatic Crops, Kozhikode, Kerala
- Dr. G. Selvakumar, served as a member of the Editorial Board of World Journal of Microbiology and Biotechnology (Springer)
- Dr. G. Selvakumar, served as a member of the Technical Committee of Bruhat Bengaluru Mahanagara Palike and Technical Committee of Bengaluru Solid Waste Management Company Limited, Bengaluru
- Dr. D. Kalaivanan, served as Executive Member, Bengaluru Chapter of Indian Society of Soil Science, UAS, Bengaluru
- Dr. D. Kalaivanan, served as Member of Editorial Board of Journal of Applied Biology and Biotechnology, Gwalior, Madhya Pradesh, India
- Dr. D. Kalaivanan, served as Member of Coir and Coir Products Sectional Committee (TXD 25) of Bureau of Indian Standards (BIS), Ministry of Food, Civil Supplies and Consumer Affairs, Government of India
- Dr. R. Venkattakumar was recognized as National Facilitator for the year 2022-23 by MANAGE Hyderabad
- Dr. R. Venkattakumar Co-organized the Rural Horticulture Work Experience (RHWE) programme of B.Sc (Ag.) students of Pandit Jawaharlal Nehru College of Agriculture and Research Institute, Karaikal, Puducherry from 26th September to 20th October, 2022
- Dr. R. Venkattakumar acted as Member Secretary for Committee to decide about the modalities for deciding the Visitors Service
- Dr. R. Venkattakumar participated as an invited speaker in the brainstorming on "Exploring researchable Issues in Agricultural Extension" organized by DAE&RS, Tamil Nadu Agricultural University, Coimbatore on 22th August, 2022
- Dr. R. Venkattakumar acted as Organizing Secretary, National Dialogue on 'Extension Services for Efficient Delivery of Horticultural Technologies: A Way Forward' during 20th-21st May, 2022
- Dr. R. Venkattakumar Co-organized the online refresher training programme on 'Opportunities and value addition in horticulture' for agripruneurs sponsored by MANAGE, Hyderabad during 15th-17th June, 2022
- Dr. R. Venkattakumar participated as an expert in the 5th Scientific Advisory Committee meeting of ICAR-KVK, Kolar on 21st January, 2022
- Dr. R. Venkattakumar participated as an expert in the 10th Scientific Advisory Committee meeting of KVK, Ramanagar on 11th January, 2022
- Dr. D. Sreenivasa Murthy served as Member QRT, ICAR-DOGR, Pune; Member of Board of studies (UG), UAS, Bengaluru; Member, IMC, ATARI, Bengaluru
- Dr. B Balakrishna was nominated as Nodal officer for horticultural extension technical committee for horticultural information centre, Lalbagh Bengaluru.
- Dr. R. Venugoplan served as an external expert to evaluate newly recruited Assistant Professors in Agricultural Statistics at Dr. YSRHU, A.P.
- Dr. R. Venugoplan was recognized as a member of Board of Faculty (PG studies) with Dr.YSRHU, A.P.
- Dr. Rajendiran S has been recognized as Editorial Board Member of Journal of Plant Sciences (ISSN Print: 2331-0723; ISSN Online: 2331-0731) from 27th-28th May, 2023
- Dr. G.C. Acharya acted as a member of the Sub-committee on research and development in Basic & Applied science for review of R & D projects of 2020-21 batch under Science & Technology Department, Govt of Odisha
- Dr. G.C. Acharya as a member attended RIC meeting for evaluation and recommendation of Startups at ICAR-NRRI during 20th October, 2022
- Dr. G.C .Acharya was an expert in panel discussion in the session 'Agripreneurship, creativity, innovation, and opportunities' during the Confluence arranged by SoA on theme "Boosting Agri-preneurship in Odisha" during 28th-30th April, 2022
- Dr. G.C .Acharya was nominated as a councillor for Indian Society of Vegetable Science, for 2022-2025
- Dr. G.C. Acharya was nominated as a member of "Finalization of Production Cost of Different Quality Planting Materials in Departmental Farms and Nurseries" under Directorate of Horticulture
- Dr. G.C. Acharya was nominated as a member of coordination committee of Knowledge portal constituted by Directorate of Agriculture and Food Production, Govt of Odisha

- Dr. G.C. Acharya was nominated as section editor for "Journal of Horticultural Sciences" w.e.f. 09th September, 2022
- Dr. G.C. Acharya was nominated as member of Board of Studies of Faculty of Agriculture of Sri Sri University, Cuttack
- Dr. Kundan Kishore and Dr. G. C. Acharya acted as an Organizing Secretary, National Seminar on Fruit production in Eastern Tropical Region, at CHES (ICAR-IIHR), Bhubaneswar during 24th-26th March, 2022
- Dr. J. Satisha acted as D.G. Nominee for committee of Career Advancement Scheme at CPCRI, Kasargod on 1st and 2nd June, 2022
- Dr. J. Satisha acted as member for the committee on fellowship up-gradation for III year Ph.D. students of IARI-IIHR on 13th June, 2022
- Dr. J. Satisha was nominated as member of Editorial Board for the Journal of Horticultural Sciences, Bengaluru
- Dr. G. Senthil Kumaran served as Chairman in the Session Traction and Mechanization Theme- Farm Machinery & Power Engineering in 56th Annual Convention of ISAE on "Agricultural Engineering Innovation for Global Food Security" held at Tamil Nadu Agricultural University, Coimbatore during November 9th-11th, 2022
- Dr. A. Carolin Rathinakumari served as Co-Chairman in the Session Traction and Mechanization Theme- Farm Machinery & Power Engineering in 56th Annual Convention of ISAE on "Agricultural Engineering Innovation for Global Food Security" held at Tamil Nadu Agricultural University, Coimbatore during November 9th-11th, 2022
- Dr. A. Carolin Rathinakumari served as Primary Member of Agriculture And Food Processing Equipments Sectional Committee, FAD 20 during the year 2022
- Dr. G. Senthil Kumaran served as Evaluator of the proposals submitted under Onion Grand Challenge 2022 during 7th-14th December, 2022
- Dr. K. Ranjitha, Sr.Scientist served as a Member, Panel 3&5 FAD 10, BIS India
- Dr. Vijay Rakesh Reddy S has been recognized as an editorial board member for the *Journal of Agriculture and Ecology* published by SAAER-Society for Agriculture and Arid Ecology Research, Bikaner, Rajasthan
- Dr. Reju M Kurian was nominated as IMC member, ICAR – CISH, Lucknow
- Dr. Reju M Kurian acted as panellist for two sessions on 'Growth, Development and Value Addition' and 'Interaction with the farmers' during 9th Group Discussion of AICRP on Fruits, 8th to 11th March 2022
- Dr. Reju M Kurian served as Chairman for Assessment Committee of Technical Personnel (Category III - Lab Technician) at ICAR - National Research Centre for Banana, Tiruchirapalli

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8. Linkages and Colloborations

The Institute has collaborative R&D linkages with several national (DST, DBT, PPV&FRA, NABARD, NASF, NMPB *etc.*) and international (WVC, Bioversity International *etc.*) organizations and universities. Research in frontier areas such as climate resilient agriculture, transgenic crops, insect biosystematics, bio-control strategies for disease management and pesticide residues were undertaken as network or outreach programs. The scientists regularly contribute to the publication of package of practices of various horticultural crops published by SAU's. Scientists of the institute actively collaborate with various central / state departments of horticulture and agriculture in the implementation of centrally aided schemes like RKVY, DUS, NHM, MIDH, TSP, SCSP, NEH *etc.* Following are the externally aided projects under operation at the institute.

8.1 Consortia Research Project

- CRP on molecular breeding in cucumber - Dr M. Pitchaimuthu, Principal Scientist, Division of Vegetable crops as PI
- CRP on hybrid technology in tomato - Dr H. C. Prasanna, Principal Scientist, Division of Vegetable crops as PI
- CRP on Agrobiodiversity in vegetable crops – Dr K. Madhavi Reddy as PI and Drs T.H. Singh (Brinjal), Vivek Hegde (Cucumber) & M. Pitchaimuthu (Okra) as CO-PIs
- AGRI-CRP on Water: Efficient water management in horticultural crops- Dr Anil Kumar Nair, Division of Vegetable crops as PI

8.2 National External Funded Projects

Project title	PI	Funding Agency
DUS Centre for papaya and custard	Dr. G. Karunakaran	PPV& FRA, New Delhi
COE Project on Protected cultivation of Horticultural crops	Dr. S. S. Hebbar	MIDH, New Delhi
Technological interventions to boost productivity and fruit quality of important chilli land races of Odisha	Dr. K. Madhavi Reddy	Govt. of Odisha
Adapting tomato germplasm to the dry and humid heat of the Indian monsoonal climate	Dr. H. C. Prasanna	DBT, Govt. of India
DUS testing of Vegetable crops: Tomato, Brinjal, Okra, Garden Pea, Cucumber, Bottle gourd, Bitter gourd, Pumpkin, Watermelon, Muskmelon, Amaranth, Palak, Ridge gourd, Dolichos bean & Curry leaf (15 crops)	Concerned crop breeders	PPV& FRA, New Delhi
DUS testing of non-notified farmers carrot variety-*Madhuvan Gajar*	Dr. K. Padmini	PPV& FRA, New Delhi
Scientific intervention of ICAR-IIHR to transform chilli cultivation practices in Karnataka for enhancing crop productivity and fruit quality	Dr. K. Madhavi Reddy	RKVY, Karnataka
Establishment of DUS nodal centre at IIHR for Jasmine Floricultural Crop	Dr. Sujatha A. Nair	PPV& FRA, New Delhi
Establishment of Nodal DUS centre at IIHR, Bengaluru for Tuberose and Carnation floriculture crop	Dr. T. Usha Bharathi	PPV & FRA, New Delhi
Identification and validation of DUS traits in Betelvine	Dr. Hima Bindu	PPV & FRA, New Delhi
Collection characterization and genetic improvement of Eclipta alba	Dr. Hima Bindu	NMPB, New Delhi
Establishment of DUS Nodal Centre at IIHR, Bengaluru for China Aster Floricultural Crop	Dr. Rajiv Kumar	PPV & FRA, New Delhi
DUS Centre for Chrysanthemum	Dr. Rajiv Kumar	PPV & FRA, New Delhi
DUS centre for Gerbera	Dr. C. Aswath	PPV & FRA, New Delhi
DUS centre for Crossandra	Dr. C. Aswath	PPV & FRA, New Delhi

Project Title	PI	Funding Agency
Development of seed health testing laboratory for supply of disease free seeds and planting materials for horticulture farmers of Karnataka	Dr. B. Mahesha	RKVY, Karnataka
Molecular diagnosis, characterization and discovery of seed transmission mechanism of Yellow mosaic disease in ridgegourd (*Luffa acutangula* L.)	Dr. B. Mahesha	DST, Govt. of India
CRISPR mediated control of geminiviruses involved in Papaya leaf curl disease	Dr. Basavaprabhu, L. Patil	DBT, Govt. of India
Genomics mediated taxonomy and function analysis of endophytic microbiome in horticultural crops and plant microbe interaction studies	Dr. Basavaprabhu, L. Patil	ICAR-NBAIM-AMAAS
Assessment of major viral diseases of banana in Northeast India and biotechnological interventions for the management of these viruses	Dr. Basavaprabhu, L. Patil	DBT-BCIL (NER-BPMC)
Enhancing water use efficiency in tomato through sensor based controlled irrigation	Dr. K. V. Ramesh	RKVY, Karnataka
Farmer FIRST Project: Enriching Knowledge – Integrating technology and institutions for holistic village development in horticulture-based farming system	Dr. B. Balakrishna	ICAR, New Delhi
Development of standard protocols for assessment of cropped area, crop monitoring and precision orchards management in mango	Dr. B. Balakrishna	NBARD, KRO, Bengaluru
Vegetable grafting: Establishment of model vegetable grafting nursery for tackling soil related biotic & abiotic constraints in Odisha	Dr. G. C. Acharya	MIDH, Govt. of Odisha
Establishment of a post-harvest cum auality analysis laboratory for enhancing market value of fruits	Dr. Kundan Kishore	RKVY, Govt. of Odisha
Establishment of Virus Indexing laboratory for horticultural Industry in Odisha	Dr. G.C. Acharya	RKVY, Govt. of Odisha
Micro/ *in vitro* propagation of underutilised vegetable crops and supply in the state of Odisha	Dr. G. C. Acharya	MIDH, Govt. of Odisha
Setting up of incubation and large scale mass production unit of Arka Microbial Consortium	Dr. G. C. Acharya	MIDH, Govt. of Odisha
SEEDS: Social and economic empowerment through dedicated Seed production clusters for vegetable crops in Odisha	Dr. P. Srinivas	MIDH, Govt. of Odisha
Production and supply of dragon fruit planting material	Dr. Kundan Kishore	MIDH, Govt. of Odisha
Technological interventions to boost productivity and fruit quality of important chili land races of Odisha	Dr. G. C. Acharya and Dr. K. Madhavi Reddy	MIDH, Govt. of Odisha
Frontline demonstration of mango + dragon fruit + pine apple	Dr. Kundan Kishore	MIDH, Govt. of Odisha
Increasing productivity and sustaining the rice based production system through farmer FIRST approach	ICAR-NRRI	ICAR, New Delhi
Farm based S&T Interventions for Socio-economic Development in the Aspirational District of Nabarangpur, Odisha	IIWM	RKVY, Govt. of Odisha
Establishment of Biotech-Kisan Hub	DBT-ILS	DBT, New Delhi
Contract research-Comprehensive potential assessment of WADI projects under TDF	Dr. G. C. Acharya	NABARD
Consultancy assignments for technical guidance for preparation of alternate crop plan	Dr. G. C. Acharya	NABARD
Developing participatory ARKA-NUTRI Garden for augmenting Mid-day meals programme in schools in Karnataka	Dr. V. K. Jayaraghavendra Rao	RKVY, Karnataka

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9. Publications

9.1. RESEARCH PAPERS

1. Acharya GC, Mohanty S, Dasgupta M, Sahu S, Singh S, Koundinya AVV, Kumari M, Naresh P and Sahoo MR. (2022). Molecular phylogeny, DNA barcoding, and ITS2 secondary structure predictions in the medicinally important eryngium genotypes of east coast region of India. *Genes*. **13**(09): 1678. https://doi.org/10.3390/genes13091678.

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9.5. POPULAR ARTICLES

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9.6 TECHNICAL BULLETINS/ FOLDERS

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9.7 READY RECKONER

1. Mahesha B, Reddy PVR, Samuel DK and Venkataravanappa V. (2022). Glimpses of current trends in diagnosis and management of emerging diseases and insect pests in horticultural crops. ICAR-IIHR, Bengaluru. Ready reckoner No. RRO: 01/2022.

9.8 MANUAL/ COMPENDIUM

1. Mahesha B and Bharadwaj P. (2022). Hand book on principles and mechanism of transmission electron microscope and scanning electron microscope. ICAR-IIHR, Bengaluru, pp: 58.

2. Chandrashekara C. (2022). Compendium of lectures on mushroom spawn production for ICAR-IIHR training.

3. Chandrashekara C. (2022). Compendium of lectures on mushroom cultivation for ICAR-IIHR training.

9.9 INVITED TALKS

1. Dr. PC Tripathi attended (online) and presented Pre-recorded presentation Crop improvement in sapota in one day webinar on "Prospects of Sapota cultivation in India" organized by Dr. YSRHU, V.R. Gudem on 10 May, 2022.

2. Dr. K. Hima Bindu delivered lecture on "Mucuna -Multipurpose Medicinal plant" in DD Chandana on 17 February, 2022.

3. Dr. B Balakrishna participated and delivered a lecture on "Quality and Market management in capsicum" in one day workshop on protected cultivation of flowers and vegetables organized by SADH, Anekal, Department of Horticulture, Govt. of Karnataka at Anekal taluk on 07 September, 2022.

4. Dr. GC Acharya acted as a resource person at the training programme on “Coconut cultivation practices", for Schedule Tribe farmers of Odisha state, Raja Atchaigarh village, ICAR-CPCRI, 25 July, 2022.

5. Dr. GC Acharya acted as a resource person to conduct a session on “Horticultural crop on the dyke under farming system” on 27 July 2022 during the “capacity building training programme on location specific farming system modules”, ICAR-NRRI during 26-29 July 2022.

6. Dr. GC Acharya conducted a training session on “Commercialized horticulture crop cultivation for better market price” on 3 August, 2022 during the training on “IFS and entrepreneurship development for WSG” at NRRI during 2-5 August 2022.

7. Dr. GC Acharya delivered a lecture on “Opportunities in aromatic crops” during the workshop at PMIT, Vikas Foundation Trust, Talcher, Odisha, organized by ICAR-Agricultural Technology Research Institute, Kolkata on 08 September, 2022 in the workshop on “Aromatic and Medicinal plants: reconnecting the agricultural heritage for public health, nutrition and employment in India".

8. Dr. GC Acharya acted as a resource person in the 5-day farmers training programme during 25-29 September, 2022 to the farmers of Madhubani, Bihar, organized by ICAR-IIWM and delivered a lecture on “Scope of Entrepreneurship in Horticulture”.

9. Dr. GC Acharya delivered a guest lecture in weekly webinar of Institute of Agricultural Sciences, Siksha ‘O’ Anusandhan (deemed to be university) weekly academic lecture series on “Scope and dimensions in Horticultural Based Entrepreneurship” on 01 October, 2022.

10. Dr. GC Acharya delivered Keynote address on “ unlocking unexplored resources- way to

nutritional security: Traditional leafy vegetables: in "International conference on advances in agriculture technology and allied sciences (ICAATAS 2022)", organized by the Society of Agriculture Research and Social Development, New Delhi, MS Swaminathan School of Agriculture, Centurion University of Technology and Management, Paralakhemundi, Odisha and Association of Rice Research Workers (ARRW), ICAR-NRRI, Cuttack at ICAATA-2022, CUTM, Parakhemundi on 4 June, 2022.

11. Dr. GC Acharya presented a paper on "Role of Horticulture in crop diversification" in the Regional thematic workshop on "Diversification of Crops" on 28 January, 2022.

12. Dr. GC Acharya delivered a lead invited lecture on "Business opportunity in moringa cultivation and marketing" in national workshop on "Horticultrue start-up opportunity in eastern india-connection youth to agri start-up ecosystem-during 24-26 February organized by ICAR-RCER Patna.

13. Dr. GC Acharya delivered a guest lecture on "Horticulture intervention for enhancement of farm income" during one-day training programme on "Sustainable utilization of agro-biodiversity and skill development for enhancing livelihood security of SC farmers" on 8 March, 2022 being organized by ICAR-NBPGR Regional Station, Cuttack.

14. Dr. GC Acharya delivered a lecture on "Role of conservation agriculture for sustainable horticultural crop production" in the Skill Development Training Course on "Conservation Agriculture" from 22-28 March, 2022 organized by College of Agriculture, Bhawanipatna, OUAT.

15. Dr. BL Manjunath delivered a lecture on "Soil, water and nutrient management in mango" in the training programme for the officials of Vegetables and Fruit Growers Association, Keralam, Kerala, organized by ICAR-IIHR on 23 September, 2022.

16. Dr. BL Manjunath delivered a lecture on "Activities of BPD, ICAR-IIHR" in the short course on farmers empowerment and entrepreneurial development through FPOs and start ups organized by ICAR-IIHR during 5-14 December, 2022.

17. Dr. R Umamaheswari delivered a guest lecture on 'Integrated approach for sustainable nematode management in horticultural crops' during National Webinar on Nematode pests of Horticultural crops and their management organized by ICAR –DFR, Pune on 30 April, 2022.

18. Dr. M Pitchaimuthu delivered a lecture on "New cucumber and Teasel gourd varieties released by IIHR, Bengaluru" during field day on Nutritional Garden held at CHES, Chettalli on 17 February, 2022.

19. Dr. M Pitchaimuthu delivered a lecture on "Awareness about the provision of the protection of plant varieties and Farmers Right Act 2021"organised by KVK, Hirehalli and ITMU Jointly on 18 May 2022.

20. Dr. Vageeshbabu S Hanur delivered a lecture on "Advances in nanobiotechnology and its applications in horticulture" at the University of Horticultural Sciences, Bagalkot, Bengaluru. on 29 September, 2022.

21. Dr. KV Ravishankar delivered a talk on "Understanding drought tolerance in Banana through culticular wax: a biochemical and molecular analysis" to the PG students of UHS, Bagalokote Campus on 07 March, 2022.

22. Dr. KV Ravishankar delivered a talk during National Seminar in Fruit Production in Eastern Tropical Region of India, CHES, Bhubaneswar, during 24-26 March, 2022.

23. Dr. KV Ravishankar delivered a talk on "Genomics studies in okra for trait-linked marker development – overview" at global okra round table 2022 at ICAR-IARI, New Delhi during 10-12 October, 2022.

24. Dr. Debi Sharma delivered an invited talk on "Pesticide and PGR Residues in Fruits - Recent Perspective" in the National Seminar on "Fruit production in eastern tropical region of India: Challenges and opportunities" conducted by ICAR-CHES, Bhubaneswar on 26 March, 2022.

25. Dr. Debi Sharma delivered an invited talk as resource person on "Pesticide Residue Analysis" at Horticultural Research Station, Lam farm, Guntur (Dr. YSRHU, VR Gudem) on 17 May, 2022.

26. Dr. RH Laxman delivered lecture on "Impact of climate change on vegetable and fruit crops and adaptation strategies" in the training program on "Climate Smart Horticulture" for the State Horticulture Officials of Haryana at Centre for Sustainable Agriculture & Climate Change and Adaptation (CSA & CCA), MANAGE, Hyderabad on 26 July, 2022.

27. Dr. KS Shivashankara delivered an invited talk on "Physiological response of mango to climate change" in the National Seminar on Fruit production in Eastern Tropical Region of India: Challenges and Opportunities, held at CHES, Bhubaneswar from 24-26 March, 2022.

28. Dr. KS Shivashankara delivered a lecture on "Researchable issues in Crop physiology" during a Brain storming session on Exploring researchable issues in plant physiology organized by TNAU on 16 September, 2022.

29. Dr. TR Rupa delivered lead talk on "Conservation horticulture for enhancing carbon sequestration and productivity of fruit crops" in the National Seminar on Harnessing the Potential of Panchabhutas (tatvas) for Sustainable Climate Resilient Rainfed Agriculture', organized by ICAR-Central Research Institute for Dryland Agriculture, Hyderabad, 28-29 September, 2022.

30. Dr. TR Rupa delivered lead talk on "Soil health management in perennial horticultural crops" in the National Seminar on Problems and Prospects of Horticulture in Semi-Arid Tropics through virtual mode, organized by Sri Krishnadevaraya College of Horticultural Sciences, Anantapuram (AP) during 27-28 June, 2022.

31. Dr. TR Rupa delivered invited talk on "High density plant geometry and nutrients for higher productivity in Arka Kiran-a processing variety of guava on Alfisol under seasonally dry tropical savanna climate" through virtual mode, in the National Seminar on Fruit Production in Eastern Tropical Region of India Challenges and Opportunities held at the Central Horticultural Experiment Station (ICAR-IIHR), Bhubaneswar, Odisha during 24-26 March, 2022.

32. Dr. TR Rupa delivered invited talk on "Soil health" in AGRI UDAAN(R) 5.0 Road Show organized by a-IDEA (Association for Innovation Development of Entrepreneurship in Agriculture) and hosted by ICAR-National Academy of Agricultural Research Management (NAARM), Hyderabad on 06th September, 2022 at Bengaluru.

33. Dr. Shilpa Shree KG delivered invited lecture on "Media and nutrition for vertical gardening" in the national webinar 'Vertical gardening in ornamentals' on 12 August, 2022 organized by ICAR-DFR, Pune.

34. Dr. Shilpa Shree KG delivered invited lecture on "Medium/substrates used in hydroponics and vertical farming; Nutrient deficiency symptoms and their corrective measures" during on-campus training programme on "Hydroponics and vertical farming in horticultural crops" on 20 August, 2022 conducted at ICAR-IIHR.

35. Dr. Shilpa Shree KG delivered invited lecture on "Medium / substrates used in vertical farming and hydroponics; Nutrient deficiency symptoms and their correction measures" on 28 December 2022 during Interstate Training Programme on "Vertical Farming" jointly organized by Centre of Excellence – Protected Cultivation, ICAR-IIHR, and State Agricultural Management and Extension Training Institute, Tamil Nadu.

36. Dr. Radha TK delivered invited lecture on "Arbuscular mycorrhizal (AM)fungi in the soil microbiological and biochemical techniques training" for M/s Zuari Farm Hub Ltd., Bengaluru during 15-18 June 2022 at ICAR-IIHR, Bengaluru.

37. Dr. Radha TK delivered invited lecture on "Microbial inoculants for sustainable horticultural production" in Special Training Programme on Advances in Horticultural Production Technologies for Horticulture Officers of Bihar (3 batches) held at ICAR-IIHR.

38. Dr. D Kalaivanan delivered invited lecture on "Soil health management for high altitude areas" in the Workshop cum field visit on "Future Fruit Crops' to UPASI Planters, ICAR-IIHR, Bengaluru, India, 23-24th November, 2022.

39. Dr. D Kalaivanan delivered invited talk on "Nutrient deficiency in horticultural crops: identification and management"in the International Conference on 'Recent Trends in Molecular Physiology of Horticultural Crops Under Abiotic Stress', VAIAL, VIT Campus, Vellore, Tamil Nadu, India, 4-5th December, 2022.

40. Dr. D Kalaivanan delivered invited lecture on "Vegetable Cultivation in Cocoponics" in training programme on " Cocoponics /Soilless culture - A new method of growing vegetables and medicinal herbs in terrace/ roof top" in collaboration with BESST-HORT on 15-02-2022.

41. Dr. D Kalaivanan delivered invited lecture on "Vegetable Cultivation in Cocoponics" in training programme on " Cocoponics /Soilless culture - A new method of growing vegetables and medicinal herbs in terrace/ roof top" in collaboration with BESST-HORT on 04-06-2022.

42. Dr. D Kalaivanan delivered invited lecture on "Vegetable Cultivation in Cocoponics" in training

programme on " Cocoponics /Soilless culture - A new method of growing vegetables and medicinal herbs in terrace/ roof top" in collaboration with BESST-HORT on 24-09-2022.

43. Dr. D Kalaivanan delivered invited lecture on "Vegetable cultivation in cocoponics" in training programme on " Cocoponics /Soilless culture - A new method of growing vegetables and medicinal herbs in terrace/ roof top" in collaboration with BESST-HORT on 30-11-2022.

44. Dr. D Kalaivanan delivered invited lecture on "Soilless terrace vegetable cultivation" in the Training Program on "Urban farming for nutritional security and environment sustainability", University of Agricultural Sciences, Bengaluru, Karnataka & National Institute of Agricultural Extension Management (MANAGE), Hyderabad, 14-16th June, 2022.

45. Dr. D Kalaivanan delivered guest lecture on "Soilless cultivation of vegetables (Cocoponics)" to the 2nd year B.Sc (Agri.,) students of VIT Agricultural Innovations and Advanced Learning (VAIAT), Vellore, 21st October 2022.

46. Dr. D Kalaivanan delivered lecture on "Soilless Cultivation of Vegetables" in EEI & MANAGE Collaborative online Training Programme on "Innovations in Urban Farming", EEI, Hyderabad, 18-22nd October, 2022

47. Dr. A Carolin Rathinakumari delivered lecture on "Onion detopping machine: Bench work to Start up". In: International Conference on Advances in Agriculture & Food System towards Sustainable Development Goals. August 22-24, University of Agricultural Sciences, Bengaluru.

48. Dr. A Nenavath Manikyam delivered lecture on "Physical and Engineering Properties of Fertilizers Relevant to Design of a Precision Ferti Drill". International Conference on Advances in Agriculture & Food System towards Sustainable Development Goals. August 22-24, University of Agricultural Sciences, Bengaluru.

49. Dr. A Carolin Rathinakumari delivered lecture on "Energy input and out put analysis for cultivation of three major types of onions". 56th Annual Convention of ISAE on "Agricultural Engineering Innovation for Global Food Security. (November 09-11, Tamil Nadu Agricultural University, Coimbatore.

50. Dr. G Senthil Kumaran delivered lecture on "Design and development of a semi automatic grafting machinery for vegetable crops". 56th Annual Convention of ISAE on "Agricultural Engineering Innovation for Global Food Security. November 09-11, Tamil Nadu Agricultural University, Coimbatore.

51. Dr. G Senthil Kumaran presented lead paper on "Emerging technologies in horticultural mechanization in India", in 56th Annual Convention of ISAE on "Agricultural Engineering Innovation for Global Food Security. November 09-11, Tamil Nadu Agricultural University, Coimbatore.

52. Dr. S Bhuvaneswari persented research paper entitled "Design and Development of motorized raw jackfruit peeler" in the International Symposium on India @2047: Agricultural Engineering perspective. Jointly organised by ISAE, New Delhi and TNAU, Coimbatore held at TNAU, Coimbatore from November 9-11th 2022.

53. Dr. K Ranjitha persented paper on "Studies on development and storage of kiwifruit based probiotic beverage. International Conference on "Advances in Agriculture and Food System Towards Sustainable Development Goals"(AAFS2022) in Aug 2022 held at UAS Bengaluru.

54. Dr. K Ranjitha persented paper on "Development of fruit probiotic beverages and associated quality changes during storage". In : International Conference on Microbiology and Society-Current trend and future prospects (MSCTFP- 2022)" from 21st to 23rd September 2022. (62nd Annual Conference of Association of Microbiologists of India) held at University of Mysore, Mysore.

55. Dr G Karunakaran delivered an invited lecture on "Avocado and other exotic fruit crops", during Interactive meeting on crop diversification strategies with high value crop in Tea plantations for UPASI delegates organized by ICAR-IIHR, Bengaluru, 8th February, 2022.

56. Dr G Karunakaran delivered an invited lecture on "Assessing the potential of avocado as an intercrop in tea plantations", during the Workshop cum Field Visit on "ICAR-IIHR technologies in Horticulture Crops" to the United Planters Association of Southern India (UPASI) farmers organized at ICAR-IIHR, Bengaluru, 18th May 2022.

57. Dr G Karunakaran delivered an invited lecture on "Dragon Fruit cultivation", during Dragon fruit workshop & MDFA Award ceremony Organized by College of Agriculture, Kadegaon, Sangli, MH, 20th August, 2022.

58. Dr G Karunakaran delivered an invited lecture on "Business opportunities in establishing nursery, during Entrepreneurship development programme on Soiless cultivation and urban gardening including other technologies of ICAR-IIHR, Organised by BPD, ICAR-IIHR, Bengaluru, 17-20th August, 2022.

59. Dr G Karunakaran delivered an invited lecture on "Production aspects of dragon fruit", during the Programme on "Buyers and Sellers Meet on Dragon Fruit" Organized by UAS Bengaluru, 19th August, 2022.

60. Dr G Karunakaran delivered a lecture on "Commercial scale production of dragon fruit with high market demand", at Agricultural Information bureau, 20th October, 2022.

61. Dr G Karunakaran delivered a lecture on "Off season Dragon fruit production", during the Workshop cum Training programme on ICAR-IIHR technologies in Future Fruit Crops" to the United Planters Association of Southern India (UPASI) farmers organized by ICAR-IIHR, Bengaluru, 23-24thNovember,2022.

62. Dr G Karunakaran delivered a talk on "Special fruit and high value crop (esp. Dragon fruit)", during the One day workshop cum training on "Special fruit and high value crop (esp. Dragon fruit)" organized by Bihar Agriculture University, Sabour, Bhagalpur at Krishi Vigyan Kendra, Kishanganj, 7th November, 2022.

63. Dr G Karunakaran delivered lecture on "Research and Development in Jackfruit" at Department of Horticulture and Plantation crops, Government of Tamil Nadu, 26th–27th December, 2022.

9.10. EXTENSION BULLETINS/ FOLDER/ REPORTS/ MANUALS

1. Abinaya S, Mahesha B, Chandana TP and Vinodini P. (2022). Rearing and handling whitefly *Bemisia tabaci* (Gennadius) for vector transmission studies. In: Souvenir on DST Funded workshop Current trends in rapid diagnosis and management of emerging diseases and insect pests in horticultural crops (Eds.) Mahesha B, Reddy PVR, Samuel DK and Venkataravanappa V., ICAR-IIHR Bengaluru.

2. Bhanushree N, Tomar BS, Saha P, Shankar K and Mahesha B. (2022). Phomopsis blight disease: A threat to brinjal production. In: Souvenir on DST Funded workshop Current trends in rapid diagnosis and management of emerging diseases and insect pests in horticultural crops (Eds.) Mahesha B, Reddy PVR, Samuel DK and Venkataravanappa V., ICAR-IIHR Bengaluru.

3. Shankar K, Bhanushree N and Mahesha B. (2022). Viral diseases of citrus and their management In: Souvenir on DST Funded workshop Current trends in rapid diagnosis and management of emerging diseases and insect pests in horticultural crops (Eds.) Mahesha B, Reddy PVR, Samuel DK and Venkataravanappa V., ICAR-IIHR Bengaluru.

9.11. PRESENTATION OF PAPERS INCONFERENCES, SEMINARS, SYMPOSIA ETC.

Mendelysm: Tending Mendel's garden for a perpetual and bountiful harvest' symposium commemorating birth bicentenary of gregor jJohann mendel, ICAR-IARI, New Delhi, 19-21 July, 2022

- Dedhia L, Tejaswini P and Venugopalan R. Diversification of marigold male sterile lines for hybrid seed production.

NAHEP-IDP 'All India Agri Start-Up Convention-2022', University of Horticultural Sciences, Bagalkot, 18-20 Oct., 2022

- Dedhia L, Tejaswini P, Arivalagan M, Venugopalan R, Lakshmana Reddy DC, Sonawane P, Kumar R and Himabindu K. Orange marigold- an ideal candidate crop for Agri start-ups

National Seminar on 'Problems and Prospects of Horticulture in Semi-Arid Tropics', Sri Krishnadevaraya University, Anantapuramu, 27-28 June, 2022

- Tejaswini P. Floriculture: Present scenario and future vision for semi-arid tropics

- Dedhia L, Tejaswini P, Venugopalan R, Kumar R, Himabindu K, Arivalagan M, Lakshmana Reddy D C, Sonawane P. French marigold, a potential crop for landscape and nursery industries in semi-arid tropics

National Conference on remembering Gregor Johan Mendel on his bicentennial birth year, G.B. Pant University of Agriculture and Technology, Pantnagar, Uttarakhand. 5th May, 2022.

- Sumalatha A, Santosh N and Tejaswini Prakash. Novel petaloid male sterile lines and a new gene governing male sterility in African marigold (*Tagetes erecta* L.)

VII[th] International conference on global research initiatives for sustainable agriculture & allied sciences, Birsa Agricultural University, Ranchi, Jharkhand, 21-23 November 2022.

- Sumalatha A, Tejaswini Prakash, D.C. Lakshmana Reddy, Bhaskar VV and Arivalagan M. Identification of molecular markers linked to male sterility in african marigold (*Tagetes erecta* L.).

National Seminar on Horticulture for sustainable development, nutritional & livelihood security, Uttar Banga Krishi Vishwavidyalaya, Cooch Behar, West Bengal, 26th-27th May, 2022

- Sujatha A. Nair. Influence of crop phase based nutrient scheduling on flower yield, quality and bulb production in tuberose cv. Arka Prajwal.
- Usha Bharathi T. Introgression of novel flower colour in tuberose (*Agave amica* (Medik.) Thiede & Govaerts.

National Symposium on ornamental and edible horticulture: emerging challenges and sustainable goals, organized by BCKV, Kalyani from 21-22[nd] February 2022.

- Smitha GR, Sujatha A Nair and Kalaivanan D. Potted plant production of China aster var. Arka Archana: Standardization of type of containers, substrate and nutrition.
- Smitha GR, Sujatha A Nair and Kalaivanan D. Influence of container type, substrate and nutrient regimes on potted plant production of crossandra var. Arka Chenna.

National Conference on underutilized horticultural genetic resources: conservation and utilization, ICAR-CIARI, Port Blair, June 3-4, 2022.

- Smitha GR. Value addition of medicinal and aromatic plants for health security and entrepreneurial opportunity.

National conference on underutilized horticultural genetic resources: conservation and utilization, june 3-4, 2022. ICAR-CIARI, Port Blair.

- Navya BL and Smitha GR. Conservation strategies for *Salacia chinensis* L.: an anti-diabetic medicinal plant.
- Smitha GR, Rohini MR and Kalaivanan D. Terrace gardening: Achieving nutrition and livelihood security.

Winter School on 'Horticultural biodiversity conservation for livelihood and nutritional security in the era of anthropocene and climate change, 11-31 March 2022.

- Usha Bharathi T. Genetic resources and its management in bulbous ornamental crops: case study of tuberose and gladiolus.

International Conference on Innovative technologies and their applications in higher education, Annamalai University, Chidambaram, Tamil Nadu, 17-19 October, 2022.

- Usha Bharathi T. Floriculture research at ICAR-IIHR -Accomplishing the mission of doubling the farmers income.

National Symposium on self-reliant coastal agriculture, 11-13 May 2022, association for Coastal Agricultural Research and ICAR-Central Coastal Agricultural Research Institute, Goa.

- Safeena SA. Assessment of the suitability of ornamental plant species for green walls based on APTI.
- Kalaivanan D, Selvakumar G, Ganeshamurthy AN and Hebbar S. Effect of varying levels of NPK and growing media on growth, yield and quality of red cabbage grown in open and polyhouse soilless cultivation

National Seminar on horticulture for sustainable Development, nutritional and livelihood security' organized by Uttar Banga Krishi Vishwavidyalaya, West Bengal during 26th -27th May, 2022.

- Safeena SA and Aswath C. Vertical farming: The future of farming

International conference on advances in agriculture and food system towards sustainable development goals," University of Agricultural Sciences, GKVK, Bengaluru from 22-24 August, 2022.

- Safeena SA. Vertical farming for commercial cultivation of Lilium

National Symposium on horticultural crops of humid tropics for nutritional and livelihood security (NSHCHT-2022), CHES (ICAR-IIHR), Chettalli, Kodagu, Karnataka, 2-3 December, 2022.

- Safeena SA. Photoperiod manipulation in cut chrysanthemum (*Dendranthema grandiflora* Tzvelev.) for off season flowering
- Safeena SA. Investigations on the feasibility of vertical farming for commercial cultivation of Lilium

7th Assam International agri-horticultural show-2022, Veterinary College Playground, Khanapara, Guwahati,17-19 December, 2022.

- Aswath C, Safeena SA and Senthil Kumaran G. Vertical Farming: A Novel Technology for Future Farming

International Conference on modernization of traditional indian medicine: industrial perspectives, Patanjali Research Institute, Haridwar, 1-4 August, 2022.

- Rohini MR and Rao VK. Biochemical evaluation of *Gymnema sylvestre* for antidiabetic content via high performance liquid chromatographic method.

International conference on advances in agriculture and food system towards sustainable development Goals, University of Agricultural Sciences, Bengaluru, 22-24 August, 2022.

- Raghavendra HC and Rohini MR. Investigating the morphological variability in *Gymnema sylvestre* (Retz.) R. Br. ex Schult collected from Peninsular India using minimal descriptors.

4th International Conference on global efforts on agriculture, forestry, environment and food security (GAFEF -2022), 17-19 September, 2022.

- Manisha, Padmini K, Dhananjaya MV, Umamaheswari R, Lakshmana Reddy and Rao VK. Evaluation of Carrot (*Daucus Carota* L) accessions for yield and quality traits.

International pepper conference-2022 (26 September, 2022 to 28 September, 2022) held at Tuscon Marriott University Park, The University of Arizona, Tucson, Arizona, United States of America (online mode).

- Ponnam N, Lakshamanareddy DC, Sandeep GM, Umamaheshwari M, Sandeep V, Subhash, Santhosh G and Madhavi Reddy K. Marker assisted root stock breeding for combined resistance for major soil borne pathogens in chilli (*Capsicum annuum* L.)'.

National Conference on Tribal Horticulture organized by Dr. YSR Horticultural University, V R Gudem, Andhra Pradesh from 17th to 18th October, 2022.

- Rohini MR, Rajendiran S and Rao VK. Nutritional Profiling of Gotukola (*Centella asiatica*): A potent underutilized green leafy vegetable for Tribal Horticulture.
- Anushma PL and Satisha J. High density guava orcharding for boosting the tribal livelihood & nutritional security.

National conference on plant genetic resources management organized by Indian Society of Plant Genetic Resources, New Delhi from 22-24 November, 2022.

- Rajasekharan PE, Rohini MR and Anil Kumar GS. (2022). Species distribution, exploration, collection and conservation of *Salacia* species (high value anti-diabetic plant) of Western Ghats.

National seminar on problems and prospects of horticulture in semi-arid tropics, Sri Krishnadevaraya College of Horticultural Sciences, Anantapuramu, A.P, 27-28 June, 2022.

- Hima Bindu. Prospects of cultivation of medicinal and aromatic crops in semi-arid tropics.

Entrepreneurship Orientation Program on Medicinal and Aromatic Plants (EOPMAP), DMAPR, Anand on 14 January, 2022.

- Hima Bindu. High value medicinal plants for Business development in Medi-Hub TBI.

National seminar on 'Fruit production in eastern Tropical region of India: Challenges and opportunities', Central Horticultural Experiment Station (ICAR-IIHR), Bhubaneswar, 24-26 March, 2022.

- Rajsekharan PE. Conservation of Fruit genetic resources.
- Rupa TR, Radha TK, Reddy PVR and Sridhar G. High density plant geometry and nutrients for higher productivity in Arka Kiran- a processing variety of guava on Alfisol under seasonally dry tropical savanna climate.
- Abhilash K, Satisha J, Shivashankara KS and Laxman RH. Studies on source-sink relationship of coloured grape varieties in mild tropics of India.
- Sane A, Sriram S, Uma Maheswari R, Selva Kumar G and Murthy BNS. Integrated approach for management of wilt disease in pomegranate.
- Umamaheswari R. Bio-rational approaches for nematode management in guava.

Asian Solaceous Round table held at IIHR 1 May, 2022.

- Rajsekharan PE. How to register a new variety?.

50 years of science and technology in Kerala celebration, KSCSTE-SRIBS.

- Rajsekharan PE. Conservation of biodiversity.

National Conference on Enhancing Competitiveness of Horticulture through Technology Innovations at ICAR-CPCRI, Kasaragod, 17-18 November, 2022.

- Rajsekharan PE. Pollen cryopreservation as an aid for crop improvement in horticultural crops.

All India Agri Start-up Convention 2022, UHS, Bagalkot, 18-20 October, 2022.

- Dedhia L, Tejaswini P, Arivalagan M, Venugopalan R, Lakshmana Reddy DC, Priti Sonawane, Rajiv Kumar and Himabindu K. Orange marigold- an ideal candidate crop for agri-startups.

National Symposium on Horticultural Crops of Humid Tropics for Nutritional and Livelihood Security, Central Horticultural Experiment Station (ICAR-IIHR) Chettalli, 02-03 December, 2022.

- Karunakaran G, Arivalagan M, Sakthivel T, Tripathi PC, and Muralidhara BM. Production technologies of emerging fruit crops of Humid tropics.
- Usharani TR, Lijina A, Chandrakanth M. Avachare and Gopala Krishna. Rapid micropropagation protocol for the commercial black pepper variety Arka Coorg Excel.
- Rupa TR, Sane Aand Tripathi PC. . Nutrient content of some important underutilized fruits.
- Radha TK, Rupa TR and Selvakumar G. Enhanced Plant growth, Nutrient uptake and Soil biological properties due to inoculation of liquid Actinobacteria in Pomegranate.
- Dedhia L, Tejaswini P, Arivalagan M and Venugopalan R. Marigold: a versatile ornamental crop for livelihood and nutritional security.
- Rohini MR, Himabindu K, Rajasekharan PE and Rao VK. Germplasm characterization studies in *Gymnema sylvetsre* (Retz.) R. Br. ex Schult: A potent anti-diabetic herb for the humid tropics.
- Rani AT, Bhat PS, Jayanthi Mala BR and Reddy PVR. Insect pollinator's diversity in potential future crops.
- Muralidhara BM, Shaktivel T, Shivashankara KS, Karunakaran G, Rao VK, Debi Sharma, Venkataravanappa V and Savadi S. Characterization of South Indian avocados for fatty acids and carotenoids profiling.
- Madhu GS, Rani AT, Muralidhara BM, Sriram S, Rajendiran S, Venkataravanappa V. Survey, Symptomotology and Identification of pathogens associated with Avocado root rot disease in India.
- Rajendiran S, Ramachandran S, Muralidhara BM, Chandrakant M Awachare and Venugopalan R. Delineation of soil critical level of boron, zinc and iron for avocado.
- Vincent L and Satisha J. Is grapevine cultivation viable in humid tropics?.
- Sangeetha Priya S, Aswath C and Safeena SA. A pertinent soil-less system for vertical farming of Gerbera.
- Muthaih G, Chidambara B, Deepak GN, Pitchaimuthu M and Ravishankar KV. Comprehensive transcriptome analysis of abiotic stress -related Lnc RNAs transcription factors in Okra [(*Abelmoschus esculentus* (L.) Moench].
- Pitchaimuthu M. IIHR varieties of Vegetable Crops and their performance.

Workshop-cum-field day on Avocado cv. Arka Supreme and Spine Gourd cv. Arka Bharath Organized at CHES. Chettalli.

- Karunakaran G, Arivalagan M, Sakthivel T and Tripathi PC. Avocado - Can offer a new gateway?.

Global okra round table conference, ICAR-IARI, New Delhi, 10-12 October, 2022.

- Pitchaimuthu M. Utilization of male sterility and its use in hybrid seed production of okra [(*Abelmoschus esculentus* (L.) Moench].
- Patil BL. Emerging plant viral diseases and their management through biotechnological interventions.

Refresher course in Botany, Batch XV (Online Mode), HRDC, University of Madras, October, 2022.

- Patil BL. Plant viral diseases and their control through biotechnological interventions.

VIROCON-2021, AIIMS, Hyderabad, 28 March 2022.

- Patil BL. miRNA-induced Gene Silencing (MIGS) for control of multiple pathogens.

International conference on biotechnology trends and future frospects (BTFP), UAS, GKVK, Bengaluru, 13-15 September, 2022.

- Nandeesha P, Madhusudan Rao B, Vasugi C, Vincent L and Prasanna HC. Hybrid Embryo Rescue in Horticultural Crops.
- Pooja, Usharani TR, Bhavadharini and Kumar KK. Genome engineering for developing jointless pedicel in tomato cv Arka Vikas.

National conference on climate resilient and sustainable development of horticulture, CSAUA&T, Kanpur, Uttar Pradesh, 28-31 May, 2022.

- Laxman RH. Phenophase based interventions for enhanced physiological activity and productivity of horticultural crops under climate change conditions.

International conference-cum-workshop on physiological and molecular mechanisms / markers for abiotic stress tolerance in plants, University of Calicut, Kerala, 26-28 October, 2022.

- Laxman RH. Visual and thermal image-based phenotyping of tomato germplasm for water stress.

International conference on reimagining rainfed agro-ecosystems challenges and opportunities, CRIDA, Hyderabad, 22-24 December, 2022.

- Laxman RH. Evaluation of eggplant wild relatives, landraces and cultivars for deficit moisture stress tolerance.

National seminar on development in soil science-2022, Mahatma Phule Krishi Vidyapeeth, Rahuri, 14-18 November, 2022.

- Rupa TR, Radha TK, Sridhar G and Aruna B. Nutrient partitioning and removal by guava with high plant density.

International Web conference on Global Research Initiatives for Sustainable Agriculture and Allied Sciences, Meerut(U.P), 13-15 December, 2022.

- Radha TK, Ganeshamurthy AN, Rupa TR, Shilpa ME, Chinthana KL and KrishnaKumar N. (2021). Culturable and metagenomic diversity of rhizospheric microbes associated with different agriculturall and use in semi-arid monsoonic climate with distinct summer, winter and rainy season.

International Conference on Advances in Agriculture and Food System towards sustainable Development Goals (AAFS 2022), UAS, Bengaluru, 22-24 August, 2022.

- Shilpa Shree KG, Naveen Kumar P, Safeena SA, Girish KS, Saha TN and Prasad KV. Standardization of agricultural by-products based growing media for indoor foliage plants.

- Shinogi KC, Srivastava S, Radha TK, Meena BP, Sinha NK, Rashmi I, Das H, Singh AB and Rao DLN. Alternative nutrient management practices to improve yield and income from the Soybean-Wheat crop rotation systems of Madhya Pradesh.

Seventh National Conference on Biological Control, Bengaluru, 15-17 December, 2022

- Radha TK, Uma maheswari R, Onkarnaik S and Lokesha AN. (2022). Biocontrol potential of entomopathogenic *Streptomyces* and its secondary metabolites on insect pests and nematodes.

Webinar on Entrepreneurship Orientation Program in Medicinal and Aromatic Plants - IV, ICAR-DMAPR, Boriavi, Anand, Gujarat, 11 January, 2022

- Kalaivanan D. Soilless cultures for business development.

National Seminar on Empowerment of Rural Youth with Novel Agricultural Technologies (ERYNAT 2022), Agricultural College, Bapatla, AP, 28-29 January 2022

- Kalaivanan D, Selvakumar G, Ganeshamurthy AN and Hebbar S. Nutrient scheduling and substrate effects on growth, yield and quality of chilli hybrid Arka Meghana under open and polyhouse soilless culture.

Workshop cum field visit on ICAR-IIHR Technologies in Horticulture crops to UPASI Planters, ICAR-IIHR, Bengaluru, 18 May 2022.

- Kalaivanan D. Soil health management for high altitude areas.

Workshop on current trends in rapid diagnosis and management of emerging diseases and insect pests in Horticultural crops, ICAR-IIHR, Bengaluru, 11-23 July, 2022.

- Kalaivanan D - Detection and management of nutritional deficiency symptoms and their remedial measures in horticultural crops.

National Conference on Horticulture: Enhancing Productivity and Mitigating Major Challenges, Kalasalingam School of Agriculture and Horticulture, Srivilliputtur, Tamil Nadu. 10-11 November, 2022.

- Kalaivanan D, Selvakumar G, Ganeshamurthy AN and Hebbar S. Cocoponics: A New and Alternate Method for Growing Vegetables under Soilless Culture.

International Conference on Recent Trends in Molecular Physiology of Horticultural Crops Under Abiotic Stress, VAIAL, VIT Campus, Vellore, Tamil Nadu, 4-5 December, 2022.

- Kalaivanan D. Nutrient deficiency in horticultural crops: identification and management.

4th International Conference on Global Efforts on Agriculture, Forestry, Environment and Food Security (GAFEF-2022), Institute of Forestry, Tribhuvan University, Pokhara Campus, Pokhara, Nepal, 17-19 September, 2022.

- Rajendiran S, Senthilkumar M, Kalaivanan D, Hebbar S, Nair AK and George S. (2022). Organic fertilization of teasle gourd and its impact on yield, nutrient uptake and soil health.

International Conference on Agriculture and Food System towards Sustainable Development Goals from 21st to 24th August 2022 held at UAS, Bengaluru.

- Madhu GS, Sajad Un nabi, Mir JI, Dinkar V, Sharma OC. *Invitro* evaluation of fungicides, bioagents and botanicals against Alternaria alternate casual agent of apple leaf and fruit spot.

2nd Indian Horticulture Summit, NAU, Navsari, 27-29 April, 2022

- Kishore K. Fruit-based multi-storey system: A viable approach for enhancing profitability.
- Karunakaran G, Arivalagan M, Sakthivel T, and Tripathi PC. Dragon fruit: A candidate fruit crop for non-traditional areas to enhance the farm income.
- Hussain F, Murthy BNS, Reddy MLN, Satisha J, Upreti KK and Laxman RH. Induction of flowering and improved fruit yield as influenced by different propagules and chemicals in pomegranate cv. Bhagwa.

International Conference on advances in Agriculture and Food system towards Sustainable Development Goals (AAFS-2022), UAS, Bengaluru, 22-24 August, 2022.

- Vincent L and Satisha J. Climate change favours flowering in *Vitis* x *champini* cv. Dogridge.

International Conference on Biotechnology trends and future prospects BTFP-2022, UAS- Bengaluru, 13-15 September, 2022.

- Vincent L and Satisha J. Omics approach to hasten breeding for downy mildew resistance in Grapes.

National Workshp on Smart management of agricultural resources for transforming Indian farms (Smart IF), ICAR- CTCRI, Trivandrum, 15-17 December, 2022.

- Vincent L. Robotics in pomegranate harvesting.

12th International Conference on Resource Management for Food, Agriculture, Environment and Health Sustainability, University of Gottingen, Gottingen, Germany, 14-24 September, 2022.

- Porika H, Satisha J, Upreti KK, Kumar M. Studies on graft compatibility of Red Globe on different rootstocks and to improve the graft success percentage with special emphasis on Dogridge rootstock.

National Seminar on Comprehensive Extension Strategies for Sustainable Development of FPOs: Challenges and Opportunities, MANAGE, Hyderabad, 22-24 April, 2022.

- Venkattakumar R. Emerging challenges for sustainability of FPOs and implicative strategies.

XVIII AZRA International Conference on Advances in Applied Zoological Researches towards Food, Feed & Nutritional Security and Safer Environment, AZRA, Bhubaneswar, Odisha, 10-11 November, 2022.

- Umamaheswari R. Developing holistic modules for nematode management in protected conditions

International Conference on Innovative technologies and their application in higher education organized by Annamalai University, Chidambaram, 17–19 October, 2022

- Umamaheswari R. Biopesticides for nematode disease complex management in horticultural crops.
- Umamaheswari R. Exploring host plant resistance and developing integrated nematode management strategies in brinjal (*Solanum melongena* L.).

International Conference on Advances in Agricultural, Veterinary and allied Sciences for Improving Livelihood and Environmental Security, Srinagar, Jammu and Kashmir, 28-30 September, 2022

- Jayanthi Mala BR, Krishnamoorthy SV, Kamala Jayanthi PD, Kumar S and Shivashankara KS. Olfactometer responses of ash weevil, *Myllocerus subfasciatus* to male aggregation pheromone 2-methyl-4-heptanol.

Golden jubilee National symposium on New opportunities in vegetable production for sustainable development, ICAR-IIVR, Varanasi, UP, 20-22 December, 2022.

- Jayanthi Mala BR, Kamala Jayanthi PD, Singh TH, Kumar S, Shivashankara KS and Naresh P. Trichome-based production of diverse specialized metabolites in wild solanum species and resistance to ash weevil, *Myllocerus subfasciatus.*

4th National Conference on Recent Advances in Agriculture and Allied Sciences and Pharmaceutical and Envirronmental Sciences, Chennai, 01 October, 2022.

- Usha Bharathi T, Rao TM, Kalaivanan D and Rajiv Kumar. Suitability of gladiolus genotypes for the corms and cormels production under Aeroponics.

International Conference on vegetable research and Innovations for Nutrition, Entrepreneurship and Environment (ICVEG-21), Indian Society of Vegetable Science, Varanasi, 14-16 December, 2021.

- Pandav AK, Padmini K, Dhananjaya MV, Sriram S, Lakshmana Reddy DC, Muthiah K and Varalakshmi B. Onion three way hybrids with male sterility (cms) background : An innovative approach to assess the processing qualities.

National Seminar on "Comprehensive Extension Strategies for Sustainable Development of FPOs: Challenges and Opportunities" during April 22-24, 2022 held at MANAGE, Hyderabad

- Venkattakumar R. Emerging challenges for sustainability of FPOs and implicative strategies.

National Seminar on 'Fruit Production on Eastern Tropical Region off India: Challenges and Opportunities' during March 24-26, 2022.

- Venkattakumar R. New Initiatives in Horticulture Produce Management by FPOs.

National conference on Fruits and Vegetables for Health and Nutrition (FVHN 2021) from 8th -10th November, 2021 at Karnataka Science and Technology Academy.

- D Sreenivasa Murthy, D. Volatality of Marketing in Fruits and Vegetables.

Webinar on Innovations during COVID 19 period, Jointly organized by CCS-NIAM, Jaipur and ICAR-IIHR, Bengaluru, 13/05/2020.

- Gajanana, T.M. Innovations and good practices for marketing of fruits and vegetables during COVID-19.

National level Cohort training, February 22, 2021, MANAGE, Hyderabad.

- Gajanana, T.M. Opportunities in horticulture: Role of ICAR-IIHR in promoting agri-start-ups.

National Seminar in Hindi on *KrutrimBudhimata and internet of Things Ka Krishi Abhiyantriki Mei Yogdan* held from 26 - 27 May,2022 at CIAE, Bhopal.

- R.B. Tiwari *"Phal Aur SabjiMukhyaSrankhala Mei Traceability Ka Mahatwa - Phal Aur Sabji Traceability maiSoochana Aur Sanchar Prodyogiki (ICT) Ki Bhumika"*.

International Conference on Advances in Agriculture and Food System Towards sustainable development Goals to be organizedby University of Agricultural Sciences, Bengaluru, GKVK during 22-24 August, 2022.

- R.B Tiwari. Utilization of unmarketable as well as surplus mongo fruits using combined processing technologies for sustainable mango production and consumption.

National conference on Agri startups: Challenges, Technologies and strategies (AGRiPACTS2022); 26th and 27th May 2022, Gangtok, Sikkim.

- Balakrishna B, Amruta A, Atheequlla GA and Shaktivel T. Horticultural innovations to Strengthen Agri startups and Entrepreneurs in NEH states. In: Technical session recent innovations, IRP, Technology commercialization and related aspects.

National Dialogue on Extension services for efficient delivery of horticultural technologies: A way forward; 21st & 22nd May 2022, ICAR-IIHR Bengaluru.

- Balakrishna B. Horticultural extension: research focus and Priorities. In: Technical session Horticultural extension: research focus and Priorities.

National Symposium on "Horticultural Crops of Humid Tropics for Nutritional and Livelihood Security (NSHCHT)" & Exhibition-2022 was organized at Hotel Crystal Court, Madikeri, in collaboration with the Society for Promotion of Horticulture (SPH), ICAR-IIHR, Bengaluru during 02-03 December, 2022.

- Sankar V. Performance of Brinjal and Chilli varieties and hybrids at high altitude and high rainfall areas of Kodagu Region.
- Sankar V. Evaluation of Chinese and Red cabbage hybrids in humid tropical region of Karnataka.

National Conference on Tribal Horticulture" held at YSRHU from 13-14 October, 2022.

- Atheequlla GA. Livelihood enhancement of tribal farmers through Institutional Interventions : Production of Arka Jackies.

2nd Rural India Business Conclave 2.0 during 9-13 lune 2022 conducted by ICAR-CPCRI, Kasaragod.

- Manjunath B.L. Nodal officer, BPD presented the activities of the BPD/ABI, ICAR-IIHR.

Farmers empowerment and entrepreneurial Development through FPOs and start ups organized by ICAR-IIHR during 5-14 December, 2022.

- Manjunath B.L. Nodal officer, BPD presented the activities of the BPD/ABI, ICAR-IIHR.

All India Agri start up Convention 2022 organised by NHEP-IDP, UHS., Bagalkot during October 18-20, 2022.

- Manjunath BL, Sarthak Kiribhaga and Shivagangavva. Agri- business incubation unit, ICAR-IIHR in promotion of Horti-start ups in India.

9.12. E-PUBLICATIONS

1. Aswath C, Safeena S, and Rohini MR. (2022). Compendium of Training Programme (Hybrid Mode) on "Vertical Farming and Hydroponics in Horticulture" ICAR-IIHR, Bengaluru, Karnataka.

2. Aswath C, Safeena S, and Hebbar S. (2022). Compendium of Training programme (Hybrid Mode) on Hydroponics and Vertical Farming in Horticultural Crops on 20 August, 2022. ICAR-IIHR, Bengaluru, Karnataka.

9.13. ABSTRACTS

1. Kanupriya C, Tripathi PC, Singh P, Venugoplan R and Radhika R. (2022). Evaluation of morphological, biochemical and molecular diversity of Karonda (*Carissa carandas* L.) germplasm. National Conference on underutilized Horticultural Genetic resources and utilization, CIARI, Port Blair, 3-4 June, 2022, pp. 72.

2. Vani NU, Tripathi PC, Rupa TR and Prabhakar Singh A. (2022). Evaluation of jamun germplasm for seed mineral content. National Conference on underutilized Horticultural Genetic resources and utilization, CIARI, Port Blair, 3-4 June, pp. 79.

3. Sane A, Tripathi PC, Kumar U, Singh P and Kanupriya C. (2022). Bael (*Aegle marmelos Corres*) Diversity of wild and cultivated types for yiled, fruit quality and nutrceautical attributes. National Conference on underutilized Horticultural Genetic resources and utilization, CIARI, Port Blair, 3-4 June, pp. 80.

4. Sane A and Tripathi PC. (2022). Promising indigenous minor fruit crops for semiarid tropical regions. National Symposium on Horticultural crops of humid tropics for nutrition and livelihood security organized by CHES,Chettalli at Madikeri (Kodagu) during 2-3 December, 2022.

5. Vani NU, Tripathi PC, Rao VK and Prabhakar Singh A. (2022). Evaluation of Jamun genotypes for physical characteristics of fruits. National Symposium on Horticultural crops of humid tropics for nutrition and livelihood security organized by CHES, Chettalli at Madikeri (Kodagu) during 2-3 December, 2022, pp. 132.

6. Rupa TR, Sane A and Tripathi PC. (2022). Nutrient content of some important underutilized fruits. National Symposium on Horticultural crops of humid tropics for nutrition and livelihood security organized by CHES, Chettalli at Madikeri (Kodagu) during 2-3 December, 2022, pp. 112.

7. Senthil Kumar R, Sankar V, Tripathi PC, Karunakaran G, Sakthivel T and Harishkuamr HV. (2022). Economic analysis of rambutan cultivation in India. National Symposium on Horticultural crops of humid tropics for nutrition and livelihood security organized by CHES ,Chettalli at Madikeri (Kodagu) during 2-3 December, 2022, pp. 264.

8. Karunakaran G, Senthil Kumar R, Sankar V, Tripathi PC, Sakthivel T and Harishkuamr HV. (2022). Economics of dragon fruit farming. National Symposium on Horticultural crops of humid tropics for nutrition and livelihood security organized by CHES, Chettalli at Madikeri (Kodagu) during 2-3 December, 2022, pp. 265.

9. Tripathi PC, Senthil Kumar R, Sankar V, Karunakaran G, Sakthivel T and Harishkuamr HV. (2022). Economics of litchi production in India. National Symposium on Horticultural crops of humid tropics for nutrition and livelihood security organized by CHES, Chettalli at Madikeri (Kodagu) during 2-3 December, 2022, pp. 266.

10. Senthil Kumar R, Sankar V, Tripathi P C, Karunakaran G, Sakthivel T and Harishkuamr HV. (2022). Economic analysis of avocado cultivation in India. National Symposium on Horticultural crops of humid tropics for nutrition and livelihood security organized by CHES, Chettalli at Madikeri (Kodagu) during 2-3 December, 2022, pp. 263.

11. Shalini RM, Hima Bindu K, Mohankumar GP and Rao KV. (2022). Antioxidant activity of Bhringaraj (*Eclipta alba* L.) morphotypes. Souvenir and Abstracts, National symposium on Horticultural Crops of Humid Tropics for Nutritional and Livelihood Security organized by CHES, Chettalli at Madikeri (Kodagu) during 2-3 December, 2022, pp. 134.

12. Hima Bindu K, Divya KS, Shivakumar, Rao VK, Shalini RM and Rohini MR. (2022). Phytochemical evaluation of elite lines of Bhringaraj (*Eclipta alba* L.). Souvenir and Abstracts, National symposium on Horticultural Crops of Humid Tropics for Nutritional and Livelihood Security (organized by CHES, Chettalli at Madikeri (Kodagu) during 2-3 December, 2022, pp. 140.

13. Hima Bindu K, Divya KS, Shivakumar, Rao VK and Rohini MR. (2022). Phytochemical evaluation of elite lines of Brahmi (*Bacopa monneri* L.). Souvenir and Abstracts, National symposium on Horticultural Crops of Humid Tropics for Nutritional and Livelihood Security organized by CHES, Chettalli at Madikeri (Kodagu) during 2-3 December, 2022, pp. 112.

14. Mounika K, Hima Bindu K, Rohini MR, Yuvaraj KM, Rao VK and Ravishankar KV. (2022). Morphological variability in germplasm of Brahmi (*Bacopa monneri* L.) Souvenir and Abstracts, National symposium on Horticultural Crops of Humid Tropics for Nutritional and Livelihood Security organized by CHES, Chettalli at Madikeri (Kodagu) during 2-3 December, 2022, pp. 141.

15. Mohankumar GP, Hima Bindu K, Shalini RM and Divya KS. (2022). Ploidy status of Inter-specific hybrids and hybrids of Betelvine through Flow cytometry. Souvenir and Abstracts, National symposium on Horticultural Crops of Humid Tropics for Nutritional and Livelihood Security organized by CHES, Chettalli at Madikeri (Kodagu) during 2-3 December, 2022, pp. 122.

16. Safeena SA, Aswath C and Senthil Kumaran G. (2022). Vertical farming for Commercial cultivation of Lilium. In: International conference on advances in agriculture and food system towards sustainable development goals, at GKVK, University of Agricultural Sciences, Bengaluru, from 22-24 August, 2022, pp. 278.

17. Safeena SA and Rajiv Kumar (2022). Photoperiod manipulation in Cut chrysanthemum (*Dendranthema grandiflora* Tzvelev.) for offseason flowering Souvenir and Abstracts, National symposium on Horticultural Crops of Humid Tropics for Nutritional and Livelihood Security organized by CHES, Chettalli at Madikeri (Kodagu) during 2-3 December, 2022, pp. 149.

18. Safeena SA, Aswath C and Senthil Kumaran G. (2022). Investigations on the feasibility of Vertical farming for commercial cultivation of Lilium. Souvenir and Abstracts, National symposium on Horticultural Crops of Humid Tropics for Nutritional and Livelihood Security organized by CHES, Chettalli at Madikeri (Kodagu) during 2-3 December, 2022, pp. 148.

19. Sangeetha Priya S, Aswath C and Safeena SA. (2022). Wick system for Gerbera over drip system. Souvenir and Abstracts, National symposium on Horticultural Crops of Humid Tropics for Nutritional and Livelihood Security organized by CHES, Chettalli at Madikeri (Kodagu) during 2-3 December, 2022, pp. 199.

20. Sangeetha Priya S, Aswath C and Safeena SA. (2022). A pertinent soil-less system for vertical farming of Gerbera. Souvenir and Abstracts, National symposium on Horticultural Crops of Humid Tropics for Nutritional and Livelihood Security organized by CHES, Chettalli at Madikeri (Kodagu) during 2-3 December, 2022, pp. 197.

21. Smitha GR, Kalaivanan D and Sujatha S. (2022). Influence of Shade and Nutrition on Dry Herb Yield, Nutrient Uptake and Post-Harvest Soil Properties of Memory Enhancing and Immune-Boosting Herb Brahmi (Bacopa monnieri L.). International Conference on Sustainable Utilization of Bioresources, Organized by Department of Botany, University of Kerala, 10-15 January, 2022, pp. 104.

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List of Ongoing Institute Projects for the year 2022 (1st Jan. - 31st Dec., 2022)

DIVISION OF FRUIT CROPS

HORTIIHRCIL2015 010: Genetic improvement of fruit crops for improved productivity, quality and resistance to biotic and abiotic stresses. Project Leader: P.C. Tripathi

Sub-Projects

010 (1): Improvement of mango for yield and quality. PI: M. Sankaran

010 (2): Improvement of sapota and jamun for yield and quality. PI: P. C. Tripathi

010 (5): Breeding papaya for PRSV tolerance. PI: C. Vasugi

010 (8): Improvement of guava for yield and quality. PI: C. Vasugi

010 (9): Rootstock and mildew resistance breeding in grapes. PI: Linta Vincent

010 (11): Improvement of annona for yield and quality. PI: T. Sakthivel

010 (12): Improvement of pummelo and grapefruit for yield and quality. PI: M. Sankaran

010 (13-H): Characterization of jackfruit accessions for vegetable and table purposes. PI: G. Karunakaran

010 (14): Studies on polyembryony in mango. PI: Reju M. Kurian

010 (15): Genetic improvement of pomegranate for improved productivity, quality and resistance to major diseases (Blight and wilt) and its management. PI: Linta Vincent

010 (16): Collection and characterization of tamarind (*Tamarindus indica* L.) for development of diversity maps. PI: Kanupriya

010 (17): Evaluation of under-utilized fruits for yield, quality and adaptability. PI: Anuradha Sane

010 (18): Mutation breeding in dragon fruit (*Hylocereus* sp.). PI: G. Karunakaran

HORTIIHRCIL2015 011: Development and refinement of production technology of fruit crops. Project Leader: Reju M. Kurian

Sub-Projects

011 (3): Exploitation of stock-scion interactions (Mango, annona, jackfruit, fig and grapes). PI: Reju M. Kurian

011 (4): Optimizing water and nutrient management (Papaya, guava, mango, sapota, annona and grapes). PI: B.L. Manjunath

011 (5): Fruit based mixed cropping systems (Sapota). PI: P. L. Anushma.

011 (6-H): Standardization of production technology for Dragon fruit. PI: G. Karunakaran

011 (8): Performance evaluation of guava hybrid Arka Poorna propagules to mineral and organic nutrient sources under high density planting PI: P.L. Anushma

011(9): Studies on effect of cane, leaf and flower regulation on quality of colour grapes. PI: J. Satisha

011(10): Integrated resource management module for different high density planting systems in mango. PI: S. Sujatha

011(11): Canopy architecture management in pomegranate and guava. PI: Anjani Kumar Jha

011(12): Management of papaya (var. Arka Prabhath) rhizosphere for quality fruit production. PI: Priya Devi

011(13): Refinement of propagation techniques for rapid multiplication of fruits. PI: T. Anupa

011(14): Evaluation and demonstration of natural farming approaches in horticulture based cropping system. PI: B L Manjunath

DIVISION OF VEGETABLE CROPS

HORTIIHRCIL2015 020: Genetic improvement of vegetable crops for improved productivity, quality and resistance to biotic and abiotic stresses. Project Leader: K. Madhavi Reddy

Sub-Projects

020 (1): Breeding tomato for resistance to biotic and abiotic stresses and gene pyramiding for ToLCV resistance through MAS. PI: H.C. Prasanna

020 (2): Breeding for biotic and abiotic stress resistance and diversification of male sterile lines in chilli (*Capsicum annuum* L.**).** PI: K. Madhavi Reddy

020 (3): Breeding brinjal for resistance to bacterial wilt

with high yield and quality attributes through marker-assisted selection (MAS). PI: T.H. Singh

020 (4): Breeding cucurbitaceous crops (watermelon and muskmelon) for yield & resistance to biotic stresses through marker assisted selection (MAS). PI: D C Manjunatha Gowda

020 (5): Breeding okra varieties/hybrids for yield, quality & resistance to biotic stresses through marker-assisted selection (MAS). PI: M. Pitchaimuthu

020 (6): Breeding garden pea,french bean and cowpea for resistance to biotic and abiotic stresses through marker-assisted selection (MAS). PI: C Mahadevaiah

020 (7): Breeding dolichos and vegetable soybean for resistance to biotic and abiotic stresses through marker-assisted selection (MAS). PI: M. Thangam

020 (8): Breeding onion for resistance to biotic and abiotic stresses with high bulb yield and quality attributes through marker-assisted selection (MAS). PI: B.R Raghu

020 (9): Breeding tropical carrot and radish for yield, quality and resistance to biotic and abotic stresses. PI: K. Padmini

020 (11): Breeding ridge gourd and bitter gourd for resistance to biotic stresses integrating maker assisted selection (MAS). PI: B. Varalakshmi

020 (12): Breeding cucumber varieties / hybrids and gherkins for resistance to biotic stresses through marker assisted selection. PI: Vivek Hegde

020 (13): Breeding cluster bean (*Cyamopsis tetragonolobus* L.) for yield, quality and resistance to biotic stresses. PI: Smaranika Mishra

020 (15): Breeding ash gourd and bottle gourd for yield, quality and resistance to biotic stresses. PI: M.V. Dhananjaya

020 (16): Breeding bell pepper (*Capsicum annuum* L. var. *grossum*) for yield, quality, biotic and abiotic stress tolerance through marker assisted selection. PI: Smaranika Mishra

020 (19): Breeding varieties / hybrids for high yield of leaf and pods with high quality in drumstick (*Moringa oleifera* L.). PI: Raja Shankar

020 (20): Breeding Curry leaf (*Murraya koenigii* (L.) Spreng) for high leaf yield, quality traits and resistance to biotic stresses. PI: B.R. Raghu

020(22): Breeding pumpkin and summer squash for yield, quality and resistance to biotic stresses. PI: Raja Shankar

020(23): Breeding for abiotic stress tolerance in hot pepper (*Capsicum annuum* L.) through marker assisted selection. PI: Ponnam Naresh

HORTIIHRCIL2015 021: Development and refinement of production technology of Vegetable crops. Project Leader: S.S. Hebbar

Sub-Projects

021 (1): Water management and rainfed production in vegetable crops. PI: Anil Kumar Nair

021 (2): Organic farming in vegetable crops. PI: Anil Kumar Nair

021 (3): Protected cultivation and precision farming in vegetable crops. PI: S. S. Hebbar

021 (4): Grafting studies in fruit vegetables for overcoming biotic and abiotic stresses. PI: S. S. Hebbar (w.e.f. 01.05.2022)

HORTIIHRCIL2015 022: Development and refinement of efficient seed production and plant propagation technologies in key horticultural crops. Project Leader: H.S. Yogeesha

022 (1): Ultra low and low moisture drying as a cost effective technique to extend seed longevity of horticultural crops under ambient storage. PI: H.S. Yogeesha

DIVISION OF FLOWER & MEDICINAL CROPS

HORTIIHRCIL2015 030: Genetic improvement of ornamental crops for improved productivity, quality and resistance to biotic and abiotic stresses. Project Leader: Tejaswini

Sub-Projects

030 (1): Genetic improvement of tuberose & gladiolus for yield, quality and resistance to biotic stresses PI: T. Usha Bharathi

030 (3): Genetic improvement of rose and marigold for flower and biochemical components PI: P. Tejaswini

030 (5): Breeding gerbera, crossandra, & dahlia for quality & higher yield PI: C. Aswath

030 (6): Breeding chrysanthemum and china aster for quality. PI : Rajiv Kumar

HORTIIHRCIL2015 031: Development and refinement of production technology of ornamental crops. Project Leader: Sujatha A. Nair

Sub-Projects

031 (5): Standardization of precision production

technologies in flower crops (marigold, gladiolus and china aster). PI: H.P. Sumangala

031(9): Standardization of production protocols for chrysanthemum varieties suitable for protected cultivation. PI: S.A. Safeena

031(10): Valorization of floral wastes for development of eco-friendly products PI: G.R. Smitha

031(11): Enhancing propagation efficiency and quality planting material production in vegetatively propagated flower crops PI: Sujatha A. Nair

031(12): Standardization of hydroponics and vertical farming technologies in commercially important flower crops PI: S.A. Safeena

HORTIIHRCIL2015 032: Genetic improvement of Medicinal Crops. Project Leader: K. Hima Bindu

Sub-Projects

032 (3): Genetic amelioration of Kalmegh (*Andrographis paniculata* Nees) for yield and quality. PI: K. Hima Bindu

032 (4): Genetic Improvement of *Centella asiatica* by polyploidy breeding. PI: M. R. Rohini,

032(6): Breeding of Gymnema (*Gymnema sylvestre* R.Br.) for biomass and high gymnemic acid content. PI: M. R. Rohini

032(7): Assessment of intraspecific variability and genetic improvement of Brahmi (*Bacopa monnieri* (L) Wettst). PI: K. Himabindu

032(8): Development of cryopreservation protocols for wild relatives and resistant genotypes of horticultural crops. PI: P.E Rajasekharan

DIVISION OF POST HARVEST TECHNOLOGY & AGRICULTURAL ENGINEERING

HORTIIHRCIL2018 044: Development and scale up of appropriate technologies for postharvest loss reduction in selected fruit and vegetables.Project Leader: C.K. Narayana

Sub-Projects

044(3): Bioprospecting of lactic acid bacteria with health benefits and development of low - moisture probiotic fruit products**.** PI: K. Ranjitha

044(4): Technology refinement and scale up for value added products of jack fruits and kamalam (dragon fruits). PI: C.K. Narayana

044(5): Process optimization for the development of fruit and vegetable based RTE extruded snack. PI: S. Bhuvaneswari

044(6): Development of fortified fruit beverages (Pineapple/guava/amla) with medicinal tree species and herbs (moringa/centella/ashwagandha). PI: Pushpa Chetan Kumar

044(7): Post-harvest treatments (physical and safe chemicals) for extension of storage life and quality maintenance of fruits (mango, papaya, guava and custard apple). PI: D.V. Sudhakar Rao

HORTIIHRCIL2016 043: Development of Machinery for conserving/saving inputs in production and processing of Horticultural crops**:** G. Senthil Kumaran

Sub-Projects

043(1): Development of DC power operated prime mover with a leafy vegetable harvester attachment. PI: G. Senthil Kumaran

043(2): Design and development of machinery for vegetable seedling production line and transplanter. PI: A. Carolin Rathinakumari

DIVISION OF CROP PROTECTION

HORTIIHRCIL2015 050: Diagnostics and Integrated management of viral diseases of tropical horticultural crops. Project Leader: D. K. Samuel

Sub-Projects

050(8): Development of integrated diagnostic and management strategies for viral diseases of lilium and gladiolus PI: D. K. Samuel

050(9): Development of diagnostics and integrated management strategies for major seed borne viruses in vegetable crops (cucumber and watermelon) PI: B. Mahesha

050(10): Diagnosis and management of emerging viruses in okra, tomato and capsicum. PI: V. Venkataravanappa

HORTIIHRCIL2015 051: Integrated management of fungal and bacterial diseases of tropical horticultural crops. Project Leader: Dr. S. Sriram

Sub-Projects

051 (11): Host-Pathogen Interaction and Management of wilt diseases of Ornamental crops (crossandra, gladilous and carnation). PI: Priti Sonavane

051 (12): Development of forewarning models for the blossom blight and hoppers in mango. PI: S. Sriram

051(13): Post-harvest management of fruit rot in mango and grapes using volatile organic compounds producing yeasts and bacteria PI: S. Sriram

051(14): Genetic diversity and management of gummy stem blight of watermelon and gherkin. PI: G.M. Sandeep Kumar

051(16): Characterization and Management of *Ralastonia solanacearum* species complex causing Bacterial wilt in solanaceous vegetable. PI: G. Sangeetha

HORTIIHRCIL2015 053: Genetic improvement and development of production and utilization technology of tropical mushrooms. Project Leader: C. Chandrashekara

Sub-Projects

053(4): Standardization of liquid spawn production technology. PI: C. Chandrashekhar

053(5): Input efficient production process and Biochemical characterization of tropical and subtropical mushrooms. PI: C. Chandrashekhar

HORTIIHRCIL2015 060: Integrated Insect pest management in tropical horticultural crops. Project Leader: Dr. P. V. R. Reddy

Sub-Projects

060 (16): Bio-ecology and sustainable management of borers in fruit crop ecosystems with special reference to mango and guava. PI: P.V.R. Reddy

060 (18): Evaluation of actinobacteria for pesticidal activity against pests of vegetable crops. PI: T.K. Radha

060 (19): Exploration of lesser known botanicals for insect pest management. PI: N.R. Prasannakumar

060(20): Interventions for management of tea mosquito bug (*Helopeltis antonii*) in guava, annona and drumstick). PI: B.R. Jayanthi Mala

060(21): Dynamics of sucking pests and their management in bell pepper (*Capsicum annum*) and gerbera (*Gerbera jamesonni*) under protected conditions. PI: V. Sridhar

060(22): Post-Harvest Management of melon thrips, *Thrips palmi* Karny on okra and bitter gourd using Novel methods and techniques PI: V. Sridhar

060(23): Understanding and integrated management of invasive South Asian Thrips, *Thrips parvispinus* (karny) on chilli. PI: V. Sridhar

060(24): Understanding the chemical ecology of thrips (*Thrips parvispinus*(Karny)/*Scirtothrips dorsalis* Hood) and mites (*Tetranychus urticae* Koch) for developing sustainable IPM strategies. PI: Bhagyasree

HORTIIHRCIL2015 063: Integrated Nematode Management in tropical horticultural crops. Project Leader: R. Umamaheshwari

Sub-Projects

063 (4): Exploring nematode host interaction and developing integrated nematode management modules in Horticultural crops (guava, brinjal, cucumber *etc.*). PI: R. Umamaheshwari

DIVISION OF BASIC SCIENCES

HORTIIHRCIL2015 070: Understanding the physiological and biochemical mechanism and their application for improving productivity and quality of mandate horticultural crops. Project Leader: K. S. Shivashankara

Sub-Projects

070 (11): Assessment of floral metabolite profiles and their influence on fruit set in mango. PI: K.S. Shivashankara

070 (14): Effect of processing on pesticide residues in horticultural commodities. PI: Partha P. Choudhury

070 (16): Evaluation of factors affecting uptake of persistent pesticides in vegetables. PI: Debi Sharma

070 (17): Studies on root characteristics of *Capsicum* species for enhancing water stress tolerance. PI: R.H. Laxman

070 (18): Understanding the biochemical and molecular mechanisms of flowering in mango. PI: Shamina Azeez

070(19): Biochemical basis of rust (*Uromyces phaseoli* Reben Wint.) resistance in French bean (*Phaseolus vulgaris* L.). PI: M. Arivalagan

070(20): Seed pre-treatments and abiotic stress tolerance (water and high temperature) in chilli. PI: K. Bhanuprakash

070(21): Studies on role of bioagents in excess and deficit moisture stress management in onion. PI: Pritee Singh

070(22): Physiological understanding and mitigation of irregular fruit shape and size in selected jackfruit (*Artocarpus heterophyllus* Lam.) accessions. PI: Sridhar Gutam

070(24): Identification of rootstocks for imparting moisture stress tolerance in cucumber and bottle gourd. PI: K.V Ramesh

070(25): Extraction of bioactive principles and their characterization in papaya leaf PI: V. Keshava Rao

070(26): Study on anti-diabetic principles in Jamun (*Syzygium cumini*) and tender Jjack fruits (*Artocarpus heterophyllus*) PI: M. Arivalagan

070(27): Phenotyping for identification of traits imparting nitrogen and phosphorous use efficiency in tomato PI: R.H. Laxman

HORTIIHRCIL2015 110: Development, refinement and use of biotechnological approaches for horticultural crop improvement and production. Project Leader: R. Asokan

Sub-Projects

110 (22): Molecular analysis and mode of action of microbial inoculants (Mis) employed for enhancing plant growth and imparting tolerance to biotic stress. PI: K.V. Ravishankar

110 (25): Genome editing of recessive resistance eIF4 genes in chilli for potyvirus resistance. PI: M. Manamohan

110 (26): *In vitro* mutagenesis of guava for *Fusarium* wilt resistance. PI: T.R. Usha Rani

110 (27): Hybrid embryo rescue in horticultural crops (focus on grapes). PI: P. Nandeesha

110(28): DsRNA-based management of *Colletotrichum gloeosporioides* involved in anthracnose of mango. PI: Basavaprabhu L. Patil

110(29): Development of EST-SSR s in *Moringa* and *Murraya.* PI: K.N. Poornima

110(30): Development of double haploids in vegetable crops. PI: K.N. Poornima

110(31): Exploitation of double haploid technology in fruit crops (papaya, guava and pomegranate). PI: H.S. Vageesh Babu

110(32): Development of non-embryonic CRISPR/Cas 9 based genome editing precision guided sterile insect technique (pg SIT) PI: R. Asokan

110(33): Development of cisgenetic chilli breeding lines against Anthracnose resistance PI: D.C Lakshman Reddy

110(34): Development of proof of concept for cisgenics in grapes for mildew resistance PI: P. Nandeesha

110(35): A comprehensive physiological and molecular approaches to improve tolerance to combined abiotic (low moisture and salinity) and biotic stress (nematode) in tomato (*Solanum lycopersicum*) - Focus on intrageneric rootstock breeding. PI: M. D. Prathibha

DIVISION OF NATURAL RESOURCES

HORTIIHRCIL2015 080: Soil, nutrient and water management in horticultural crops and cropping systems. Project Leader: T. R. Rupa (w.e.f. 01.11.2022)

Sub-Projects

080 (7): Development of nutrient management module for guava under high density planting system. PI: T.R. Rupa

080 (10): Identification of suitable rose rootstocks for tolerating bicarbonate toxicity (high pH) and salinity for polyhouses and open field conditions. PI: L.R. Varalaksmi

080(13): Engineered Nanoscale Nutrient: Synthesis, Characterization and their effect on some vegetable corps. PI: G.C. Satisha

08(14): Efficiency of green manures on nutrient dynamics in vegetable cropping systems. PI: R. Ramachandra.

08(15): Studying micronutrient constraints and development of foliar formulations in commercial flower crops. PI: G. Chethan Kumar

080(16): Standardization of bio enriched organic manure using post-methanated cattle dung slurry as a feedstock and its utilization for vegetable crop production PI: D. Kalaivanan

HORTIIHRCIL2015 081: Addressing soil health and environmental safety in horticultural crops and cropping systems. Project Leader: G. Selvakumar

Sub-Projects

081 (9): Development of Actinobacterial liquid inoculants for growth promotion, nutrient and health management in pomegranate. PI: T.K. Radha

081(12): Exploration of Methylotrophic Bacteria for their utilization as inoculants in horticultural crop production PI: G. Selvakumar

081(13): Evaluation of ameliorating effect of bio stimulants on vegetable crops under salinity stress PI: Shilpa Shree

081(14): Exploration of potential arbuscular mycorrhizal (AM) fungi from harsh environments and their utilization in fruit. PI: T. K. Radha

DIVISION OF SOCIAL SCIENCES AND TRAINING

HORTIIHRCIL2015 090: Improving knowledge and skill of stakeholders for improving productivity of horticultural crops and impact assessment of adopted technologies. Project Leader: R. Venkatta Kumar

Sub-Projects

090 (12): Assessment of spread, acceptance and profitability of selected fruit crop technologies. PI: R. Senthil Kumar

090 (14): A study on spread and acceptance of ICAR-IIHR released vegetable hybrids in South India. PI: V. Sankar

090(15): Assessment of horticultural based farming system for enhancing profitability of small and marginal farmers. PI: B. Narayanaswamy

090(16): Assessment of spread and acceptance of selected floriculture technologies. PI: T. M. Reddy

090(19): Capacity analysis of selected FPOs and promotion of horticultural technologies through FPOs. PI: R. Venkatta Kumar

090(20): Assessment and refinement of crop protection and natural resources management technologies of IIHR. PI: G. A. Atheequlla

HORTIIHRCIL2015 091: Development and application of economic, statistical and ICT tools and strategies for improving and assessing productivity of horticultural crops. Project Leader: **D. Srinivasa Murthy (w.e.f. 01.11.2022)**

Sub-Projects

091 (1): Assessing the socio-economic impact of horticultural technologies on crop diversification, farm income, employment and trade. PI: D. Srinivasa Murthy

091 (3): Development of statistical models for horticultural crops research. PI: R. Venugopalan

091 (4): Development of database and program modules for horticultural crops. PI: M. K. Chandra Prakash

091 (5): Development of decision support system for horticultural crops. PI: Reena Rosy Thomas

CENTRAL HORTICULTURAL EXPERIMENT STATION, CHETTALLI

HORTIIHRCIL2015 170: Development, refinement and popularization of cropping system models for improving productivity of horticultural crops in high altitude regions of Western Ghats of India. Project Leader: Dr. Rajendiran (w.e.f 2.11.2021)

Sub-Projects

170 (10): Harnessing the genetic potential of *Momordica sahyadrica* through wide hybridization. PI M. Pitchaimuthu

170 (11): Development of integrated nutrient management module for improving yield and quality of Coorg mandarin. PI: Rajendiran S.

170(12): Improvement of Coorg mandarin and avocado through mutation breeding. PI: B.M. Murlidhara

170(13): Diagnosis and management of major fungal diseases of avocado in high humid tropic regions of Western Ghats of India. PI: V. Venkataravanappa

170(14): Insect pollinator diversity in potential future crops, their foraging behavior and conservation measures. PI: P. A. T. Rani

170(15): Studies on assessment and standardization of nutrient requirements of avacado. PI: S. Rajendiran

170(16): Insect pest complex of underutilized fruit crops in high altitude regions of Western Ghats and their management PI: A. T. Rani

170(17): Studies on development of ecofriendly management practice for major pests of avocado and Coorg mandarin PI: A. T. Rani

170(18): Etiology and management of avocado wilt disease in India. PI: G. S. Madhu

CENTRAL HORTICULTURAL EXPERIMENT STATION, BHUBANESWAR

HORTIIHRCIL2015 180: Development and refinement of technologies for improving productivity of fruit and vegetable crops in east coast regions of India (Bhubaneswar). Project Leader: Dr. G.C. Acharya

Sub-Projects

180 (6): Collection, evaluation and improvement in *Moringa* and leafy vegetables of eastern region for desired characters. PI: G. C. Acharya

180 (14): Improving productivity of fruit crops (custard apple and mango) through application of plant growth regulators. PI: Deepa Samant

180 (15): Demonstration and study of impact of IIHR technologies in Eastern coastal regions. PI: P. Srinivas

180 (17): Breeding pole type French bean (*Phaseolus vulgaris* L.) resistant to rust with round and stringless pods. PI: A.V.V. Koudiniya

180(18): Development of inbred lines and high yielding F1 hybrids of chilli and brinjal suitable for Eastern coastal region market segment having combined resistance to bacterial wilt and root knot nematodes. PI: G. C. Acharya

180(19): Crop load management in fruit crops for quality and return bloom under eastern tropical region of India PI: Kundan Kishore

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11. Commercialization of Technologies

Technologies Licensed

Sl. No.	Details of License	Technology licensed	Date of MoU exchange
1	Meristem Genetech, Ullal, Vishveshwaraiah Layout, Bengaluru.	Embryogenic cell suspensions for mass multiplication of Banana (cv. Elakkiballe)	04.01.2022
2	STARJAACK Pvt. Limited, Pathanamthitta, Kerala.	Jackfruit seed powder and mushroom based biscuits/ cookies (Arka Jackies)	11.01.2022
3	Sri Renukayallamma Engineering Works, Tammarasahalli, Bengaluru Urban, Karnataka.	Arka vertical garden model	19.01.2022
4	Bloom Biotech, Chikkamagalur, Karnataka.	Arka microbial consortium (Liquid formulation)	19.01.2022
5	ARAM Energy Pvt. Limited, West Punjabi Bagh, New Delhi.	Jackfruit seed powder and mushroom based biscuits/ cookies (Arka Jackies) technology	24.01.2022
6	Kaaikari Ventures Private Limited, Mylapore, Chennai, Tamil Nadu.	Arka minimally processed onion + in a cluster (shelf life extensionof minimally processed cabbage+ fresh cut carrot+peeled garlic+ minimally processed coriander leaves+ fresh cut cucumber+ fresh cut capsicum+fresh cut French beans+ fresh cut radish)	24.01.2022
7	Steel Industrials Kerala Limited, Thrissur, Kerala	Arka vertical garden model	28.01.2022
8	M/s. Team Flame Engg & Solutions, Abbigere, Karnataka.	Licensing of machinery drawings for manufacture of Arka power operated watermelon seed extractor	18.02.2022
9	AG Organicz, Yelachenahalli, Bengaluru Karnataka.	Arka microbial consortium(S+L)	19.02.2022
10	Krishi Vigyan Kendra, Visakhapatnam, Andhra Pradesh.	Jackfruit seed powder and mushroom based biscuits/ cookies (Arka jackies) technology	24.02.2022
11	ICAR- Krishi Vigyan Kendra, Bagalkot, Karnataka.	Arka vegetable special	05.03.2022
12	Bhima Bhumi, Puri, Odisha.	Arka Kiran	24.03.2022
13	Shriven Agritechs Private Limited, Pallavaram, Chennai.	Osmotic dehydration technology of mango	26.03.2022

14	Spice Zone Nursery, Pollachi, Coimbatore.	Arka supreme Avocado variety	05.04.2022
15	Suraj shree chemicals Limited, Dwarka, New Delhi.	*Trichoderma viride* 1.5% W. P.	11.04.2022
16	Krishi Vigyan Kendra, Dumarbahar, Chhattisgah.	1. Jack fruit seed powder and mushroom based biscuits/cook ies (Arka jackies) 2. Crushed tomato technology	19.04.2022
17	HAL - Hindustan Anti-biotics Limited, Pune, Maharastra.	*Trichoderma viride* 1.5% W.P.	21.04.2022
18	Ecophytocare India Pvt. Limited, Mysuru, Karnataka.	Arka microbial consortium (solid & liquid formulations) and Arka vegetable special	22.04.2022
19	Bloom Biotech, Chikmagalur, Karnataka.	*Pseudomonas fluorescens* 1% W.P. and *Pochonia chlamydosporia* 1% W.P.	26.04.2022
20	Sharp Garuda Farm Equipments Limited, Pappampatti, Coimbatore.	Solar power operated tricycle cartfor fresh fruits andvegetable vending	27.04.2022
21	Ashok Kumar, Hesaraghatta, Bengaluru.	Arka Savi Rose	09.05.2022
22	Chittoor MangoProducer Limited, Chittoor, Andhra Pradesh.	Raw mango slice preservation in brine technology	10.05.2022
23	Ashoka Farm Aids, Yeshwanthpura, Bengaluru, Karnataka.	Chilli CGMS line	18.05.2022
24	Bindu Agri Enterprises, Tumukuru, Karnataka.	Neem Soap	20.05.2022
25	Trishul Biotech, Taramani, Chennai.	*Trichoderma harzianum*1%W.P., *Trichoderma viride* 1.5% W.P, *Pseudomonas fluorescens* 1% W.P. and *Pochonia chlamydosporia* 1% W.P.	30.05.2022
26	Siddivinayaka Horticulture Nursery, Dharmavaram, AndhraPradesh.	Arka Savi Rose	02.06.2022
27	Amith Vir, Tatanagar, Bengaluru.	Fruit and Vegetable vending van	06.06.2022
28	National Fertilizers Limited, Noida, Uttar Pradesh.	Arka microbial consortium (Solid & liquid formulations)	08.06.2022
29	Poombatta Self Help Group, Kannur, Kerala.	Sapota wine and banana wine	13.06.2022
30	Phala Agrotech, Mahalakshmipuram, Bengaluru.	Mango fruit bar, mango squash	20.06.2022
31	ADH Davanagere, Davanagere, Karnataka.	Arka microbial consortium (Solid & liquid formulations)	24.06.2022
32	Vegetable and Fruit Promotion Council Keralam (VFPCK), Ernakulam, Kerala.	Arka Sasya Poshak Ras	22.10.2022
33	Earth First Solutions LLP, Bengaluru Rural, Karnataka.	Arka Sasya Poshak Ras	15.12.2022

Patents Granted

Patent Application No.	Title of the Patent	Date of Filling	Date of Grant and Patent No.
201741044055	A novel kairomone formulation and septa design for attraction of female *Bactrocera dorsalis*	07.12.2017	Granted on 23.02.2022 Patent No. 390086.
2470/DEL/2013	DNA based diagnostics for identification of citrus rootstock cultivars	21.08.2013	Granted on 27.09.2022 Patent No. 407695.
2203/CHE/2014	"Arka Saka Nivarak" - An environmentally-safe formulation for prevention of internal breakdown disorders in mango – spongy tissue in alphonso	05.01.2014	Granted on 12.12.2022 Patent No. 414246.

Technologies included in ITMU price list for commercialization

Sl. No.	Technology name	License fee without royalty (Rs.)
1	Chilli inbred line IHR 4517	2,50,000
2	Chilli inbred line IHR 4597	2,50,000
3	Chilli inbred line IHR 4615	2,50,000
4	CGMS line with maintainer IHR 4388/ IHR 4389	3,00,000
5	CGMS line with maintainer IHR 4390 & IHR 4391	3,50,000
6	CGMS line with maintainer IHR 4392 & IHR 4393	3,50,000
7	Bottle gourd GSB resistant line BG -95(Round)	3,00,000
8	Bottle gourd Arka Nutan (GSB resistant line BG -114-3 (Medium cylindrical))	3,00,000
9	Bottle Gourd GSB resistant line BG -114-1 (Short cylindrical)	3,00,000
10	Arka Sasya Poshak Ras	1,00,000 (No training fee)
11	Arka Floral Agarbathi and Dhoop	30,000 Rs 5000/- as training fee

Business Planning Development (BPD)/Agri Business Incubation (ABI), ICAR-IIHR

During the period of report, four on site incubates were encouraged on the Institute developed technologies *viz.*, banana special, vegetable special, neem soap and mushroom. During 2022, ABI has organised three entrepreneurship development programmes (EDP) on business opportunities in horticulture for self employment, soilless cultivation & urban gardening and IIHR innovative technologies in vegetable nursery management. It has also trained 159 participants and in each of the programme awareness was created on the technologies which are having potential to start horti business by imparting skill development in the participants. Awareness was also created through the conduct of webinar on novel ideas of insect pest management in creating entrepreneurial opportunities through IIHR technologies. The guidelines of R&D recognition were framed with score -card so as to make it more comprehensive with better quality assurance. During the period, four seed companies were reviewed for R&D recognition through visit to the company, assessment of field and lab facilities and quality aspects of the seeds being sold. R&D companies Dhana Crop Sciences Limited, Hyderabad and Amazon seeds, Solan were recognized for undertaking R&D in seed production and marketing during the period. The revenue generated during the period from the incubation activity, conduct of EDPs and the R&D recognition during the period was Rs. 6,86,110.08.

R&D team on field visit to Amazon seeds company, Karnal, Haryana

Glimpse of Entrepreneur Development Programme on soilless cultivation and terrace gardening

12. Institute Research Council Recommendations

The 92nd IRC meeting was held from 22nd to 28th June and 22nd to 23 July, 2022 under the Chairmanship of Dr. Debi Sharma, Director, ICAR-IIHR, Bengaluru through video conference. At the outset, Dr. P. C. Tripathi, Member-Secretary, IRC welcomed the chairman and all the other scientists. A total of 23 projects; 142 sub-projects and 21 new sub-projects were reviewed and the technical programs for 2022-23 were approved. The major recommendations (project-wise) are elucidated below:

1. Genetic improvement of fruit crops for improved productivity, quality and resistance to biotic and abiotic stresses

- In papaya concentrate on screening of F_2 inter-generic / three way crosses by challenge inoculation and vegetative propagation (at the right stage) of selected PRSV resistant / tolerant progenies having desirable fruit quality.
- Vegetative propagation of selected F_2 intergeneric / three way cross progenies will be carried out by Dr. Linta Vincent, the Co-PI of the project.
- In grapes concentrate on breeding of scion varieties resistant to wilt and nematode coupled with desirable fruit quality rather than resistant rootstock.
- Large numbers of progenies to be raised, if necessary by collecting pollens of male parents from NRC for Grapes, Pune for crossing work.
- In *Annona* five selected self-fruitful progenies may be multiplied and evaluated in row trials for secondary selections for yield and quality attributes.
- The traits of interest and their benchmark for further augmentation of germplasm are to be clearly outlined and further collection to be done only after in situ evaluation / assessing the data available at the AICRP centres for specific traits for conservation at IIHR NAGs.
- The existing jackfruit germplasm at IIHR (Main campus) may be maintained till they are established well at Hirehalli.

2. Development and refinement of production technology of fruit crops

- Technical programmes for the two newly proposed activities on "Assessment of secondary nutrients on productivity, quality and plant health status in fruit crops'' and "Studies on organic matter recycling in *Annona* cv. Arka Sahan'' are approved and both may be initiated as proposed.
- The experiments on water and nutrient requirements have to be conducted for 3 and 2 years, respectively; hence the project needs extension from 2022 to 2024.
- Substitution of inorganic sources with organic sources should be based on nutrient equivalent.
- The fruit quality parameters may be recorded season wise.
- The results of overcoming uneven ripening in Gulabi variety of grapes may be passed on to Cumbam valley where it is cultivated with the help of AICRP on Fruits.
- After the completion of ongoing research works, a new trial on addressing the problem of slow canopy coverage and sun scorching in Red Globe variety may be initiated.

3. Genetic improvement of vegetable crops for improved productivity, quality and resistance to biotic and abiotic stress

- Work on late blight, CMV and GBNV resistance need to be emphasized.
- Head, Division of Crop Protection has to identify a virologist & bacteriologist as collaborators.
- Anthracnose resistance breeding need to be emphasized.
- Work on moisture stress breeding may be taken up.
- Emphasis on *Verticillium* wilt and poty virus resistance need to be given focus.
- Seed multiplication of Arka Avinash need to be intensified.
- Orange/yellow pulp colour in watermelon can be for the long term and immediate focus should be on regular colour
- Emphasis should be given to develop lines with combined resistance to Root knot nematode, Fusarium wilt and YVMV in okra.
- The search for new sources of multiple resistance to be intensified
- Convergent crossing/ hybridization may be attempted to widen the genetic base

- NBPGR short listed lines may be used for YVMV and ELCV in okra.
- The core collection may be screened at hot spots for resistance.
- Germplasm with targeted traits may be collected from secondary sources in legume vegetables.
- Season for screening powdery mildew in garden pea should be taken in *Rabi.*
- Emphasis has to be given for purple blotch resistance, split bulb problem and development of short-day red onion varieties.
- Onion MS lines may be evaluated across seasons/locations to find out its stability.
- Crossing long day onion with short day type may be attempted.
- Work on novel types of radish need to be emphasized.
- Carrot variety Arka Suraj may be re-evaluated for further improvement.
- Purification may be attempted in Radish germplasm and lines.
- Emphasis may be given for the single harvest type gherkin lines.
- An external expert may be consulted for collection of gherkin germplasm worldwide.
- Allelic study may be done to distinguish the R alleles for GSB in bottle gourd.
- The selected capsicum lines may be evaluated with commercial check hybrid, Indra along with Arka Athulya, evaluation for thrips and gall midge should be taken.
- Mutation breeding to identify the line suitable for round the year cultivation may be initiated in capsicum.
- The shelf life studies in drumstick leaves may be explored
- Tea mosquito bug screening may be attempted in drumstick.
- Drumstick lines suitable for HDP to be evaluated and Nutritional data may be collected for 3 years.
- Heat tolerant lines may be evaluated in hotspots like Guntur, Baramati, Varanasi, Bengaluru and Khammam.
- Registration of disease resistant lines identified earlier at CHES Bhubaneswar may be done.

4. Development and refinement of production technology of vegetable crops

- The PoP may be prepared along with fertigation schedule for vegetable crops
- In all Fertigation/ irrigation projects the correction factor for seasonal variation have to be included, while giving recommendations.
- Threshold level of yield reduction under organic farming in different vegetable crops to be looked into.
- The package of practices for cluster bean and cucumber Arka Veera may be included in technical programme.
- Study on influence of rootstock on scion may be studied when bottle gourd is used as rootstock.
- Rootstock scion interaction between bottle gourd and watermelon may be established.
- Prototype of grafting machine developed at institute may be evaluated for vegetable crops for any refinement and to be standardized.

5. Development and refinement of efficient seed production and plant propagation technologies in key horticultural crops

- Season based data on drying protocol of vegetable seeds may be provided.
- Non-destructive method for moisture estimation in seeds may be standardized.
- The NRI facility at PHT lab may be used for non-destructive method of moisture estimation in vegetable crops.

6. Genetic improvement of ornamental crops for improved productivity, quality and resistance to biotic and abiotic stress

- Pink coloured double type tuberose should be developed.
- Tuberose varieties suitable for pot culture should be developed.
- Mutation breeding in gladiolus should be continued.
- Efforts should be made to display IIHR rose varieties (suitable for landscape purpose) at different places.
- In French marigold, variegated red and orange stripes varieties to be developed.
- Marigold varieties suitable for industry (lutin and carotenoids) need to be developed.

- Collaboration of Dr. Chandra Prakash and Dr. Ramesh in the project is approved.
- Dwarf Dahlia suitable for pot and garden display with different flower colour background to be identified.
- Segregating material of dahlia to be given for landscaping of the institute.
- In gerbera, varieties suitable for pot culture and open grown condition to be given emphasis.
- Vertical farming aspects of the project should be reported under the production technology project.
- Mutation breeding in chrysanthemum should be given emphasis for novelty.
- China aster lines suitable for pot culture and garden display with different colour background need to be identified. Breeding chrysanthemum varieties for polyhouse cultivation should be the priority
- F_1 hybrid in China aster to be attempted using apetalous IIHR identified genotypes.

7. Development and refinement of production technologies of ornamental crops

- Indian bred chrysanthemum varieties should be evaluated in different photoperiod.
- Economics to be worked out for *agarbatti* making using floral wastes.
- Development of value added technologies with floral wastes to be intensified.
- Acidified methanol should be used as solvent for extraction of both anthocyanins and polyphenolics.
- The EC to be monitored periodically in soil samples where production trails are conducted.
- The title of the subproject may be modified as "Standardization of hydroponics and Vertical Farming technologies in commercially important flower crops"
- Other flower crops like lilium, gladiolus, chrysanthemum, gypsophila, limonium, lisianthus, alstroemeria etc. should be tried in vertical farming.
- Different varieties of flower crops identified by VTIC may be evaluated in vertical structures.

8. Genetic improvement of Medicinal Crops

- One-year extension is recommended to evaluate promising F_5 lines
- One-year extension is given for completing replicated trial of polyploid evaluation
- The active ingredient in *Gymnemma* leaf to be recorded.

9. Development of sustainable technologies for Post-Harvest Management, processing and waste utilization

- Activity carried out by Dr. P. Priti on "Survey to Assess Postharvest Losses in flower crops" should be included in RPP II, while being submitted by PI.
- The positive results of extended shelf-life in crops found in this project should go as recommendations for improved postharvest handling methods from the Institute.
- Best results of extended shelf-life were found in fresh cut fruits under Active MAP with 0% oxygen and 55.9% CO_2. The results shall be validated and scientific basis of survival of living tissues without oxygen for over 10 days has to be analysed to reaffirm the results. Hence caution has to exercised before recommendation.
- The best treatments which can go as technology may be presented for VITC identification.
- For upscaling, the possibility of using plastic also may be attempted.
- The economically viable outcome should go as recommendations.
- Storage studies on pumpkin soup ready mix and jackfruit seed & pumpkin seed *chikki* may be carried forward as activities in the Technical programme for 2022-23 in the new project.
- The storage studies of millet incorporated fruit beverages (mango/ guava/ pomegranate) up to 6 months may be carried forward into the new project as an activity in Technical programme. The increase in fibre content due to millet incorporation may be documented.
- As the GI of the millet incorporated beverages is above 90, they should not be recommended as low GI beverages.
- Testing of promising edible coating treatments on capsicum (green and colour) may be carried forward as activities in Technical programme for 2022-23 in the New Project.

10. Development of machinery for production and processing of horticultural crops

- The field testing of chilli harvester may be carried

forward as activities in Technical Programme in 2022-23.

- The guava pruner developed seems to be heavy. It is suggested to reduce the weight using carbon-based material. Improvement in pineapple peeler-cum-slicer has to be completed. These activities may be carried forward as activities in the new project proposal.

11. Diagnostics and integrated management of viral diseases of tropical horticultural crops

- The disease tolerant progenies may be tested in National Fund project after conclusion of the project.
- Seed washing and seed coat direct testing should be attempted for externally contaminated viruses.
- For CGMV in cucurbits international seed health testing procedure is available. Instead, work should be carried on Tomato leaf curl New Delhi virus in cucurbits to develop seed health testing procedure for this virus.
- Seed transmission nature has to be proved, plants should be artificially inoculated and maintained till harvest to get infected seeds. Seeds from the naturally infected fruits also may be tested.

12. Integrated management of fungal and bacterial diseases of tropical horticultural crops

- In mango and grape, effect of pre-harvest sprays with biocontrol agents on post-harvest diseases to be included in the study.
- Bioagents may be collected from selected healthy plants in sick plots.
- Tamil Nadu and Telangana to be included in the survey.

13. Genetic improvement and development of production and utilization technology of tropical mushrooms

- As Dr. Meera Pandey is superannuated, Dr. C. Chandrashekara to be the PI of the project.
- Request for extension of the project till October 2022 is approved.

14. Integrated Insect pest management in tropical horticultural crops

- Effect of EPN on mango stem borer may be evaluated in comparison to other methods of control.
- One-year extension is approved to study emerging pests like blossom and fruit feeding caterpillars on mango.
- The efficacy of formulations may be compared with NBAIR formulations.
- Six months' extension is approved for testing field efficacy of the formulations developed.
- Effect of other pest loads need to be recorded along with target pests.
- Status of incidence of chilli mite needs to be mentioned.
- Critical stage of application needs to be identified for TMB management in *Moringa*.
- Recommendations emerging from this project for TMB management shall be forwarded to UPASI for testing the efficacy of the same on TMB in tea by UPASI scientists.
- Management of all the major sucking pests of the crops should be targeted.
- The collaborative work regarding use of Cold Atmospheric Plasma (CAP) for pest management with NMIT needs to be discussed regarding its feasibility.

15. Integrated Nematode Management in tropical horticultural crops

- One-year extension is approved and natural occurrence of *Meloidogyne enterolobii* may be studied in other horticultural crops besides guava.
- Collaboration of Dr. Partha Choudhury is approved for chemical residue analysis in cucumber and brinjal.

16. Understanding the physiological and biochemical mechanism and their application for improving productivity and quality of mandate horticultural crops

- Strategies to enhance root growth have to be identified.
- Request for extension for three months is approved.
- Request for extension for one year approved to complete work on temperature heat stress.
- Dr. Raghu will be the collaborator and activities to be carried out by him have to be reflected in technical programme.
- The threshold for waterlogging needs to be defined.

- Flowering pattern in Royal Special shoud be studied.
- Effect of individual component and combined component to be compared.
- Water extract can be analysed for water soluble compounds.
- The trade names of commercial products have to be avoided from the results.

17. Development, refinement and use of biotechnological approaches for horticultural crop improvement and production

- Leaf essential oil phenotyping data may be linked with genotyping data in *Murraya*
- Based on the transcriptome data generated e-PCR can be carried out for validation of SSR markers.
- The proposal to change the cis-geneic approach to CRISPR based approach is approved.
- The revised technical programme shall be prepared in consultation with crop breeders and submitted.
- Instead of PEG, hydroponics with salt stress gradient may be tried for screening genotypes.
- Genotyping by sequencing (GBS) may not help in initial screening. Selection based on phenotypic characters from F_2 population may be carried out.
- All the available brinjal lines/ sorted cores or mini-cores if available may be used.
- Any further requirement of embryo rescue to be attended as a part of the breeding.
- Cas12 a based Kit for assay to be demonstrated.
- Mutants undergoing screening for *Fusarium* resistance should be screened for nematodes as well.
- Seeds of selected promising papaya (Arka Prabhath) mutant lines to be handed over to Dr. Vasugi for pre-breeding selection.
- Onion gynogenesis to be followed.
- *Cam H3* gene pathway approach followed in potato may be explored for generation large number of haploid plants .
- Spermatogenesis pathway genes are to be included in technical programme for 2022-23.

18. Soil, nutrient and water management in horticultural crops and cropping systems

- The base line data for carbon sequestration has to be generated and compared with high density and ultra-high density guava orchards. A logical conclusion has to emerge from the project.
- A logical conclusion has to be made at the end of the project.
- The collaboration with ICAR-CIRCOT has to be strengthened for furthering the research on nanotechnology.
- The analysis part of the synthesized nanoparticles has to be carried out at CIRCOT/TNAU/IISc on payment basis. The expenditure towards the analysis will be met from institute funds.
- The existing MoU with TNAU can be explored to see if there is a possibility of research collaboration in nanotechnology.
- The sample size for the survey has to be increased with a minimum size of at least thirty farmers .
- In rose and other crops where protected and open cultivation are practiced the survey can be done independently for both the conditions.
- The Head, Division of Floriculture can be contacted for getting the list of flower growers.
- The copper uptake in tuberose can be verified.
- Assessment of mineral nutrient content in different plant parts of selected flower crops to be continued and nutrient uptake data to be worked out for using as basis for making the right micronutrient formulations.
- If any published data is available on the nutrient content and uptake by flower crops at different phenological stage wise, the data can also be used for development of micronutrient formulations.
- The formulation can be prepared if published data is available and evaluated in the flower crops simultaneously.
- Only three or four crops may be chosen for evaluation.
- Fresh coir pith may also be tried for production of bio-enriched compost.
- The SRS of ICAR-NDRI can be contacted to enquire if any such products have been developed at the center.

19. Addressing soil health and environmental safety in horticultural crops and cropping systems

- Dr. Sangeetha to be included as a collaborator for carrying out the bacteriological work.
- The mode of evaluation of the developed formulation *i.e.* by challenge inoculation or through farmer's field trials can be finalized in consultation with Head of Division of Crop Protection.
- Dr. K. S. Shivashankara is included as a collaborator for carrying out the LC-MS studies on the plant growth hormone production by the bacterial strains.

20. Improving knowledge and skill of stakeholders for improving productivity of horticultural crops and impact assessment of adopted technologies

- NICRA funds may be utilized for undertaking studies at Kadmat Island for assessing the spread and acceptance.
- Feedback on the post-harvest issues faced by Arka Kiran growers if any may be recorded.
- The reason for the observed constraints may be provided.
- Reasons for particular variety being sold through seed portal at large quantity may be assessed.
- The reason for the observed constraints may be highlighted.
- Quantification of spread and acceptance need to be done as done in other projects.
- Both for aster and crossandra varieties' primary data to be collected and analysed.
- Instead of aster, may take up *Mucuna* varieties.
- Based on the outcome of the study, a policy paper may be prepared and submitted to different stakeholders.
- Data from non-APMC members may be collected and presented from the Karnataka state only.

21. Development and application of economic, statistical and ICT tools and strategies for improving and assessing productivity of horticultural crops

- Economic time/ value period (break-even point) of the vending van shall be worked out.
- Information on technology spread may be provided.
- Survival analysis, i.e., average age of the technology may be attempted.
- The technical programme for the period 2022-23 is approved.
- The scientists of the Division of Fruit Crops are requested to share the required information with Dr. Gajanana.
- Automation of new non-parametric stability method may be taken up for ease of use by the potential users.
- Query/ feedback from the farmers/ user may be categorized.
- Effectiveness and impact may be assessed by number of users registered and integrate the general farmers' query from Kisan Call Centre.
- The application may be strengthened through adding disease management module, in local language for the users.
- The technologies developed have to be routed through ITMC for appropriate recognition.
- The ICAR guidelines on securing copyright for digital multimedia products has to be followed.

22. Development, refinement and popularization of cropping system models for improving productivity of horticultural crops in high altitude regions of Western Ghats of India

- Identified lines to be handed over to CHES, Bhubaneswar in consultation with Head.
- The propagation efficiency of clone No. 6 identified by Dr. L.K. Bharathi, should be completed.
- The land site characteristics and weather parameters of the experimental field may be recorded and the soil profile can be characterized.
- Targeted collection of seedless Coorg mandarin may be attempted.
- More OP population have to be raised instead of mutation breeding in avocado.
- Dr. B. M. Muralidhara may discuss with previous workers of Chettalli presently serving at main institute for fine tuning and ensuring continuity of the research work and Dr. P. C. Tripathi may facilitate this.
- Only citrus greening work to be carried out and another project on avocado should be kept in abeyance.

23. Development and refinement of technologies for improving productivity of fruit and vegetable crops in East Coast regions of India

- Among the many leafy vegetables identified, 2 or 3 potential types may be short listed and popularized based on its nutrition and acceptability.
- Amaranthus line showing resistance to white rust may be registered with NBPGR.
- Heavy metal contents in the selected leafy vegetables grown in and around of swampy and marshy areas may be estimated.
- The consistency of best treatment in mango and custard apple may be tested across different agro-climatic zones of Odisha (at 5-6 locations).
- Instead of the word 'impact' use the phrase 'economic assessment'. The revised title may be "Demonstration and economic assessment of ICAR-IIHR technologies in different agro-climatic regions of Odisha".
- Geo survey of IIHR technologies may be done in the study districts.
- The number of technologies can be prioritized based on the state of Odisha.
- The crop production technologies may be finalized in consultation with crop production scientists at IIHR HQ.
- Large number of farmers (>30) may be included for demonstration of technologies.
- After evaluation in segregating generations the advanced breeding lines may be sent to IIHR, Bengaluru for screening for rust resistance.
- Bacterial wilt screening through root inoculation should be followed instead of leaf clip inoculation.

* * * * * *

National Water Award for ICAR-Krishi VigyanKendra, Tumakuru, Karnataka

Dr. G. Parameshwara, Ex Deputy CM and MLA, Koratagere has visited the Yelerampura Grama Panchayat, D. Nagenahalli NICRA Village on 11th Jan 2022 and appreciated work done and congratulated the team ICAR-KVK, Hirehalli for winning 'Best Village Panchayat'- South Zone, First Rank under 3rd National Water Awards-2020, by Ministry of Jal Shakti, Government of India. The water storage structure and dryland horticulture crops demonstration under, NICRA Project, KVK, Hirehalli,Tumakuru was witnessed.

SAC meeting of ICAR KVK, Kodagu

The 52nd Scientific Advisory Committee meeting of KVK Kodagu was conducted on 16th February 2022 at KVK Gonikoppal. The meeting was held under the chairmanship of Dr. B.N.S. Murthy, Director (I/c.), ICAR-IIHR, Bengaluru. Dr. B. Hemla Naik, Director of Extension, UAHS, Shivamogga and Dr. K. Thimappa, Principal Scientist, ATARI, Bengaluru also participated in the meeting. Totally there were eighteen officials from various line departments, one FPO representative, One entrepreneur and two farmer participants in the meeting. Dr. Saju George, Principal Scientist and Head, ICAR-KVK, Kodagu welcomed all the dignitaries and farmers to the meeting. It was followed by a briefremark by the chairman wherein, he spoke about the importance of the meeting and asked the participants to give their valuable feedback, for improvement of the KVK activities. All the officials and farmers gave various suggestions, which will be included in the next year action plan.

Workshop on Hydroponics and Vertical Farming

A Workshop on "Hydroponics and Vertical Farming" in Hybrid mode was organized jointly by ICAR-IIHR, Bengaluru and Society for Promotion of Horticulture on 5th March, 2022 at ICAR-IIHR, Bengaluru. Aspects covered during the workshop were solution culture and solid media culture, wick and aeroponic systems, inorganic and organic medium used in hydroponics, nutrient management and parameters to track in nutrient solution and vertical farming techniques in leafy vegetable crops, gerbera, lilium and gladiolus. Dr. C. Aswath, Dr. S. A. Safeena and Dr. M.R. Rohini, Division of Floriculture and Medicinal crops served as Training Coordinators for the Workshop. The program was attended by participants from different states.

Training on Horticultural Technologies for livelihood and entrepreneurship development for tribal farmers

Three days training on "Horticultural Technologies for livelihood and entrepreneurship development for tribal farmers" during 13th-15th March, 2022 at IMAGE campus, Bhubaneswar. The main objective of the programme was to educate the participating farmers of the region for entrepreneurship development and livelihood security. More than forty tribal beneficiaries from five tribal districts of Odisha attended the training programme.

National Seminar on Fruit production in Eastern Tropical Region of India: Challenges and Opportunities

The seminar was organized by the Central Horticultural Experiment Station (ICAR- IIHR), Bhubaneswar during 24th-26th March, 2022 in collaboration with the Society for Promotion of Horticulture, ICAR-IIHR, Bengaluru in a virtual mode. The aim of the seminarwas to devise a roadmap for the development of fruit industry in eastern tropical region through deliberations and recommendations.

Climate change sensitisation workshop in collaboration with NABARD organised at KVK Kodagu

ICAR-KVK Kodagu in collaboration with NABARD conducted a one-day training program on "*Climate change and its mitigation and adaptation strategies in Kodagu*" on 18th March, 2022 at KVK campus. Forty-two farmers attended the workshop. Dr. Saju George welcomed the guests and farmers to the programme and talked about the importance of climate change in the context of Kodagu. Captain Ranan Najappa, a progressive farmer from Gonikoppal spoke about how climate change is affecting farmers based on his experience. The untimely rainfall has forced many farmers to invest on ponds for harvesting water. Therefore, during recent years only the farmers having their own irrigation facilities are getting good harvest of coffee and pepper. Officials from Coffee Board, Veterinary department, Agriculture department, ICAR-IISR Regional Centre, Appangala and NGOs were present. It was followed by technical session handled by Dr. Harish M.N., SMS (Agrometeorology) on climate change emphasising mainly on weather abnormalities and its adaptation and mitigation strategies in Kodagu district. Later Dr. George Daniel, DDR, Coffee Research Sub-station, Chettalli delivered a talk on coffee physiology and its adaptation to changing climate. Finally, Dr. Anke Gowda, Principal Scientist & Head IISR-RS, Appangala spoke about black pepper and cardamom cultivation *vis-a-vis* to changing climate. The program concluded with a positive remark from Mr. Ramesh Babu (DDM, NABARD). At the end of workshop, the participants received participation certificate and a fruit sapling of rose apple.

Capacity Building Training Programme on Cultivation and Propagation of IIHR Varieties of Roses held at ICAR-IIHR

The capacity building programme was organized on 29th March 2022 under RKVY project entitled "Dissemination of Horticultural production technologies through extension approach for enhancing livelihood of farming community". Purpose of the training programme was to provide "Hands-on-experience" regarding cultivation and propagation of ICAR-IIHR rose varieties to farmers, officials from Karnataka State Horticulture Department, Bengaluru Rural District comprising SADH, ADH, Horticulture Officers, Assistant Horticulture Officers, Horticultural Assistants, various farm staff, students *etc.* Hands-on training cum method demonstration on production and propagation of rose varieties with special emphasis to budding was given to all the participants. Training included all the steps of planting material production in detail starting from raising of root stock, selection of buds, budding and maintenance of budded plants. Capacity Building Programme was coordinated by Dr. P. Tejaswini and Dr. S.A. Safeena.

Use of Drone in Agriculture and Horticulture Crops at ICAR- KVK Hirehalli

Agricultural Drone Demonstration was organised at ICAR-KVK, Hirehalli, Tumakuru for DAESI students on 8th April, 2022, in collaboration with Multiplex Drone Private Limited. The programme was coordinated by Shri K.N. Jagadish, SMS Agril. Extension, Shri S.M. Aravind, Senior Manager, Marketing, AGRIPLEX Private Limited, Bengaluru and Shri S. Manish, Marketing Asst. Manager- Business Development, M-DRONE, Bengaluru.

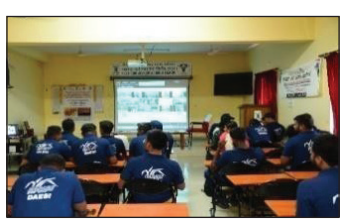
Kisan Bhagidari, Prathmiktha Hamari Campaign organized by ICAR-Krishi Vigyan Kendra, Hirehalli

On 26th April 2022 Shri G.S. Basavaraj, Member of Parliament, Tumakuru, graced the occasion of "Kisan Bhagidari, Prathmiktha Hamari" Campaign organized by ICAR-Krishi Vigyan Kendra, Hirehalli, Tumakuru II and Smt. Bhagya Satish President Hirehalli Panchayat, Tumakuru District. Farmers felt happy to receive them, Shri Basavaraju in his speech gave a message to the farmers to be together in a joint family for the success of agriculture and visited the exhibition stall in presence of Dr. R. Venkattakumar, R. Head, Social Science and Training, ICAR- IIHR, Bengaluru. He appreciated the efforts done by Team KVK Hirehalli. Smt. Rajasulochana, JDA, KSDA, Tumakuru, Smt. Keerthi Prabha, DDM NABARD, Tumakuru and Mr.Yellurkar B.D. Lead Bank Manager, Tumakuru were also present in the programme. During the day four progressive DFI farmers were also felicitated, Shri. Mahesh, Korategere; Shri Mahalingappa, Madhugiri; Shri Syed, Tumakuru and Shri Channakeshava, Tumakuru. Dr.N.Loganandhan, Head ICAR KVK Hirehalli gave

an introduction about the KBPH Campaign in his speech to the august gathering and farmer friends. Guest Speaker were Mr.Raghu (Director, ORDER), NGO's and awardee DFI farmers. The programme was coordinated by K.N. Jagadish, Ramesh PR, J.M. Prasanth, B.H Gowda, Somashaker, Jayashankar, Sannamanjunath, Shashidhar and team along with ATMA Shri Vinay and Shri Sridhar team, Dept. of Agriculture, Tumakuru. More than 288 farmers participated during the occasion.


Inauguration of Honey Testing Lab

A honey testing laboratory was inaugurated at ICAR- KVK, Hirehalli, was Tumakuru on 20th May 2022, International Honey Bee Day. This established under National Bee Keeping and Honey Mission by Government of India, as part of the Atma Nirbhar Bharat package, by National Bee Board. Shri Narendra Singh Tomar, Honorable Minister of Agriculture and Farmer's Welfare, Government of India, inaugurated this facility on a virtual platform from a similar programme organized at Kevadia, Gujarat. Mrs. Keerthi Prabha, District Development Manager, NABARD, opened the curtain. Dr B.N. Srinivasa Murthy, Director (I/c.), ICAR-IIHR, Hessarghatta, Bengaluru, was instrumental in bringing this facility to KVK, during his earlier tenure as Horticulture Commissioner, GoI. This facility will help bee keepers to test honey and other bee products for their quality and nutrient parameters. Earlier in the programme, Honorable Minister had directly interacted with Mr Chandra Sekhar, (Bee keeper and Director, Bee Keeping Cooperative Society, Tumakuru). The Honorable Minister emphasized the role of bee keeping in supporting the farmers to double their income. KVK would help potential bee keepers to takeup proper skill training for scientific bee keeping and an FPO, exclusively on Bee keeping, supported by NABARD is also on the cards. Bee keepers can test their products in this lab, which would add their brand value.

World Environmental Day - Only One Earth

On the occasion of World Environmental Day on 6th June, 2022 a Webinar on the theme "Healthy soil, water and atmosphere for healthy environment under climate change conditions" was organized. Dr. P. Raja, Principal Scientist, ICAR-IISWC, Research Centre, Udhagamandalam, T.N., was the Guest Speaker in this webinar. He highlighted various issues like soil health, landdegradation, climatechange, managing soil organic matter, soil and water conservation measures to prevent soil erosion, agricultural production cycle as impacted by climate change. He emphasised on the soil, air and water pollution issues and its ill effects on human health and ecosystem. He endedhis talk by elaborating about the water crisis our country is facing during past few decades andmeasures to overcome soil, air and water pollution to save our environment for our future generation.

Celebration of 8th International Yoga Day at ICAR-Indian Institute of Horticultural Research, Hesaraghatta

International Yoga Day (IYD) observed on the 21st of June every year in many countries including India. This year, the Ministry of AYUSH has coined the theme "Yoga for Humanity" and to celebrate IYD at heritage, historical places or near water bodies, ICAR-Indian Institute of Horticultural Research, Hesaraghatta, Bengaluru in collaboration with AYUSH Department, Bengaluru Urban District and Gram Panchayat, Hesaraghatta celebrated the International Yoga Day on 21st June, 2022 from 6 - 9 am at the premises of Hesaraghatta Lake, Bengaluru. After welcome address, IYD protocol was demonstrated by Dr. Niranjan, Yoga instructor and students from AYUSH Department, Bengaluru Urban District. Dr. Debi Sharma, Director (I/c.), ICAR-IIHR, explained the theme of Yoga Day- 2022. She added why Hesaraghatta lake was chosen and expressed her happiness and unique experience for conducting the programme at Hesaraghatta lake premises. Further, she emphasised about the pre-requisites for practicing yoga and urged staff members to practiceyoga to keep stress at bay. More than 500 participants including scientists and staff from ICAR-IIHR, staff and students from Adichunchanagiri Ayurveda college, Sanatana Ayurveda

college, Hesaraghatta High school, Gram Panchayat President and Members, nearby villagers participated in this historic event.

National Dialogue on Extension Services for Efficient Delivery of Horticultural Technologies: A Way Forward

ICAR-IIHR organized a National Dialogue on "Extension Services for Efficient Delivery of Horticultural Technologies: A Way Forward", during 20th-21st May, 2022. In the inaugural session of the two-day National Dialogue, Dr. R. Venkattakumar, Principal Scientist and Head (I/c), Division of Social Sciences and Training and Organizing Secretary delivered the welcome address. Dr. V. V. Sadamate, Former Advisor (Agriculture), Planning Commission (now NITI Aayog) set the context of thedialogue. Dr. B.N.S. Murthy, Director,(I/c.) ICAR-IIHR delivered the introductory remarks wherein he emphasized the need for dissemination of advanced horticultural production technologies through latest extension delivery services. Dr. P. Das, Former DDG (Agricultural Extension), ICAR, New Delhi and Dr. K. Narayana Gowda, President, International Society of Extension Education, Nagpur, Former Vice-Chancellor, UAS, Bengaluru delivered special address. Dr. V.K. Pandey, ADG (Hort. Science-I) graced the programme through online mode and addressed the participants. Dr. A. K. Singh, DDG (Horticulture), addressed the delegates and highlighted the importance of efficient extension services for promotion of horticultural technologies.

Technical sessions were held on both days covering various aspects of extension programmes and management such as horticultural perspective, entrepreneurships, partnerships and startups in horticulture sector and reorienting extension services, horticultural extension: research focus and priorities and ICT in horticulture.

Training programme on Nutri Garden

Training programme on Nutri garden was conducted on 22nd June 2022 at Hosapalya village, Sira. This training programme was organized in collaboration with Swawalambi FPO, Bukkapattana, Sira. Mrs. Radha R. Banakar, SMS-Home Science, explained about the role of fruits and vegetables in daily diet to achieve nutrition security among farm family members. Mr. J.M. Prashanth, SMS (Horticulture), explained about the layout of nutri garden and uses of some medicinal plants in day today life and Mr. P.R. Ramesh SMS-Soil Sciencebriefed about the use of organic micronutrients and foliar application in nutri gardens.This training programme was attended by 25 farmers and farm women from Hosapalya village.Later basic data of selected farm families was collected and critical inputs (seed kit, some fruits and medicinal plants seedlings, micro nutrients, AMC *etc*) were distributed to the selected farm women. This programme was co-ordinated by Mr. Tipperudrayya, Swavalambi FPO, Bukkapattana, Sira Taluk.

Training and Capacity Building Program for Chief Executive Officers and Board of Directors of Amrith Farmer Producer Organizations

Training and Capacity Building Program for Chief Executive Officers and Board of Directors of Amrith Farmer Producer Organizations Promoted by WDD and DoH in Tumakuru Districtwas organized in collaboration with ICAR-KVK, Hirehalli on 1st July, 2022 in presence of Dr. Ashok S. Alur, Director, Centre of Excellence for farmer producer organization, GKVK Campus, Bengaluru. About 50 farmers attended the training.

Visit of Honourable Union Minister for Agriculture and Farmers Welfare Shri Narendra Singh Tomar ji to ICAR-IIHR

Honourable Union Minister for Agriculture and Farmers Welfare Shri Narendra Singh Tomar ji visited ICAR-IIHR, Bengaluru, on 15th July, 2022. Shri Kailash Choudhary, Minister of State for Agriculture and Farmers' Welfare, Shri Surya Pratap Shahi, Minister of Agriculture, Govt. of Uttar Pradesh, Shri Dinesh Pratap Singh, Minister of Horticulture, Govt. of Uttar Pradesh also accompanied him during the visit. During this occasion, Honourable Agriculture Minister inaugurated two state-of-the-art facilities created at ICAR-IIHR. Honourable Agriculture Minister first inaugurated the Centre of Excellence for Protected cultivation that has been funded by Mission on Integrated Development of Horticulture (MIDH), MoA& FW, Government of India through NHM-Karnataka. All dignitaries visited the newly created facilities and appreciated the infrastructure that would be beneficial to large number of stakeholders.

This infrastructure will facilitate the production of quality seedlings of vegetable and flower crops using automated sowing machine, assembly line, and hi-tech greenhouses; demonstration of polyhouse cultivation, training farmers on protected cultivation of vegetables, flowers and fruits, production and distribution of grafted vegetable seedlings, promoting newer technologies such as soil less cultivation, organic vegetable production, biological pest and disease management, terrace gardening, vertical farming and conducting research for refinement of technologies in protected cultivation.

Honourable Agriculture Minister also inaugurated the Business Entrepreneurship and Start-up Support through Technology in Horticulture (BESST-HORT), a Technology Business Incubator of the Institute that is funded by Department of Science and Technology, GoI under its National Initiative for Developing and Harnessing Innovations (NIDHI) Scheme. This initiative would provide a springboard for the youth to establish start-ups in horticulture / agriculture through innovation and entrepreneurship. BESST-HORT would provide technical handholding, mentoring and other support to the agri start-ups on its campus. The centre also provides onsite and virtual training and hand holding assistance.

During this occasion, an exhibition on horticultural technologies developed by the Institute where displays of recent successes with improvement of varieties & hybrids, products, technologies were displayed. All dignitaries appreciated the progress made in the research on horticultural sciences by the institute. It was followed by a function where the Honourable Minister addressed all the gathering at the auditorium. Dr. Debi Sharma, Director (I/c.) welcomed the dignitaries and Dr. A.K. Singh, Deputy Director General (Hort. Sci.) highlighted the contribution of the institute for the last 55 years with highlights, *viz.* dogridge rootstock of grapes, multiple disease resistant varieties, microbial formulations, micronutrient specials, honeybee assisted pollination success in commercialization horticultural technologies etc. He specifically highlighted the successes achieved by Ph.D. Scholars of the Institute. A new video on "Honey bee Assisted Pollination in Protected Cultivation" was released by the Chief Guest. The website of the BESST-HORT also was inaugurated virtually. Besides the three technical bulletins *viz.*, Success Stories of ICAR-IIHR Interventions in NEH Region towards Livelihood Security, Avocado cultivation in India (Hindi), Dragon Fruit in India: Present Situation and Possibilities (Hindi) were released by the Chief Guest. Honourable Agriculture Minister addressed the gathering and he lauded the progress made by Horticulture Subject Matter Division of ICAR and IIHR. He mentioned the importance given by the government for the promotion of horticulture in the country. In his address he highlighted how the visionary guidance of Honourable Prime Minister has helped in achieving the progress made so far as well as his vision for the future.

PCRA Training programme on Energy Conservation

PCRA Training programme on Energy conservation was held at Junjaramanahalli, Koratagere Taluk, Tumakuru on 15th July, 2022 by Krishi Vigyan Kendra, Hirehalli, Tumakuru. Mr. P.R. Ramesh, Subject Matter Specialist (Soil Science) has explained about energy conservation measures required at various segments of agricultural activities. Mr. Anand, Director, AVISHKAR NGO also graced programme. 15 Soil Health Cards were distributed to famers post event and 21 farmers participated in the programme.

On-campus training on Oyster Mushroom Cultivation

On-campus training on Oyster mushroom cultivation was conducted on 19th July, 2022 at Krishi Vigyan Kendra, Hirehalli. Mr. Ramesh P.R, SMS-Soil Science delivered lecture on spawn production techniques. Mrs. Radha R. Banakar SMS- Home Science gave a lecture on nutritional importance of different kinds of mushrooms along with oyster mushroom cultivation technique. Later trainees were demonstrated on mushroom bag filling and bag incubation methods. At the end, certificates and training manuals were distributed to the participants. This training programme was attended by 29 farmers and farm women from Tumakuru and surrounding districts.

Off campus training under National Food Security Mission (NFSM) Scheme

Off campus training programme was organized at Budubetta Village, Pavagada on 19th July, 2022 under National Food Security Mission to create the awareness on improved technologieson pigeon pea cultivation. This

programme was organized in collaboration with FPO-ULUMEof Y.N.Hosakote, Pavagada, Tumakuru. Totally 25 farmers participated in the programme.

On-campus training on Coconut Value-Addition under EDP programme

On-campus training on Coconut Value Addition under EDP programme was conducted on 27th July, 2022 at Krishi Vigyan Kendra, Hirehalli. Mrs. Radha R. Banakar SMS- Home Science explained about the training programme. Dr. N. Loganandhan, Principal Scientist and Head, KVK, Hirehalli explained about the importance of coconut value addition as coconut products were selected under One District One Product (ODOP) for Tumakuru district. Mrs. Chandrakala Nagesh participated in this training programme as resource person. She demonstrated preparation of value added products like Coconut chips, *burfi*, coconut-flax seed *laddu*, coconut –millet *laddu*, coconut biscuit, and cookies.

Celebration of 75th Independence Day

ICAR-IIHR celebrated 75th Independence Day on 15th August, 2022 following all COVID-19 protocols. The programme started with the flag hoisting by Dr. Debi Sharma, Director (I/c.), ICAR- IIHR, followed by mass singing of National Anthem. In her speech, Director conveyed Independence Day wishes to all the staff members and remembered the struggle and sacrifices of our freedom fighters to get independence. She also recollected India's 75 years of efforts Independence to be self-reliance in all aspects including food production. She also appreciated the hard work and contribution of farmers for the record evaluation of horticultural crops. She also appealed to all the staff to work with dedication and commitment for a self-reliant India. 'Har Ghar Tiranga campaign' was also successfully organized by distributing the flag to IIHR staff members and uploading the photo in GoI website.

At Central Horticultural Experiment Station (ICAR-IIHR), Chettalli Independence Day-2022 was celebrated from 13th-15th August, 2022. Har Ghar Tiranga: flags were distributed to all the staff, selfies were taken and uploaded in the Har Ghar Tiranga website. On 15th August, 2022, flag hoisting was done by Dr. S. Rajendiran, Scientist and Head (I/c), CHES, Chettalli, honoured the freedom fighters by paying floral tribute and addressed the gathering. Cauvery Staff Recreation Club, CHES Sports Club and CHES Padasalai were inaugurated. Various sports and cultural activities were organized and prizes were distributed to the winners and theparticipants. All the staff and their family members actively took part in the programme.

17th Parthenium Awareness Week

The 17th Parthenium Awareness Week was organized at Central Horticultural Experiment Station (IIHR), Chettalli from 16th-22nd August, 2022. Several activities were organized to create awareness on Parthenium eradication among staff members, college students, field workers and school children. The posters and folders of 'Parthenium Awareness Week', were displayed in front of office to create awareness to the visitors and staff members.

Central Horticultural Experiment Station, ICAR-IIHR, Bhubaneswar observed "Parthenium AwarenessWeek" during 16-22 August, 2022 following Covid protocols. On 22nd August 2022, all the staffs including research scholars, outsourced personnel, field workers etc participated in the parthenium awareness week. Dr G.C. Acharya, elaborated the harmful impact of parthenium to environment, agriculture production and human health and need for complete eradication of parthenium in the surroundings. Officials of the station spokeabout the importance of the programme. Mr. M.K. Pattnaik, TA & member, Swachha Bharat Abhiyan demonstrated the species to the gatherings. Emphasis was given for a parthenium-freecampus.

Celebration of 56th Foundation Day

ICAR-IIHR, Bengaluru celebrated its 56th Institute Foundation Day program on 05th September, 2022, which was also webcasted through zoom and YouTube platform. The program commenced with ICAR and IIHR theme songs followed by invocation. Dr. Debi Sharma, Director (I/c.), ICAR-IIHR, Bengaluru delivered her welcome address and also briefed about the IIHR achievements during the past year. She briefed about the new varieties of fruits, vegetables and flowers and various other technologies released and also those in pipeline. Dr. M. Angamuthu, Chairman, APEDA and Chief Guest of the function delivered the foundation day lecture on the topic "Boosting agricultural and horticultural export". In his talk, he explained the development of horticulture over a period of time that has brought a tremendous change in Indian economy. He emphasized on the impact assessment of horticultural products *vis-à-vis* trade and export and also on the need for development of sea protocols. He congratulated all the staff who have contributed immensely towards

the development of horticultural sector and wished for collaboration between APEDA and IIHR. Dr. Debi Sharma, Director (I/c.), ICAR-IIHR and Dr. Angamuthu, Chairman, APEDA exchanged the signed copies of the MOU between ICAR-IIHR and APEDA. The session was followed by felicitation of chief guests and retired staff of ICAR-IIHR in different categories. Director also awarded the 'Best Farmer Award' to five innovative farmers: Mr. Raj Halappa, Ms. Babuni Sahoo, Mr. Sreedhara C.Y., Mr. Lokesh and Mrs. Jayalakshmi, who have adopted ICAR-IIHR technology, earned more income and became role models to fellow farmers. On this occasion, best Staff (Technical/ Administration/ SSS), Best Teacher and Best Student awards were also distributed. Prizes were distributed to the winners of foundation day sports event. Dr. Vikramaditya Pandey, Assistant Director General (HS-I), ICAR, New Delhi, Guest of Honour, in his virtual address congratulated the ICAR- IIHR staff on Institute's Foundation Day and conveyed his best wishes for future endeavours. Directors and staff of various Institutes, scientists and staff of IIHR, retired staff and other participants joined the program from auditorium and also through zoom and YouTube. Post lunch a dazzling cultural event was also organized in which staff as well as students participated.

Guest lecture on Nutritious Food for students

Department of Women and Child development, Zilla panchayat, Tumakuru organized workshop on Nutritious food for students on 12th September, 2022 at District balbhavan, Tumakuru. Mrs. Radha R. Banakar, SMS-Home Science, ICAR-KVK, Hirehalli attended this programme and delivered lecture on Health, nutrition and Nutritious foods for students.

National Campaign on Poshan Abhiyaan and Tree Plantation

National Campaign on "Poshan Abhiyan and Tree Plantation" was organized on 17th September, 2022 at ICAR-KVK, Hirehalli, Tumakuru in collaboration with IFFCO and DHAN foundation. Dr. N. Loganandhan, Head, KVK, Hirehalli inaugurated the function by lightening the lamp and explained the purpose of this programme. Sri Parashanth J.M, SMS (Horticulture), delivered a lecture on importance of nutrition and their plant based sources like fruits and vegetables and how to cultivate in limited area. Mrs. Radha R. Banakar, SMS (Home Science),covered the topic on importance of Nutri-cereals in daily diet and their role on human health and also explained about bio fortified varieties. Vegetable seed kits from IFFCO and planting materials from KVK were distributed to all the participants. About 51 farm women from DHAN Foundation took part in the programme. Participants along with staff were involved inTree plantation activity at the KVK instructional farm.

Awareness cum Training on Recent Developments in Nutri-Cereals

Awareness cum Training on "Recent Developments in Nutri-Cereals" was held at Tovinakere, Koratagere Taluk, Tumakuru on 26th September, 2022 by Krishi Vigyan Kendra, Hirehalli, Tumakuru. Mr. Hemdore Raghu, progressive farmer has explained cultivation of millets. Dr. Suresh, Head, CoE, Nutri-Cereals, GKVK, Bengaluru gave lecture on millet value-addition. Mrs. Keerthiprabha, DDM, NABARD, Tumakuru explained the facilities available in banks for agriculture. Dr. Loganandhan, Head, KVK, Hirehalli, has explained about the KVKactivities. Mr. P.R. Ramesh Subject Matter Specialist (Soil Science) has explained about importance of soil testing. About 200 farmers participated in the programme.

Visit of quinquennial Review Team (QRT)

Quinquennial Review Team (QRT), ICAR-IIHR for the period 2017- 22, constituted under the chairmanship of Dr. V.A. Parthasarathy, President, National Academy of Biological Sciences and former Director, ICAR-IISR, Calicut, visited ICAR- IIHR on 6th October, 2022 to review the activities. Honorable members of the QRT committee, Dr. B.N. Hazarika, Dr. K.P. Singh, Dr. A.K Mishra, Dr. Sreenath Dixit, Dr. D. Balasimha and Dr. V. Ravi were present.

Dr. Vikramaditya Pandey, ADG (HS),during his online inaugural address, welcomed the Honorable Chairman and members and sought suggestions on tangible recommendations for overall improvement of the horticultural sector. Committee visited central facilities like Centre of Excellence on protected cultivation, nursery, mushroom lab, food safety Referral lab and seed unit apart from experimental fields.The facilities provided at these centers were well appreciated by the Chair.

Director, ICAR-IIHR presented the overall achievements of the institutes for the period 2017-22 followed by action Taken Report of last QRT, PC (Fruits), Nodal officers of PG Education and ITMU, ICAR- IIHR. Chairman and members congratulated the Institution for being awarded with first rank among 93 ICAR institutes.

District Level Workshop on "Multiple Cropping System with High Value crops inTumakuru District"

A District level Workshop on "Multiple Cropping System with High Value crops in Tumakuru" was organized in association with Farm TV Bengaluru funded by Directorate of Cashew and Cocoa Development Kochi (DCCD) at MBA Auditorium, SIT, Tumakuru on 14th October, 2022. The Chief Guest Dr. Prasad, Joint Director, Department of Horticulture, Government of Karnataka, while inaugurating the workshop, emphasized on the significance of multi-cropping system in Arecanut and Coconut gardens and also production of quality planting material of cashew, pepper crops for increasing the farmers' income in the district. Dr. N. Loganandhan Head, KVK welcomed the guests, farmers and spoke on KVK activities carried out in the district and production of the agri inputs products at KVK. Mr. J.M. Prashanth SMS (Horticulture) ICAR-KVK, Hirehalli proposed vote of thanks. This workshop was attended by more than 300 farmers from all over Karnataka.


Training programme on Honey bee keeping

Training programme on Honey bee keeping was organised at ICAR-KVK, Hirehalli, Tumakuru-II on 18th October 2022. Dr. N. Loganandhan, Head, KVK, Hirehalli has given introductory remarks on importance of honey bee keeping in as a source of income as an enterprise one can involve in commercial activity. The honey bee expert Sathyanarayana Bhat, Sagara Shivamogga district has delivered a lecture on the Honey Bee Keeping and practical session was carried out for Honey bee Production. The Bee Keepers Cooperative Society, Tumakuru coordinated the training programme. About 27 trainees were attended thetraining programme.


QRT Team Visited ICAR-KVK, Hirehalli

The QRT team of ICAR-IIHR, Bengaluru visited to ICAR-KVK, Hirehalli on 3rd November, 2022. Dr. V.A. Parthasarathy FNABS, President, National Academy of Biological Science, Chairman QRT and Dr. D. Balasimha (Former Principal Scientist, ICAR-CPCRI, Vittal), QRT Member visited different demonstration units of KVK. A brief progress report was alsopresented by Dr. N. Loganandhan, Head and Principal Scientist, KVK. Chairman and member of QRT appreciated the activities of KVK.


Celebration of 30th Foundation Day, CHES Bhubaneshwar

Central Horticultural Experiment Station (ICAR-Indian Institute of Horticultural Research) Bhubaneswar celebrated its 30th Foundation Day on 6th November, 2022. At the outset Dr. G.C. Acharya, Head (I/c.) welcomed all the guests and office staff present at the venue. Dr. G.C. Acharya, Head (I/c.) while delivering his welcome address gave a brief account of achievements and activities of the station. He appreciated the hard work put up by the present and past employees, and other workers towards the development of the Station as a prestigious institution in the State. Several staff like Dr. Kundan Kishore, Dr. P. Srinivas, Dr. A.V.V. Koundinya, Dr. Deepa Samant, Dr. Manas Sahoo, Mrs. Rina Pattnayak, Mrs. Annapurna Behera, Sri. Manoj Pattanaik, Smt. Suchitra Behera, Sri. A.K. Barik, Mrs. Suvasini Pradhan, Mr. BiswanathPaikray, etc shared their experience, and old memories during the long journeyof the Station. On this occasion, successful farmers Sri Susanta Kumar Patra, Khordha and Sri Deepak Kumar Nayak, Sambalpur were facilitated for adoption and promotion of ICAR-IIHR technologies. Chief Guest of the function Dr. Gourahari Naik, former Head, elaborated the history of CHES establishment and highlighted the contribution of staff in the development ofthe station. He appreciated the station for working with same zeal for the benefit of farmers. Guest of Honour, Mr. Banshidhar Mohapatra, former AF & AO, fondly recalled his memoriesand experiences during his tenure the Station. A brief cultural program also organized at the end.

CHES (ICAR-IIHR), Chettalli organized a capacity building program on "Sustainable Crop Production & Resources Distribution" under TSP at Valnur, Kodagu

The inputs like fruit plants and *Trichoderma* were distributed. Nearly 110 tribal farmers participated from

Kushalnagar and Somawarpet taluks, and staffs from Swami Vivekananda Youth Movement, Tribal Welfare Department, Kodagu and Valnur Gram Panchayath Officialsand Members were also present.

Interaction Meet with State Minister, Scientists and Department Officials

District Horticulture Department organized an interaction meet with District in-charge Minister Shri. B. C. Nagesh, Primary and secondary education Minister, Government of Karnataka. This Farmers-Scientists interaction meeting was held at Tiptur on 17th November 2022 regarding the outbreaks of Stem bleeding in Coconut and Stem rot diseases in Arecanut. The KVK expert SMS (Horticulture) and other scientists explained about the severe epidemic of stem bleeding and Stem rot caused by the fungus due to heavy rainfall andprevalence of favourable weather conditions over a relatively long period of time. On the remedial steps, advice was given for community based integrated disease management. Minister suggested to go for mass media publicity and technical demonstrations in severely affected areas. The KVK Scientists along with Department officials visited the problematic Coconut and Arecanut orchards in and around Tiptur. Awareness was brought to ADHs and AHOs on the management of diseases.

National Symposium on Horticultural Crops of Humid Tropics for Nutritional and Livelihood Security (NSHCHT) cum Exhibition- 2022, ICAR-IIHR-CHES, Chettalli

To commemorate Platinum Jubilee Year (75th year) Celebration of CHES, Chettalli, a National Symposium on "Horticultural Crops of Humid Tropics for Nutritional and Livelihood Security(NSHCHT)" & Exhibition-2022 was organized at Hotel Crystal Court, Madikeri, in collaboration with the Society for Promotion of Horticulture (SPH), ICAR-IIHR, Bengaluru during 02-03 December, 2022.

In the inaugural function, presided over by Dr. Debi Sharma, Director (I/c.), ICAR-IIHR, Shri Appachu Ranjan, MLA, Madikeri, Dr. Sateesha B. C, Deputy Commissioner of Kodagu District, and Ex-Vice Chairman of Coffee Board and Progressive Planter from Suntikoppa, Shri Bose Mandanna were welcomed and honored. They expounded the contribution of CHES to the farming community and suggested to open the sales outlet centre at Madikeri to cater to the needs of the public/farmers. The retired Heads, ex-employees and their family members of the station were felicitated. Three progressive farmers were also awarded in the function for adopting and disseminating IIHR technologies.

Sponsored Training Programme on Beekeeping

Sponsored Training Programme on Beekeeping was organized at KVK, Hirehalli in collaboration with Bee-Keepers Cooperative Society Ltd, Tumakuru. The programme was inaugurated by Dr. N. Loganandhan, Principal Scientist and Head KVK, Hirehalli. Sri Shankar, Technical Assistant delivered a lecture on Bee keeping. During the training programme practical exposure on separation of queen bee was dealt by him. The Programme was coordinated by Sri K.N.Jagadish, SMS (Agril. Extn.), KVK,Hirehalli and Sri Paramesh, President, Bee Keepers Society.

Celebration of World Soil Day

ICAR-Indian Institute of Horticultural research, Bengaluru celebrated World Soil Day 2022 with the message "Soils: Where food begins" on 5 December, 2022. The chief guest, Dr. J. C.Tarafdar, ICAR & UGC Emeritus Scientist and Member QRT, ICAR-IIHR, in the virtual mode, delivered a lecture on the "Role of Nano Fertilizers for Global Farming", and dwelt at length on the importance of nano fertilizers in modern day agriculture, their developmental processes, evaluation protocols in different crops and the need for such formulations in order to enhance the nutrient retention and uptake in different crops. Dr. Debi Sharma, Director (I/c.), in her presidential address lauded the Division of Natural Resources for arranging the functionin a befitting manner and emphasised on the need for soil health in the emerging scenario of climate change. Eminent scientists from the Division of Natural Resources delivered lectures on "Conservation Agriculture for restoration of Soil Health" by Dr. T.R. Rupa, "Aberrations and Adaptive Concepts in Soil Health" by Dr. G. C. Satisha, "Soil and Water Salinity – Problems and Management" by Dr. L. R. Varalakshmi and "Importance of Soil Biodiversity" by Dr. G. Selvakumar. Messages of the Hon'ble Minister of Agriculture and Farmers Welfare

and Director General, ICAR were read out and displayed at all prime locations in the office premises. Soil Health Cards were also distributed to the farmers during the occasion.

ICAR-KVK, Hirehalli, Tumakuru-II organized "World Soil Day" at Jaggenahalli, Madhugiri, Tumakuru on 5th December 2022 in collaboration with AVISHAKR, NGO, Tumakuru. Dr. N. Loganandhan, Principal Scientist & Head KVK, Hirehalli explained about the theme of year World Soil Day 2022 "Soils Where Food Begins". He also explained about the various support that KVK provides with reference to Soil & Water Conservation. Mr. Anand, Head, AVISHAKR NGO, Tumakuru explained about importance of Soil fertility with use of organic manure, especially AMC from ICAR- IIHR, Bengaluru. In this programme Soil Health Cards were also distributed to the farmers and farm women. About 50 farmers were participated in the programme.

Distribution of Soil Health Card to farmers on World Soil Day

Sponsored Training on Recent Technologies in Agricultural and Horticultural Crops

A Sponsored Training on "Recent Technologies in Agricultural and Horticultural Crops" was organized in association with Command Area Development Authority, Govt. of Karnataka,on 13th December 2022 at ICAR-KVK, Hirehalli. Sri Maruthi, ADA of CADA welcomed the Guest and Farmers. The Chief guest Dr. Loganandhan, Principal Scientist &Head, KVK, Hirehalli, inaugurated the programme and emphasized on the KVK activities carried out in the district, production of the agri products at KVK premises. During technical session Sri P.R.Ramesh, SMS, delivered a lecture on "Role of Soil and Soil Health Management in Food Production Technologies", Dr. Somasekhar , SMS, delivered a lecture on "Cereals and Pulses Production Technology" and Sri J M. Prashanth, SMS, delivered a lecture on "Arecanut and Coconut Scientific Cultivation Practices". The Veterinary Officer, Dept. of Animal Husbandry, Tumakuru interacted with the participants regarding the diseases management in the mulching animals.

Kisan Diwas-2022 at ICAR- KVK, Hirehalli

In collaboration with Department of Agriculture " Kisan Diwas-2022" was organized at ICAR- KVK, Hirehalli on 23rd December 2022. During the occasion five innovative farmerswere felicitated. Mr. Aswath, Assistant Director of Agriculture, Tumakuru highlighted the importance of Kisan Diwas and details about the various schemes for the farming community.Dr. Somasekhar, SMS-Plant breeding, KVK, Hirehalli highlighted the importance of sustainable agriculture. He also gave the information on the various activities being conductedat KVK, Hirehalli. The programme concluded with vote of thanks by Mr. Sridhar of ATMA Scheme. The programme was coordinated by Mrs. Radha R Banakar, SMS Home Science, KVK, Hirehalli, About 50 farmers, ATMA scheme staff and other KVK staff were participated.

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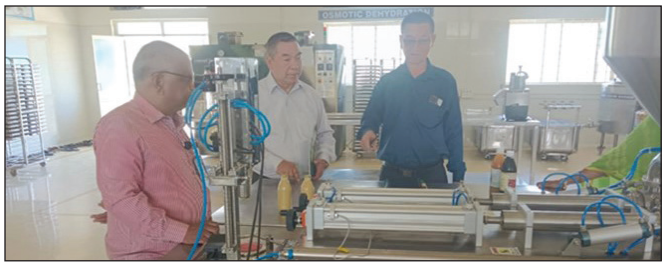
14. North East Service, Tribal Sub-Plan, Women Empowerment and MGMG

A. NEH

Since the commencement of NEH program, ICAR-IIHR varieties and technologies were spread across all north eastern (NE) states such as Assam, Manipur, Tripura, Meghalaya, Mizoram, Nagaland, Sikkim and Arunachal Pradesh which covered an area of more than 4200 acres. During 2022, a total quantity of 1070 kg seeds of different vegetables *viz.*, tomato hybrid (Arka Abhed), chilli hybrid (Arka Meghana), okra hybrid (Arka Nikita), brinjal (Arka Harshita), pumpkin (Arka Suryamukhi), yard long bean (Arka Mangala), palak (Arka Anupama), bottle gourd (Arka Bahar), ridge gourd (Arka Prasan), cowpea (Arka Garima), french bean (Arka Komal), radish (Arka Nishant), muskmelon (Arka Siri), dolichos (Arka Sambhram), china aster (Arka Archana), watermelon (Arka Shyama), amaranthus (Arka Suguna) and coriander (Arka Isha), were distributed to 601 beneficiaries. This has created lot of demand for seeds of IIHR vegetable varieties and many NE state departments are purchasing seeds and planting materials directly from the institute. More than 17 training programs (including on-campus and off-campus) on fruit, vegetable and flower crop production technologies, post-harvest technologies, kitchen gardening and mushroom cultivation *etc.*, were organized in coordination with 15 KVKs and all the NE state department of Agriculture/ Horticulture. About 542 participants were benefitted from 17 training programs conducted under ICAR-IIHR-NEH program. To increase the knowledge on latest horticulture production techniques, ICAR-IIHR along with KVKs and state department of agriculture and horticulture has conducted 1020 demonstrations during 2022 with latest varieties and technologies developed by ICAR-IIHR, which helped farmers in NE regions to increase productivity and quality in horticultural crops. About 50 avocado (cv. Arka Supreme) plants were distributed to KVK, Aizawl for establishing scion bank. Jack, annona, mango, guava and dragon fruit plants were also distributed to the farmers of NE states. About 1500 kg of bio-fertilizers and micronutrients special were distributed to 550 farmers for improving soil health and quality of horticultural crops. Strengthened the inter-institutional linkages between ICAR-IIHR and KVKs, NHB, NABARD, Developmental Departments of all the NEH states to spread ICAR-IIHR technologies.

Training program on "Post-harvest management and value addition of kiwifruit, pineapple and other fruits of North East India" from 13th- 18th August, 2022.

Visit of Honourable Agriculture, Cooperation and Irrigation Minister, Government of Mizoram Shri C. Lalrinsanga to ICAR-IIHR on 3rd October, 2022



CEO, BESST-HORT explained about incubation facilities available at ICAR-IIHR to the officials from Department of Horticulture, Govt. of Mizoram on 21st December, 2022

Capacity building cum interaction programe with farmers of Tenzingaon, West Kameng district of Arunachal Pradesh, Aizawl district of Mizoram, Udalpuri and Darrang district of Assam during 19th - 22nd August, 2022

B. TRIBAL SUB-PLAN (TSP) PROGRAM

During the year 2022, ICAR-IIHR was involved in developmental activities for uplifting tribals of our country under TSP program. ICAR-IIHR varieties and technologies were spread across India in general and South India in particular through TSP program. About 49 training programs (including on-campus and off-campus) were organized for tribal farmers in coordination with KVKs and the state department of Agriculture/Horticulture to improve the knowledge on latest horticulture crops varieties and production techniques. Conducted 2456 demonstrations with latest varieties and technologies developed by ICAR-IIHR, which helped the tribal farmers of the country to increase productivity and quality in horticultural crops. A total of 20,375 number of planting materials of different fruit and flower crops *viz.*, mango, guava, dragon fruit, annona, rose, marigold and aster were distributed to 662 TSP beneficiaries from different states covered under the ICAR-IIHR Tribal Sub-Plan (TSP) program. A total of 2900 kg seeds of different vegetables *viz*., tomato, chilli, brinjal, bhendi, amaranthus, french bean, dolichos, bottle gourd, ridge gourd, radish, coriander, watermelon, muskmelon, cowpea, yard long bean, garden pea and palak were distributed to 1550 beneficiaries from Karnataka (Mysore, Bengaluru, Kolar, Chitradurga, Chikkaballapura, Bijapur, Raichur, Tumkur and Kodagu district), Kerala (Kollam, Kottayam, Wayanad and Idukki district), Tamil Nadu (Salem, Dharmapuri, Theni, Thiruppattur, Virudunagar and Coimbatore district), 12 districts of Telangana, 6 districts of Andhra Pradesh and Odisha. About 3351 kg of tuberose bulbs were distributed to 21 TSP beneficiaries from Sira taluk of Tumkur district, H.D Kote taluk of Mysore district, Chitradurga, Ramanagara and Chikkaballapur district of Karnataka. Tuberose farmers were impressed with the performance of IIHR tuberose variety Arka Prajwal in terms of yield, market and monetary benefit. Due to the success through demonstration conducted under TSP program there is an increasing demand for more seeds of ICAR-IIHR released varieties/hybrids and many state departments are purchasing large quantity of seeds and

planting materials directly from the institute. A total of 550 farmers were benefitted with supply of 4267 small implements (mainly mango harvester, lemon harvester, sprayers *etc*.,) and traps under the TSP programme. A total of 2020 farmers were supplied with the inputs like fertilizers, micronutrients special, bio-fertilizers, bio-pesticides and other organic manures (neem cake, pongamia cake, vermicompost *etc*.,) under the TSP program. With respect to promotion of kitchen garden, about 800 farmers and tribal women were provided with vegetable seed kits comprising of 8 OP varieties of IIHR, garden tools *etc.*, Mushroom production structures were provided to 20 tribal beneficiaries from Heggadadevanakote (HD Kote) taluk of Mysore. Six nurseries were established in Chikkaballapur and HD Kote under TSP programme for producing quality vegetable seedlings of ICAR-IIHR varieties.

C. WOMEN EMPOWERMENT

International women's day

The International Women's day was celebrated at ICAR-IIHR on 8th March, 2022 in hybrid mode, wherein about 400 staff participated. The chief guest of the day was Dr. Geetha Ramanujam, a well-known educationalist, founder and academic director of GR educational institutions, Bengaluru. Dr. Geetha addressed the ICAR-IIHR staff, through her inspiring speech on the topic "Women self-reliance". As a mark of appreciation, five inspiring women namely, Smt. Padma S. and Smt. Gangamma N., the progressive women farmers, Smt. Anitha L., the entrepreneur, who is an onsite incubate of ICAR-IIHR multiplying "Arka Microbial Consortium (AMC)" technology, Smt. Prathima Adiga, a *chef cum* in terrace gardener and Smt.Prema Nadapatti, the first lady driver of BMTC were felicitated by the chief guest. The institute held various competitions like essay writing, slogan writing, extempore, vegetable carving and sports events like musical chair, tug of war and filling the bottle for the women staff and students. The prizes were distributed to the winners by the dignitaries. In addition, women wellness camp was also organized at the institute with the help of Dr. Nikitha Murthy, MS (OBG), Infertility Specialist. Dr. B.N.S. Murthy, Director (I/c.) ICAR-IIHR presided the program and addressed the gathering. As a part of the celebration, lunch was arranged for all the women staff of institute, followed by various cultural events performed by the institute staff.

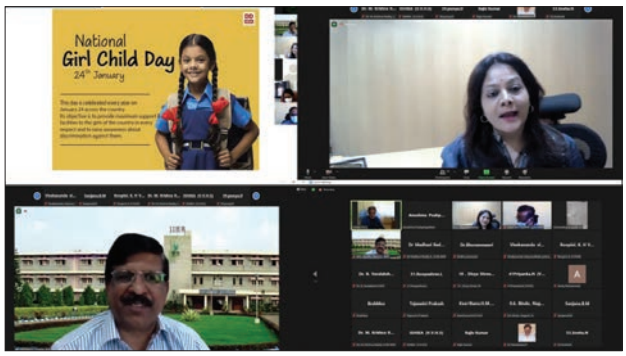
International women's day 2022 celebration

Director, ICAR-IIHR, Bengaluru welcomed the officials of Department of Horticulture, Mizoram

National Girl Child Day celebrations

In connection with the Azadi Ka Amrit Mahotsav, ICAR-IIHR Bengaluru celebrated 'National Girl Child Day' on virtual mode through a webinar on 'Take care of Your Girl Child and She will Take care of the World', on 24th January 2022 which was attended by about 110 participants. In addition to the institute staff, about 50 high school students from Vivekananda Vidyavardhaka High School and National Public School, Hesaraghatta also attended the event. Dr. K. Gayathri Reddy, Associate Professor and Special Officer, Universal Human Values Cell, Visvesvaraya Technological University, Bengaluru Campus served as the invited speaker, who elaborately

presented on key problems faced by the girl children, various girl child empowerment schemes and programs undertaken by various government and non-government organizations, relevance of value education *etc.* In his introductory remarks, Dr B.N.S. Murthy, Director (I/c.) ICAR-IIHR,reiterated the need and importance of girls' empowerment. After the presentation, elaborate discussions on the topic were made by the participants and the resource person. Besides the webinar, staff members were requested to send the pictures with their daughters and a collage of the same from 32 staff members was also prepared.



D. MERA GAON MERA GAURAV (MGMG)

***Swachhta pakhwada* acitivities at ICAR-IIHR, Bengaluru:** As a part of *Swachchta Pakhwada* implementation (December, 16th to 31st, 2022), various awareness and motivation programmes, mass campaigns, demonstration on composting and cleanliness drive were taken up by ICAR-IIHR, Bengaluru and CHES, Chettalli. To create awareness and emphasize *Swachhata* campaign among school children, a painting competition was conducted to motivate the school children from Government High School, Hesaraghatta, Bengaluru on the theme, 'Clean India :Green India' and best performers were selected as prize winners and will be awarded during the valedictory programme. A demonstration on 'Vermicomposting' was conducted at ICAR-IIHR, Bengaluru. Dr. B.L. Manjunath, Principal Scientist, Division of fruit crops explained the importance of earthworms and benefits of vermicomposting as a potential component for converting 'Waste to Wealth'. Around 26 trainees of entrepreneurship development program from different states of South India participated in the demonstration.

Swachchta pakhwada celebration at ICAR-IIHR Bengaluru

***Kisan Diwas* celebration in ICAR-IIHR, Bengaluru:** As a part of *Swachchta Pakhwada* program, *Kisan Diwas* was celebrated at ICAR-IIHR, Bengaluru on 23rd Decemberr 2022. Around 120 farmers from five districts of Karnataka *viz.*, Bengaluru Rural,Mandya, Mysore,Kodagu and Chikkaballapura and around 80 college students from Bengaluru participated in this program. The program started with floral tribute to Shri Chaudhary Charan Singh, India's fifth Prime Minister whose birth anniversary is commemorated as National Farmer's Day on December 23rd every year. Dr R. Venkattakumar, Principal Scientist and Head, Division of Social Sciences and Training delivered the welcome address and it was followed by the introductory remarks about the program by Dr V. Sankar, Principal Scientist & Nodal Officer, *Swachhta Pakhwada* and MGMG Committee. Three progressive farmers namely, Shri. S. Anand, Shri. Jayarame Gowda and Shri. Chaluva Raja were felicitated during the program and awarded with 'Best Farmer Award' for their contribution in adopting IIHR varieties and technologies. The awardee farmers shared their experience in profitable crop cultivation and motivated other farmers for using IIHR varieties and technologies. It was followed by Presidential address by Shri. Harish Kumar, H.C.President, Local Raita Sangha, Hurulichiknahalli Gram Panchayat who emphasized the motto of *Swachch Bharat* mission and appreciated the role of IIHR in improving horticultural crop production. Prof.Sanjay Kumar Singh, Director, ICAR-IIHR explained the origin of *'Kisan Diwas'* and fifth Prime Minister of India, Shri.Choudhary Charan Singh's contribution to the agriculture sector and farmer's welfare. He urged the scientists to focus on farmer-centric projects and come out with practical solutions. All the farmers were provided with IIHR Seed kit and were taken for a field and lab visit, to the expose them to latest IIHR technologies.

***Kisan Diwas* celebration, 2022**

Awareness program on "Clean India and Green India" for school children : *Swachchtha* campaign was conducted in school and college students of Hessaraghatta, Chettalli and Bhubaneswar and awareness was created to teachers on special *swachchtha* campaign following which students were encouraged to speak about the importance of cleanliness. Later, students and teachers were engaged in cleaning activity in the school premises.

***Swachchtha* campaign in school premises**

Demonstration on composting farm residue : It was conducted at compost yard, IIHR with farm waste materials like leaves, straw, areca husk and flower stalks. Dr Chetankumar and Dr S. Ramchandran, Scientists from Division of Natural Resources,ICAR-IIHR demonstrated the process of composting using Arka Decomposer. About 30 participants including Scientists, Professors, post graduate agriculture students from Annamalai University, Chidambaram, Tamil Nadu and farm labourers of ICAR-IIHR actively participated in the demonstration.

Demonstration of "Waste to Wealth": An activity on demonstration of composting of kitchen waste was conducted in the premises of IIHR residential quarters. Dr D.Kalaivanan, Senior Scientist from Division of Natural Resources, ICAR-IIHR demonstrated the process of composting of kitchen waste into useful manure by Kappa's method. About 15 participants including 10 ladies from residential quarters of ICAR-IIHR actively participated in this demonstration.

Demonstration of "Waste to Wealth"

***Swachhta* Campaign at public places:** *Swachhta* activities were taken up in the premises of State Bank of India, IIHR, Hesaraghatta on 26.12.2022. The staff members were motivated to involve in the cleaning activity and were also created awareness about the importance of waste segregation into biodegradable and non-biodegradable waste along with safe disposal of plastic and e-wastes. Staff members from SBI, Hesarghatta and scientific, technical and contractual staff members from ICAR-IIHR, Bengaluru were involved in this program.

ICAR-IIHR-Central Horticultural Experiment Station, Bhubaneswar, Odisha: The Special *Swachhta* Campaign 2.0 was conducted at CHES – Bhubaneswar in various office premises like in and around office buildings, administrative section, laboratories, farm, MGMG villages and neighbouring schools.

Valedictory Function of *Swachhta Pakhwada* (16th December, 2022 to 31st December, 2022) : Valedictory session of the *Swachhta Pakhwada* program was conducted at ICAR –IIHR, Bengaluru. Dr H. R.Ramya, Scientist, Division of Social Sciences and Training welcomed the gathering. With a brief history about the motto and launch of *Swachch Bharat Abhiyan* program in India, Dr V. Sankar, Principal Scientist and Nodal Officer (*Swachh Bharat* and MGMG Committee) briefed the activities carried out under *Swachhta Pakhwada* program at ICAR-IIHR during the period. Prizes were distributed to the toppers of school and college, house-keeping staff members, divisions and sections of IIHR for their contribution to Swachhta activities. Chief Guest, Smt. Renuka, K.B., Principal of Government PU College, Hesaraghatta appreciated the activities taken

up by IIHR in promoting horticulture and implementing *swachchta* program. Dr Sanjay Kumar Singh, Director, ICAR-IIHR emphasized the importance of *Swachchta* drive initiated by the Government and motivated the school students and IIHR staff memberes to work towards clean and green India. The program finally ended with vote of thanks by Dr R.Uma Maheswari, Senior Scientist and Member (staff welfer and MGMG Committee), Division of Crop Protection.

***Swachhta Pakhwada* Conducted at Central Horticultural Experiment Station (CHES), Chettalli, Karnataka**: The surroundings of water tank, vehicle shed, canteen premises and anthurium shade net house were cleaned by scraping off grass, weeds *etc.*, and the wastes were segregated before disposal. Laboratories and main building areas were also cleaned and old unwanted files, boxes and empty bottles were properly discarded following the guidelines. Awareness was created among staff members about the problems of plastic usage on environment and human health. All the staff members including scientists, technical, supporting staff members and young professionals actively participated in the program. An awareness program was conducted by CHES, Chettalli for school children from Ponnanathmotte on importance of cleanliness to maintain good health and problems associated with plastic wastes. More than 80 students participated in the program. Cleaning activity was taken up along the roadsides and awareness was also created among the public.

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15. Official Language Implementation

The Official language implementation section of the Institute carried out the following activities for the effective implementation of Official Language Policy of Govt. of India during January to December, 2022.

ICAR-IIHR, Bengaluru

Quarterly meetings of official language implementation committee

During 2022, three quarterly meetings of official language implementation committee (OLIC) of the institute were convened on March 19th, August 8th and Dec 7th, 2022 during January-March, July-September and October-December, 2022, respectively.

Hindi Workshops

The Institute organized the following Hindi Workshops in 2022:

An Hindi workshop on "Working in Hindi on Computer" was conducted on June 27th, 2022 for the staff members of administration.

An Hindi workshop on "Working in Hindi on Computer" was conducted on August 23rd, 2022 for the staff members of administration.

Hindi Fortnight Celebration

The Indian Institute of Horticultural Research, Hesaraghatta, Bengaluru organized Hindi fortnight during September 14th-28th, 2022. Various hindi competitions, *viz.*, Hindi recitation, Hindi terminology and noting, Antakshari, Hindi conversation, Hindi song, Hindi essay, Hindi typing, Hindi presentation skill and extempore were organized.

Shri Ishwar Chandra Mishra, Retd. Joint Director, Central Translation Bureau, Bengaluru was the Chief Guest of the inaugural function. During his address, he urged the staff to use Hindi in their day-to-day work, and described the correct usage and minor differences between certain words. Dr Debi Sharma, Director of the institute presided over the program and remarked that the Institute was efficiently meeting the targets related to the implementation of Official Language (OL) .

The valedictory and prize distribution ceremony of Hindi fortnight was organized on September 28th,2022 under the chairpersonship of Dr. Debi Sharma, Director (I/c.), ICAR-IIHR, Bengaluru, with Smt. Seema Chopra, Director (OL), ICAR, New Delhi, as the Chief Guest. As our country is celebrating Azadi Ka Amrut Mahotsava, the Chief Guest urged the need to propagate Hindi by adopting popular words from regional languages and work in Hindi using simple words. Prizes and Certificates for the winners of different competitions were distributed during the valedictory function.

Address by the Chief Guest of the inaugural function

Address by the Director (Acting) ICAR-IIHR during hindi fortnight celebertion

Address by the Chief Guest during valedictory function

Prize distribution during hindi fortnight celebertion

Hindi Vividha Competition

ICAR-Indian Institute of Horticultural Research, Bengaluru organized "Hindi Translation Competition" on October 28th, 2022 under the auspices of TOLIC (O-2), Bengaluru for the staff members of different Central Government offices located in Bengaluru. Staff members from Coffee Board, office of the Principal Chief Commissioner of income tax, office of the Principal Chief Commissioner of central taxes, office of the Principal Accountant General (Audit-I), office of Accountant General (Audit-II), Employee provident organization, training command headquarters, Air Force, Bengaluru participated in the competition. Dr V.Thilagam, Retd. Senior Hindi Officer, Indian Institute of Science, Bengaluru coordinated the program.

Hindi Vividha Competition

Hindi Publications

Three publications namely, 'Dragon fruit', 'Avocado' and Annual Report (Hindi) were brought out in Hindi during 2022.

Hindi Incentive Scheme

Hindi incentive scheme was implemented at the Institute for working in Hindi originally. The prizes and certificates for the participants were distributed during the valedictory function of Hindi fortnight celebration.

CHES, Bhubaneswar

Hindi week celebrations

ICAR-IIHR-Central Horticultural Experiment Station (CHES), Bhubaneswar, observed the 'Hindi Week' during September 14th-22nd, 2022. Sri Anjan Kumar Khatua, Principal, Kendriya Vidyalaya, Bhubaneswar, while inaugurating the program on September 14th, 2022, emphasized the importance of the Hindi Diwas and the role of Hindi in national integration and the development of society. Dr G.C. Acharya, Head, CHES, Bhubaneswar, explained the importance, necessity and scope of the Hindi language in day-to-day official work. Various activities to be carried out during the 'Hindi Week' celebration were detailed out by Dr Deepa Samant, Scientist and nodal officer, official language implementation. During the valedictory held on September 22nd, 2022, Dr G.C. Acharya congratulated all the staff members for their active participation and the winners' namely, Sri Gagan Bihari Sundaray, Smt. Rina Pattnayak, Smt. Annapurna Behera, and Smt. Suchitra Behera, who grabbed the first prizes in dictation, translation, Quiz, and speech competition, respectively. The 'Hindi week' program was coordinated by Dr Deepa Samant and her team Smt. Annapurna Behera and Sri Manoj Kumar Pattnaik.

Hindi week celebration at CHES, Bhubaneswar

CHES, Chettalli

"Hindi Week" was celebrated at ICAR-IIHR-Central Horticultural Experiment Station, Chettalli, Karnataka during September, 14th-22nd, 2022. The chief guest, Dr K.Chandrappa, Deputy Director (Research), Coffee Research Sub-Station, Coffee Board, Chettalli, while inaugurating the program on 14th September 2022, highlighted the significance of hindi as national official language and its importance for development of society. Dr S.Rajendiran, Senior Scientist and Head (I/c.)) emphasized the importance and necessity of Hindi language in our daily life. Dr A.T.Rani, Scientist and Member, OLIC briefed the events to be organized during the Hindi Week. Mr. Madhu G.S, Scientist conducted various competitions which were participated by the staff of the station. Mr. Manoj, Hindi teacher from Government high school, Chettalli, was the Chief Guest during the valedictory function held on 22nd September 2022, elaborated the value of Hindi in the society and also distributed prizes to the winners of various competitions. Dr S.Rajendiran, Head (I/C), congratulated all the staff for their active participation in different events. Mr. Madhu G.S. Nodal Officer, OLIC, CHES, Chettalli, proposed a formal vote of thanks.

Hindi week celebertion at CHES, Chettalli.

* * * * * *

16. Personnel

DIRECTOR

Dr B.N. Sreenivasa Murthy, Ph.D. (Acting)
Upto 31.05.2022

Dr Debi Sharma, Ph.D. (Acting)
w.e.f. 01.06.2022 to 12.12.2022

Dr Sanjay Kumar Singh, Ph.D.
w.e.f. 13.12.2022

SCIENTIFIC STAFF

IIHR, HESARAGHATTA, BENGALURU, KARNATAKA

DIVISION OF FRUIT CROPS

Reju M. Kurian, Ph.D.,
Principal Scientist (Horticulture) & I/c Head

Tripathi, P.C., Ph.D.,
Principal Scientist (Horticulture)

Manjunath, B.L., Ph.D., Principal
Scientist (Agronomy)

Anuradha Sane, Ph.D.,
Principal Scientist (Horticulture)

Sujatha, S., Ph.D.,
Principal Scientist (Agronomy)

Sakthivel, T., Ph.D.,
Principal Scientist (Horticulture)

Satisha, J., Ph.D.,
Principal Scientist(Horticulture)

Sankaran, M., Ph.D.,
Principal Scientist (Horticulture)

Anjani Kumar Jha, Ph.D.,
Principal Scientist (Horticulture)

Vasugi, C., Ph.D.,
Principal Scientist (Horticulture)

Karunakaran, G., Ph.D.,
Principal Scientist (Horticulture)

Kanupriya, C., Ph.D.,
Senior Scientist (Horticulture)

Linta Vincent, Ph.D.,
Scientist (Fruit Science)

Anushma, P.L., M.Sc.,
Scientist (Fruit Science)

Anupa, T., M.Sc.,
Scientist (Fruit Science), w.e.f. 09.04.2022

DIVISION OF VEGETABLE CROPS

Madhavi Reddy, K., Ph.D.,
Principal Scientist (Horticulture) & I/c Head

Yogeesha, H.S., Ph.D.,
Principal Scientist (Seed Technology)

Aghora, T.S., Ph.D.,
Principal Scientist (Horticulture) Upto 31.05.2022

Pitchaimuthu, M. Ph.D.,
Principal Scientist (Horticulture)

Varalakshmi, B., Ph.D.,
Principal Scientist (Horticulture)

Shankar Hebbar, S., Ph.D.,
Principal Scientist (Agronomy)

Singh, T.H., Ph.D.,
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Anil Kumar Nair, Ph.D.,
Principal Scientist (Agronomy)

Dhananjaya, M.V., Ph.D.,
Principal Scientist(Genetics & Plant Breeding)

Prasanna, H.C., Ph.D.,
Principal Scientist (Genetics & Plant Breeding)

Padmini, K., Ph.D.,
Principal Scientist (Horticulture)

Sreenivasa Rao, E., Ph.D.,
Principal Scientist (Horticulture)
on deputation w.e.f. 05.03.2022

Thangam, M., Ph.D.,
Principal Scientist (Horticulture-Vegetable Science)

Raja Shankar, Ph.D.,
Principal Scientist (Horticulture-Vegetable Science)

Mahadevaiah, C., Ph.D.,
Scientist (Genetics & Plant Breeding)

Vivek Hegde, Ph.D.,
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Smaranika Mishra, Ph.D.,
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Raghu, B.R., Ph.D.,
Scientist (Genetics & Plant Breeding)

Ponnam Naresh, Ph.D.,
Scientist (Vegetable Science)

Senthil Kumar, M., Ph.D.,
Scientist (Vegetable Science) on deputation to Coffee Board w.e.f. 17.05.2022

Manjunatha Gowda, Ph.D.,
Scientist (Vegetable Science) w.e.f. 06.06.2022

DIVISION OF FLOWER & MEDICINAL CROPS

Aswath, C., Ph.D.,
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Tejaswini Prakash, Ph.D.,
Principal Scientist (Plant Breeding)

Rajasekharan, P.E., Ph.D.,
Principal Scientist (Economic Botany)

Sujatha A. Nair, Ph.D.,
Principal Scientist (Horticulture)

Hima Bindu, K., Ph.D.,
Principal Scientist (Plant Breeding)

Rajiv Kumar, Ph.D.,
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Safeena, S.A., Ph.D.,
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Sumangala, H.P., Ph.D.,
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Usha Bharathi, T., Ph.D.,
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Smitha, G.R., Ph.D.,
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Rohini, M.R., Ph.D.,
Scientist (Spice, Plantation crops & M.A.P)

DIVISION OF POST-HARVEST TECHNOLOGY & AGRICULTURAL ENGINEERING

Narayana, C.K., Ph.D.,
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Sudhakar Rao, D.V., Ph.D., Principal Scientist (Horticulture)

Senthil Kumaran, G., Ph.D.,
Principal Scientist (FM&P)

Harinder Singh Oberoi, Ph.D.,
Principal Scientist (Microbiology)
on Deputation to FSSAI, GoI

Carolin Rathinakumari, Ph.D.,
Principal Scientist (FM&P)

Bhuvaneshwari, S., Ph.D.,
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Pushpa Chethan Kumar, M.Sc,

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Preethi, P., Ph.D.,
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Krishna Reddy, M., Ph.D.,
Principal Scientist (Plant Pathology) & I/c Head
Upto 30.06.2022

Venkata Rami Reddy, P., Ph.D.,
Principal Scientist (Agricultural Entomology) & I/c Head w.e.f. 01.07.2022

Sridhar, V., Ph.D.,
Principal Scientist (Agricultural Entomology)

Sriram, S., Ph.D.,
Principal Scientist (Plant Pathology)

Kamala Jayanthi, P.D., Ph.D.,
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Samuel, D.K., Ph.D.,
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Sangeetha, G., Ph.D.,
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Uma Maheshwari, Ph.D.,
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Chandrashekhara, C., Ph.D.,
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Radha, T.K., Ph.D.,
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Priti Sonavane, Ph.D.,
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Venkataravanappa,V., Ph.D.,
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Bhagyasree, S.N., Ph.D.,
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w.e.f. 30.03.2022

Manjunatha, L., Ph.D.,
Scientist (Plant Pathology) w.e.f. 02.07.2022

Keerthi, Ph.D.,
Scientist (Agricultural Entomology)

DIVISION OF BASIC SCIENCES

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Debi Sharma, Ph.D.,
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Upreti, K.K., Ph.D.,
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Upto 31.10.2022

Asokan, R., Ph.D.,
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Upto 31.10.2022

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Chethan Kumar Gurumurthy, Ph.D.,
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DIVISION OF SOCIAL SCIENCES & TRAINING

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Gajanana, T.M., Ph.D.,
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Sudha Mysore, Ph.D.,
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Venugopalan, R., Ph.D.,
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Narayanaswamy, B., Ph.D.,
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upto 30.06.2022

Sankar, V., Ph.D.,
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Chandra Prakash, M.K., Ph.D.,
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Reena Rosy Thomas, Ph.D.,
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Reddy, T.M., Ph.D.,
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Atheequlla, G.A., M.Sc.,
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Harish Kumar, M.Sc.,
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Ramya, H.R., Ph.D.,
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Prakash Patil, Ph.D.,
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Project Coordinator (Fruits)

Priya Devi, S., Ph.D.,
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Sridhar Gutam, Ph.D.,
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CENTRAL HORTICULTURAL EXPERIMENT STATION, BHUBANESWAR

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Manas Ranjan Sahoo, Ph.D.,
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Kishor Kumar Mahante, M.Sc.,
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Madhu, G.S., M.Sc.,
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KRISHI VIGYAN KENDRA, GONIKOPPAL, KODAGU

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KRISHI VIGYAN KENDRA, HIREHALLI, KARNATAKA

Loganandhan, N., Ph.D.,
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TECHNICAL STAFF

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Prakash, H.,
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Muralidhara,
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w.e.f. 28.09.2022

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DIVISION OF POST-HARVEST TECHNOLOGY & AGRICULTURAL ENGINEERING

Dayananda, P.,
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Mahantesh, P.T.,
Technical Officer (Mech.)

Paramashivaiah, P.,
Senior Technical Assistant (Lab)

Bharathamma, H.,
Senior Technical Assistant (Lab)

Ananda Murthy, H.S.,
Technical Assistant (Lab)

Anjanamma, R.,
Senior Technician (Field/Farm)

DIVISION OF CROP PROTECTION

Balasubramanian, K.,
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Rajanna,T.S.,
Technical Officer (Field/ Farm) upto 30.06.2022

Saroja, S.,
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Gundappa Manoji,
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Deenadayalan, P.,
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Mohan, B.P.,
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DIVISION OF BASIC SCIENCES

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Banoth Sreenu,
Technical Assistant (Lab)

Latha, J.,
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Hanumantharaju, M.,
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Amal Johny,
Technician (Lab)

DIVISION OF NATURAL RESOURCES

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Balakrishna, L.,
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Ramachandra, N.,
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Shilpashree, V.M.,
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DIVISION OF SOCIAL SCIENCES & TRAINING

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Chandra Kumar, C.,
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Shashi Kumar, V.,
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RFS-FRUIT, VEGETABLE & FLOWER CROPS UNIT

Nagegowda, N.S., Ph.D.,
Asst. Chief Technical Officer (Field/Farm**)**

Prashanth Kumar, G.M.,
Technical Officer (Field/Farm)

PROJECT COORDINATOR'S CELL (TROPICAL FRUITS)

Nagaraj, M.R.,
Senior Technical Assistant (Lab)

PRIORITIZATION, MONITORING & EVALUATION CELL

Ravindra Kumar, Ph.D.,
Asstt. Chief Technical Officer (Lab)

AGRICULTURAL KNOWLEDGE MANAGEMENT UNIT

Thippeswamy, S.,
Chief Technical Officer (Information Technology)

Krishnananda, S.,
Technical Officer (Information Technology)

LIBRARY

Shankara Prasad, K.V., MSc., MLISc.,
Asstt. Chief Technical Officer (Lib. Science)
Upto 31.05.2022

Challuri Srinivas,
Technician (Information Technology)

MEDICAL & PARAMEDICAL

Mandakranta Bhattacharya, MBBS, DLO,
Chief Technical Officer (Medical)

ARTIST CELL

Rajendra Astagi, MFA,
Asstt. Chief Technical Officer (Artist)

PHOTOGRAPHY CELL

Chandrashekaraiah, K., B.Com.,
Senior Technical Officer (D.R.A.)

FARM MANAGEMENT

Nagaraj E. Kodekal,
Technical Officer (Mech.)

Jagadeesh Kumar, D.N.,
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upto 28.02.2022

Avinash, K.N.,
Technical Officer (Lab)

Ramesh, V.,
Senior Technical Assistant (Lab)

Rajanna, Y.,
Technical Assistant (Driver)

Avinash, B.,
Technical Assistant (Field/Farm)

Raghavendra Rao, M.A.,
Senior Technician (Field/Farm)

NURSERY

Nagaraju, T.N.,
Technical Assistant (Field/Farm)

LANDSCAPE UNIT

Rajanna, A.,
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WORKS UNIT

Bhanu, A, Ph.D., MTech, PGDBA, MIE,
Chief Technical Officer (Engg.)

Harish, K.M., B.E.,
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Veerappa K. Mahishi,
Senior Technical Officer (Elect.- Workshop)

Narendra, S.,
Senior Technical Officer (Elect.- Workshop)

Manjunath, R.,
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Sridhar, R.,
Technical Officer (Ref. Workshop)

Ganesh, M.,
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Chinnapullaiah, M.,
Senior Technical Officer (PHO-Workshop)

TRANSPORT SECTION

Siddaram G. Kalashetty, B.E. (A.E.),
Asst. Chief Technical Officer (Transport)

Suresh Angadi,
Technical Officer (Driver)

Narayanappa, P.,
Senior Technical Assistant (Driver)

Rajanna, L.,
Senior Technical Assistant (Driver)
upto 30.06.2022

Suresh, M.R.,
Technical Assistant (Driver)

Velmurugan, K.,
Technical Assistant (Driver)

CASH & BILL

Jyothi Appu Naik,
Technical Officer (IT) Upto. 12.05.2022

CENTRAL HORTICULTURAL EXPERIMENT STATION, BHUBANESWAR

Singray Majhi,
Technical Officer (Lab)

Biju, K.,
Technical Officer (Information Technology)

Suchitra Behera,
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Syed Idrish Ali,
Technical Officer (Driver-Workshop)

Chandrasena Durga,
Technical Officer (Electrical -Workshop)

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Purna Chandra Majhi,
Technical Assistant (Field/Farm)

Abhimanyu Das,
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Upto 02.07.2022

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Ashok Kumar Durga,
Technician (Information Technology)

CENTRAL HORTICULTURAL EXPERIMENT STATION, CHETTALLI

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Girirajanaik,
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Shivaraj, D.T.,
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KRISHI VIGYAN KENDRA, GONIKOPPAL, KARNATAKA

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Veerendra Kumar, K.V.,
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(Plant Pathology- Field/Farm)

Suresh, S.C., Ph.D.,
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(Livestock- Field/Farm)

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Upto 30.04.2022

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FARM, HIREHALLI

Nagendrappa, N.T.,
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Sanjeev Kengere,
Senior Technician (Field/Farm)

Manjanna, G.,
Technician (Field/Farm)

KRISHI VIGYAN KENDRA, HIREHALLI, KARNATAKA

Ramesh, P.R.,
Asstt. Chief Technical Officer
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Jagadish, K.N.,
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Prashanth, J.M.,
Asstt. Chief Technical Officer
(Horticulture-Field/Farm)

Hanumanthe Gowda, B.,
Asstt. Chief Technical Officer
(Plant Protection-Field/Farm) Upto 03.09.2022

Somashekhar, Ph.D.,
Asstt. Chief Technical Officer
(Plant Breeding, Field/Farm)

Jayashankar, N.,
Asstt. Chief Technical Officer (Information Technology) Upto 18.05.2022

Radha R. Banakar,
Asstt. Chief Technical Officer
(Home Science-Field/Farm)

Jyothi Appu Naik,
Technical Officer (IT) w.e.f. 13.05.2022

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Shashidhara, K.N.,
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Ningappa, M.H.,
Senior Technician (Driver,Workshop)

ADMINISTRATION, FINANCE & ACCOUNTS

IIHR, HESARAGHATTA, BENGALURU, KARNATAKA

ADMINISTRATION

Harakangi, G.G.,
Chief Administrative Officer (Sr. Grade)

Ramesh, R.G.,
Senior Administrative Officer upto 31.01.2022

Raghuraman, V.,
Senior Administrative Officer

Viswanathan,T.,
Administrative Officer

Jenny C.M.,
Administrative Officer w.e.f. 13.06.2022

Tittu Kumar, K.B.,
Assistant Administrative Officer w.e.f. 21.05.2022

Shailaja R. Prasad,
Assistant Administrative Officer
upto 31.12.2022

Vijayalakshmi, D.,
Assistant Administrative Officer

Prashanthi, C.,
Assistant Administrative Officer

Pandian, A.,
Assistant Administrative Officer
upto 31.10.2022

Lokesh, B.M.,
Assistant Administrative Officer

Ahmed, S.M.A.,
Assistant Administrative Officer

Sangeetha, M.,
Assistant Administrative Officer

Pooja Kumari,
Assistant Administrative Officer

Senthil Kumar, P.,
Assistant Administrative Officer w.e.f. 14.10.2022

Syed Rabbani,
Assistant Administrative Officer w.e.f. 01.11.2022

Subramanya, N.,
Private Secretary

Giri, M.V.,
Private Secretary

Ravi Kumar, S.,
Private Secretary

Rajendran, S.,
Private Secretary

Prathiba, M.,
Personal Assistant w.e.f. 14.06.2022

Sheela, S.,
Personal Assistant w.e.f. 14.06.2022

Surendra, H.R.,
Assistant

Vijaya Kumar, K.M.,
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Bhagyalakshimi,
Assistant

Aachal Palewar,
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Lakshmidevi, K.C.,
Upper Division Clerk

Renuka, R.,
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Jagadeesh,T.C.,
Upper Division Clerk

Bindu, V.,
Upper Division Clerk

Ramakrishna, G.S.,
Upper Division Clerk

Gangadhareshwara, L.,
Upper Division Clerk

Sai Monica Lakshmi,
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Jayashree,
Lower Division Clerk

Prasana Kumar, R.,
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Anuradha, L.,
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Shilpa, R.,
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Mallesh, B.,
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DIRECTOR CELL

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Principal Private Secretary

Mubeen Taj,
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OFFICIAL LANGUAGE SECTION

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Principal Scientist (Agronomy) & I/c
Upto 31.07.2022

Jagadeesan A.K.,
Deputy Director (OL) w.e.f. 01.08.2022

CENTRAL HORTICULTURAL EXPERIMENT STATION, BHUBANESWAR

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Arun Kumar Barik,
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Suvasini Pradhan,
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KRISHI VIGYAN KENDRA, GONIKOPPAL, KARNATAKA

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KRISHI VIGYAN KENDRA, HIREHALLI, KARNATAKA

Veda Kurnali.,
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SKILLED SUPPORT STAFF

DIVISION OF FRUIT CROPS

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Thimmaiah, V.

DIVISION OF FLOWER AND MEDICINAL CROPS

Venkatesh Murthy, H.T.

Hanumantharaju, M.

DIVISION OF VEGETABLE CROPS

Anjanappa, C.M.

Venkateshappa

DIVISION OF POST HARVEST TECHNOLOGY & AGRICULTURAL ENGINEERING

Sharadamma, R.

DIVISION OF CROP PROTECTION

Rudraiah, M.

NURSERY UNIT

Hanumantharayappa

Maruthi, N.

FARM MANAGEMENT

Lakshmaiah, T.V.

Kumar

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Anjanamma, D.

Aveen, M.

WORKS UNIT

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Anjanappa

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Poornima, K.S.

AUDIT & ACCOUNTS

Hanumanthappa, N.

CENTRAL HORTICULTURE EXPERIMENT STATION, BHUBANESWAR

Abhimanyu Bhulugayan

Gagan Bihari Sundaray

Biswanath Paikaray

Bulu Kumar Maharana

Harihar Bindhani

Gobind Chandra Ranasingh

Gobinda Naik

Subasini Singh

CENTRAL HORTICULTURE EXPERIMENT STATION, CHETTALLI

Shankar, H.L.

Ramesh, B.K.

Narayana, A.S.

Parameshswari

Mayandi, K.

KRISHI VIGYAN KENDRA, GONIKOPPAL, KARNATAKA

Karapuswamy

FARM, HIREHALLI

Rajanna, V.

* * * * * *

17. Varieties and Technologies Released during 2022

I. List of Varieties

A. Fruit Crops

1. Rose apple (*Syzygium jambos*): Arka Neelachal Akshay (IC:639459): This is a seedling selection developed at Central Horticultural Experiment Station (ICAR-IIHR), Bhubaneswar. It is an early maturing variety (March-April).The fruits are attractive yellow in colour, round in shape, medium to big (28-34 g) in size. The pulp is firm, with high recovery (75 to 80%) and good TSS (14-16°B).The yield potential is good and are having less incidence of fruit fly.


2. Avocado: Arka Coorg Ravi (CHES-PA XIII-1, IC:0644473): This is a seedling selection developed at Central Horticultural Experiment Station (ICAR-IIHR), Chettalli. It is a regular bearer with good yield potential (150 to 200 kg/tree). The fruits are rhomboidal in shape with thick base, fruit weight ranged from 450-600 g. Pulp is thick (> 2.5 cm) having a TSS of 6.5 to 8.0 °B and with good pulp recovery(> 80%). The fat content is 12 to 14 %. The flowering behaviour is B type. This line can be planted as a pollinizer for the already identified A type (Arka Supreme) for obtaining higher yield.


B. Vegetable crops

1. Brinjal:

Arka Neelachal Yodha (IC:0598430-5-22-4):

It is a pure line selection from germplasm collection of IC0598430-5-22-4 (Pipli, Odisha) developed at Central Horticultural Experiment Station (ICAR-IIHR), Bhubaneswar. The plants are tall, erect and vigorous in growth habit. Fruits are green with white patches having green calyx, oblong and medium in size (90 to 110 g). Have good yield potential (45 to 50 t/ha) with high resistance to bacterial wilt (*Ralstonia solanacearum*).




2. Amaranthus:

i) Arka Neelachal Ruchitha (IIHR-B-AM8-13-5-2): This is a pure line selection from the germplasm collection of *Amaranthus blitum* developed at Central Horticultural Experiment Station (ICAR-IIHR), Bhubaneswar. It is a multi-cut type, fleshy tender yellowish green stem with obovate green small leaves having an yield potential of 22.59 t/ha and resistant to white rust *(Albugobliti* (Biv.) Kuntze.


ii) Arka Neelachal Vrichitha (IIHR-B-AM45-6-2): This is a pure line selection from the germplasm collection of *Amaranthus tricolour* developed at Central Horticultural Experiment Station (ICAR-IIHR), Bhubaneswar. It is a pulling type, fleshy tender greenish-pink stem with ovate green leaves having purple blotches, suitable for rabi and pre-summer season, resistance to white rust having an yield potential of 7.08 t/ha.

iii) Arka Neelachal Bainishi (IIHR-B-AM65-7-3-8): This is a pure line selection from the germplasm collection of *Amaranthus tricolour* (IC-550145) developed at Central Horticultural Experiment Station (ICAR-IIHR), Bhubaneswar. It is a pulling type, fleshy tender pink stem, pink petiole with greenish purple leaves suitable for Rabi and pre-summer season. Resistant to white rust having yield potential of 8.58 t/ha.

C. Flower crops

Chrysanthemum :

i) Arka Anirudh (IIHR 4-8:IC 636415): This is a half-sib seed selection from the variety 'Lal Pari'. Plants are dwarf, semi-erect growth habit with early flowering (62.77 days). Suitable for pot culture/ bedding, flowers are semi-double, maroon-yellow colour (RHS colour: 17A, Yellow 7 Orange Group, Fan 1) having 5 to 6 rows of ray florets and resistant to white rust disease (*Puccinia horiana* Henn.).

ii) Arka Dhaval (IIHR 2-16: IC 636418): This is a half-sib seed selection from the variety 'White Prolific'. Plants are dwarf, spreading growth habit with early flowering (69.17 days), Suitable for pot culture/bedding, flowers are semi-double, pinkish white colour (RHS colour: 3D, Yellow Group, Fan 1) with 3 to 4 rows of ray florets.

iii) Arka Manohar (IIHR 2-13: IC 0645570): This is a half-sib seed selection from the variety 'Sunil'. Plants are dwarf with erect growth habit with early flowering (66.52 days), Suitable for pot culture/ bedding, semi-double flowers, deep pinkish-purple (RHS colour: 71B, Red-Purple Group, Fan 2) with 5 to 6 rows of ray florets.

II List of Technologies

1. Arka Microbial Sahishnu: A bacterial inoculant (*Bacillus amyloliquefaciens* strain P-72) suitable for tomato cultivation under deficit irrigation conditions which has the ability to promote plant growth and improve yield. Under field conditions, application @ 5 Kg/ha as a suspension (20 g/l) on the seventh day of transplantation followed by another application on the 30th day, improved the marketable yield levels of tomato by 28.26% over uninoculated plants when irrigated at 40% of Pan Evaporation (PE). The cumulative water savings (litre/plant) under rain out shelter condition was 55.15% and under field condition was 55.3%.

2. Arka Floral Agarbathi and Dhoop: This is a plant based biodegradable and eco-friendly technology using floral wastes. The floral incense sticks can be prepared both from individual flower wastes like rose, marigold, tuberose, gladiolus, chrysanthemum, china aster etc. and also with the mixture of floral wastes. The smoke emitted has lesser toxic pollutants like CO, SO_2, NO, VOCs, compared to commercial charcoal-based incense sticks, and thereby it is safe for human health besides reducing the environment pollution. It has twenty minutes more burning time, hence is more efficient compared to charcoal-based incense sticks. The natural colour of the flower adds beauty to the finished product. The benefit cost ratio of the technology is 2.3:1. It can

be stored for 12 months under ambient condition without much reduction on the burning time and quality. The product also confirms to the Indian Standard Agarbatti specification as per Bureau of Indian Standards (BIS).

3. Arka Vertical growing system for foliage plants

The vertical growing system is suitable for foliage species namely *Chlorophytum comosum*, *Sanseveria trifasciata*, *Syngonimum podophyllum* white and *Peperomia obtusifolia* which are having good air pollution tolerance index (APTI).

The vertical garden structure consists of a rectangular frame of 1.4 x 3 m-dimension with mesh surface made up of mild steel 1" angle of and 1" square mesh accommodating 160 vertical plastic containers of 6-inch size with the media holding capacity of 300 g/ pot, fitted with manually controlled irrigation system having discharge rate of two litres per hour irrigated at 200 ml of water per pot with an interval of three days (as per the weather conditions). It has 4 Nos. of 2" nylon wheels for easy shifting and reorienting the position, if needed.

The standardised substrate mix is a light weight soilless medium with blend of Arka Fermented Cocopeat and Burnt clay balls (LECA) at 3: 1 (volume basis). The clay balls are 100% inert (reusable), micro-porous structure (aids better aeration), light in weight, good water drainage (prevent roots from rotting), excellent thermal insulation (less water evaporation), low co-efficient of thermal expansion (aids healthy plantation), provides good anchorage, non-toxic and eco-friendly. The substrate media retains more moisture (12.5 %) than commercial media (9.12%) and is cost effective (Rs 16/Kg) than commercial mix (Rs 60 to 80/Kg)

The nutrient supplement of 0.2% water soluble fertilizer (19:19:19) to be given at an interval of 30 days for uniform and sustainable growth of the plants with enhanced aesthetic value.

The whole package is cost effective which would have the actual cost Rs 580/sq.feet compared to commercial package (Rs. 1200 to 1300/sq.feet).

4. Arka Kamalam RTS beverage

The juice has clear appearance, free from seeds and mucilage. It contains health promoting bioactive compounds, *viz.*, ascorbic acid (84.80 mg/100 g), total betalain(2.61 mg/100 ml) and total polyphenols (291.78 mg GAE/100 g) at initial storage period with more than 50% retention of these bioactive compounds after six months of storage under room temperature.It has got a good appearance with more than 8 score for the sensory parameters on 9-point hedonic scale.It can be stored for six months under ambient condition without any microbial spoilage. It has a unique taste of dragon fruit and does not contain any synthetic flavour and colour. The product meets the FSSAI Regulation of Thermally Processed Fruit Beverages / Fruit Drink/ Ready-to-serve Fruit beverages.

III. Varieties identified by CVRC

Sl. No.	Crop	Variety	Significant traits	Recommended zone(s)
1	Mango	Arka Neelachal Kesari 	Early maturing, coloured, high yielding and fruit fly free.	Odisha
2.	Chilli	Arka Swetha (MSH 149) 	F_1 hybrid of the cross IIHR 3903 (CGMS line) x IIHR 3315. High yielding hybrid with 28-30 t/ha fresh yield and 4.5 t/ha dry yield; fruits are smooth, light green and turn to red on maturity; field tolerant to viruses.	Punjab, Uttar Pradesh, Bihar, Jharkhand
3.	Chilli	Arka Khyati (MSH 206) 	F_1 hybrid of the cross MS4 (A line) x IIHR 3315 (R line) (INGR No. 05024). High yielding hybrid with 35-38 t/ha fresh yield and 5-5.5 t/ha dry yield; fruits are smooth and highly pungent; green and turn to red on maturity.	Karnataka, Madhya Pradesh, Maharastra, Goa
4.	Brinjal	Arka Avinash 	High yielding bacterial wilt resistant variety derived from cross between Arka Kusumakar x IIHR-3. Plants tall and spreading. Fruits green long with fleshy green calyx. Yields 40-42 t/ha in 95-115 days.	Karnataka, Kerala, Tamil Nadu
5.	Spine gourd/ Teasel gourd	Arka Neelachal Shanti 	It is developed through hybridization between spine gourd and teasel gourd, naturally pollinated, high yielding (15-16 kg/vine) with medium sized fruit (20g), moderately tolerant to fruit borer, anthracnose and downy mildew.	Odisha

18. Meteorological Data

Meteorological Data (January–December 2022)

ICAR-IIHR, Bengaluru

Month	Temperature (°C)		R.H. (%)		U.S.W.B.Class 'A' Pan evaporation (mm)	Mean wind speed (km/h)	Rainfall (mm)
	Max.	Min.	07.30 hrs.	14.00 hrs.			
January	29.1	13.8	74.3	47.0	3.5	2.6	1.2
February	31.6	13.1	69.4	36.2	5.1	2.9	0.0
March	33.4	14.8	58.8	32.0	6.2	3.6	11.7
April	34.9	18.8	64.7	34.5	6.0	2.6	87.7
May	31.6	19.8	77.1	54.9	4.5	3.6	218.4
June	30.7	19.7	78.5	52.7	4.9	4.0	203.2
July	28.4	20.1	83.9	63.4	3.5	5.1	122.6
August	28.9	19.7	84.1	62.6	4.2	4.4	224.2
September	29.3	19.1	79.0	57.8	4.3	3.3	225.8
October	28.6	17.7	80.9	56.0	3.9	1.8	302.5
November	27.0	16.1	81.5	55.2	3.`	2.0	37.2
December	26.9	14.7	80.4	52.7	3.1	2.2	75.9

CHES, Bhubaneswar

Month	Maximum Temp. (°C)	Minimum Temp. (°C)	Total Rainfall (mm)	Evaporation (mm)	R.H. morning (%)	R.H. evening (%)	Rainy days
January	26.5	14.7	29.1	3.1	94	47	4
February	30.0	17.2	41.1	3.2	95	71	1
March	35.4	22.5	0.0	3.6	94	70	0
April	36.9	26.5	0.0	4.1	94	76	0
May	35.9	26.3	185.9	5.0	93	79	9
June	35.4	27.1	98.2	5.7	93	83	8
July	32.3	26.1	379.3	4.3	95	91	19
August	32.2	25.7	329.4	4.5	94	90	15
September	32.8	25.8	234.1	3.2	95	89	13
October	31.8	24.0	169.1	2.9	93	84	10
November	30.7	18.6	0	2.9	83	52	0
December	29.2	16.3	0	73	87	44	0

KVK, Gonikoppal

Month	Rainfall (mm)	Temp. Max. (°C)	Temp. Min. (°C)	R.H. morning (%)	R.H. evening (%)	Wind speed (km/h)	Rainy Days
January	0	29.5	14.8	96	41	4.1	0
February	0	31.3	15.5	93	30	3.9	0
March	82	32.4	17.9	88	60	4.5	5
April	124	32.1	19.7	93	48	3.7	9
May	236	28.6	19.4	94	69	4.4	16
June	135	28.4	19.4	94	71	4.4	18
July	630	26.4	19.6	95	79	5.1	25
August	382	27.4	19.6	95	74	5.4	23
September	264	28.2	18.4	95	67	4.5	17
October	125	29.6	18.3	93	54	3.7	14
November	15	29.1	17.2	94	51	3.9	5
December	53	28.9	16.2	90	47	4.6	4

WILD FRUITS

Ceylonbox wood (*Canthium dicoccum*)

Wild jujube (*Ziziphus rugosa* Lam.)

Indian Plum (*Flacourtia Indica* Merr.)

***Paalehannu* (*Chrysophyllum lanceolatum*)**

Huliannu (Rourea minor)

Kokkarchiannu (Scutia myrtina)

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