10th Indian Horticulture Congress 2023

Indian HortiCulture Congress-2023

G20 भारत 2023 INDIA

Unleashing Horticultural Potential for Self-Reliant India

Souvenir

Cum Lead & Oral Paper Abstracts

November 06-09, 2023

Venue:

College of Veterinary Science Campus, Assam Agricultural University, Khanapara, Guwahati

Organised by

Indian Academy of Horticultural Sciences (IAHS), New Delhi

Assam Agricultural University Jorhat, Assam

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Assam Agricultural University Jorhat, Assam

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Citation: Pal, R.K., Prakash, J., Dey, S.S., Saikia, A., Patel, V.B. and Deka, B.C. (Eds.). 2023. *Souvenir cum Lead & Oral Paper Abstracts*, *10th Indian Horticulture Congress - Unleashing Horticultural Potential for Self-Reliant India*, held at College of Veterinary Science Campus, Assam Agricultural University, Khanapara, Guwahati, Assam, India from 06-09, November, 2023, organized by the Indian Academy of Horticultural Sciences, 260 p.

Opinions in this publication are those of authors and not necessarily of the Organisers

November, 2023

Published by:

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F-1, Societies Block, NASC Complex, DPS Marg,
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Printed at:

Malhotra Publishing House
B-6, DSIDC Complex, Kirti Nagar, New Delhi - 110 015
Phone: 011-41420246, E-mail: vinay.malhotra@gmail.com

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भारतीय उद्यान विज्ञान अकादमी

RAJ BHAVAN
GUWAHATI

Shri Gulab Chand Kataria

MESSAGE

It gives me immense happiness to learn that the Indian Academy of Horticultural Sciences and Assam Agricultural University are jointly organizing the 10th Indian Horticulture Congress on "Unleashing Horticultural Potential for Self-Reliant India" in Guwahati. A commemorative souvenir is being published to mark the event.

Our country Bharat is very rich and diverse. Its salubrious climate from Kashmir to Kanyakumari and Arunachal Pradesh to Gujarat is suitable for growing different kinds of agri and horticultural products. The horticultural sector has tremendous potential to cater to the domestic needs besides capturing the markets of the foreign countries. I sincerely hope that the assembly where scientists, policy makers, faculty members, researchers and progressive farmers attend will act as a knowledge sharing platform and discuss to set an action plan to tap the horti-potential of the country. I moreover hope that the outcome of the congress will formulate a roadmap to fulfill our hallowed objective of Atmanirbhar Bharat.

I convey my best wishes to the organiser for resounding success of the congress. Hope the souvenir being published on the occasion is well received.

Dated: October 17, 2023

(Gulab Chand Kataria)

नरेन्द्र सिंह तोमर
NARENDRA SINGH TOMAR
D.O. No. 1028 /AM

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भारत सरकार
कृषि भवन, नई दिल्ली
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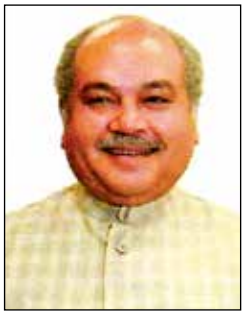

MESSAGE

I am pleased to know that the Indian Academy of Horticultural Sciences (IAHS) is organizing the 10th Indian Horticulture Congress-2023 in collaboration with the Assam Agricultural University (AAU), at Guwahati, Assam on 6th - 9th November, 2023.

Best wishes for successful deliberations at Indian Horticulture Congress-2023.

(Narendra Singh Tomar)

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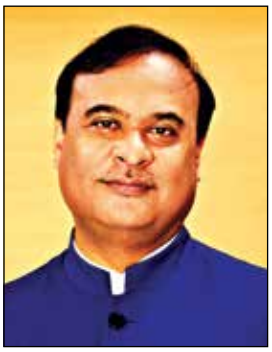

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Dispur 24 Ahin, 1430 Bhaskarabda
12th October, 2023

MESSAGE

I am happy to learn that Indian Academy of Horticultural Sciences and Assam Agricultural University are organizing the 10th Indian Horticulture Congress 2023 in Guwahati. A commemorative souvenir is being published to mark the event.

Horticulture plays an important role in attaining nutritional security and self-reliance. This sector however, needs more attention following the burgeoning food demands. The horticultural research is the key for enabling this sector generate sustainability.

Therefore, it is pertinent that we put in concerted efforts to strengthen the goal of horticultural research and production. In this backdrop, I hope the Horticulture Congress taking place will deliberate on the role of Artificial Intelligence, Machine Learning, Big Data, Next Generation Sequencing and Genome Editing to create new avenues for developing new crop varieties in horticulture. I moreover, hope that the presence of scientists, faculty, policy makers, researchers, students and progressive farmers in the congress augurs well in drawing a new action plan for enabling the horticulture sector towards a self-reliant India.

I convey my best wishes for resounding success of the Horticulture Congress. Hope the souvenir being published on the occasion becomes highly beneficial in sharing the knowledge and furthering the growth of horticulture.

(Dr. Himanta Biswa Sarma)

शोभा करांदलाजे
SHOBHA KARANDLAJE

राज्य मंत्री
कृषि एवं किसान कल्याण
भारत सरकार
Minister of State For
Agriculture & Farmers Welfare
Government of India
D.O. No.....MOS(A&FW)/VIP/2022-23/

MESSAGE

It is a matter of great pleasure for me to know that the Indian Academy of Horticultural Sciences (**IAHS**) is organizing the 10th Indian Horticulture Congress-2023 on the theme **'Unleashing Horticultural Potential for Self-Reliant India'** from **6th-9th November, 2023** in collaboration with Assam Agricultural University at Guwahati with special focus on N-E region.

I firmly believe that horticulture sector will play a pivotal role in making India self-reliant and developed country through innovations and adoption of modern-day tools and techniques during the *Amrit Kaal*.

I am pleased to note that over 70 speakers of national and international stature will be engaged in the deliberation of pertinent issues related to the horticultural production, protection, procession and export. My heartiest congratulations to IAHS and AAU for holding such a relevant and timely event and engage policy makers, researchers, students, private industries, farmers, NGOs, etc. in a national platform to deliberate on new and emerging issues relevant to Indian Horticulture so that it gives a way forward for future research, education and development.

I profusely congratulate IAHS and AAU and I convey my best wishes for success of the 10th Indian Horticulture Congress-2023.

Shobha karandlajj

(Shobha Karandalje)

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Atul Bora
Minister
Agriculture Horticulture Animal Husbandry & Veterinary Border Protection & Development, Implementation of Assam Accord

GOVERNMENT OF ASSAM

MESSAGE

It brings me great joy to know that the 10th Indian Horticulture Congress, with the theme of "Unleashing Horticultural Potential for Self-Reliant India," will take place in Khanapara, Guwahati from 6th to 9th November, 2023. This prestigious event is a collaborative effort between the Indian Academy of Horticultural Sciences, New Delhi and the Assam Agricultural University.

It is understood that approximately 500 eminent Horticultural scientists from across the nation will converge to discuss recent advancements and chart the future course of action within the Horticulture sector. Moreover, more than 70 distinguished speakers of national and international eminence, have been invited to address critical aspects of Horticulture. In my view, Horticulture is poised to be a cornerstone in India's journey toward self-reliance and development, serving as a catalyst through innovations and the adoption of contemporary tools and techniques.

I firmly believe that this national platform will provide extensive opportunities for researchers, policymakers, industries, students and farmers to engage in meaningful discussions regarding issues relevant to the future of Indian Horticulture in the years to come.

I wholeheartedly congratulate IAHS and AAU once again and extend my best wishes for successful conduct of the 10th Indian Horticulture Congress-2023.

Date : 27th October, 2023

(ATUL BORA)

Block - C, Ground Floor, Assam Sachivalaya, Dispur, Guwahati - 781006, Tel. : 0361-2237008 (O), E-mail : ministeratulbora@gmail.com

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Message

I am happy to learn that the Indian Academy of Horticultural Sciences (IAHS) is organizing the 10th Indian Horticulture Congress-2023 on the theme 'Unleashing Horticultural Potential for Self-Reliant India' from 6th-9th November, 2023 in collaboration with Assam Agricultural University at Guwahati with special focus on North Eastern Region.

Horticulture being a core sector of Indian Agriculture and has proved to be an inseparable part Government's vision of doubling of farmer's income. A remarkable growth in terms of overall production has been made by this sector reaching to the level of about 352 million MT. I understand that horticulture Congress would deliberate on the priorities for research and education, identify opportunities for new age technologies to facilitate sustainable horticulture production, and explore the potential of Northeast India as a growth engine for horticulture.

The Indian Horticulture Congress is a platform to discuss and deliberate upon the recent technological advancement in different frontiers namely advancement in crop improvement, production and protection technologies, use of artificial intelligence (AI), machine learning (ML), big data, next generation sequencing and genome editing etc. I hope the outcome of the deliberations in the Congress would be instrumental for getting insight about the technological and policy interventions required for achieving self-reliance in Horticulture.

I am sure the deliberation of the Congress would address the pertinent issues Horticulture through the integration of various stakeholders.

I wish the Congress a grand success.

(Himanshu Pathak)

31st October, 2023
New Delhi

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Members:	**Dr Masfiqual Hussain**, Jr. Scientist, AAU- HRS, Kahikuchi
	Dr Jogadev Mahanta, Professor, Deptt. of Poultry Science. CVSc, Khanapara
	Dr Mihir Sarma, Jr. Scientist, O/o DR (Vety). CVSc, Khanapara

Certificate and Award Sub-Committee

Chairman:	**Dr Samiran Pathak**, Principal Scientist, AAU-HRS, Kahikuchi
Convenor:	**Dr Seema Bhagowati**, Jr. Scientist, AAU- HRS, Kahikuchi
Members:	**Ms Ranjita Bora**, CVSc, Khanapara
	Mr Madhurjya Bora, PA, AAU- HRS, Kahikuchi
	Mr Baikuntha Das, OA, AAU- HRS, Kahikuchi
	Mr Nazib Hazarika, FC, AAU- HRS, Kahikuchi
	Ms Jahnabi Sarma, Acctt., AAU- HRS, Kahikuchi

Logistics Sub-Committee

Chairman:	**Dr Chinmoy Sarmah**, Chief Scientist, IWM, AAU, Jorhat
Co-Chairman:	**Dr Sheriful Alam**, Professor, (Horticulture), AAU, Jorhat
Convenor:	**Dr Mukul K. Deka**, Professor (Entomology), AAU, Jorhat
Members:	**Dr Kritideepan Sarmah**, Scientist, Bio. & Agril. Chem., AAU, Jorhat
	Dr Pankaj Deka, Assistant Professor, department of Microbiology, CVSc

	Dr Ilakshy Deka, SMS, KVK Kamrup
	Mr Subhash Kalita, Programme Assistant, KVK Morigaon
	Mr Tapan Sensowa, AAU, Jorhat

IT Sub-Committee

Chairman:	**Dr Raju Paswan**, Professor & Head, Agril. Statistics, AAU, Jorhat
Convenor:	**Dr Hemanta Saikia**, Asst. Professor, Sericulture, AAU, Jorhat
Co-Convenors:	**Dr Bharat Nath**, Scientist (Plant Pathology), AAU, Jorhat
	Dr Deepak Sarma, Asst. Professor, Agril. Stat., AAU, Jorhat

Farmer Scientist Interaction Sub- Committee

Responsibility : Arranging for farmers – scientist interaction (IIHR), conveyance, accommodation (if needed)

Chairman:	**Dr Promod Chandra Deka**, Principal Scientist & CEO, AAU-CBBO, HRS, Kahikuchi
Convenor:	**Dr Niranjan Deka**, Head, KVK, Nagaon
	Dr Jayanta Kr. Sharma, Sr. Scientist, AAU- HRS, Kahikuchi
Members:	**Dr Samiran Pathak**, Principal Scientist, AAU- HRS, Kahikuchi
	Dr Rizwal Halim, SMS, KVK- Kamrup
	Dr Ilakshy Deka, SMS, KVK- Kamrup
	Dr Madhusmita Kataky, SMS, KVK- Kamrup
	Dr Dorodi Priyam Duwarah, SMS, KVK- Kamrup

Medical Sub-Committee

Responsibility : To look after medical facilities for all participants

Chairman:	**Dr Yogiraj Das**, CVSc, Khanapara
Convenor:	**Dr Parsha Jyoti Nath**, Asst. Prof., Dept. of VSR, CVSc, Khanapara
Members:	**Mr Nizamuddin Ahmed**, JRF, AAU- HRS, Kahikuchi
	Mr Tarique Aziz, JRF, AAU- HRS, Kahikuchi
	Mr Abhishek Rajkhowa, PA- I, AAU- HRS, Kahikuchi
	Mr Imran Hussain, APS, AAU- HRS, Kahikuchi
	Mr Madhurjya Bora, PA, AAU- HRS, Kahikuchi
	Mr Baikuntha Das, OA, AAU- HRS, Kahikuchi
	Mr Nazib Hazarika, FC, AAU- HRS, Kahikuchi

FOREWORD

Indian horticulture sector contributes about 33% to the agriculture Gross Value Added (GVA) making very significant contribution to the Indian economy. Apart from ensuring nutritional security of the nation, it provides alternate rural employment opportunities, diversification in farm activities, and enhanced income to farmers. India is currently producing about 351.92 million tons of horticulture produce which has surpassed the food grain production. The area under horticulture crops has increased from 12.8 million ha in 1991-92 to 28.04 million ha in 2021-22 resulting in cumulative increase of 100 % during the last 30 years. India has emerged as world leader in the production of a variety of fruits like mango, banana, guava, papaya, sapota, pomegranate, Lime & aonla and is the second largest producer of fruits and vegetables. Besides, India has maintained its dominance in the production of spices, coconut and cashewnut. Among the new crops, kiwi, gherkins, kinnow, date palm and oil palm have been successfully introduced for commercial cultivation in the country. Horticulture sector is pivotal in meeting the Sustainable Development Goals (SDGs) of the United Nations. Horticulture crops production has been given a major focus by Govt. of India in future crop diversification, improving livelihood through doubling farmers' income, economic opportunities through export and job opportunities. Indian horticulture is a bright spot in agriculture-based economy mainly because of systematic research and development in the past. However, with the rapid evolution of new technologies and tools there is an urgent need to adopt and apply these tools for rapid advancement of this important sector. Rapid advancement in production technologies, improvement of crop plants, Artificial Intelligence (AI), Machine Learning (ML), Big data and next generation sequencing and development of new pipelines for analysis of the genomics data opened several new avenues for precise cultivation and designing of new crop varieties in horticulture. The congress will discuss the most relevant and emerging issues related to improvement, role in food and pharma industry, precise cultivation, approaches to meet the emerging biotic and abiotic stresses, application of AI, ML, Bigdata and genome editing tools in horticulture. Special emphasis will be given to the potential of the North-East India as a hub for horticultural production and export. The congress aims to identify such issues, set priorities to unleash the potential of this sector in attaining self-reliance. In 2023, India emerged as a major producer of horticultural crops and emerged as the Horticulture Bowl of the world. The horticulture production is estimated at 351.92 million tonnes, and India ranks second after China. The Horticulture sector *per se* is contributing over 30% share in the agriculture GDP of the country, which is also forming the base for rural entrepreneurship and employment generation.

The Indian Academy of Horticultural Sciences (earlier Horticultural Society of India) is one of the premier horticultural societies in the Indian sub-continent founded on 1st January, 1942 at Lyallpur and registered on 6th November, 1950. The decision to start the society was taken by four eminent horticulturists of the country at that time, namely, Sardar Bahadur Lal Singh, Shri S.S. Bhat, Shri Aslam Khan and Dr P.K. Sen in a Fruit Committee meeting organized by the then Imperial Council of Agricultural Research at Delhi. Since its inception in 1942, the Indian Academy of Horticultural Sciences has travelled and has the distinction of the premier professional academy and had been leading in organizing several symposia, conferences, seminars, brainstorming sessions, etc. both International and national on topical issues related with Horticulture thus impacting the research and development personnel, students, technocrats, growers, policy makers, entrepreneurs, and industry representatives involved in Horticulture and allied sectors. The earlier path-breaking initiatives of the academy include national seminars on topics like Hi-tech Horticulture, Plant Biotechnology, Organic Farming and Pre & Post-harvest Management in Horticulture. The academy also organized several crop-specific dedicated symposia, *e.g.* sapota, grape, papaya, banana, citrus and temperate fruits. Though the society has held a number of symposia to deliberate and sensitize latest advancements on topical issues.

The Indian Academy of Horticultural Sciences has marched attune with the changing times and has been the true flag bearer in championing the cause of horticulture in the country. Time and again it has served as the source for flagging off R & D issues in Horticulture, which have far reaching influence on setting up of research and development agenda. Since its inception the academy had the patronage of several stalwarts and luminaries in Horticulture who have contributed immensely in shaping this sector in the country from a homestead activity to a full-fledged organized industry. In the recent times more emphasis was given to re-shape the research and education landscape of Indian horticulture through implementation of New Education Policy, 2020, application of genome editing in horticultural crops and clean plant production. Today, as a result of better synergy between research agencies, technological and policy initiatives by different central and state governmental agencies, proactive participation of private sector and higher degree of employment generation diversification to Horticulture, this sector has emerged as a sustainable and viable proposition for even the small and marginal farmers including different stakeholders in the commodity chain. In spite of the remarkable progress made in the Horticulture Sector in India, there is a lot of scope in further consolidating the missing links. This could better happen in a situation where private agencies, which have strong forward linkages and public & private-funded agencies having strong backward linkages join together to harness the potential of this sector to forge towards newer heights in the era of globalization, consumerism, skill development, organized retail and e-trading, better access to market information, micro-finance and crop insurance etc. The time has come for forging rewarding

PPP ventures, which would pay rich dividends to all the partners. The challenges are many, namely, nutritional security in diverse agro-climatic zones, threat of climate change, need for new plant genotypes for diversified end uses, efficient management of production deficit and gluts, lack of infrastructure in commodity value-chain, retail chains and organized market systems, establishment of farmer producer companies/ SHGs, Crop clusters and export promotion. It is, therefore, necessary that modern Horticulture sector gears to meet the new challenges and to bring overall change leading to redefining the short- and long-term goals in research, production system, education and human resource development, public and private sector collaboration, market intelligence and auction system and, refinement & implementation of diligent policies to boost production, productivity, processing and export of fresh and processed horticultural produce and products.

Several states have taken the advantages of the pro-horticulture programmes and policies of both central and state governments and have marched ahead and made remarkable progress in almost all sub-sectors in Horticulture. Several newer issues are however cropping in and the world community is discussing the impact of climate change on crop production and concerns for the depleting biodiversity, which are also affecting horticulture sector too. It is timely that the 10th Indian Horticulture Congress is being organized on the theme Unleashing Horticultural Potential for Self-Reliant India' is being organized from 06-09 November, 2023 at College of Veterinary Science Campus, Assam Agricultural University, Khanapara, Guwahati, Assam. This event will be an occasion to take stock of the current situation of Horticulture and to identify critical gaps in various existing and emerging areas in horticulture with special emphasis on North-East regions of India.

The Indian Academy of Horticultural Sciences has made an effort in this Souvenir to publish the Invited paper abstracts of scheduled to be presented in 11 Technical Sessions and 3 Panel Discussion on Nationally important issues to frame guideline for progress of the Horticulture sector. The academy had requested resource persons and organizations of repute to contribute in this Souvenir to bring their experiences, enable formulation of strategies for the future holistic growth of the sector in the competitive global market. The response received has been quite encouraging. We are indeed indebted to all the contributors who accepted our request and agreed to share their expertise/ views.

On behalf of the Indian Academy of Horticultural Sciences, I take this opportunity to profusely thank the members of Organizing Committee, Local Organizing Committee, Office Bearers & members of the Executive Committee of the academy; faculty, students and staff members of the Assam Agricultural University, Jorhat, Assam and Veterinary College Campus, Khanapara, Guwahati, Assam, Chairmen/Co-chairmen/Conveners/Rappoteurs and the team members of different Committees who have toiled hard in organizing the 10th Indian Horticulture Congress-2023 in a befitting manner. I would also like to place

on record our gratitude to all the public and private organizations supporting the Congress, namely, Ministry of Agriculture and Farmers Welfare, GoI, Govt. of Assam, Indian Council of Agricultural Research, Assam Agricultural University, Jorhat, Assam; IPL Biologicals Limited, Coconut Development Board, National Horticulture Board, Alliance of Bioversity International and CIAT, National Bank for Agriculture and Rural Development for co-sponsoring the event.

I am immensely thankful to the Ministry of Agriculture and Farmers Welfare, Dr H. Pathak, Secretary DARE and DG, ICAR; Dr Bidyut C. Deka, Vice Chancellor, Assam Agricultural University, Jorhat for co-hosting the Congress. My special appreciation is for the Core team at the Secretariat of the Organizing Committee, namely, Dr V.B. Patel, Secretary, IAHS, Dr D. R. Singh and Dr S.K. Singh, Vice Presidents, Dr Jai Prakash, Treasurer, Dr Shyam Sundar Dey, Joint Secretary, Dr Ananta Saikia, Local Organising Secretary, and several others who have made significant contributions. Sincere efforts of the Academy Secretariat staff, namely, Ms Preeti Gaba, Ms Ishita Srivastav and Mr Sanjeev Kumar are duly acknowledged.

Thanks are due to Chairmen, Conveners and members of different Local Organising sub-committees for their whole hearted support in organising this congress. I am equally thankful Chairpersons, Co-Chairpersons and Conveners who have agreed to conduct the Technical Sessions. I am extremely obliged to all the invited speakers and guest contributors who have responded to our request for both participation and presentation. I am sure the Congress would generate meaningful discussions culminating in more relevant recommendations, which can be projected to different agencies for consideration in framing policies and developmental progammes for future improvement of productivity of horticultural crops and income of horticultural farms.

I wish every participant in the congress a very happy stay at Guwahati, participation in fruitful discussions and good luck for their future endeavours. The IAHS family conveys all the delegates a Very Happy and Prosperous New Year-2024.

K.L. Chadha

31st October, 2023

(K.L. Chadha)

President IAHS & Chairman, National Organizing Committee

10th INDIAN HORTICULTURE CONGRESS - 2023

Keynote & Lead Speakers

Session I: Horticulture in *Amrit kaal*: Research Priorities

Dr V. B. Patel

Dr Sudhakar Pandey

Dr K. V. Prasad

Dr K. B. Hebbar

Dr R. Dinesh

Dr Manish Das

Panel discussion-1: Horticulture in *Amrit kaal*: Education Priorities

Dr Bidyut C. Deka

Dr Anupama Singh

Dr Bijendra Singh

Dr T. Janakiram

Dr K.B. Kathiria

Dr Neeraja Prabhakar

Dr Z. P. Patel

Dr R. S. Kureel

Session II: Elite Germplasm and Variety Development

Dr Bijendra Singh

Dr K.B. Kathiria

Dr S.K. Malik

Dr M. Sankaran

Dr Vijay Mahajan

Dr Pritam Kalia

Dr Anil Khar

Session III: Digital farming in Horticulture

Dr Neelam Patel

Dr Anil Rai

Dr Subhasisa Dutta

Dr R. N. Sahoo

Dr S.K. Dwivedy

Dr Bijoy K. Handique

Session IV: Use of Rootstocks in Horticulture

Dr Z.P. Patel

Dr S. Rajan

Dr M.K. Verma

Dr O.P. Awasthi

Dr E. Sreenivasa Rao

Dr Anant Bahadur

Dr Markandey Singh

Panel discussion-2 : Genome Editing in Horticultural Crops

Dr Sanjay Kumar Singh

Dr T. K. Behera

Dr C. Viswanathan

Dr R. C. Bhattacharya

Dr Bidyut Kumar Sharma

Session V: Innovation for Sustainable Horticultural Production

Dr D.R. Singh

Dr R.S. Chandel

Dr R.K. Pathak

Dr Tsering Stobdan

Dr Bikas Das

Dr J.I. Mir

Mr Randip Ghosh

Dr Vimala Prakash

Dr Murli Yadav

Dr G. Selvakumar

Dr Sachin S. Suroshe

Session VI: Strategies for Development of Minor Commercial Crops

Dr J. C. Rana

Dr Sanjay K. Dwivedi

Dr P. L. Saroj

Dr V.P. Sharma

Dr K. Suresh

Dr S. P. Das

Dr A. K. Singh

Session VII: Urban and Peri-urban Horticulture

Dr Balraj Singh

Dr T. Janakiram

Dr Alka Singh

Dr Anand R. Zambre

Dr Naveen Kumar Patle

Session VIII: Horticulture in North-Eastern India

Dr H. S. Gupta

Dr S. P. Ghosh

Dr Suresh Kumar Malhotra

Dr Prabhat Kumar

Dr Bhanu Pratap Singh

Dr K. K. Jindal

Dr Akali Sema

Dr C. P. Suresh

Dr T. K. Hazarika

Session IX: Management of Biotic and Abiotic Stresses

Dr K. Sammi Reddy

Dr Jagdish Rane

Dr T. Damodaran

Dr R. M. Sharma

Dr R. Selvarajan

Dr V. Ambethgar

Dr Akhilesh Sharma

Session X: Horticulture for Food, Pharmaceutical and Cosmetic Industries

Dr M. L. Chadha

Dr R. K. Pal

Dr Kaushik Banerjee

Dr Suneel Pareek

Dr Dinesh Kumar

Dr Gopal Lal

Dr P. Suresh Kumar

Dr G.J. Janavi

Panel Discussion-3 : Clean Plant Production in Perennial Horticultural Crops

Shri Priya Ranjan

Dr V. B. Patel

Dr V.K. Baranwal

Dr S. C. Dubey

Dr Dilip Ghosh

Dr R. A. Marathe

Dr Celia Chalam Vasimalla

Dr Sujoy Saha

Dr P. K. Shukla

Shri C.P. Gandhi

Session XI: Exploiting Emerging Trade Opportunities

Dr Raka Saxena

Dr Prakash Patil

Dr Dinakar Adiga

Dr Brajesh Singh

Dr P. K. Gupta

10th INDIAN HORTICULTURE CONGRESS - 2023

Panel Discussion

Day 1: November 06, 2023 **Time: 15:30- 16:45**

Panel Discussion-1 : Horticulture in Amrit kaal: Education Priorities

Chair: **Dr D.R. Singh**

Convener: **Dr S.K. Singh**

Rapporteurs : **Dr M. Sankaran** and **Dr Kalyan Barman**

Theme Presentation-I	**Horticultural Education in changing scenario of NEP 2020** **Dr Bidyut Chandan Deka**	Vice Chancellor, Assam Agricultural University,Jorhat, Assam
Theme Presentation-II	**Horticulture in Amrit Kaal: Education Priorities and SWOT analysis** **Dr. Anupama Singh**	Dean and Joint Director (Education), ICAR-Indian Agricultural Research Institute, New Delhi
Panelist	**Dr. Bijendra Singh**	Vice Chancellor, Acharya Narendra Deva University of Agriculture & Technology, Kumarganj, Ayodhya, Uttar Pradesh
	Dr. T. Janakiram	Vice Chancellor, YSR Horticulture University, West Godavari District, Andhra Pradesh
	Dr. K. B. Kathiria	Vice Chancellor, Anand Agricultural University, Anand, Gujarat
	Dr Neeraja Prabhakar	Vice Chancellor, Sri Konda Laxman Telangana State Horticultural University, Siddipet, Telangana
	Dr. Z. P. Patel	Vice Chancellor, Navsari Agricultural University, Eru Char Rasta, Dandi Road, Navsari, Gujarat.
	Dr. R. S. Kureel	Vice Chancellor, Mahatma Gandhi Udyaniki Evam Vaniki Vishwavidyalaya, Patan, Durg, Chhattisgarh

Day 2: November 07, 2023 **Time: -12:00-13:30**

Panel Discussion–2:
Genome Editing in Horticultural Crops

Chair: **Dr Chittaranjan Kole**

Convener: **Dr T.K. Behera**

Rapporteurs: **Dr Achuit K. Singh** and **Dr S.S. Dey**

Theme Presentation-I	**Dr. Sanjay Kumar Singh**	Director, ICAR-Indian Institute of Horticultural Research, Bengaluru, Karnataka
Theme Presentation-II	**Dr. T. K. Behera**	Director, ICAR-Indian Institute of Vegetable Research, Varanasi, Uttar Pradesh
Panelist	**Dr. C. Viswanathan**	Joint Director (Research), ICAR-Indian Agricultural Research Institute, New Delhi
	Dr. R. C. Bhattacharya	Director, ICAR-National Institute for Plant Biotechnology, Pusa, New Delhi
	Dr. Bidyut Kumar Sharma	Centre Director, DBT NECAB, Assam Agricultural University, Jorhat, Assam
	Dr. Achuit K. Singh	Principal Scientist, ICAR-Indian Institute of Vegetable Research, Varanasi, Uttar Pradesh
	Dr. M. Ravindran	Director of Research, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu
	Dr. Swarup Parida	Scientist-V, National Institute of Plant Genomic Resources, New Delhi

Day 3: November 08, 2023 **Time: 16:45-18:15**

Panel Discussion-3:
Clean Plant Production in Perennial Horticultural Crops

Chair: **Shri Priya Ranjan**

Convener: **Dr V. B. Patel**

Rapporteurs: **Dr Sujoy Saha** and **Shri C. P. Gandhi**

Lead Presentation	**Shri Priya Ranjan**	Joint Secretary, MIDH, Ministry of Agriculture and Famrers Welfare , New Delhi
Moderator	**Dr V. B. Patel**	Assistant Director General (Fruits and Plantation), Indian Council of Agricultural Research, New Delhi
Panelist	**Dr. V.K. Baranwal**	National Professor, ICAR-Indian Agricultural Research Institute, New Delhi
	Dr. S. C. Dubey	Assistant Director General (Plant Protection & Biosafety), Indian Council of Agricultural Research, New Delhi
	Dr. Dilip Ghosh	Director, ICAR- Central Citrus Research Institute, Nagpur, Maharashtra
	Dr. R. A. Marathe	Director, ICAR-NRC pomegranate, Solapur, Maharashtra
	Dr. Celia Chalam Vasimalla	Head, Division of Plant Quarantine, ICAR-National Bureau of Plant Genetic Resources, New Delhi
	Dr. Sujoy Saha	Principal Scientist, ICAR-NRC on Grapes, Pune, Maharashtra
	Dr P. K. Shukla	Principal Scientist, ICAR-Central Institute for Sub- Tropical Horticulture, Lucknow, Uttar Pradesh
	Shri C.P. Gandhi	Joint Director, National Horticulture Board, MoAFW, Govt. of India, Gurugram, Haryana

Day 1, November 06, 2023

International Auditorium, Sankaradeva Kalakshetra Society, Panjabari, Guwahati

Session I

HORTICULTURE IN *AMRIT KAAL* : RESEARCH PRIORITIES

Chair : Dr T. Janakiram, Vice Chancellor Dr. YSR Horticultural University Venkataramannagudem, West Godavari, Andhra Pradesh

Co-chair : Dr S. Rajan, Ex-Director, ICAR-Central Institute of Sub-tropical Horticulture, Lucknow, Uttar Pradesh

PRIORITISING RESEARCH ON FRUIT CROPS

V.B. Patel[1*] and M. Sankaran[2]
[1]Horticultural Science Division, Indian Council of agricultural Research, New Delhi
[2]Division of Fruit Crops, ICAR-Indian Institute of Horticultural Research, Bengaluru, Karnataka
Email: vishaw.patel@icar.gov.in; patelvb7@gmail.com

India's diverse climate and geography offers a favourable environment for growing a wide variety of horticultural crops such as fruits, vegetables and tuber crops, spices, flowers, medicinal and aromatic plants, plantation crops, each with unique flavours, nutritional profiles, and economic potential. Horticulture sector in the country is witnessing a record production of 352 million tonnes which has increased the exports. The demand for fruits is keep on increasing at a very faster rate due to the demographic change, change in food habits resulting in increased consumption, realization of nutritional and health properties, exports and value addition. The current demand of fruits at present is about 112 million MT which is expected to reach 244 million MT by 2047 with a change of 2.18 times. So far, the higher fruit production is achieved majorly through area expansion i.e. area led growth and technology enhanced productivity growth is yet to achieve to its potential. Several new initiatives and technologies required to be taken to meet the increasing demand. Some of the key areas require to be focussed are mainstreaming of genetic resources for various traits, use of wild relatives to develop pre-breeding lines, trait specific breeding of scion and rootstock varieties to address various biotic and abiotic factors (salinity & drought) etc. Enhancing the breeding efficiency by using the molecular markers, functional genomics, genome editing and robust bioinformatics tools for shortening the breeding cycle. Emphasis is required on bio prospecting of underutilized fruits and promotion of cultivation of exotic fruits such as avocado, dragon fruit, rambutan, durian, blue berry and other exotic berries, etc. to reduce the imports. Refinement of package of practices for high density planting (HDP)/Ultra HDP, canopy management, enhancing water and nutrient use efficiency, development of GAPs standards for higher yield, quality and traceability. Development of package of practices for protected cultivation utilizing photovoltaic, sensors, vertical farming and hydroponics, application of AI / IoT tools for smart fruit production systems and precision farming are also required. Integrated Farming System (IFS), organic and natural farming in fruit based cropping systems need to standardise. Strengthening of infrastructure and research for large scale multiplication of quality seeds and planting material will go a long way to bring about remarkable change in the fruit production scenario in the country. Development of integrated pack houses including sorting, cleaning, grading and packaging will certainly help in reducing the post harvest losses to enhance the availability. Further, extension research strategy should include web based interactive digital information management in horticultural crops for stakeholders. A robust research and development strategies are required to meet the domestic demand, import substitution and earning through exports in the *Amril Kaal*.

Lead Paper

PRIORITIZING RESEARCH ON VEGETABLE CROPS

Sudhakar Pandey[1*], J. K. Ranjan[2] and Pradeep Kumar[3]
[1]Horticultural Science Division, Indian Council of agricultural Research, New Delhi, Delhi
[2]Division of Vegetable Crops, ICAR-Indian Agricultural Research Institute, New Delhi, Delhi
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Horticulture plays a pivotal role in meeting the challenges of food and nutritional security and provides a sustainable livelihood option in the backdrop of diminishing land and water resources in the present era of global climate change. Vegetables are one of the most important components (58.9% of the total horticultural production in India) of horticulture. India stands second in world vegetable production with a global share of about 13.6% by producing 209.14 million tonnes (mt) from an 11.37 million ha area. They are mainly grown in tropical and subtropical climates and are influenced by various factors. Vegetables are also a major source of nutrients, vitamins, minerals, and phytochemicals that are essential for the growth and development of vegetable crops. The growing demand for vegetable crops has led to the development of a variety of vegetable varieties and hybrids. The development of new vegetable varieties, hybrids, and improved vegetable varieties as well as the advancement of resource-efficient, commercially viable, and environmentally safe production and protection technologies for vegetables should be our top priorities in vegetable research. This paper focuses on the current state of research in the field of vegetables in order to address the challenges related to improving crop productivity, nutritional value, sustainability, and resilience in the face of climate change and to discuss the future directions of research.

PRIORITIZING RESEARCH ON ORNAMENTAL CROPS

K. V. Prasad*
Director, ICAR-Directorate of Floriculture Research, Pune, Maharashtra
Email: directordfr@gmail.com

With an area of 305000 ha and overall production of 23.01 lakh tons loose flowers and 7.63 lakh tons of cut flowers, Indian floriculture sector contributes Rs 25000 crores through domestic trade and Rs.725 crores through exports. India also imports floricultural produce worth Rs.160 crores. The foundation for systematic improvement of flower crops was laid by Dr. B.P.Pal at IARI, New Delhi during 50's. Division of Ornamental Plants came in to existence at IIHR, Bengaluru during 1969 and Division of Floriculture and Landscaping at IARI during 1983 which shaped the research, teaching and outreach approaches in floriculture. With the inception of AICRP on Floriculture during 1972, research work on a network mode got the impetus. Indian Council of Agricultural Research (ICAR) upgraded the AICRP on Floriculture in to a full-fledged Directorate of Floriculture Research in 2009 with specific mandate to conduct basic, applied and strategic research of floriculture. Floriculture sector is uniquely positioned to address SDG 1- No Poverty as they are high Value low volume crops, ideally suited for doubling the farmers Income; SDG 3-Good Health and Well Being as they are rich in nutraceutical pigments, anti oxidants and natural flavours and fragrances therefore can replace harmful synthetic colours, fragrances and improve health and wellbeing; SDG 5-Gender Equality as floriculture activities are mostly women centric operations in production, post harvest and value addition; SDG 11-Sustainable Cities and Communities as they have the ability to improve Indoor Air Quality, Vertical gardening/Farming, Urban Floriculture, Terrace gardening, Smart City projects are key avenues through with it can be addressed; SDG 12-Responsible Consumption Responsible Production calls for developing India GAP, Flower Labels (MPS ABC, MPS-GAP, MPS-Quality), Zero wastage, zero post harvest management; SDG 15-Life on Land as floriculture is uniquely poised to ensure quality of life by providing clean environment (arboriculture, vertical gardens, indoor plants, carbon sequestration); high value phytochemicals (nutraceuticals, essential oils, antioxidants); supporting ecosystem services (pollinators/natural enemies/apiculture/birds) developing Biopesticides, Biofertilizers, Biocontrol Agents; sustainable production (Vertical Farming, Urban Horticulture, Terrace gardening, Aeroponics/Hydroponics etc. An analysis of Critical Research Gaps indicates the gaps are narrow in Crop Improvement, Crop Production, Crop Protection, Post harvest management, Protected cultivation, Seed and Planting material, Dry flower technology while the gaps are wide in areas like Alternate media for Pot plants, Cut foliage and Fillers, New Flowers, Landscaping, Grasses, Micropropagation, IPR-PBR, Nematode Management, Biotechnology, Market Intelligence, Programmed Production, Protected Cultivation etc. whereas the gaps are wider in areas like Nutraceuticals, Alternate light sources, Packaging and Packaging Material,

Mobile Based Apps, Ecosystem services, Organic Floriculture, Micro-nutrient Management, Aromatherapy, Temperate Floriculture, Aquatic flowers, Urban Floriculture, Quality Labels, Pollution mitigation, Nanotechnology, Mechanization, Carbon sequestration etc.,

Therefore, research focus needs to be on Native Ornamentals, Green ways to pollution mitigation, Mapping of nutraceutical content, Ecosystem services (NBHM), Marker Assisted Selection/Breeding, Organic Floriculture/ Natural Farming, Molecular Diagnostics (APEDA), Nematode Management, Ready to use formulations (PHT, INM), SEM studies of Pollen, Alternate Light Sources, Turf management, Genome Editing, Speed Breeding; Biotic Stress resistance/ tolerance; Weather Based forecasting models; Biocontrol; Expansion of label claims; Digital Floriculture with focus on development of Sensors, Wearables, Automation, B2B, B2C platforms, AI & IoT technologies.

PRIORITIZING RESEARCH ON PLANTATION CROPS

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Plantation crops constitute an important component of horticultural crops with appreciable economic potential. Owing to their perennial nature and cultivation in vulnerable regions, plantations in India and elsewhere witness a stagnating yield, deceleration in cultivable area, and climate change induced adverse conditions among other constraints. Therefore, adoption of novel research approaches is mandatory to ward off these constraints and to develop a sustainable system based on plantation crops. Nevertheless, research pertaining to perennial crops necessitates greater investment of time, resources, including manpower, than what is involved in annual crops. This operating environment poses several constraints for research and developmental activities. This paper highlights various novel approaches so that research gaps in the plantation sector could be prioritized in a systematic manner and desired objective of overall sustainability and economic prosperity could be achieved.

Lead Paper

PRIORITIZING RESEARCH ON SPICE CROPS

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India is the "Land of Spices" and spices are cultivated in an area of 4.36 mha with a production of 11.15 mt during 2021-22. The export of spices/spice products from the country has been 1.53 mt valued at Rs. 30,576 crores (4.10 billion US$) during 2021-22. Spice trade is evergreen and there is a greater demand for spices produced from India. Spices contribute 26% of the volume and 50% of the export value of horticultural exports from the country and spices export occupies the 5th place in terms of value during 2023, and contributes 7.2% to the total agricultural products export. Driven by nutraceutical and pharmaceutical applications, the recent years have witnessed an increased demand for spice commodities and their value-added products across the globe. Targeted production using precision technologies and trait specific varieties, value addition and aggressive marketing of spices would double our trade and progressively increase to 10 billion USD by next decade and around 25 billion USD by 2050. To achieve this, India must change its strategy from major exporter of raw spices to the exporter of value added products like food flavours, nutrceuticals, cosmoceuticals and novel high value phytochemicals. The total nutraceutical market in India is evolving and is estimated to reach USD 18 billion by the end of 2025. Concerns about food safety and quality are also on the rise. Uncontrolled use of agricultural chemicals is one of the major food safety challenges in spices supply chain. The developed models on organic farming, Good Agricultural Practices and sustainable initiatives need to be popularized among the farmers for getting a cleaner produce. Basic, applied and transdisciplinary research should enable growers to adopt innovative practices that will lower their costs of production and enhances profitability and sustainability. The spice sector also needs to improve its environmental image and reduce its carbon footprint. There is a need for a coordinated, strategic approach between public and private sectors that achieves a long-term goal. The major research priorities to be taken up are in the areas as specified.

- Breeding spices varieties for climate resilience, biotic stress tolerance, yield enhancement and nutritional security through genomic approaches
- Unravelling the biosynthetic pathway of important secondary metabolites in spices through genomics approaches and Metabolic engineering for overproduction of nutraceuticals.
- Employing advanced techniques of large scale production of disease free planting materials of trait oriented targeted spice crop varieties
- Integrating AI and IOT based sensors for improving input use efficiency and pest surveillance targeting delivery of technologies for enhancing productivity and ensuring food safety in spices

- High tech horticulture interventions like precision/ vertical farming techniques to maximize productivity and quality of spices for targeted markets
- Rhizosphere engineering for soil health management and Development of novel molecules of plant and microbial origin as next generation green pesticides
- Developing electronic devices/ sensors for monitoring quality and adulteration of spices and Nutrigenomics/pharmacogenomics in spices
- Reaching the unreached through digital means and promoting community/ group farming with assured block chain & value chain management
- Formation of consortia of producing countries to regulate quality safeguards and price fluctuation

With the concerted and coordinated efforts, India will take the lead in developing viable and effective solutions to the technological challenges in the spices sector, and play a catalytic role in bringing a progressive change for making the country a global leader in spices.

Lead Paper

PRIORITIZING RESEARCH ON MEDICINAL AND AROMATIC PLANTS

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The history of medicinal plants in India spans millennia, showcasing the deep connection between humanity and the plant world. Medicinal plants are vital in India's healthcare, bridging ancient wisdom with modern science. In the contemporary era, medicinal and aromatic plants (MAPs) maintain significance in scientific research and pharmaceutical development. They stand at the intersection of tradition and innovation, preserving health, preventing disease, and advancing therapeutics, showcasing their enduring importance in our evolving healthcare systems. The global medicinal plants industry rapidly expanded and was valued at approximately USD 165.66 billion in 2022. This growth is fueled by the increasing demand for natural and organic products, the rise in chronic diseases, and a greater acceptance of traditional medicine. Projections indicate that by 2030, the industry could reach an impressive USD 347.50 billion, with a remarkable Compound Annual Growth Rate (CAGR) of 11.16%. Noteworthy industry trends encompass the development of new plant-based medicines, the integration of traditional healing into modern healthcare, the incorporating of medicinal plants into food and beverages, and a strong emphasis on sustainable sourcing. India and China are leading exporters of MAPs, with India demonstrating a remarkable 6.14% CAGR in exports from 2017 to 2021, in contrast to China's negative growth. Trade patterns reveal distinctions, as China primarily exports to neighboring countries, while India engages in long-distance trade, notably with the US and Germany. Competitive trade dynamics also highlight countries like Luxembourg, Iceland, and Tanzania, which have shown substantial export growth. The Indian medicinal plants industry offers great potential but faces challenges like habitat degradation and biopiracy. A holistic approach is vital to address this, involving total research involving sustainable cultivation, conservation, and ethical trade. Meeting international standards, ensuring quality, and preserving traditional knowledge are essential. Innovations in herbal drug discovery and collaborations between academia, industry, and traditional practitioners show promise. Responsibility lies with all stakeholders: governments should enact and enforce sustainability policies, industry leaders should invest in research and ethical sourcing, and research institutions should explore untapped potential. Progress in research and development of technologies in India is very encouraging but requires further push and refinement. Collaboration is critical to such research and the industry's sustainable growth, ensuring a prosperous future for all.

Day 1, November 06, 2023

International Auditorium, Sankaradeva Kalakshetra Society, Panjabari, Guwahati

Session II

ELITE GERMPLASM AND VARIETY DEVELOPMENT

Chair : Dr Bijendra Singh, Vice Chancellor, Acharya Narendra Deva University of Agriculture & Technology, Kumarganj, Ayodhya, Uttar Pradesh

Co-chair : Dr W.S. Dhillon, Ex-ADG, ICAR, New Delhi

BREEDING VEGETABLE CROPS FOR YIELD, QUALITY, ADAPTABILITY AND EXPORT

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Vegetable crops are increasingly recognized as essential component of food, nutrition and employment security as they are affordable source of vitamins, minerals and nutraceuticals needed for good health; key component in farm and food diversification; and provide promising opportunity for reducing rural poverty and unemployment. Over the next few decades, a rising Indian population, greater urbanization, increased per capita income, decline in arable land and demographic changes in the population would create new challenges for agricultural production. To meet the growing demand, India needs to raise its annual vegetable production to 375 mt by 2050 against the current level of 204 mt from 11.28 mha area. Vegetable breeding has to fulfil the ever-increasing demands of the consumers, industries, exporters and producers; and the success depends on knowledge, application of new technologies, access to genetic resources, prioritized pre-breeding & parental line development programmes, and investment.

To meet the future demand, the breeding on vegetables needs focused attention for desirable traits such as processing, TLCV, extreme temperatures, cherry type in tomato; FSB, little leaf, BW, PB, ratooning in brinjal; thrips, virus, BW in chilli; thermos-insensitive, high temperature in capsicum; high temperature, compactness, self-blanched, earliness, DBM in cole crops; smoothness, cylindrical shape, colour intensity, self-coloured core in carrot; high temperature & humidity, leaf shape in radish; YVMV, ELCV, shorter internode in okra; sweetness, earliness, powdery mildew, cluster bearing in pea; GCPMV, fleshiness, non-stringiness in cowpea; non-stringiness, slower seed development, fleshiness, high temperature in French bean and photoperiod insensitive, better storability, shallow eyes, high dry matter, early & late blight in potato. Like breeding for higher yield and better quality, it is to be mandatory in all vegetables to develop cultivars with wider adaptability for expanding the availability of produce for longer period. Furthermore, developing cultivars of tomato, capsicum, gherkin, cucumber & muskmelon suitable for protected structures to harvest more from less land and fulfill the ever-increasing demand of vegetables. Moreover, the intensive breeding for specialty traits related to processing/ nutraceutical industries in tomato, chilli, potato, carrot, onion, pea & beans, leafy vegetables; and export for onion, pea, chilli, gherkin, okra, baby/sweet corn & brinjal is required to make noticeable presence of Indian varieties. Further, development and utilization of roust genetic emasculation techniques (male sterility, gynoecism) and doubled haploid lines should be on

priority to harness the heterosis and produce cheaper hybrid seed especially in cross-pollinated vegetable crops. The rootstock breeding is a relatively new discipline but very important in coping with extremes of biotic, climatic and edaphic conditions, particularly in Solanaceous and Cucurbitaceous crops. Overall, the high yielding vegetable cultivars with enhanced quality, tolerance to pests, ability to cope-up with abiotic extremes; modified & précised production systems; and efficient post-harvest management & supply chain using classical breeding methods and cutting-edge technologies will certainly meet out the future demands of consumers, producers, processing/nutraceutical industries and exporters.

TRAIT ENHANCEMENT IN HORTICULTURAL CROPS THROUGH WIDE HYBRIDIZATION

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Wild relatives are good reservoir of untapped genetic diversity, which may not exist in the cultivated gene pool that can be used to improve the numerous traits of interest including resistance/tolerance against diseases, insect-pests, drought, salinity, cold, heat and good agronomic adaption with quality improvement. The recent concept of breeding involves an integration of conventional breeding strategies with advanced molecular, genomic and phenomics tools to efficiently and effectively breed the resilient crop cultivars with enhanced yield potential. Interspecific hybridization allows the exploitation of useful genes from wild, unimproved species for the benefit of the cultivated species. Distant hybridization center operational at AAU, Anand has released two new and unique varieties like ornamental okra (Anand Shobha) and cucumber (Anand Sheetal). The most important features of ornamental okra include intense red large flowers, round the year flowering, perennial, easily propagated through soft wood cuttings, pest and disease resistant and suitable as pot plant and landscaping hedges. Moreover, highly promising genotypes/lines are under testing in the crops like tomato, okra, cucumber, chilli and fruit crops like custard apple.

Lead Paper

MANAGEMENT OF INDIAN FRUIT GENETIC RESOURCES FOR SUSTAINABLE UTILIZATION AND POSTERITY: CURRENT STATUS AND CHALLENGES

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Southeast Asia is rich in genetic diversity of tropical fruits.More than 500 species of native fruits are estimated to be reported from this area, while the Hindustani region of diversity which was distinguished separately from rest of South Asia represents 344 species of fruits. Several tropical fruits species have been originated in India and still populations of some of these along with related species of major and minor fruits are found as wild and semi-wild forms in the areas of diversity. ICAR-NBPGR during last several years has been collecting and conserving indigenous genetic diversity of fruits from various parts of the country. Collected genetic diversity is being conserved using ex-situ conservation approaches in the Field Genebanks and Cryogenebank depending upon the propagation method, storage behaviour of the species and conservation needs. Various Field Genebanks in India at ICAR Institutes, State Agricultural Universities and State Departments hold about 10,000 accessions of various tropical fruits as live collections. However, germplasm conserved in these Field Genebanks is highly vulnerable to various biotic and abiotic stresses.In addition to this Field Genebanks are highly resource consuming in the form of labour and land requirement. Therefore, cryobanking of fruit germplasm is the most convenient and economically viable strategy for achieving long-term conservation of these valuable genetic resources. Successful cryopreservation protocols have been developed at ICAR-NBPGR for cryopreservation of seeds, embryos, embryonic axes, pollen and dormant buds of several of these indigenous fruit species. More than 4000 accessions belonging to approximately 25 genera and 80 species have been successfully cryopreserved in various forms in the cryogenebank. Several wild species of Citrus namely *C. indica*, *C. macroptera*, *C. latipes*, *C. assemensis*, *C. medica*, *C. magaloxycarpa* and cultivated *Citrus* species have been cryopreserved as embryo and embryonic axes. Several other important fruit species such as*Anona squmosa* (Custard apple), *Aegle marmelos* (Bel), *Artocarpus heterophyllus*, *Buchanania lanzan* (Chironjee), *Capparis decidua* (Ker), *Carissa carandus* (Karonda), *Cordia myxa* (Lasoora), *Embelica officinalis* (Aonla), *Grewia asiatica* (Phalsa), *Manilkara hexandra* (Khirni), *Morus* spp., *Musa* spp., *Phoenix sylvestris* (Date sugar palm), *Salvadora oleoides* (Pilu), *Syzygium cumini* (Jamun), *Tamarindus indica* (Tamarind) and *Ziziphus* species (Ber) have been cryostored as seed, embryos, embryonic axes and dormant buds.Pollen grains of important species and cultivars of highly recalcitrant tropical fruit species like mango, litchi, Garcinia and Citrus, have been successfully cryopreserved as nuclear genetic diversity and also for use in crop improvement programmes of these fruits. More than 500 accessions belonging to indigenous and exotic species of Morus have been successfully cryopreserved as dormant buds. In the present paper,the current status of management of Indian fruit germplasm and various challenges being encountered for the conservation of these difficult- to-store species have been discussed.

DEVELOPMENT OF ELITE GERMPLASM AND VARIETIES IN PERENNIAL HORICULTURAL CROPS

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The perennial horticultural crops breeding is a difficult process and time consuming due to the inherent characteristics such as distinct floral biology, out crossing, high heterozygosity, self incompatability, cross incompatability, sterility, parthenocarpy, apomixis, polyembryony, poor fruit set, excessive fruit drop, low rate of sexual propagation with mostly one seed from one fruit, less studies on inheritance of traits, lack of selection procedures for isolation of desired hybrids and long pre-bearing age, etc. Although the breeding methods are the same as for other group of crops, resulting progenies in fruit breeding requires huge space for evaluation because both the parents are in heterozygous conditions. There is also need to refine the selection procedure in different crops coming in the way of improvements as understanding of the genetics and inheritance pattern of the quantitative traits in fruit crops has been extremely difficult. Hence, the selection of parents in a breeding programme based on the phenotype becomes difficult and progeny performance or manifestation of hybrid vigour becomes unpredictable. The progenies are also influenced to a great extent by environment. Simultaneously, exotic introduction of new fruit species and varieties have been made in several fruits adding to the existing variability. As a result, a rich reservoir of species and cultivars of several fruit crops has been built up at various research centres. The breeding methods such as introduction, selection (Open Pollinated Seedling Selections/ Half-sibs/clones), hybridization (Inter-varietal and Interspecific/generic), mutation (for breaking the tightly linked traits) and polyploidy (to overcome cross incompatability, to create homozygous lines & new species and bridging the species) are commonly employed in fruit crops. Among all breeding methods in perennial horticultural crops, selection method has yielded almost 90% of the present day varieties followed by hybridization and mutation. Fruit crops breeding comprises of two parts, scion and rootstocks. The scion breeding objectives mostly includes improving quality with respect to attractive colour and high yield, dwarfing for adoption to high density planting, precocity and regular bearing, seedlessness, soft seeds, improved nutra-ceutical properties, etc. However, the rootstocks to be bred for imparting dwarfness to scions, effective uptake of nutrients, drought and salt tolerance, resistance to soil borne pathogens etc. Rootstock breeding is more difficult and time taking as compared to scion breeding. Evaluation of rootstocks for desirable traits and stionic influence also requires more time. Exploitation of wild species and incorporation of genes from wild species is one of the ways to improve the cultivated species. However, in addition to the conventional breeding methods, the time has come to use the modern methods of breeding based

on biotechnological interventions such as application of molecular markers (for diversity analysis, markers linked to the genes governing the trait of interest and hybridity confirmation), genotyping by sequencing (GBS), genome wide association mapping (GWAS) studies for specific traits, Transgenics, Cisgenics and Genome editing technologies (zinc-finger nucleases (ZFNs), transcription activator-like effector nucleases (TALENs) and clustered regularly interspaced short palindromic repeats, (CRISPR/Cas9) to cut short the breeding cycle and to develop the trait specific varieties/prebreeding lines including the tolerance/ resistance to biotic and abiotic stresses.

INNOVATIONS IN YEAR-ROUND PRODUCTION AND AVAILABILITY OF THE ONION AND GARLIC

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Excess rainfall, water scarcity and onion export policy are the major factors affecting year-round availability and onion prices in the country. In order to maintain year-round onion availability, these three factors need to be managed properly. Water scarcity/drought reduces area and production of rabi onion. However, exporting onions without knowing the current situation reduces the availability of onions in the domestic market. In addition, the excess rainfall in the subsequent kharif season damages kharif onion and causes shortage in the domestic market. To avoid this shortage, the government has been forced to import onions from neighboring countries. Onion production could be increased by selecting suitable cultivars, kharif onion production technologies, drip irrigation technologies and improved package of practices for onion. In addition, onion bulbs harvested could be stored up to October in the controlled onion storage structure with less than 15% total storage losses. This improved storage technologies developed by ICAR-DOGR in public-private partnership mode help us in reducing the storage losses and increasing the availability of onion bulbs for consumption. Furthermore, proper prediction of extreme meteorological events, advance estimation of onion area using the remote sensing data and onion production using the crop simulation models support the policy makers to make proper planning for domestic consumption and export. Crop resilient cultivars need to be developed for managing extreme conditions like excess rainfall and drought

Lead Paper

NUTRACEUTICAL HORTICULTURAL CROPS IMPROVEMENT: A WAY FORWARD FOR SHAPING HORTICULTURE FUTURE IN INDIA

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Plants are rich sources of nutraceuticals/bioactive compounds/phytonutrients/ secondary metabolites, which are in use for their potential role in tackling different health problems. These products may have physiological benefit or provides protection to the human body against chronic diseases. Hence, nutraceutical represent a hybrid role of both 'nutrition' and 'medicine'. The term 'nutraceutical' was coined by Stephen De Felice who explained it as 'a food (or a part of food) that provides medical or health benefits, including the prevention and/or treatment of a disease'.

Over the past several years, nutraceuticals have attracted considerable interest due to their potential nutritional, safety, and therapeutic effects. Plant bioactive compounds are part of the system that operates in the plant to adapt to the environment and to the possible challenges that the plant is exposed to that can be of abiotic and biotic origin. These compounds could have a role in a plethora of biological processes, including antioxidant defenses, cell proliferation, gene expression and safeguarding of mitochondrial integrity. Therefore, nutraceuticals may be used to improve health, prevent chronic diseases, postpone the aging process, and in turn increase life expectancy, or just support the functions and integrity of the body. These products are considered to be healthy sources for the prevention of life-threatening diseases such as diabetes, renal and gastrointestinal disorders, as well as different infections. A wide range of nutraceuticals has been shown to impose crucial roles in immune status and susceptibility to certain disease status. Nutraceuticals also exhibit disease-modifying indications related to oxidative stress including allergies, Alzheimer's disease, cardiovascular diseases, cancer, eye conditions, Parkinson's diseases, and obesity.

Horticultural crops especially play a key role as an important source of health promoting bioactive compounds for humans. There is an array of bioactive compounds in plants known as secondary metabolites with nutraceutical properties that consumers could benefit from. Major groups of such secondary metabolites/ nutraceuticals prevalent in horticultural crops, especially fruits, vegetables and spices are: Carotenoids (Lycopene, Lutein, Zeaxanthin, β-carotene), Polyphenolics (Flavonoids, Flavones, Anthocyanins), Glucosinolates (Sulphoraphane, Indole-3-Carbinol, Sinigrin), Thiosulphides (Alliin, Methiin, Ethiin), Dietary fiber (Lignin, Pectin, Cellulose), Miscellaneous (Selenium, Phytosterol & stanol, Saponins etc.).

These nutraceuticals/bioactive compounds have a plenty of health promoting potential and will contribute significantly in elevating quality of life of our people *vis a vis* reduction of health costs of nation. Besides enhanced quality of fresh produce for consumption, these metabolites will go a long way in contributing to pharmaceutical, nutraceutical, cosmetic and processing industrial development in the country promoting simultaneously contract farming, tackling malnutrition problem presently ailing the country, solving problem of post harvest losses to a greater extent. Since horticulture crops encompass variation for nutraceutical compounds, therefore there is a better opportunity to breed nutraceutical dense future varieties in the *Amrit Kaal* to address present problems of shelf life and post harvest losses in perishable horticultural crops. This paper reports the use of modern breeding tools in improvement of nutraceutical quality in new varieties and their prospects in shaping future of horticulture in India

Lead Paper

STRATEGIES AND POTENTIAL FOR INDUCTION AND UTILIZATION OF HAPLOIDS AND DOUBLED HAPLOIDS IN HORTICULTURAL CROPS

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Haploids and doubled haploids accelerate the generation of hybrid varieties within a minimal timeframe. They also hold significant roles in various developmental studies and breeding programs. Haploids can be generated through both *in vitro* and *in vivo* methods. *In vitro* techniques encompass haploid production via androgenesis or gynogenesis, while *in vivo* methods involve irradiated pollen-induced parthenogenesis, intra and interspecific hybridization, and the utilization of haploid inducer lines (such as Cenh3 technology). These methods have been applied to a variety of crops, including pepper, onion, apple, citrus, marigold, sugar beet, brassica and olive, each chosen based on the specific responsiveness of the crop to a particular method. Ongoing research is conducted to standardize factors that influence the efficiency of doubled haploid production in various crops, including crop genotype, microspore developmental stage during culture, donor plant growth conditions, composition of the initial induction medium, types and concentrations of growth regulators, and the application of different stress factors. Doubled haploid plants have a wide range of uses, playing essential roles in fast-tracking breeding and cultivar development, conducting *in vitro* mutagenesis studies, aiding in genetic mapping and genomics due to their complete homozygous nature, ease of replication, and shorter development time. When it comes to genetic transformation, various stages from microspore embryogenesis to full plant regeneration can be used, with unicellular microspores or cells representing the ideal material for transformation. Additionally, the ease of patenting doubled haploid plants, owing to their complete homozygous nature, makes them a valuable resource.

Day 2, November 07, 2023

Auditorium, College of Veterinary Sciences, Khanapara, Guwahati

Session III

DIGITAL FARMING IN HORTICULTURE

Chair : Dr Neelam Patel, Member-Senior Advisor, Agriculture Allied Sector, Niti Aayog, Government of India, New Delhi

Co-chair : Dr Subhasisa Dutta, Professor, Department of Civil Engineering, Indian Institute of Technology Guwahati, Guwahati, Assam

APPLICATION OF AI BASED TOOLS FOR EFFICIENT HORTICULTURE PRODUCTION

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Horticulture plays a pivotal role in India's agricultural landscape, contributing significantly to the nation's economy, ensuring nutritional security, improving the income of the rural people and generating employment. The sector utilizes only 8 percent of the total area under agriculture, leaving ample room for productivity enhancement through innovative practices and leveraging technological advancements. The horticulture landscape is continuously evolving and each season brings new technologies designed to improve efficiency and capitalize on the bountiful harvests. These innovations in technology are becoming increasingly essential due to global challenges such as climate change, shortage of skilled labours, resource limitations, population growth etc. In this context, the abstract explores the application of artificial intelligence (AI)-based tools to augment horticulture production in India, shedding light on the evolving landscape of smart horticulture. AI's applications in the horticulture industry are diverse, spanning the entire value chain (from the planting stages till the product reaches the consumers). The future of horticulture undoubtedly lies in the adoption of robotic systems, drones, and automation to enhance efficiency and productivity. Notable applications of AI in horticulture encompass precision farming (using data to make informed decisions for precise application of inputs based on the need of the crop), pest and disease diagnosis, nutrient deficiency recognition, produce maturity assessment, (determines proper age of maturity of fruits), field management for resource optimization, automated irrigation systems, yield prediction, and the automated grading of fruits (automatic image processing technique for sorting and grading of fruits), among others. Drones, in particular, have emerged as game-changers, facilitating in-depth field analysis, long-distance crop spraying, and high-efficiency crop monitoring. These aerial devices are equipped to assess soil conditions, monitor the health of crops and also determine the optimum time of harvesting. Their ability to perform real-time spraying significantly outpaces traditional machinery, providing a high-tech makeover to agriculture. Robots also play an important role in horticulture, engaging in task like harvesting, drone-assisted spraying, field monitoring, sorting, grading, and packing of the final produce. Their use also extends to nurseries and greenhouses, offering the potential to simplify potted plant cultivation and delivery. Fruit harvesting robots, excels at picking fruits without damaging the branches or leaves of the tree, relying on advanced image-capturing techniques to distinguish between fruits and foliage. In conclusion, AI-based tools are becoming an indispensable part of Indian horticulture, offering innovative solutions to multifaceted challenges. These innovative technologies offer numerous advantages, encompassing precision, sustainability, productivity, and profitability. The application of AI-based tools holds the promise of revolutionizing horticulture production in the country, making it more resilient and efficient. This transformation not only contributes to long-term food and nutritional security but also fuels economic growth. The integration of AI in horticulture promises to usher in a profound shift in research and development practices.

DISRUPTIVE ICT TECHNOLOGIES FOR DIGITAL HORTICULTURE

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The contribution of horticulture sector in India is about 33% to the agriculture Gross Value Added (GVA), which significant contribution to the Indian economy. India is currently producing about 320.48 million tons of horticulture produce which is much higher than food grain production from much less area (25.66 million Ha. for horticulture against 127.6 M. ha. for food grains). The horticulture provides diverse crop portfolio, ensuring higher income, generates employment, contributes significantly to foreign exchange earnings, improves the nutritional intake, promotes crop diversification, contributes to women's empowerment, contributing to environmental conservation and carbon sequestration, leads to the development of rural infrastructure etc. Digitalization of horticulture has a great potential to bring about significant innovation and transformation in India's agricultural sector. The adoption of digital technologies can help India to increase horticultural productivity, reduce waste, increase export, increase farmers' income and improve food and nutrition security. In view of high penetration of cheaper digital technologies in India, it becomes possible to adopt and promote Disruptive Information and Communication Technology (ICT) technologies in horticulture sector. Disruptive Information and Communication Technology (ICT) technologies are innovations that significantly alter or revolutionize day to day human activities specially existing industries, business models, or markets. In this article we discuss some important ICT technologies such as Cloud Computing, Artificial Intelligence (AI) and Machine Learning (ML), Big Data Analytics, Internet of Things (IoT), Blockchain, 5G Technology, Virtual Reality (VR) and Augmented Reality (AR), Edge Computing, etc. which bring disruptive revolution in Indian Horticulture.

AI ENABLED GEOSPATIAL TECHNOLOGY FOR HORTICULTURE DEVELOPMENT

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In this lecture, use of hyper-spectral remote sensing data from in-situ and satellite images will be discussed for plot-scale variability mapping of Chlorophyll, Nitrogen content and Water stress of paddy fields. New spectral indices of different wavelengths have been proposed for mapping these characteristics of paddy agriculture in India. The studies were conducted in paddy fields in Assam and Odisha states. The spectral indices obtained from paddy fields in China agriculture system have not performed well in predicting the chlorophyll, nitrogen content and water stress. The spectral indices, internationally accepted, have been fused with high-spatial resolution satellite data such as Resource-Sat of 5 m resolution to map plot-scale variability of the paddy characteristics, which can easily be integrated for precision farming. No doubt, use of Artificial intelligence (AI) for analyzing of hyperspectral remote sensing, micro-climate variability, field based sensing of crop, soil and water will address many issues related to horticultural crops. For hilly area, availability of solar energy and water controls the yield of the horticulture crops. Use of high resolution of Digital Elevation Model from different global sources and field measured LiDAR survey can help in accurately mapping for site-suitability of the crops, crop growth prediction, diseases occurrence and yield predication. At the end, we shall discuss how to bring high-end technologies to farmers of low-economic group in Indian context.

Lead Paper

DRONE TECHNOLOGY: BENEFITS AND CHALLENGES FOR PRECISION FARMING OF HORTICULTURAL CROPS

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Precision farming in horticultural crops has been gaining prominence with the advent of fast-paced advances in cutting edge technologies like sensors, remote sensing, IoTs, drone and ICTs, etc. These technologies could be employed for capturing spatio-temporal variabilities to enhance the input use efficiency and optimize the sustainable production system. Unmanned Aerial Vehicles (UAVs) popularly called drone have shown promising ability for precision farming in horticultural crops particularly for two purposes. Drone can be used as one of the viable solution for near real time monitoring of the crop growth and health, particularly stresses related to nitrogen, water, heat, pest and diseases using different sensors like thermal, multispectral and hyperspectral and big data analytics. Drone has been identified as a viable substitute and/or compliment to remote sensing platforms for applications in horticultural crops. Different spraying drone can also be used for different input (liquid fertilizers and pesticides) applications using variable rate technology. Intelligent irrigation system using low-cost sensors and IoT technology has been developed for precision water management and enhancing water use efficiency. Sensor technology has been used to monitor quality and grading of fruits and their traceability.

ROBOTICS APPLICATION IN HORTICULTURE: AN INDIAN PERSPECTIVE

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The shift to "precision horticulture" and data-driven farming, where crops are tracked at the plant level, is a significant advancement in horticulture. From data collection and analysis to fine-scaled crop actions, it necessitates a high degree of automation. Due to their low operating costs and ability to travel in three dimensions, drones have the potential to be highly useful in this field. They can be used to monitor every greenhouse area. In general, the drone assisted agricultural practices helps in not only improving crop productivity but crop analysis to assess crop growth, identifying the beginning of pest outbreaks which help in timely interventions. The calculation of Normalized Difference Vegetation Index (NDVI) which is a standardized way to measure healthy vegetation (High NDVI values means healthier vegetation) can be calculated from the wavelength-based data which requires multispectral camera payloads with the drones. In a single drone use one may find the real time information through multiple types of data for example, numbers of plants available, crop quality, possible nutrient deficiencies, pest infestation etc., which can be analysed altogether at the same time, Drones also assists in pollinations, finding heat map (temperature, CO2, and humidity) data which finally helps in increasing the potential yield in the protected environment. Altogether, Drone assist Horticulture practices helps in making better informed decisions regarding timely watering, fertilizing, pesticide applications and harvesting. Similarly, an autonomous robotic vehicle (ARV) can assist in monitoring plant needs such as nutrient requirements and watering schedules using algorithms. It can also assist in measuring important characteristics like temperature, humidity, heat level, wind data, and soil health using sensor integrated systems. ARVs attached with the manipulators and AI based vision sensors can help in plucking the fruits and crops which overall reduces the continuous observation of the garden. The gardening rover's on-board sensors may collect data that can be regularly transferred to a cloud storage platform for real-time data visualisation and analysis on Android-based mobile devices. Furthermore, future projections are created to maintain the field more successfully and economically based on the collected data and past experiences.

IoT based automation in agriculture, aquaculture, mariculture and horticulture will contribute towards the improvement in the livelihood of our farmers. A better yield and profit will definitely bring back the falling agricultural interest among youths.

Lead Paper

UAV AND REMOTE SENSING USE IN HORTICULTURAL CROPS FOR NE REGION

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The North Eastern Region (NER) of India, characterized by its diverse soil types and favourable agro-climates, holds substantial potential for horticultural development. One of the prominent uses of remote sensing applications for horticulture in the NER has been evaluating the suitability of horticultural crops for area expansion to meet the growing demand. Approximately 397608 ha of suitable land have been identified for the expansion of economically important horticultural crops in 24 selected districts of NER, which is about 1.52% of the total geographical area of NER. Remote sensing technology has also been effectively used for horticultural crop monitoring, generating crop inventory, and providing real-time information on crop health and growth stages. Unmanned Aerial Vehicles (UAVs) or drones, which have emerged as effective tools in mapping and monitoring horticultural resources are capable of providing very high-resolution imageries that helps in providing detailed information at farm level. A number of UAV based studies have been conducted in NE region for horticultural crop inventory, crop stress detection, damage assessment etc. NESAC conducted a study to hierarchically classify horticultural crops within a mixed cropping system using multispectral data through UAV surveys where an overall accuracy of 91% and 79.8% was achieved in the first and second levels of classification, respectively. While acknowledging the technology constraints for detailed assessment of horticultural crops in the region due to fragmented landholdings, terrace and shifting cultivation, etc., future strategies are emphasized. These include adopting hyperspectral remote sensing in horticulture for precise crop monitoring, IoT based sensors for real time monitoring of horticultural crops etc. Effective use of geospatial technology will be a significant driver for the holistic advancement of the horticulture sector in the NER.

Day 2, November 07, 2023

Auditorium, College of Veterinary Sciences, Khanapara, Guwahati

Session IV

USE OF ROOTSTOCKS IN HORTICULTURE

Chair : Dr Z. P. Patel, Vice Chancellor, Navsari Agricultural University, Navsari, Gujarat

Co-chair : Dr T. Damodaran, Director, ICAR-Central Institute for Sub- Tropical Horticulture, Lucknow, Uttar Pradesh

THE TRANSFORMATIVE ROLE OF ROOTSTOCKS IN MODERN HORTICULTURE

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The horticultural landscape is undergoing a paradigm shift, thanks to the transformative potential of rootstocks in horticulture. These specialized plant bases are not just a biological marvel but also an economic game-changer. They offer a multi-faceted approach to some of the most pressing challenges in horticulture today, from enhancing disease resistance and nutrient uptake to improving stress tolerance and fruit quality. One of the most significant benefits of using rootstocks in horticulture is their ability to confer resistance against different disease and pests and tolerance to abiotic stress. By selecting rootstocks that are naturally resistant to specific pathogens, growers can effectively mitigate the risks of diseases like root rot, Fusarium wilt, and nematode infestations in vegetable crops. This not only ensures healthier plants but also leads to higher yields, as the plants can grow unimpeded by disease stress. By selecting rootstocks that are naturally resistant to specific abiotic stress, it becomes possible to cultivate crops like grapes, guava, pomegranate, apple, etc., in conditions that would otherwise be considered less than ideal. The use of dwarfing rootstocks in canopy management or controlling plant size is especially beneficial for high-density plantings where space is at a premium specially for plants like apple, peach, plum, pistachio, and citrus. Rootstocks are also revolutionizing the fruit industry by enhancing quality and yield parameters also. Grafting is an art form in itself, and advances in this field have made it even more effective. Various methods like hole insertion, tube grafting, and pin grafting have gained popularity for vegetable crops. These techniques are not just convenient but also time-saving. Robotic grafting machines further have added advantage of faster rate of graft production with higher efficiency. Recent innovations like double grafting and micrografting have opened up new possibilities, allowing for the cultivation of two different vegetables on a single rootstock. Rootstocks have a particularly fascinating role in the world of ornamental plants. They can induce hardiness and enhance the aesthetic appeal of plants like roses, bougainvillea, and hibiscus. For instance, grafting different coloured varieties of hibiscus onto a red-flowering local rootstock results in a plant that not only thrives better but also blooms in multiple hues. In the realm of cacti, rootstocks like Nopalea sp. have been found to accelerate growth and induce earlier flowering. The technique for developing the stunningly beautiful moon cactus, a combination of colored cactus *Gynocalycium mihanovichii* and *Hylocereus* rootstock, has been standardized, adding a new dimension to ornamental horticulture. The economic benefits of using rootstocks are manifold. They significantly reduce labour costs, especially in disease management and harvesting. Rootstocks that are resistant to soil-

borne diseases can cut down on the need for chemical treatments, contributing to more sustainable farming practices. In today's challenging landscape, marked by labour shortages and climate change, rootstocks offer a practical solution to maintain yields and reduce operational costs.

Rootstocks serve as a cornerstone for sustainable and economically viable farming. Their role in enhancing plant health, yield, and economic efficiency positions them as a key element in the future of sustainable agriculture. As we navigate through this era of rapid environmental and economic change, the strategic use of rootstocks will be crucial in ensuring food security, economic stability and the overall sustainability of our agricultural systems.

CHALLENGES AND OPPORTUNITIES IN MANGO ROOTSTOCK RESEARCH

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Mango cultivation, characterized by its diverse global traditions and flavors, owes a significant portion of its success to the often-underappreciated mango rootstock. These rootstocks serve as the foundation of mango orchards, shaping the tree's size, structure, and most importantly, fruit yield and adaptability. In many parts of the world, the cultivation of mangoes faces a significant obstacle because of the high salinity of the soil. In order to find a solution to this problem, the salt tolerance of polyembryonic mango types from various sources has been subjected to stringent testing in sodic conditions. These conditions are characterized by a high PH and elevated sodium levels. These investigations aimed to identify salt-tolerant rootstocks mango cultivation practices in salt-affected soils. The quest for salt-tolerant mango rootstocks has yielded several promising candidates, including '13/1,' 'Gomera 1,' 'Olour,' 'Sukkary,' as well as 'ML-2,' 'ML-6,' 'K-5,' and other reported tolerant rootstocks. With challenges like climate change and evolving consumer preferences, there is an increasing urgency for advanced rootstock research. This endeavor seeks to develop rootstocks that can cater to diverse environmental conditions and market demands, thereby paving the way for a resilient future in mango farming. However, this journey is not without its challenges. Threats such as the *Ceratocystis fimbriata* fungus emphasize the importance of disease management and ongoing research. In essence, while mango rootstocks may operate in the background, their role is indispensable, harmonizing tradition with innovation to ensure a prosperous future for mango cultivation. Historically, rootstocks were supports, but they now play a central role. Rootstock selection is a strategic decision in modern mango cultivation, impacting tree growth, fruit production, and orchard success. Research shows that rootstock research is crucial for tree dimensions, early fruiting, environmental resilience, nutrient absorption, yield, fruit quality and climate adaptability. Factors in new rootstock development include nuclearembryonic, climate adaptability, and soil challenges. An important future concern for mango cultivation is managing soil pathogens through rootstocks. Present day high-density mango cultivation, coupled with precise pruning, paclobutrazol application and scion-specific considerations, have reduced the reliance on dwarfing rootstocks in orchards. Long-term rootstock trials have demonstrated that rootstock effects vary among different scion cultivars. As a result, there is a shift towards more versatile and cost-effective orchard management, moving away from traditional dwarfing rootstock research. Despite the fact that the impact of rootstocks has been documented, there have been very few in-depth studies of their interactions with scion cultivars. In the future, research should concentrate on salinity tolerance, dwarfing effects, adapting to challenging conditions, disease resistance, improving yield, and improving fruit quality. For the purpose of advancing mango rootstock knowledge and promoting sustainability, standardized trials, clonal propagation, morphological and molecular studies, and global collaboration are essential.

Lead Paper

CURRENT TRENDS IN STANDARDIZATION OF ROOTSTOCK IN APPLE (*MALUS DOMESTICA* BORKH.)

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The role of rootstocks and their use in different fruit crops has a significant impact on fruit crop production by influencing canopy architecture, nutritional uptake, flowering, and yield and fruit quality. Besides, it can also confront biotic and abiotic stresses such as soil pathogens, thermal stress, salinity, and nutritional stress. Significant development has been going on in apple rootstock standardization resilient stock production for combating problems. Initial apple rootstocks were generated to combat against fire blight, cold-hardiness, and vigor control. Traditionally, propagation is practices through seeds resulting in variable in vigor, bearing habit, and fruit characteristics. Apple trees raised from seed are vigorous and bear fruits of poor size, appearance, and quality. Clonal selections used to control the intrinsic vigor of the scion, its habit, its precocity and efficiency of cropping, adaptability etc. In the late 1800s, East Malling Research Station selected superior rootstocks based on plant vigour and called as Malling rootstocks. Malling-Merton series, Geneva series, Budagovsky, and Vineland series are some of the standard rootstocks developed. Apple rootstock breeding is a long-term process that has mostly focused on yields, disease resistance and efficiencies gained by tree architecture modification like dwarfing of grafted scions. In recent years, researchers have been able to understand more about the interaction between scions and rootstocks and have begun to leverage the interactions to identify scion-specific traits such as higher calcium rootstocks for calcium-deficient scions (Honeycrisp). The implementation of new selection traits in a plant breeding program requires knowledge related to the complexity, heritability and reliability of the selection process for the new trait. The complexity of a trait depends on the number of segregating factors and the importance (size) of their contribution. From there, we can estimate what these traits are worth to apple growers and the industry at large.

RECENT TRENDS IN STANDARDIZATION OF NEW ROOTSTOCKS IN CITRUS

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Citrus is one of the important fruit crops of the world and is known as the "world fruit" for its high socio-economic and nutritional attributes. It is globally grown in areas with suitable climates between latitude 35°N~35°S. In India, citrus is the third most important fruit industry of India after banana and mango and share 15.53 per cent (1.09 million ha) of the total fruit acreage and contributes 13.8 per cent (14.81 million tonnes) of the total fruit production (Anon., 2023). The main citrus groups in India are mandarins (*Citrus reticulata* Blanco), sweet oranges *(Citrus sinensis* Osbeck), lime (*Citrus aurantifolia* Swingle), lemons (*Citrus limon* (L) Burm. f), grape fruit (*Citrus paradisi*Macf.) and pomelo (*Citrus grandis* (L.) Osbeck). These citrus species are grown on array of rootstock for diverse morphological, physiological and biochemical characteristics. The significance of rootstocks in citriculture needs no emphasis because rootstocks have contributed perhaps more than any other factors to the success or failure of citrus crops. Rootstocks however, have their own merits and demerits for example sweet orange, grapefruit, mandarin and lemon on rough lemon rootstock are large, extremely vigorous and productive among most rootstocks' worldwide. However, scion cultivars on rough lemon are very susceptible to frost damage. Sour orange, although is an excellent rootstock for areas free of Citrus Tristeza Virus (CTV) but its susceptibility to CTV, particularly of sweet orange on sour orange has greatly restricted its use. *Jattikhatti* has been reported to be an ideal rootstock for Kinnow mandarin under arid and semi-arid conditions but it is somewhat susceptible to *Phytophthora*.Due to long production periods and climate change, citrus production is impaired by wide range of biotic and abiotic stress. Among the various abiotic stress, phytophthora and huanglongbing (HLB) associated with *Candidatusliberibacter* asiaticus have resulted in a rapid decline of citrus orchards, while the abiotic stresses like salinity, drought and frost adversely affect the growth and productivity. Keeping in view the challenges confronting the citrus industry of India, new generation/responsive rootstocks such as Alemow, X-639, Forner alcaide series of rootstocks, allotetraploid somatic hybrid rootstock Flohrag 1 were evaluated for tolerance to various degree of stresses. New breeding strategy of superior rootstocks "Super sour" and nucellar polyembryony have opened new vistas to breed superior varieties for tolerance to multiple traits. This paper is a comprehensive compilation of advances in rootstock research through traditional and modern breeding approaches and its impact on the citrus industry.

Lead Paper

RECENT TRENDS IN OPTIMIZATION OF ROOTSTOCKS IN IMPORTANT VEGETABLE CROPS

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Vegetable crops play a vital role in securing food and nutritional security. Being remunerative, these crops are being cultivated even in non-traditional areas and seasons to meet market demand. As a result, soil-borne pathogens are emerging as a major yield-limiting factor in most of the regions. Moreover, the impact of different abiotic factors like moisture stress, flood, high temperature, drought and heavy metal toxicity is gradually becoming prominent, especially under changing climatic scenario. Genetic improvement of vegetable crops against these stresses through trait-staking or trait pyramiding is time and resource-consuming and laborious due to linkage drag and pleiotropic effects of a single gene on many traits. In this context, grafting of susceptible scion onto resistant rootstock has emerged as a quick, cost-effective, environmentally sound and sustainable method of management of the emerging biotic and abiotic stresses. Moreover, the adoption of this grafting technique would help in creating additional job opportunities. This technique is commercially being followed in solanaceous and cucurbit vegetables in countries like China, Japan, Korea, Spain, The United States, Italy, France, The Netherlands, Canada, Israel and Turkey (Lee et al. 2010). However, the technique is yet to be adopted on a commercial scale in India. Grafting in solanaceous vegetable crops are targeted mainly against *Fusarium* wilt, *Verticillium* wilt, Bacterial wilt, root-knot nematode, excess and deficit soil moisture conditions as well as against heavy metal toxicity of soil. Likewise, in Cucurbit vegetables, grafting is followed against *Fusarium* and *Verticillium* wilt, vine decline, *Phytophthora* blight, root-knot nematode as well as for imparting tolerance to low temperature, flood, drought and salinity. Solanaceous vegetables are mainly grafted onto resistant accessions belonging to the same species as well as on *Solanum torvum*, *S. sisymbrifolium*, *S. integrifolium, S. Habrochaites* and the hybrids of *S. torvum* × *S. sanitwongsei*. The cucurbit vegetables are mainly grafted on the hybrids of *Cucurbita maxima* × *Cucurbit moschata*, bottle gourd, sponge gourd, wax gourd and African horned cucumber (*C. metuliferrous*) and fig leaf gourd (*C. ficifolia*).

In the recent past, the selection of rootstocks has been carried out by studying the phenotypic performance from a set of germplasm lines, especially concerning their resistance to soilborne pests and diseases, abiotic stresses, root vigour,germination and seedling uniformity. However, there is a vast scope for research on identification of molecular makers with large phenotypic

effects to carry out marker-assisted selection, as well as the development of commercial rootstocks through transgenics and genome editing technologies. Gene pyramiding and gene stacking in rootstocks for disease resistance need more emphasis in the near future. Further research is also required in the fields of graft hybridization and rootstock-mediated changes in the gene expression of scions (epigenetic mechanisms) in different vegetable crops.

A few examples of vegetable grafting technologies developed in India are discussed in this paper along with the need to scale up such efforts. Thus, immediate identification /development of desirable rootstocks followed by their demonstration, registration, commercialization and awareness building through training programmes by the NARES system; development of commercial nurseries for grafting by the private sectors/ seed companies and adoption of the technology by the farming community will cumulatively scale up the area under grafted vegetable crops in India.

Lead Paper

EXPLOITATION OF STIONIC COMBINATION USING INTER-SPECIFIC ROOTSTOCKS IN VEGETABLES

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In the recent pasts, grafting has emerged as a promising and an alternative toolto the relatively slow conventional breeding methods aimed at increasing tolerance to abiotic stresses, soil pathogens, and enhancing yield, and quality attributes infruit vegetables. Grafting has been commercially practiced in watermelon, muskmelon, cucumber, tomato, sweet pepper and eggplant. The improvement in yield have been reflected due to enhanced plant vigour, biomass, water and nutrient uptake, photosynthetic activities and mitigating effect of biotic and abiotic stresses. In addition, grafting is known to affect the quality of fruits in vegetables, including physical properties, flavour and contents of health-related compounds (mainly vitamin C, carotenoids and minerals). Studies conducted on solanaceous vegetables, like brinjal, revealed that the maximum number of fruits (43.6) and fruit yield (8.71 kg/plant) with least low collar rot (*Sclerotium rolfsii*) infection (2.75%) were observed when hybrid brinjal was grafted on Surya rootstock. However, rootstock *S. torvum* was found to be resistant to little leaf and collar rot infection. Similarly in tomato, among the wild rootstocks, the maximum fruit yield was obtained on *Solanum cheesmaniae*rootstock followed by *S. pimpinellifolium*. The maximum lycopene and β-carotene content were reported on Armada and *S. cheesmaniae*rootstocks, whereas Vitamin C content was higher in non-grafted control. In grafted Brimato (Brinjal + Tomato graft union), the maximum yield of brinjal (2.56 kg) and tomato (2.68 kg) was noted with Kashi Sandesh brinjal and Kashi Aman tomato. The grafting technique for Brimato production has been certified by the ICAR as an innovative technology for harnessing the dual benefits of both tomato and brinjal from the same plant. In grafted Pomato, dual scion grafting of Kashi Aman produced the maximum fruits (67.0) and yield (2.64 kg/ plant) of tomato with potato tuber yield of 1.757 kg/plant.

Drought, high soil salinity, high temperature, cold, oxidative stress, and heavy metal toxicity are the common abiotic stresses that limit crop productivity worldwide. Theses abiotic stresses are responsible for over 50% reduction in agricultural production. It comprises mostly of high temperature (40%), salinity (20%), drought (17%), low temperature (15%) and other forms of stresses. In the past few decades, the horizon of grafting technology has also expanded to abiotic stresses, and among which, salinity and drought stress got the most priority. It is amply evident that grafting vegetable crops onto suitable rootstocks is an effective tool that may alleviate the susceptible scion to various environmental stresses, improved yield and quality in vegetables. Several rootstocks in vegetables have been identified that are able to enhance vegetable productivity and yields. Considering its several benefits, this technology has potential to become one of the major tools in the coming years for enhancing vegetable productivity in face of imminent challenges (edaphic and environmental) posed by climate-change.

CHANGING SCENARIO IN ROOTSTOCK FOR COMMERCIAL ROSE PRODUCTION

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Rose (*Rosa* spp.), is universally known as 'Queen of flowers' and belongs to the family Rosaceae. Rose as a cut flower has great demand in the domestic as well as international markets. The demand for rose flowers is escalating day by day with rising standard of living, aesthetic sense and awareness among the people. In India, roses are grown for cut flowers, loose flowers, to prepare gulkand, pankhuri, essential oil, attar, rose water, rose tea, etc. In addition, roses are used in food, pharmaceutical, cosmetic and perfume industries. Modern garden roses are generally propagated through seeds, cuttings, grafting, budding, layering, etc. This technology widely propagates species that cannot be propagated by seed or cuttings. It also improves growth, yield, and promote biotic/abiotic stress resistance. Grafting/budding has been reported to modify the metabolic profile of root exudates. In India, roses commercially propagated through T- budding or shield budding for grown in both the open field and greenhouse conditions. The T-budding method consists of the insertion of a bud of a noble variety into an incision in the bark of the root neck of the rootstock. Rootstock provides many advantages such as fast and cheap multiplication of a large number of plants, control of vigour of the scion, good uptake of nutrients, hardiness to diseases, insects, winter, salinity and drought, etc. and therefore, it is necessary to choose the most suitable rootstocks for budding or grafting roses. Some of rose wild species which are widely utilized as rootstock in India and other countries are *Rosa indica* var. *odorata*, *Rosa× bourboniana, Rosa multiflora, Rosa canina,* 'Dr. Huey', *Rosa ceriifoliafroebelii, Rosa manetti, Rosa rugosa,* Natal Briar, Ragged robin, etc. *Rosa indica* var. *odorata* is recommended for North Indian plains. *Rosa multiflora* is recommended for central, eastern and southern parts, in the temperate regions of India. *Rosa× bourboniana*(Edouard) is widely used in North India for producing standard roses as it throws vigorous and strong shoots. This can withstand dry or wet and salinity conditions. It has field tolerance to powdery mildew and insect-pests. ICAR institutes such as IARI, IIHR and other CSIR institute had extensively worked on rootstock development and management in India. In changing scenario of the climate, there is need to strengthen the research work on rootstock –scion interactions, compatibility, non-conventional breeding methods, etc. Development of rose rootstocks resistant to abiotic stresses such as high temperature, low temperature, drought, salinity, water logging; biotic stresses such as die back, black leaf spot, powdery mildew and Downey mildew, phytoplasma *etc*. is one of the major challenges in the rootstock development and management programme. There is need to identified new rootstocks for specific agro-climatic zones/regions, having graft compatibility and suitable for climatic change, need of understanding of the rootstock scion interactions in relation to changing climate.

Day 2, November 07, 2023

Auditorium, College of Veterinary Sciences, Khanapara, Guwahati

Session V

INNOVATION FOR SUSTAINABLE HORTICULTURAL PRODUCTION

Chair : Dr Balraj Singh, Vice Chancellor, Sri Karan Narendra Agriculture University, Jobner, Rajasthan

Co-chair : Dr R. A. Marathe, Director, ICAR-NRC pomegranate, Solapur, Maharashtra

POTENTIAL OF HORTICULTURE CROPS FOR SELF-RELIANCE IN ISLAND BASED AGRI-SYSTEM

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The tropics have a rich biodiversity of flora and fauna but also have around 40% of world population which will be going to increase 55% by 2050. An analysis of the agricultural scenario of the islands indicates that agriculture is an important source of income in many of the tropical islands. Nearly 80% of the population of Comoros islands, 70% of Fiji, 65% of Vanuatu and 40% of Dominica are dependent on agriculture. Agriculture also contributes significantly to GDP of the tropical island nations like Solomon Islands (31.70%), Federal State of Micronesia (28.90%) and Madagascar (26.80%). Horticultural crops are major source of food, nutrition and livelihood particularly in island regions. This also serve in traditional health system prevalent in native people. Andaman & Nicobar Islands is an archipelago of 572 Islands located in Bay of Bengal. Horticultural crops are playing significant role in Andaman Islands towards improving factor productivity, generating employment opportunities, livelihood and economic conditions of the farmers, and also ensuring nutritional security to the Islanders. The horticultural based farming system occupies about 70% percent of total cropped area (50000 ha), with major horticultural crops being coconut (21768 ha), rice (9081 ha), vegetables (6695 ha), areca nut (4152 ha) and fruits (3160 ha). The predominance of horticultural based farming system traced back from colonization of Islands. Tropical fruits and vegetables have direct roles in improved health through their micronutrient and antioxidants properties. Tuber and root vegetables are staple diets for indigenous tribes and one can't imagine tribal life without coconut Though, large number of species were brought into Islands from different parts of the adjoining countries/regions through natural and anthropogenic factors but, existing environmental pressure and geographical isolation modified their genetic makeup and level of survival. The efforts at CARI, Port Blair for germplasm management has resulted in documentation of around 734 species, conservation of 365 species/germplasm, deposit at NAGS/NBPGR of 160 and registration of seven species/germplasm in different horticultural crops. The systematic breeding programme in some of the horticultural crops led to develop 44 superior genotypes in 16 crops. All the varieties were developed from local germplasm through selection process. Except coconut and arecanut, the majority of the varieties belong to underutilized crops like indigenous vegetables (except chilli), *Morindacitrofolia*, ground orchid, West Indian cherry and tuber crops (except sweet potato).

The development of horticulture sector in tropical island is essential for self-reliance particularly to reduce the high price and maintain consistent supplies.

For this, efforts have been made through development of improved varieties through use of local breeding materials, identification of suitable varieties, identifying potential of exotic crops for tourist demand, protected cultivation technologies, promoting Horticulture based cropping system, local production and supply of quality planting materials, establishing local processing set up, storage facilities and also promotion of homegardens/ kitchen gardens in urban and tribal communities. Research and development efforts have made horticulture an indispensable option for livelihood and nutrition, however, there are several issues which need timely attention for sustainable development.

TRANSFORMING HIMALAYAN MOUNTAINOUS HORTICULTURE THROUGH NATURAL FARMING

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The advancements in agriculture technology since green revolution helped to ensure the food security of the world's rapidly expanding population, but concerns of deteriorating soil quality, decreasing biodiversity, environmental pollution, human and animal health, and rising cultivation costs are being raised due to increasing use of agrochemicals, and the sustainability of production systems is under question. The Agriculture, Forestry, and Other Land Use (AFOLU) sector is responsible for about a quarter (~10–12 Gt CO_2eq yr^1) of anthropogenic greenhouse gas emissions, of which agricultural/horticultural emissions from soil, nutrient and water management form a major portion. Mountains occupy 24% of the terrestrial surface of the earth. The Himalayan region covers an area of nearly 7,50,000 km^2, spanning over 3,000 km in length, 250-300 km in width, at an elevation of 300 to >8000 m above mean sea level. Indian Himalaya is home to 46 million people with more than 70% population living in rural areas. Horticulture is an important livelihood activity of farmers residing in these tough mountainous terrains. Himachal Pradesh, one of the Himalayan states with around 90% rural population, has seen significant changes in the agriculture/ horticulture scenario. Area under apple cultivation has increased by 854% and that under vegetables has increased by 364%. The use of agrochemicals has also increased tremendously especially in fruits and vegetables. The farm products in this horticultural state carries about 1% higher pesticide residue (3.47%) in various market-based food commodities than the national average (2.4%). The per capita income of the state increased from ₹1.34 Lakh in 2015-16 to ₹2.22 Lakh in 2022-23. However, the proportion of children (under 5 years) having acute malnutrition has increased from 13.7% in 2015-16 to 17.4% in 2019-20. About 80% people have reported eye irritation, skin allergy, vomiting, etc. after pesticide applications. This data represents the state of affairs in one of the Himalayan states. Thus, focus is needed on maintaining agroecology and sustaining crop production and farmers' livelihood through sustainable farming practices without any adverse effect on soil and environment. Natural Farming (NF) is a local input based, low-cost, ecologically safe and climate resilient farming practice that lays emphasis on agroecosystem functioning. NF practices have shown to reduce input costs, improve crop productivity, quality and net income. Studies have shown that cost of cultivation under NF across all crops decreased on an average by about 36%, and net income increased by an average of 28.6%. Under NF, the population of natural enemies of insect-pests and soil microbes has shown an increase of 8-10% and 12%, respectively. NF has been found to reduce incidence of diseases like scab and marssonina blotch in Apple and pests *Tutaabsoluta* and leaf miner in tomato. Further, up to 09 crops are being grown concurrently by the NF farmers leading to crop intensification and thus increasing biodiversity. NF has also shown improvement in soil health, better soil moisture and drought resistance than chemically grown crops, without compromising the crop productivity.

Lead Paper

COSMIC NUTRIENT MANAGEMENT IN HORTICULTURAL CROS: A RAY OF HOPE FOR NUTRITION, HEALTH, ECONOMIC & AMP; ENVIRONMENTAL SECURITY

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Breathable air, drinkable water, eatable food grown from Organic Carbon Rich Soil (Ataman) and Pranic Urja (Life Energy) rich biosphere are essentialities for health and harmony. Energy is needed for every activity. In agriculture, energy from finite sources of fossils fuels is used. These sources are dwindling, becoming expensive to government, farmers, people with many adverse impacts. It has poisoned the soil, water and air, the three basic elements of nature.To meet the fertilizers need, government of India has to enhance financial alocation 2.25 lakh crores, but with current Russian & Ukrine war and many other factors has further escalated the problem. Besides this allocation, financial burden and many other problems in timely availibility and use of fertilizers has to be faced by the farmers. Any quantity of agrochemicals dumped in soil or pumped on foliage cannot address twin issues. Soil organic Carbon (humus) and Pranic Urja can't be introduced from any country, neither manufactured by industry or laboratory. Hence, altogether, new initiatives for Nutrient Management are dire need to manage these essentialities. With industrial agriculture and AC- culture, people have developed a lifestyle totally contradictory to the natural rhythms. Is it too late to mend our ways? Cosmic Nutrient Management is one step, which will prove life changer with major positive implications for human health and harmonious survival. Horticultural crops are grown for higher production, therapeutic, nutritional, health and aesthetic values. In few vegetables, often hazardous pesticides are sprayed in evening, crops are harvested in early morning. There is minimum gap between farms & fork and most of these are consumed fresh or for juice /salad. Hence these should be free from any contamination. If these are loaded with cocktail of hazardous chemicals, concept gets jeopardized. Few of the chemicals are cariogenic need introspection.

FRUIT PRODUCTION IN THE TRANS-HIMALAYAN LADAKH, INDIA: COMPETITIVE ADVANTAGES AND FUTURE DIRECTIONS

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Ladakh is a high-altitude desert criss-crossed by a massive mountain range. Because of the cold desert conditions, only 0.4 percent of the total geographical area is under cultivation, and the area under forest cover is a meager 0.236 percent. The area under fruit crop is 3671 ha. Ladakh has many natural advantages for temperate fruit production. The region experiences long day hours with high light intensity and relatively warm days with cool nights and low relative humidity from May to October. Apricot and apple are the two main fruit crops grown in the region. Fresh apricots are available during July-September, while apples are available during August-October. A minor quantity of grapes, peaches, cherries, and plums are found in the region. In general, the fruits grown in Ladakh are sweeter and intensely colored. The fruits ripe late in the season and have a comparative advantage. Ladakh is the biggest apricot producer in India, with a total production of 15,864 tonnes in 2022. The maiden export of Ladakh apricot began in 2021, and fresh apricots are sent to the domestic market outside Ladakh. *Raktsey Karpo*, apricots with white seed coat, got the Geographical Indication (GI) tag in December 2022 and became Ladakh's first GI-tagged product. Ladakh produced approximately 5,191 tonnes of apples in the year 2022. Several native cultivars are grown in the region, and *Thra*, *Mongol*, and *Karkechu* are the three most popular cultivars. *Karkechu* is a special apple cultivar of the Ladakh region known for its fruit aroma. Apples produced in Ladakh are late maturing with high TSS, intense coloured skin with high phenolic contents, and has comparative advantage as that of major apple growing regions of India. In view of the climate change affecting apple production in major apple producing regions in the country, the high altitude Ladakh region has the potential to emerge as a favorable place for quality organic apple production. Considering the vast potential and holistic growth of fruits in Ladakh, several new initiatives have been taken in recent years. Under the government's One District One Product (ODOP) scheme, the apricot has been chosen for the Kargil district and Seabuckthorn for the Leh district. The priority areas that need attention in the coming years are product differentiation and branding, diversification to high-value crops, area expansion, increasing agricultural water productivity, growing fruits in an orchard system, establishment of commercial nursery, establishment of marketing infrastructure, development of value-added products, and conservation of genetic resources.

Lead Paper

HIGH DENSITY ORCHARDING IN TROPICAL AND SUBTROPICAL FRUITS-LEARNING AND RESEARCHBLE ISSUES

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In India, single species high density orcharding has been a success story in fruit crops like apple, banana, pineapple, papaya, mango, guava, ber, pomegranate where yield increases ranging from 1.5 times to 2.5 times have been recorded. Apart from yield advantages, high density orchards have several other advantages over the conventional low-density planting. It facilitates better utilization of incident solar radiation and increase in bearing surface per unit land area. It is more amenable to modern input saving techniques like drip irrigation, fertigation, mechanical harvest as well as horticultural operations such as pruning and plant protection measures that enhances the labour output efficiency in addition to the increased effectiveness of these operations. However, achieving desirable fruit quality under high density planting through appropriate canopy, nutrient and water management has been a major challenge for the researchers as well as orchardists. The success of high density orcharding in selected tropical and subtropical fruits in India has opened up possibilities of this technology in other fruits. With a better understanding of the plant growth behaviour as well as its interaction with factors influencing the plant growth and productivity, more crops can be grown under high density orcharding for improving the overall productivity of fruit crops in India.

NEW DEVELOPMENTS IN TRAINING AND PRUNING OF TEMPERATE FRUIT CROPS

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The agro-climatic conditions in the Himalayan region are highly favourable for growing temperate fruit crops such as apples, pears, peaches, plums, apricots, almonds, walnuts, kiwi fruit and other minor nuts and berries. However, the productivity of these crops is low compared to their potential. Based on several research investigations, it has been found that the fruiting capacity of a tree is largely dependent on its architecture, canopy density and photosynthetic efficiency. The choice of training systems affects the success of the orchard in terms of planting spacing, light interception, and ultimately fruit quality and yield. Pruning is one of the many techniques used in tree training to control the growth or shape of the tree as well as to strengthen the structural framework of the tree.

Architectural engineering optimizes plant design for mechanization and resource use. Plants are developed to increase morphology (tree shape, scaffold orientation, and specific leaf area), architecture (fewer growing shoots, non-competitive shoots, and flower cluster percentage), and phenology (precocity and fewer days at full bloom). Innovative two-dimensional architectural concepts like Tall Spindle System, Espalier System, and Tatura Trellis generate designer plants that gather and absorb solar energy efficiently. Slender Pyramid, Spindle Bush, Super Spindle, Long Spindle, Dwarf Pyramid, Head and Spread, Vertical Axis, SolAxe, Espalier, Cordon, Multiple Leader Bush, Palmette, Y-Trellis, and other apple, pear, cherry, and peach designs increase productivity by 4-5 times. ICAR-CITH, Srinagar, with long spindle, vertical axis, espalier, and cordon training systems yielded 55-66 t ha^{-1} in apple and 50-55 t ha-1 in peach from V-shaped Tatura trellis. Different harvesting methods can drastically reduce tree size and increase light interception and distribution. In fruit production, dwarf rootstock reduces tree size and increases dry matter distribution, causing premature flowering. Pinch, girdle, round, and apply BA, BA + GA 4+7 to nursery plants to develop feathers. Canopy design, mechanical harvesting, and plant growth hormones increase temperate fruit yield and quality. By adding or modifying rol, tumor-inducing (T)-DNA, phyA, FT1 gene, Co-gene, and other genes, genome editing and genetic engineering may adapt apple, peach, plum, and kiwifruit plant architecture to novel production systems.

Lead Paper

ESPALIER SYSTEM OF CANOPY MANAGEMENT FOR INCREASED FRUIT PRODUCTION IN GUAVA, CUSTARD APPLE & MANGO

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A study was conducted at a research farm of VNR in the Bastar district of Chhattisgarh, focusing on two varieties: “VNR Bihi” (guava), “VNR Madhur” (custard apple), and a Mango cultivar “VNR Mongra”. The VNR Bihi, VNR Madhur, and VNR Mongra plantation were done in January 2016, June 2019, and July 2018, respectively. The fruit varieties covered an area of 10.1 ha, 2.8 ha, and 0.016 ha. A total of 8,500 Guava-VNR Bihi plants (16 ft × 8 ft), 4,200 Custard apple-VNR Madhur plants (12 ft × 6 ft), and 20 Mango-VNR Mongra plants (12 ft × 8 ft) were planted. To know enhancement of quality parameters of the produce we followed espalier system of canopy management. The trellis was made with 10 mm GI wires placed at differential height i.e., 1st wire was installed 80 cm above the ground, 2nd wire was installed 50 cm above 1st wire and 3rd wire was also installed 50 cm above 2 nd wire, supported on a concrete pole of 7.4 ft. height installed 32 ft. apart from each other in a bed of 200 ft. length. Pruning of Guava VNR Bihi plants was done on 26th of November, 2021 continued up till December end, while bagging of fruits started from 21st of April to 15th of May, 2022 using materials like foam net, Antifog polybags and Newspaper, targeting 120 fruits per plant. Whereas, pruning of VNR Madhur was done on 15th of May, 2022, where 75% of new growth was pruned, bagging of fruits started from 15th of July, 2022 with materials like foam net and laminated butter paper, with target of 60 fruits per plant. Harvesting started from 1st of October and continued till 15th of November, 2022. Pruning of Mango VNR Mongra was done on 6th of June, 2022, removing whorls which bore fruits last season, bagging of fruits started March, 2023, with white non-woven fruit covers, with target of 165 fruits per plant. Harvesting of fruits started from June 15th till June end 2022. In Guava VNR Bihi yield - 42.5 MT ha-1 /season (50 kg/plant) where average fruit weight per fruit was 500 gm. In Custard Apple VNR Madhur, yield - 32.4 MT ha-1 / year (21.6 kg/plant), with an average fruit size of 400 gm. In case of Mango VNR Mongra, yield recorded was 37.5 MT ha-1 /year (30 kg/plant), with 200 gm average fruit size. The yield obtained from plants under Espalier system was 20-30% higher compared to that of plants under Open canopy. The Net income thus generated from the produce per hectare was INR 14,65,000, INR 12,52,500 and INR 7,40,625 for VNR Bihi, VNR Madhur and VNR Mongra, respectively. It also offers additional benefits, including improved space utilization, facilitating various cultural practices such as pruning, sprays, and fruit harvesting. Espalier system optimizes sunlight utilization, and ensures increased aeration throughout the crop canopy, resulting in reduced disease incidence and lesser pest infestations.

BIOLOGICALS: INNOVATIVE APPROACHES FOR SUCCESSFUL BIOLOGICAL SOLUTIONS

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The increase in the world population has generated an important need for both quality and increased quantity of agricultural products which has led to a significant increase in the use of chemical pesticides in agriculture practices. Due to various ill effects of chemical pesticides like pesticide resistance, pest resurgence, toxic impact on the environment and human health, Consumers are now looking for safe and healthy food. Providing safe food along with sustainability is a big challenge. These challenges can be met only through novel and innovative approaches. Biologicals is one of the novel approach in finding solutions for chemical pesticides. Biologicals are based on the concept of "nature to nature" and success of the biologicals is through innovative approaches like virulent strains, robust screening processes, robust process and product development, broad-scale product validation, stringent manufacturing processes and products with higher shelf life. Successful biological solution is feasible only through holistic approach where the microbiome of the crop is understood and the package of practices are followed in developing a heathier microbiome to combat the pest and diseases. One of the Innovative approaches has been exploiting the endophytic nature of the Biologicals and harnessing their potential in successful cost effective biocontrol measures.

Biologicals are the need of the society and successful adoption of Biologicals globally is feasible only through well established and feasible regulatory systems.

Lead Paper

IMPACT OF CUSTOMIZED NUTRIENT SOLUTION THROUGH ENHANCED EFFICIENCY FERTILIZERS (EEF) ON PRODUCTIVITY, QUALITY, SOIL HEALTH & CLIMATIC RESILIENCE IN HORTICULTURAL CROPS

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Horticultural crops vary a great deal in their nutrient removal patterns depending upon respective targeted yields. Considering the nutrient removal rate projections in the year of 2016-17, the fertilizer requirement for fruits and vegetable crops was estimated to be 7.56 million. For most horticultural crops, due to increased fertilizer prices, growers are concerned about improving NUE ensuring maximum yield and quality improvements. Adoption of improved technologies at faster pace is one of the solutions e.g., use of fertigation in fruit crops is reported to save 30-50% of fertilizer doses as well as irrigation. Balanced nutrient management (primary, secondary & micronutrients) as per the crops and their stages plays an important role in improving the productivity and quality, significant saving in nutrient losses, providing nutrient rich prod produce and reducing GHG emission. Horticultural crops like Grapes, Tomato, Banana, Pomegranate, Melons, Citrus, and others are highly nutrient responsive particularly through fertigation. However, except in a few states and in some crops, nutrients are applied through bulk fertilizers via soil applications. This is a big bottle neck for productivity and quality enhancement of our horticultural crops as these crops do not get nutrients as per their stage specific requirement on real time basis.

MAHADHAN AGRITEK LTD (MAL), a 100% subsidiary of Deepak Fertilizers & Petrochemicals Corporation Ltd., Pune has been working on addressing the above mentioned problems for the last 4 years. As per MAL's experience, NUE in horticultural crops can be further improved through right customization of nutrients as per respective crop and their stages in comparison to nutrients applied on individual basis through fertigation. This also brings ease of application and better decision making for the growers. MAL conducted multilocation trials (Maharashtra, Karnataka, Gujarat, Rajasthan etc) be and 2023 for the development of Crop & Stage Specific Customized Water Soluble Fertigation Grads along with complete package using 20: 80 principle of nutrient ratio (soil vs. fertigation) for Grapes, Tomato, Pomegranate, Banana, Melons, Citrus, Potato, Sugarcane, Chilli and other fertigated crops. Overall, 'Solutek Solutions' in horticultural crops are not only increasing farmer's income by enhancing their crop productivity, quality and saving in input cost but also making their farm operation very easy and convenient. Because farmers are not required to make difficult decisions every now and then, and don't have to use many

fertilizers from different sources. Over and above these, 'Solutek Solutions' are improving the NUE significantly and hence saving significant quantity of nitrogen (62-67%) along with minimum percentage of amide nitrogen. India is committed to UNFCCC to reduce its GHG emissions by 30% by the year 2030 (MoEFCC,2019). Out of the total N_2Oemission, 77%aredueto the application of nitrogenous fertilizers (MoEFCC, 2019). Type of Nitrogenous fertilizers used and water management decide the impact on climate change because of emission of GHG. Therefore, development of climate smart technologies for mitigation of GHG emissions is the need of the hour. MAL has already been contributing to this national endeavour.

Lead Paper

ARKA MICROBIAL CONSORTIUM: A SUCCESS STORY IN TECHNOLOGY LICENSING AND ENTREPRENEURSHIP

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The overuse of mineral fertilizers, pesticides and inadequate soil management practices, affects the soil quality by altering their physical, chemical, and biological properties, and hence pose a threat to sustainable crop production. In 2008-09, a survey undertaken by ICAR-IIHR, Bangalore in major vegetable growing regions of Karnataka, recorded low population levels of beneficial microbes in the fields that were surveyed, thereby prompting the institute to undertake the research on the development of a microbial biofertilizer consortium that can improve and sustain horticultural crop yields. As a result of this, the "Arka Microbial Consortium" popularly known as AMC, a carrier/ liquid based biofertilizer consortium of efficient strains of N fixing , P & Zn solubilizing, K mobilizing and plant growth promoting bacteria was developed and identified by the institute Varietal and Technology Identification Committee for commercialization during December 2011. Though initially developed for use in vegetable crops, due to its versatility and adaptability the product has been accepted by farmers for use in various horticultural, field and plantation crops across regions. The salient benefits arising from the use of this product are its ability to reduce N&P fertilizer usage by 25 % and enhancement in yields of different crops by 6 to 20 %. Over the years AMC became a game changer in biofertilizer technology commercialization and it has been licensed to more than forty diverse clientele such as start-up entrepreneurs, established biofertilizer units, state departments of agriculture/ horticulture and *Krishi Vigyan Kendra's* on a non-exclusive basis by following the technology licensing guidelines of the Indian Council of Agricultural Research, for a period of five years thereby enabling the widespread spread and adoption of the product across geographical regions. Apart from offsite manufacturing, the onsite incubation of the Arka Microbial Consortium wherein start-ups are hosted at the pilot scale incubation facility of the institute for periods ranging from six to 12 months, during which they are provided with scientific mentoring support and market support by the Agricultural Technology Information Centre (ATIC), has led to the successful incubation and graduation of eight start-up entrepreneurs, who presently operate at different scales of production. The versatility of the product coupled with the technology licensing and incubation model has led to the successful spread of the technology besides creating successful entrepreneurs.

BEE AND OTHER POLLINATORS FOR SUSTAINABLE HORTICULTURE PRODUCTION

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Beekeeping is an art and science of rearing honey bees for the betterment of humankind. Of late, it's a lot about art, art and art of rearing and caring bees in the present demanding scenario due to climate change, pollution and habitat loss etc. Animals as a whole are estimated to benefit the agricultural production by more than USD 577 B at the global level. Pollination through honey bee provides USD 145.22 B, representing 9% of the total economic value of agricultural production used directly for human food. Not just pollination, honey bees provide us with various valuable hive products *viz.,* honey, beeswax, pollen, propolis, royal jelly, and bee venom. Among these, major emphasis had been on honey and to some extent on beeswax. However, hive products other than honey are garnering more attention in recent years. Research and development (R&D) efforts related to these hive products have gained momentum globally due to their potential economic, medicinal, and nutritional benefits. India is a major honey producing country in the world, with annual honey production being 1,33,200/- MT during 2021-22. Production technology for honey, royal jelly, pollen, bee venom, propolis and queen bee rearing have already been standardized in India under the ICAR-All India Coordinated Research Project on Honey Bees & Pollinators. However, to further increase productivity, work on genetic improvement of *Apis mellifera*, *Apis cerana, and Tetragonula irridipennis* etc. is going on. We have already identified molecular markers for *Apis mellifera* with high potential for the royal jelly production. We have standardised the technology for bee venom collection and which could be exploited for the establishment of apitherapy centres across the country. Apiculture for bee hive products offers a wealth of opportunities for research and development, spanning from medicine and cosmetics to functional foods and biotechnology. Both India and the global community recognize the value of these hive products and are investing in R&D to harness its potential. Many FPO's which are closely working with ICAR-AICRP on HBP have already came up with value added products from bee hive products which are slowly and steadily popular among the customers. As we continue to unlock the secrets of Apiculture for prosperity, it is imperative to balance innovation with conservation, ensuring the well-being of both honey bees and the environment at large.

Day 2, November 07, 2023

Auditorium, College of Veterinary Sciences, Khanapara, Guwahati

Session VI

STRATEGIES FOR DEVELOPMENT OF MINOR COMMERCIAL CROPS

Chair : Dr Neeraja Prabhakar, Vice Chancellor, Sri Konda Laxman Telangana State Horticultural University, Siddipet, Telangana

Co-chair : Dr J. C. Rana, National Project Co-Ordinator, Alliance of Bioversity International and CIAT, New Delhi

ROLE OF THE MINOR VEGETABLE CROPS IN DIVERSIFICATION OF HORTICULTURAL SECTOR TO MEET GLOBAL CHALLENGES OF CLIMATE CHANGE AND MALNUTRITION

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Minor vegetable crops offer tremendous opportunities for small-scale farmers to produce highly nutritious crops in their local environment. They are rich in vital micronutrients and can play significant role in addressing the issue of malnutrition across regions. Being rich in micronutrients such as iron, zinc, vitamins, and other phytochemicals, they provide several health benefits which help protecting people against non-communicable diseases, especially cardiovascular diseases, cancer, obesity and type 2 diabetes mellitus that kill more people every year than any other cause of death. The importance of local crops and their role in food systems has been not only recognised but realised during the COVID pandemic globally. Minor vegetable crop production is central to the livelihoods of many small-scale farmers. Since there cultivation is largely niche specific, they have great potential in diversifying agri-horticultural production system and to improve livelihoods of the small holder farmers. Minor vegetable crops like amaranths, buckwheat, spinach, chenopods, kankoda, many tubers and legumes are also act as climate smart crops as they grow well under adverse weather conditions like heat, cold and drought stresses. Besides, crops like moringa, sweet potato leaves, bitter gourd, and spider plant also have high levels of anti-inflammatory phyto-chemicals, like flavonoids and other antioxidants, beta carotene, vitamin C, folic acid, magnesium, phosphorus, and potassium are being used extensively to provide better human health and wellness. Despite having so much importance, minor vegetables have been relatively neglected in terms of policy attention, investments for research and extension, and support for agribusinesses. Also, there is a need of create awareness among consumers about their health benefit using various communication tools especially social media platform. We assume that incorporating Indigenous minor vegetables crops in the local food system will signifyingly contribute to addressing the issues of malnutrition, climate through diversification of agri-horticulture production system and livelihoods of small holder famers.

Lead Paper

PRESENT TREND AND FUTURE PROSPECTS IN CULTIVATION OF ARID TEMPERATE FRUITS IN INDIA

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There are over 7000 plant species known to the mankind to play a crucial role in our livelihood, but only 150 plant species are used commercially. However, there have been very limited efforts to develop technologies for the effective utilization of minor and underutilized crops in the country.

Himalayan regions are called water towers and are considered one of the major hot spots of plant diversity in India. A large number of indigenous plants have been growing naturally in various parts of the Himalayas since time immemorial. These wild plants play a crucial role in the livelihoods and nutritional security of the local and tribal populations in the regions. These resources have been used traditionally for the purpose of food, medicine, fodder, timber etc., and have time-tested utilities. These crops have tremendous potential to mitigate the challenges of climate change, water crises, and utilization of poor degraded lands, etc. as they have an excellent ability to tolerate, both biotic and abiotic stresses. In light of the above, the Defence Research & Development Organisation (DRDO) through its laboratories namely DIHAR, Leh; DIBER, Haldwani and DRL, Tezpur have conducted various studies on underutilized minor crops in different parts of the Indian Himalayas. The basic aim of the study was to conserve ethnobotanical knowledge available on the crops, identify valuable genotypes, evaluate &characterise them, and conservation of important genetic diversity by developing scientific methods of propagation, cultivation, and utilization for future crops of the Himalayas. The major crops identified from different parts of the Indian Himalayas are *Hippophae* spp (Seabuckthorn), *Crataguscrenulata* (Hawthorn), *Rhododendron arboreum* (Buransh), *Pyrus pashia* (Mehal), *Myrica esculenta* (Kaphal), *Rubus ellepticus* (Hisalu), *Berberis aristata* (Kilmora), *Punica granatum* (Darim), *Ficus palmata*(Bedu), *Dillenia indica* (Elephant apple) etc. as potential fruit crops. Similarly, there are many vegetable crops like *Cyclantherapedata* (Meetha Karela), *Diplazium esculantum* (Linguda) *Solanum incanum* (Bitter brinjal), and over 100 leafy vegetables that have tremendous potential for commercialization for the purpose of nutritional security and as emergency food. These crops may also play a role in area expansion and boosting production in non-traditional sectors, thus need immediate attention. There are a number of potential indigenous crops to be used for ornamental purposes, which may also be domesticated and utilized.

Some initiatives taken in this direction have shown excellent results and are success stories on minor crops. Technologies developed on these crops are not only helping to conserve and cultivate them by locals but also have established many small/ home scale industries in remote regions, which in turn provide employment to locals and also serve many nutrient-rich products. Based on these experiences, there is an immediate need to identify such crops and standardize their scientific propagation methods to conserve and characterize valuable diversity and boost the availability of quality planting material for commercial cultivation. There is also a need to set up field gene banks in different zones to conserve valuable diversity, demonstrate their utility, and also provide material for breeding/ varietal development programmes. Efforts also need to be initiated to standardize production technology, and processing/value addition protocols. Such efforts will only be feasible with adequate policy support and constant R&D efforts by networking with different organizations/ institutions.

Lead Paper

MINOR COMMERCIAL FRUIT CROPS IN DIVESIFYING HORTICULTURAL SECTORS

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In India, 39.54 million hectares of land is categorized as arid regions which includes 31.71 million hectares under hot arid region and 7.84 million hectares under cold arid region. The hot arid region is mainly spread over north-western part of the country covering the state of Rajasthan (19.60 million hectares) followed by Gujarat (6.20 million hectares) and Punjab (1.50 million hectares) and only 3.10 million hectare is in the peninsular region of the country. The cold region is mainly in the States of Jammu and Kashmir, Himachal Pradesh and Uttarakhand. The major farming constraints of arid region are poor and erratic rainfall, extremes of temperature, sandy soil with poor fertility, high wind velocity, very deep water table and brackish underground water resource, problem of wild animals etc. The major challenges in arid region are complex diverse and risk-prone farming situations owing to poor productivity and profitability, vulnerable to climate change, genetic erosion of important biological diversity, poor input use efficiency, limited and traditional post-harvest management, loose linkage and coordination among public and private organizations, limited state of art facilities. On account of various strengths such as vast land resource, intense solar radiation, increasing canal command area, low incidence of pest and diseases, surplus family labourers, good animal population and suitability to establish agro-based and allied industries; the arid region is gaining importance to promote as horticulture bowl of the country. The stress conditions coupled with wide variations in day and night temperature greatly favours production of high quality fruits, vegetables, spices and medicinal and aromatic plants.In hot arid conditions, existing flora including fruit crops have developed and/or modified their organs to perform certain vital physiological functions such as strong deep root system (ber, bael, aonla, wood apple, jamun, etc.), synchronize their flowering and fruit development with the season of moisture availability (ker, lasora, aonla, pilu, etc.) and other xerophytic characters i.e. leaf shedding in summer (ber), scanty foliage (ker), mucilaginous sap in plant part (ker, gonda, pilu, bael, etc.), sunken stomata and fur/ hairiness and waxy coating on the leaf surface (phalsa, ber, lasoda, fig, etc.) thorny nature, and selective or reduced absorption of cation (Na+) and anions (Cl^-, $SO4^{--}$) for their survival. Under resource poor conditions, mono-cropping is often risky preposition. Therefore, to minimize the risk of mono-cropping, compatible fruit based cropping system models were developed for better cash flow, nutritional, environmental and livelihood security. Under the scenario of climate change and increasing demand of organic and/ or safe food; there is great future of arid horticulture in years to come in diversification of horticultural sector.

TRANSFORMATION OF INDIAN MUSHROOM INDUSTRY: PROSPECTS AND CHALLENGES

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The paper looks into the structural transformation of mushroom farming in India. The world production of mushroom has now touched 44 million metric tonnes (2021) with a CAGR of 9.6% from the past 5 decades. Nonetheless, production is highly skewed and concentrated in the Asian subcontinent, which shares a major chunk (95%) of production solely. Likewise, China has a share of 93% in world mushroom production with a CAGR of 12%. India with a production of around 0.3 million tonnes, too have a comparable CAGR of 9.1% and it stands at No. 4 globally. This growth in Indian mushroom production is majorly driven by abundance of raw material, cheap labour, promotion and adoption of mushroom farming as an agribusiness enterprise by rural as well as urban youth and consumers' shift towards high value medicinal mushrooms. Mushroom, as a commercial commodity, requires less land and resources, which are already scarce in the country. Thus, with immense potential of generating income from least capital, mushroom as a commodity can uplift the livelihood of resource and land-constrained farmers in the country. Although, a SWOT analysis shows some lacunae such as lack of suitable infrastructure, quality inputs, well-linked value chains, consumer awareness etc. still exist and need to be addressed to bring about further transformation and making mushroom farming reach its full potential in the country. Occurrence of diseases and pests, requirement of highly technical manpower, perishable commodity, and per capita low consumption instability in market prices are some threats which needs to be attended.

Lead Paper

UNLEASHING THE POTENTIAL OF OIL PALM PRODUCTION IN INDIA TO REDUCE THE IMPORT OF EDIBLE OIL AND ENSURE SELF-RELIANCE

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Oil palm cultivation in India assumes significance as it is the highest oil yielding perennial crop and can thus augment the indigenous availability of edible oil. The crop has the potential for production of 4-5 T of oil and 0.4-0.5 T of kernel oil. In comparative terms, yield of palm oil is 5 times more oil than traditional oilseeds. In India, the demand for edible oils has been increasing due to several factors like rising income, growing population, and expanding urbanization; but the domestic production has not been able to keep pace with the growth in consumption. Because of this persistent supply-demand gap, India is dependent on imports and, is presently the largest importer of edible oils in the world. About 60 per cent of domestic edible oil demand is met through imports. With this dependence on imports weighing on its exchequer and also leaving it vulnerable to supply chain disruptions, India is making a push to drastically boost domestic production and eventually become self-sufficient in meeting its edible oil demand. Palm oil occupies a major share in imports and constitutes 40 % of total edible oils consumed. Keeping in view the ever-increasing demand for edible oils and the country's dependence on imports, Government of India has launched National Mission on Edible Oils - Oil Palm during 2021with an outlay of Rs. 11,040 crores. The Mission aims at increasing the oil palm area to 10 lakh ha and Crude Palm Oil production to 11.20 lakh T by 2025-26. At present an area of 4.61 lakh ha is under oil palm cultivation with annual CPO production of 3.70 lakh T. Presently an area of 27.99 lakh ha has been recommended in 22 states through Remote Sensing and Geographic Information Systems. North East Region has immense potential for the development of oil palm and 9.62 lakh ha has been identified in the seven Northeast States. Presently it is being cultivated in an area of 38,992 ha in NER, leaving much scope for expansion. Intercropping in juvenile and adult oil palm plantations is being vouched for improving resource use efficiency and additional income. Technologies for best management practices, doubling farm income along with lowering cultivation costs has been given more emphasis by ICAR-IIOPR. However, for realizing the objective of Atmanirbhar Bharat in vegetable oil production, there is an urgent need to adopt multi-pronged strategies like faster area expansion, improved productivity, remunerative price to farmers, development of need-based infrastructure, etc., which will be discussed.

POTENTIAL NON-CONVENTIONAL AREAS TO ENHANCE ORCHID PRODUCTION IN INDIA

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Today global cut flower trade alone generates revenue of US $ 28,891.5 million and expected to grow up to US $ 47,965.5 million at a CAGR of 5.8% by 2030. Orchids represent 10% of the total global cut flower trade, left aside the huge turnover of potted orchids and legal and illegal orchid species trade. Prime position of Orchids in global floriculture is due to their explicit diversity in flower shape, size and colour; long shelf life, year round production of different species. Tremendous development in inter-specific and inter-generic hybrids of orchids, advancement of micro-propagation techniques and optimization of controlled growing conditions for economically important genera for year round production of cut flowers and potted flowering plants, helped orchids to climb among the top 10 floricultural crops at global level. India is home to 1256 orchid species belonging to 155 genera, out of which 388 species are endemic to this part of the globe. India, unlike most established orchid growing countries globally such as Thailand, Netherland, Taiwan, etc.; can grow all types of orchids: temperate, sub-tropical and tropical, very successfully owing to its agro ecological diversity. The ability to grow all kinds of orchids in different parts of India offers her a unique advantage over several other orchid growing countries. However, in spite of all these advantages, India's share in orchids trade is negligible. One of the ways to promote orchids in India is to promote and enhance orchid cultivation in non-conventional areas. In this paper the potential non-conventional areas for orchid cultivation and promotion will be discussed.

Lead Paper

MINOR ARID FRUITS: PRESENT STATUS AND FUTURE PROSPECTS

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India is origin of many fruit crops and the most of crops is limited to its growing region only. In spite of their high nutritional and medicinal properties, their commercial cultivation is not still in vogue. Most of minor fruit crops are underutilized and are utilized in the core recipes of many *ayurvedic* formulations. These fruit crops are neither grown commercially on large scale nor traded widely, but cultivated, traded, and consumed locally. These fruits have many advantages like easier to grow and hardy in nature, producing a crop even under adverse soil and climatic conditions. So, exploitation of these fruit crops can be a solution of health and nutrition insecurity, poverty, and unemployment to the masses of dwelling in aberrant agro-climatic conditions. The consumption of minor fruits can provide nutrition to the poor and needy masses by meeting the nutrient requirements of vulnerable groups. These fruits are a rich of source of carbohydrates, fats, proteins, energy, vitamins: A, B_1, B_2, B_3, B_6, B_9, B_{12}, C, folic acid, and minerals: Ca, P Fe, and dietary fiber. These fruits are rich in bioactive compounds to prevent and cure various diseases like marasmus, night blindness, anemia, diabetes, cancer, hypertension, bacterial, fungal and viral infection, and hidden hunger. The minor fruits have potential to give health and economic security to the people by giving employment and by fetching good returns from their sale in raw form as well as value-added products. In India, minor fruit crops of arid and semi-arid region for food system are: bael, chironji, karonda, ker, phalsa, pilu, jamun, tamarind, ber, lasoda, wood apple, custard apple,fig, cape gooseberry, phalsa, mulberry, manila tamarind, timru, mahuaand palmyra palm, sugar datepalm etc. These fruit crops are rich source of vitamins (ascorbic acid, thiamine, niacin, pyridoxine and folacin), minerals, fat, protein, and dietary fiber. These crops can be grown with minimal management under aberrant agro-climatic conditions. Most of the important minor semi-arid and arid fruits are indigenous and it is easily available, can play major role for socio-economic upliftment of poor masses of the country in changing climatic scenario. India is facing the problems of hidden hunger, nutrient and micronutrient deficiencies, poverty, and unemployment. These fruit crops are present around us in unsystematic manner. So, cultivation of these crops in systematic manner and efficient utilization of marketing systems and channels for fresh fruits and processed products can motivate the growers towards growing these crops and can uplift the economy of country. There is tremendous scope of utilizing these crops in different promising value added products to the food system and nutraceutical industry. Use of these crops often declines due to changes in farming practices, changes in market forces, and cultural erosion that results from modernization, migration, urbanization, and land degradation. For sustainable food system, these minor fruit crops can play vital role for livelihood and economic security to the people living in the aberrant agro-climatic conditions across the world.

Day 3, November 08, 2023

Auditorium, College of Veterinary Sciences, Khanapara, Guwahati

Session VII

URBAN AND PERI-URBAN HORTICULTURE

Chair : Dr M. L. Chadha, Former Director, AVRDC, The World Vegetable Centre, Hyderabad, Andhra Pradesh

Co-chair : Dr B. Hemla Naik, Director of Education & Sr. Professor, KSN University of Agricultural & Horticultural Sciences, Shivamogga, Karnataka

OPPORTUNITIES FOR EXPANSION OF PROTECTED CULTIVATION IN DIFFERENT STATES IN INDIA

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The future of expansion of the protected cultivation technology in India in different states huge but highly dependent upon the technicality and recommendation of the technology implementation but the technology can be expended up to the area of 15.0 lakh hectares by 2050 and the cluster approach in adoption can play crucial role in successful expansion of this technology. It is believed that protected cultivation technology has to play a significant role under varied agro-climatic conditions of the country as a means for sustainable crop diversification, intensification, and for vertical growth of productivity of horticultural crops leading to optimization of water and fertilizer use efficiency in an environment of water scarcity in addition to better control of product quality and safety, in line with the market demands, standards and regulations. In the near future, the first and most important requirement for the use of protected cultivation technology is for its large-scale use for raising disease and virus free healthy planting material in all kinds of horticultural crops and secondly to use the technology for hybrid seed production of vegetables and thirdly production of fresh food for better economic viability in the country and mostly in cluster approach. Further, for sustainability of the technology it is utmost important to develop a large skilled manpower in form of rural youths in two sets, one set for designing, fabrication/ installation and thereafter maintenance of the protected structures and the other set for entire crop production management system under protected conditions.

Keynote Lecture

POTENTIAL OF ORNAMENTAL CROPS IN URBAN AND PERI-URBAN HORTICULTURE

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India's flourishing floriculture industry, driven by domestic and international demand, has emerged as a prominent player in the agricultural landscape. Globally, the floriculture industry spans 150 countries and commands a valuation of US$70 billion. India plays a vital role, contributing $400 million to the domestic retail sector and an additional $100 million to international trade. This presentation explores the industry's growth potential, government support, varietal development, and its far-reaching socio-economic impact. While Karnataka, Tamil Nadu, Madhya Pradesh, and West Bengal are at the forefront of commercial floriculture, the industry's share in agriculture output remains relatively modest at 1.4 to 1.5 percent. This indicates a substantial scope for expansion, particularly in states like Mizoram, Gujarat, Andhra Pradesh, Orissa, Jharkhand, Haryana, Assam, and Chhattisgarh. Floriculture offers diverse opportunities, providing self-employment and entrepreneurship prospects for small and marginal farmers. Driven by the trend of expressing sentiments with flowers and their high value per unit area, flowers are increasingly seen as a means of diversification. The industry encompasses a wide array of products, including cut flowers, loose flowers, dry flowers, cut foliage, pot plants, live plants, seeds, bulbs, tubers, bedding plants, potted plants, nutraceuticals, natural dyes, and value-added items. Over the last two decades, it has displayed impressive annual growth of 10-15 percent.

In today's globalized market, ornamental plant cultivation and trade have become integral to both domestic and international commerce. To meet global consumer preferences, the development of diverse crop varieties, hybrids, and mutants is crucial. India's diverse agro-climatic regions enable the breeding and production of a wide variety of flower crops adaptable to different climates. Recognizing the industry's potential, the Indian government has initiated several programs and support measures. Model Floriculture Centers in 11 major production zones offer quality planting material, production technologies, and post-harvest management training. The National Horticulture Board provides financial assistance for integrated projects focused on production and marketing. Additionally, the Agricultural and Processed Food Products Export Development Authority (APEDA) has introduced schemes to promote floriculture exports, including infrastructure development, packaging improvements, market expansion, and air freight subsidies, reflecting the government's commitment to fostering entrepreneurship in the field. Ongoing varietal development caters to consumer demands, with Indian institutes and universities actively participating in this endeavor. The industry has evolved into a high-tech sector with controlled climatic conditions for crop cultivation. With a focus on innovation, technology, and policy, this sector is poised for continued growth, benefitting both the industry and the nation's economy.

URBAN AND PERI-URBAN HORTICULTURE IN INDIA: A TRANSFORMATIVE BLUEPRINT FOR SUSTAINABLE URBAN DEVELOPMENT, FOOD SECURITY AND ENVIRONMENT RESILIENCE

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Urban and Peri-Urban Horticulture (UPH) is increasingly recognized as a transformative force in India, a nation grappling with the complexities of rapid urbanization, food security, and environmental sustainability. With India's population recently surpassing China's, the challenges associated with accommodating a burgeoning urban populace are escalating. Nearly 40% of India's 1.42 billion people reside in urban areas, a figure projected to swell to 60% by 2050. This demographic shift amplifies existing challenges, such as land and water scarcity, soil contamination, and waste management, thereby elevating the significance of UPH as a multi-dimensional solution. UPH holds immense promise, offering an array of benefits that extend beyond food and nutrition security to include economic development, job creation, and environmental services. It encompasses a broad range of activities, including green-scaping in urban pockets, interior scaping with plants, kitchen and home gardening, and the development of public parks. Vertical farming and hydroponic towers, roof top gardening are increasingly being adopted to maximize the use of limited urban space. Given the recent trend towards urban farming, community gardening, and urban greening initiatives, there's significant potential for the further development and expansion of urban horticulture in the country. In India, government Schemes and public-private Initiatives have boosted UPH in the country. To encourage urban horticulture in India, the government has rolled out various schemes like Atal Mission for Rejuvenation and Urban Transformation (AMRUT), National Urban Livelihoods Mission (NULM), and Pradhan Mantri Fasal Bima Yojana (PMFBY). National Horticulture Mission (NHM), through Mission for Integrated Development in Horticulture (MIDH), has also been influential in supporting horticulture practices in both rural and urban environments. Cities like Bangalore, Pune, Hyderabad, and Kolkata have seen an upswing in greenscapes, with vertical gardens, traffic green islands, and beautiful landscapes at airports and residential areas becoming more common. Kerala's capital, Thiruvananthapuram, has been a pioneer in embracing sustainable practices such as rooftop and balcony gardening, which are becoming popular across the country. Besides, projects on protected cultivation of high value vegetables and flower crops, vertical farming, organic farming and soilless cultivation systems are also been taken up and in great demand in urban areas. In addition to this, value addition based small scale business initiatives have been growing up in the urban peri-urban vicinities. Despite its promise, urban horticulture in India faces significant challenges, including land and water scarcity, pollution, waste disposal, and erratic weather patterns. Overcoming these hurdles necessitates a collaborative effort from the government, urban planners, and citizens to promote and support UPH through effective policies, sustainable practices, and infrastructure development.

Lead Paper

LOW-COST PROTECTED STRUCTURES FOR HIGH VALUE CROPS CULTIVATION IN NORTHEAST REGION

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In Northeast region of India, the resources or uts like soil, water climate etc are very much favorable for the rare and high value crops to be grown. However, topography of land is a limited factor for large size protected structures greenhouses and farmers have to construct small greenhouses suitable to sloppy lands available. Also, big markets are far distant with transport infrastructure not being proper, low-cost structures and overall low investments are more beneficial for the farmers in this region. A study in different Northeast regions on greenhouse cultivation has shown that quality vegetables, flowers can be grown in low-cost protected structures that can fetch good returns in markets. Flowers like orchids, Anthuriums can be successfully grown in walk in tunnels, wooden polyhouses etc to improve financial status of local farmers boosting economy of the region. Northeastern states like Sikkim have successfully grown dendrobium and cymbidium orchids fetching high prices in domestic markets. Similarly, Anthuriums from Mizoram have crossed Indian boundaries attracting buyers from UAE and other countries.

There is tremendous scope for cultivation of high value vegetables like colored capsicums and other exotic vegetables under low cost protected structures. Experiments at various regional ICAR/IARI stations and CIH Dimapur have proved that excellent quality of exotic vegetables can be grown successfully in low cost protected structures improving financial status of the local farmers.

BEEKEEPING IN NORTH EAST REGION OF INDIA

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Beekeeping is considered as fifth important input for overall development of Agriculture in a sustainable manner. It is also required as fifth input to get higher yields and quality production in cross pollinated agricultural and horticultural crops. Although, North East India has wide floral resources and plant diversity with a very congenial climatic condition for production of honey but the region has yet to prove the potentiality of being one of the 'honey capital' in the country due to lack of awareness, scarcity of skill manpower, lack of integration of beekeeping with agriculture and lack of bee colonies for commercial cultivation. The source of honey in the region is from both wild and cultivated bee hives. Most of the beekeepers in the region are marginal, having one or two bee hives. Despite, the importance of beekeeping in employment and livelihood generation, the potentiality of beekeeping is not fully tapped. Integration of beekeeping with agriculture will not only benefit the farmers with the direct benefits in the form of honey, bees wax, hive products and employment opportunities, but indirectly benefit greatly through increased crop production. In the North east region, a separate subspecies of Asian honeybee, *Apis cerana himalaya* exists, which differed from *Apis cerana cerana* of North-west Himalayas and *Apis cerana indica* of South India. Further, there are three locally adapted populations or ecotypes of the subspecies *A. cerana himalaya* that correspond to geographic distributions in (1) the Naga and Mizo hills, (2) Brahmaputra valley and Khasi hills, and (3) the foothills of the northeast Himalayas. Government of India has launched a new Central Sector Scheme entitled "National Beekeeping & Honey Mission (NBHM)" of Rs. 500.00 crores for overall promotion and development of scientific beekeeping in mission mode to achieve the goal of "Sweet Revolution" in the country under Aatma Nirbhar Bharat Programme with the support of 3 Mini Missions, covering production, extension, post harvest management and R & D support.

The assistance is available under National Beekeeping & Honey Mission to NE States for all individuals, institutions/ organizations/ societies/ Co-operatives/ Self Help Groups (SHGs)/ Joint Liability Groups (JLGs)/ Farmers/ Beekeepers Interested Groups (FIGs)/ Societies/ Firms /Companies/ FPOs/ Member Societies/ Firms/ Companies of NBB/ FPCs, etc. and for Government agencies/ organizations in NE States. With the support of various programmes, honey production has reached to 3990 Metric tons during 2021-22 in NE States. Till date total no. of honeybee colonies registered on Madhukranti are 38984. 17 honey FPOs/clusters have been formed by NAFED & NDDB to support beekeeping activities in North East Region. Various projects under NBHM were sanctioned to Assam, Tripura, Sikkim and Arunachal Pradesh states for creating value chain in honey sector in last 02 years.

Day 3, November 08, 2023

Auditorium, College of Veterinary Sciences, Khanapara, Guwahati

Session VIII

HORTICULTURE IN NORTH-EASTERN INDIA

Chair : Dr H. S. Gupta, Chairman, Assam Agriculture Commission (AAC) and former Director, ICAR - Indian Agricultural Research Institute, New Delhi

Co-chair : Dr Prabhat Kumar, Horticulture commissioner, Department of Agriculture & Farmers Welfare, Ministry of Agriculture, New Delhi

STRATEGIES FOR HORTICULTURE RESEARCH & DEVELOPMENT IN N-E REGIONS WITH FOCUS ON ASSAM

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North-Eastern India in general and Assam in particular harbour rich genetic diversity of many field crops including horticultural species. Vegetables, fruits, and spices are the major components of horticultural production system in Assam. Tomato, brinjal, cucumber, chilly, carrot, and okra are the prominent vegetables cultivated in the state, which produces 55.8 lakh tons (LT) vegetables against a requirement of 36.4 LT. This makes the state surplus by around 19 LT. of vegetables. The average productivity of an important vegetable like potato is, however, 8.5 t/ha which is 1/3rd of the national average (25.5 t/ha) which is mainly because of the poor quality of tuber seed that Assam gets from the neighbouring state. This can be reversed if micro/mini tuber-based seed production is pursued vigorously and systematically. Assam is surrounded by Arunachal Pradesh and Bhutan in north, Meghalaya, Tripura, Mizoram & Manipur in south and Nagaland in south-east where surplus vegetables can be exported. The state needs to promote low-cost polyhouse cultivation of vegetables in kharif during which vegetables cultivated in open gets damaged frequently due to heavy rains resulting in steep rise in prices of vegetables. Assam produces 24.8 LT of fruits which provides 185 gm/capita/day of fruits against subsistence requirement of 100 gm/capita/day. Thus, there are surplus fruits to the tune of >12 LT which can be exported to the nearby states as well as other countries too. Some attempts have been made recently due to which pineapple was exported to the Middle East and Assam lemon to Europe. Citrus decline has adversely impacted mandarin production causing steep reduction in production as well as productivity. Department of Biotechnology (DBT) has funded a big project on production of disease-free saplings of Mandarin orange that will help in rejuvenating citrus orchards not only in Assam but neighbouring states too. Of late, new introductions of Dragon Fruit, ber (Zizipus sp) and Thai guava have been found to perform well and farmers have adopted cultivation of these fruits. In addition, strawberry cultivation is fast becoming popular among the farmers, therefore, it needs to be promoted with organized marketing. Assam is known for its high-quality fruits like banana, pineapple and litchi all of which need area expansion. Apart from this, cashew plantations in areas adjacent to Garo hills, foot-hills of Karbi-Anglong and tila land of Cachar should be promoted.

Ginger, turmeric and black pepper are the major spices grown in Assam, however, losses due to poor post-harvest handling are enormous that can be reduced significantly. Floriculture is picking up and the Govt. of Assam has recently launched a Mission on Floriculture. Strategies for R&D in horticultural crops will be presented.

Lead Paper

ACCELERATED GROWTH IN HORTICULTURE IN NORTH EASTERN REGION: SUGGESTED POLICY INTERVENTIONS AND TECHNOLOGY COMMERCIALIZATION ISSUES

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North Eastern India is the home of a large number of horticultural crops. Two central sector missions, viz., the 'Technology Mission for Integrated Development of Horticulture in North Eastern and Himalayan States', and the 'National Horticulture Mission' had been implemented successfully for the overall growth of the Horticulture industry in the region. Commercialization of advanced technologies, their adoption and private investment for value chain integration can bring fortunes to NER horticulture farmers. The paper discusses the present status of Horticulture in NER and suggests policy interventions for land use planning, shifting cultivation,niche area development,technology commercialization processing and value addition.

POTENTIAL OF NORTH-EAST INDIA TO ENSURE SELF-RELIANCE IN HORTICULTURE PRODUCTION

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Northeast India has an added demographic advantage, in the sense that it occupies 7.8 percent of the country's total land space, is a reservoir of rich natural resources. All the Northeast (NE) States have distinct advantages and provide immense economic and trade opportunities to domestic and international players. According to the available information for the year 2021-22, the total area under fruits, vegetables and spices in the region is 4.3, 5.3 and 1.8 lakh hectares respectively. Out of the total horticulture production of 122.96 lakh tonnes, 47.46, 65.21, 6.43 lakh tonnes for fruits, vegetables and spices respectively have been achieved. Depending upon the climate, altitude, and physiography wide range of horticultural crops cultivated in different NE parts. The mandarin, pineapple, turmeric, ginger, litchi, lemon, banana, chilli, cucurbits, large cardamom, etc., are traditional crops cultivated in the region. The kiwi fruit, apple, guava, pear, walnut, broccoli, cabbage, capsicum, carrot, cauliflower, knol-khol, muskmelon, pea, potato, pumpkin, radish, spinach, sweet potato, onion, tapioca, and tomato are finding place in different areas. The productivity of many horticultural corps in the entire NE region is below the National level. This weakness of the region can be converted into an opportunity and productivity and production levels can be increased significantly to enhance the total production at national level, to meet the ever-growing demand for horticulture produce. Since horticulture provides higher return per unit of land and generates higher employment, development of horticulture will definitely help in alleviating the economic condition of the farmers.

The NER was given the GI registration for major horticultural crops, granting the region exclusive rights to produce peculiar types, few of them are Assam Karbi Anglong ginger, Arunachal orange, Dalle khursani, Khasi mandarin, Kachai lemon, Mizo Chilli, Memang narangi, Naga mirchi, Naga tree tomato, Sikkim large cardamom, Tezpur litchi, Tripura queen pineapple, and Elephant chilli.

The NE focused research initiatives by ICAR and also under HMNEH are yielding results in improving the production and supply chain of major high value works in the NE region and recommend further strategy to achieve the goal of marking the North-Easter region a true horticulture hub, not only of India but for the entire South-Asian region. Evolving new varieties, production, protection and post-harvest technologies and value additions are essential to keep up the pace with current growth of horticulture for self-sufficiency. Besides, clean planting material production, horticulture cluster development, digital horticulture, organic horticulture, and natural farming also assume importance. The efforts for boosting productivity must continue, through the introduction of climate resilient varieties and quality planting material production for area expansion. Blessed with rich biodiversity, and conducive agro climatic conditions, the region has all the potential to transform into a commercial horticulture hub.

Lead Paper

IMPACT OF TECHNOLOGY MISSION FOR NORTH-EASTERN REGIONS IN IMPROVING LIVELIHOOD

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Horticulture crops cover about 8% of gross cropped area and contribute more than 25% of gross value of agriculture output. India is currently producing 342.33 Million Tonne of horticulture produce from an area of 28.08 Million Ha which has surpassed the estimated food grain production of 316.06 Million Tonne. As a result of changing dietary patterns, the composition of agricultural production has diversified over the years. The North Eastern Region comprising of eight States: Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim, and Tripura has nearly 8% of total geographical area of the country and a population of fiftyone million. A study was conducted by Dr. Swaminathan committee during 1999 in North Eastern States. The Study recommended that the region has immense potential for development of various horticulture crops to improve the livelihood of population. Based on this study "Technology Mission for Integrated Development of Horticulture in North Eastern States" was launched during 2001-02 with an outlay of Rs. 229.38 crores during IXth plan with an end to end approach. The mission was implemented with bottom up strategy and allocations were based on AAP prepared at district level. The mission was Centrally Sponsored Scheme with 100% share from Government of India. The funds under mission were routed directly by SFAC to District Horticulture Officer for approved components as per AAP. The scheme had very good response in the form of enhanced production and productivity of horticulture crops. Based on success of the mission and demand from Himalayan States, the mission was extended to Himachal Pradesh, J&K and Uttarakhand in 2003-04 and subsequently during 2005-06, the mission was extended to potential districts of all states as National Horticulture Mission. During Xth plan period, mission in NE states was implemented with an outlay of Rs. 845.00 crores. During XIth plan period, an outlay of Rs.2500.70 was approved and during XIIth period an outlay of Rs. 3000.00 crores was approved for the programmes of mission. The growth and proportionate increase in the annual rates of production, as compared to the area under cultivation, indicates that the budgetary support and policy directions under Technology Mission has made favourable conditions for optimum utilization of resources. Present requirement is, linking of farm produce of North East with consumption centres in the country and outside the country. This can be achieved by creation of efficient supply chains and reducing the volumes of produce into high value products through processing. Continuation of incentives and dissemination of modern farming techniques will further help in diversification into the production of horticulture crops hitherto underutilized sector in North East which can generate higher employment and income, both in domestic and foreign currencies, for the region.

POTENTIAL OF THE GI TAGGED HORTICULTURE BASED PRODUCTS FOR INCREASING FARM PROFITABILITY OF THE N-E REGION

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Importance

- Economical
- Industrial
- Exports
- Livelihood Improvement
- State Name Promotion

(Proves product is unique, has unique qualities & can be grown / produced in a specific area only, making it special)

Income of Black rice farmers from Manipur has increased by 1.75 times as it got GI

Current Initiatives for GI Promotion in India

- Indian GI stores - wahgi.ncog.gov.in
- APEDA – Division to export GI products
- TRIFED GI corners
- Private Initiatives (GI product promotion, Innovative Value Addition, etc)
- Exports- Arunachal Orange, Black Rice, Queen Pineapple, Muga Silk, Karbi-Anglong Ginger

Process for filing GI Registration

Identify product- (Uniqueness in scientific form, Commercial / production quantity, Proof of origin in documented form)

Finalize association / applicant- Interest of producers

Submission- Application in form, affidavit, map, 5000 INR fee

Attend hearing / reply queries

Publishing in journal for 4 months (any objections, etc)

Grant of GI

Initiatives suggested post GI Registration-

Registration of Authorised User, Branding, Promotion, Marketing Campaigns, Product Development, Value addition, Integration with Tourism deptt as GI Tours etc

Lead Paper

SCOPE OF INTRODUCTION OF NEW FRUITS CROPS IN DIFFERENT STATES OF NORTH-EAST INDIA: A CASE STUDY OF KIWI FRUIT

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Among the recent crop introductions to horticulture practices in Mid-Himalayan states in India such as, HP and J&K in the North-West and Sikkim, Arunachal, Manipur, Mizoram, Meghalaya states of North-East India Kiwi fruit has been among the major ones, given its success story over the years especially in the North Eastern Indian region. Although considered a minor fruit of exotic origin, over past few years this fruit has attained immense popularity among consumers due to its nutritional value, while also it has gained appeal among small and marginal farmers owing to its high benefit-cost ratio, particularly through Hi-Tech cultivation techniques.

Kiwi fruit from North-Eastern states of India, especially Arunachal Pradesh and Sikkim, as well as other hill states, has increasingly attain a commercial identity at a national as well as international level and has been competing in the respective markets. Yet, despite the suitable climate soil conditions, many factors such as lack of quality planting material, lack of package of practices, unavailability of modem technology for precision farming, along with trained manpower, have been ascertained as some of the major constraints in enhancing the productivity of temperate fruits in general and Kiwi Fruit in the region.

Based upon the aforementioned concerns, a Roving Team for production of Temperate Fruitsin general and Kiwi fruit in particular was set up by ICAR, which thereupon recommended a road map for the cultivation of Kiwi fruit in the Northeastern Hill Region. It has therefore been observed through the implementation of modern horticultural practices for growing Kiwi Fruit in the mid-Himalayan region of the country to benefit the rural economy in the region, particularly the North-East states, comprising largely of small and marginal farmers whose practice of subsistence agriculture faces great challenge from changing climate scenario and other demographic constraints. The paper shall deliberateupon the key horticulture technologies developed for increased productivity of Kiwi fruit towards nutritional security and improved livelihoods of small and marginal farmers.

HORTICULTURE BASED CLIMATE FRIENDLY INTERVENTION FOR SUSTAINABLE LIFESTYLE FOR NE COMMUNITIES

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The North East Region has a varied range of agro-climatic condition with 60 per cent of the area being the store house of natural resources. Conservation of traditional lifestyle with scientific approaches in a climate friendly way based on conservation of the local food knowledge, cultivation of these local food as homestead food forests and Community Food Forests, Consumption of the local food for healthy lifestyle of the grass root communities and then commercialization of the local food as low volume and high value processed wellness food products by Community Enterprises. SPREAD NE is such organization in Assam which is successful in developing a sustainable model of cultivating, processing and marketing of the local horticultural crops as a Food Forest, Homestead Food Forests and Community Food Forests. The organization is working with the mandate of imparting practical farm education, conduct research in agriculture and allied sciences and to effectively disseminate technologies so generated in the field of climate friendly agriculture. Climate friendly intervention is of prime importance since more than 80 % of the population is rural and is dependent on farming and natural resources. A project of the International Fund for Agricultural Development (IFAD) is being implemented in the two North Eastern states – Nagaland and Mizoram to alleviate this issue. Likewise, Technology demonstration is being implemented in KVKs under ICAR-ATARI to mitigate the impact of climate change by focusing on adaptation of technologies like construction of water harvesting structures, micro irrigation and introduction of climate resilient varieties (CRVs). Traditional horticultural crops and the inherent multi-storeyed cropping pattern of those horticultural plants in the homesteads as a food forest, carried forward in more natural & scientific way of management can lead the communities to a sustainable lifestyle in the region.

Lead Paper

NORTH EAST INDIA – THE PARADISE UNEXPLORED: ELEVATING UNDERUTILIZED FRUIT CROPS AND MAINSTREAMING THE BOUNTY

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The North East Region of India, often referred to as the “Paradise Unexplored,” harbours a wealth of underutilized or lesser-known fruit crops, which have largely remained on the fringes of mainstream agriculture. North East India, with its diverse agro-climatic zones and rich genetic resources, provides an ideal environment for the cultivation of a wide variety of fruit crops. Many of these fruit crops, including indigenous varieties and wild relatives, possess unique flavours, nutritional attributes, and climate resilience, making them valuable resources. Moreover, the cultivation and promotion of these crops have the potential to bolster livelihood security among marginalized communities. However, mainstreaming of these potential fruit crops faces several challenges, including limited awareness, inadequate research and development support, and underdeveloped market linkages. Therefore, mainstreaming these lesser-known fruit crops through adequate researches on its cultivation, processing, and marketing can stimulate rural economies, create employment opportunities, and reduce poverty levels among marginalized communities. In conclusion, mainstreaming of underutilized fruit crops of North East India holds a significant potential for enhancing food security, stimulating economic development, and conserving biodiversity in the region. Recognizing their value, promoting their cultivation, and addressing associated challenges are pivotal in unlocking their potential for the region’s sustainable development

RESEARCH STRATEGIES FOR CONSERVATION OF LESSER KNOWN FRUITS OF NORTH-EAST INDIA

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Biodiversity is the very basis of human survival and economic well-being and constitutes the resources upon which families, communities, nations and future generations depend. The North-east region of India, being one of the mega hot spots of biodiversity is considered as one of the richest reservoir of various horticultural crops. A vast reservoir of fruit resources exists in this region which varied in morphological and physiological characteristics, adaptability and distribution. This region contains more than one third of the country 's total fruit diversity. In addition to commercial fruits, the region is also known for its rich genetic resources of underutilized and under exploited fruits. These crops are scattered in wild forest or semi wild in homestead gardens. Most of them are very rich sources of vitamins, minerals along with carbohydrates, proteins and fats and play an important role in food and nutritional supplement of rural community.

The region is considered as original home of citrus species. In citrus, 17 species with 52 varieties /types identified to be grown in this region. Many inedible *citrus* species like *C. indica, C. ichangensis, C. latipes* and *C. macroptera* are found growing wild and semi wild in the region. Besides this different strains of citron (*C. medica*), sour pummelo (*C. megaloxycarpa*), rough lemon (*C. jambhiri*) and sour orange (*C. aurantium*) are also reported to grow in semi wild conditions in this region. In banana, in addition to cultivated triploids, *Musa acuminata* and *M. bulbisiana* diploids are found in semi wild state. *Musa flaviflora* is localized in Manipur and Meghalaya. Different types of jackfruit *viz. Artocarpus heterophyllus*, *Artocarpus chaplasha, Artocarpus lakoosha* are available in the region.

But of now, the genetic resources of these fruits may come under the threat of extinction because of large-scale urbanization, changing attitude and taste of peoples and developmental projects. Research strategies should be undertaken to conserve the underutilized fruits to safeguard them from further extinction. Development of propagation protocol along with cultivation practices is very imperative. Development of comprehensive databases that helps in framing strategies for conservation, identifying priority sites following 'hot spot' concepts for immediate conservation, identifying the habitats of indigenous horticultural species for creating species oriented conservation, establishment of gene banks/ seed banks for long term conservation, undertaking restoration ecology and reproductive biology studies of these endangered species whose population have reached a critically low level is urgently required to safeguard the fruit diversity of the region. E*x situ* and *in situ* conservation of rare and endangered species should urgently be undertaken to ensure safe storage of germplasm for dynamic conservation and sustainable use of genetic resources of all available germplasm. There is urgent need to launch global level network programme for conservation and sustainable utilization of all underutilized fruit crops of this region.

Day 3, November 08, 2023

Auditorium, College of Veterinary Sciences, Khanapara, Guwahati

Session IX

MANAGEMENT OF BIOTIC AND ABIOTIC STRESSES

Chair : Dr K. Sammi Reddy, Director, ICAR-National Institute of Abiotic Stress Management, Baramati, Pune, Maharashtra

Co-chair : Dr R. Selvarajan, Director, ICAR-National Research Centre for Banana, Tiruchirapalli, Tamil Nadu

ABIOTIC STRESS MANAGEMENT IN HORTICULTURAL CROPS TO MAXIMIZE WATER USE EFFICIENCY

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Climate change-induced uncertainties in weather patterns have become increasingly prevalent in this century, posing significant challenges to horticultural crop production. Horticultural crops, valued for their health-promoting nutrients. These crops depend on consistent irrigation for successful growth and yield. However, these crops are now facing severe abiotic stresses due to shifting climatic conditions. In India, horticultural crops are grown in diverse agro-climatic zones and they are expose to various abiotic stresses, including drought, salinity, floods, heat and wind. These stresses disrupt crucial growth stages, impacting nutrient balance, plant metabolism, and photosynthesis, leading to osmotic and oxidative stress and cellular damage. This ultimately affects the potential yield of the horticultural crops. Water scarcity is a critical factor affecting horticultural crops, with even mild stress significantly reducing crop yields. To address this challenge, several strategies have been developed such as identification of drought-tolerant germplasm and rootstocks is essential for enhancing water use efficiency (WUE). Rootstocks, especially in fruit crops, have demonstrated increased WUE without compromising yield. Further, improved crop management practices, such as mulching, low tunnels, and raised beds, effectively conserve moisture and enhance WUE in horticultural crops. Deficit irrigation strategies, particularly in arid and semi-arid regions, have successfully managed water resources, increasing marketable fruit yields. Furthermore, the application of plant biostimulants in combination with deficit irrigation has shown promise in improving crop water productivity, particularly under moderate to severe water stress conditions. Protected cultivation has gained prominence in enhancing yields and water efficiency in greenhouse vegetable crops. This article will provide readers with information on the critical importance of managing abiotic stresses to maximize water use efficiency in horticultural crops. Integrating strategies such as genotype and rootstock selection, deficit irrigation, plant biostimulants usage, and protected cultivation will help to mitigate the adverse impact of abiotic stress in horticultural crops. These approaches collectively reduce yield losses, enhance water use efficiency, and improve fruit quality in water-deficient regions of India.

Lead Paper

PHYSIOLOGICAL AND MOLECULAR BASIS OF HEAT TOLERANCE IN IMPORTANT HORTICULTURAL CROPS

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The increasing effect of heat stress on horticultural crops has become a critical concern, given the current and anticipated global warming trends. The horticultural sector, playing a vital role in the economy, is making significant strides. It is no longer optional but an imperative necessity to address the challenges posed by a warming future. Thermal stress, a major environmental factor, limits plant growth and impacts metabolism, productivity, and quality in horticultural crops. Generally, the ideal temperature for most plant species falls between 20°C and 35°C. Fruit crops in tropical and subtropical regions face similar challenges due to high temperatures. Sunburn, leaf aging, inhibited shoot and root growth, fruit discoloration, and damage are common issues. Temperature fluctuations affect various physiological processes, including photosynthesis, carbon fixation, and reproductive functions in plants. Similarly, most vegetables are sensitive to heat stress, especially during flowering and fruit setting. Heat stress reduces leaf water potential, stomatal conductance, internal CO2 concentration, and photosynthesis, which can lead to cell death and impact metabolic processes. Heat stress can cause various adverse effects in plants, including protein misfolding, enzyme inactivation, reduced photosynthesis, ROS accumulation, and damage to plant growth and development. Plants have developed mechanisms like ROS scavengers, antioxidant systems, heat shock proteins, heat stress transcription factors, and microRNAs to cope with high temperatures. Genetic responses to heat stress are being explored, focusing on unique reactions to combined stress situations. Additionally, efforts to increase heat tolerance in horticultural crops have shown promise. In conclusion, rising ambient temperatures have the potential to significantly affect crop cultivation in horticulture, including productivity, growth cycle, and product quality.This article intends to provide a glance at the physiological and molecular basis of heat tolerance based on recent research articles.It is evident that there is surge in information on physiological and molecular aspects of heat tolerance in plants. However, translational plant biology for abiotic stress tolerance is expected to offer solutions for genetic improvement and precision horticulture in the face of predicted temperature increases. It is essential to explore escape, avoidance, and tolerance mechanisms to develop climate-resilient cultivars and climate-smart management practices.

BIOSMART STRATEGIES FOR BIOTIC AND ABIOTIC STRESS MANAGEMENT: ADVANCING CLIMATE-RESILIENT AND SUSTAINABLE HORTICULTURE

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Climate change is exerting profound impacts on global agriculture and horticulture. Over the next few decades, temperatures are projected to rise by 1.5–2.0°C, leading to more frequent heatwaves, elongated warm seasons, and abbreviated cold seasons. Key crops such as mangoes, bananas, tomatoes, and potatoes are particularly susceptible to these climactic shifts, especially during their crucial flowering and fruiting phases. For instance, unseasonal rains combined with fluctuating temperatures in the subtropics have been detrimental to mango crops. Early monsoons in these regions intensify the occurrence of *Colletotrichum* and *Lasidiplodia* spots on mangoes, diminishing both their quality and market value. Changes in climate regimes are also giving rise to new diseases and pests, which further challenge conventional agricultural practices. The altered environmental conditions make ecosystems more hospitable to pests and pathogens previously not encountered in certain regions. Alterations in rainfall patterns over time in the subtropical Indian subcontinent have catalyzed the emergence of the menacing banana Fusarium wilt Tropical race 4, wreaking havoc in countries across Southeast Asia, including the Philippines, China, India and Bangladesh. Furthermore, prolonged dry spells elevate soil pH due to salt accumulation, notably in the canal command regions of the Indo-Gangetic plains.

To counter these climatic challenges, there's an urgent need for multidimensional research strategies. Breeding must pivot towards generating climate-resilient varieties and hybrids equipped to handle both abiotic and biotic stresses. The ICAR Central Institute for Sub-tropical Horticulture has made commendable strides in this domain, notably with the development of mango hybrids like Arunika, which displays adaptable flowering patterns suitable for pruning and thinning in subtropical climates. Other promising hybrids with Tomy Atkins lineage, such as H-4254, H 1739, and H-2040, have demonstrated extended shelf life and enhanced resistance to pests like thrips and diseases like anthracnose. Embracing metabolomics offers a promising avenue for devising climate-resilient agricultural technologies. Current research explores microbial biomolecules as pre-harvest treatments to prevent anthracnose and shield fruit from unpredictable rains and humidity. Groundbreaking protocols utilizing biomolecules and lipo-polypeptides from microbial strains in stressed microbiomes have facilitated the growth of crops like tomatoes in salt-afflicted and water-scarce terrains.

Next-generation biostimulants, enriched with microbial metabolites, activate anti-senescence pathways in plants, bestowing them with resilience against environmental adversities. Marrying microbial and metabolite technologies with precise application methodologies boosts the yield and productivity of various horticultural crops, especially in challenging terrains. Advances like the *in vitro* bioimmunization of banana tissue cultures, leveraging metabolites from antagonist fungi, have shown promising results against formidable challenges like the Fusarium wilt Tropical race 4. Furthermore, antifungal compounds, such asIturin C and Fengycin, alongside specific flavonoids like quercetin, play a pivotal role in bolstering plants against biotic stresses. IAA-based amino acids are instrumental in counteracting abiotic stresses, such as salinity, by suppressing ethylene synthesis and promoting ACC deaminase production. In today's digital age, capitalizing on microbial diversity for biomolecule production and integrating it with technologies like the Internet of Things, sensor-based irrigation, cloud data analytics, and artificial intelligence paves the way for a smart, climate-resilient, and sustainable horticultural future.

HIGH-THROUGHPUT PHENOTYPING: A MULTIDIMENSIONAL APPROACH FOR STRESS RESILIENCE BREEDING AND MANAGEMENT OF FRUIT CROPS

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The high velocity of plant phenotyping based on phenomics accelerates the selection phase of potential advanced germplasm resilient towards climate induced stresses. It has been evidenced that physiological traits that are affected by stresses (salt, drought, and heat) can be accurately estimated using various imaging technologies (UV Fluorescence, Visual, NIR, IR, Hyperspectral, Chlorophyll Fluorescence) for the rapid non-destructive screening of hybrid progenies. The UAV (unmanned aerial vehicle)-based technique can detect the tree vigour, and count citrus trees with high precision (99.9%). The proposed technique can be utilized to evaluate tree cultivars and management practices accurately and rapidly, and aid researchers, breeders, and growers to identify citrus rootstock cultivars that perform better in the HLB affected area. The hyperspectral imaging technique coupled with the smart-phone imaging devices (SID) based image classification method has been proved effective for discriminating citrus canker and grapevine powdery mildew from other confounding diseases and nutrient deficiencies. Hyperspectral Imaging (HSI) being an integration of two modalities, imaging, and point spectroscopy, is nowadays emerging as a potential tool for rapid, non-destructive, and automated close-range assessment of plants functional dynamics both in terms of structure and physiology. The application of hyperspectral reflectance as a high-throughput phenotyping approach has been proved effective for early identification of water stress and rapid assessment of leaf photosynthetic traits in citrus trees. The leaf hyperspectral reflectance is a reliable and stable method for monitoring water stress and yield increasing in large-scale orchards. Fluorescence imaging has been used to study drought responses under controlled environments and to investigate photosynthetic performance under stressful environments. Increase in the chlorophyll fluorescence ratios depict the stress induced decrease in chlorophyll content and it is very early stress indicators to screen germplasm. In several areas, the fresh citrus fruit industry is threatened by yet another citrus disease called citrus black spot (CBS), which

has arrived as the industry battles two other recently introduced and devastating diseases (citrus canker and Huanglongbing). Tree canopy architectural traits on large area and their response to biotic or abiotic stress under field conditions can be determined with UAV and remote sensing devices. In the pursuit of drought-tolerant crops, phenotyping involves assessing traits such as surface temperature, transpiration rates, and shoot biomass, which enable breeders to identify plants with superior resilience to water scarcity. The nutritional status of citrus leaves is very important to the determining of fertilization plans. The spectrum technique is a quick, un-injured method and is becoming widely used for plant nutrient estimation. The use of non-destructive approach (visible light imaging) can predict the sugar content of citrus fruits to achieve the prediction and classification of the sugar conditions in the citrus orchard.

ADVANCE AND EMERGING PLANT PATHOGEN DETECTION TECHNIQUES IN HORTICULTURAL CROPS

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Horticultural crops are part of our daily life and mainly include fruits, vegetables, materials for beverages and fragrances, herbal medicine, and ornamental plants. Horticulture contributes around 30.4% to the Gross Domestic Product (GDP) while using only 13.1% of the gross cropped area, making it a significant player in India's agricultural growth. Plant pathogens currently pose a major threat towards the agricultural and horticultural industry. These pathogens cause up to 40% yield loss of economically important crops each year. In order to reduce yield losses, it is important to detect pathogens as early as possible, and preferably even before disease symptoms are visible. Effective diagnostic tools for timely determination of plant diseases become essential to the assurance of horticultural sustainability and global food security. Ideally, a plant pathogen detection technique is Affordable, Sensitive, Specific, User-friendly, Rapid and robust, Equipment-free or simple, and Deliverable to end-users, and able to detect pathogens in complex matrices, such as soil samples or plant extract. Nucleic acid- and antibody-based molecular assays are gold-standard methodologies for the diagnosis of plant diseases, but the analyzing procedures are complex and laborious. However, there is a growing interest in developing techniques that can be based in real-time and thus facilitate in-field or onsite diagnosis. Several recent advances have demonstrated that CRISPR-associated (Cas) endoribonuclease systems may offer useful features for nucleic acid detection. Next-generation sequencing (NGS)-based innovative methods have been shown to possess great potential to detect multiple pathogens simultaneously. In this invited lecture, main advantages and disadvantages of currently available and recent emerging detection techniques a-re discussed in detail, which should allow researchers and stakeholders to easily compare the different options that are available nowadays and select a method that is most suited for their specific use.

Lead Paper

EVENTS OF INVASIVE PESTS IN INDIA: CURRENT STATUS AND MANAGEMENT CHALLENGES IN HORTICULTURAL CROPS AMIDST CLIMATE CRISIS

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India is highly diversified in its weather and climate, which supports establishment of various invasive align species (IAS) including the agriculturally important insects from other parts of the world. Increased international agricultural trade, movement of seeds as well as other planting materials, and increased movement of humans across the continents has enhanced the risk of entry of invasive insect pests into India. Invasive insect species can act as a plague across the globe, capable of vast expansion with rapid reproduction potential. Invasive pests are exponentially devastating the economy ever since India faced its first invasive pest, the woolly aphid, *Eriosoma lanigerum* (Hemiptera: Aphididae) in 1889 from China. The most common expedition of invasive pests includes the passage of sea (shipping), land (surface transport) and air (forceful wind). Recent analysis has indicated that India has lost $127.3 billion (Rs.8.3 trillion) in the last 60 years to invasive alien species, making the South Asian nation the second most invasion-cost bearing country after the United States. The spread of Invasive Alien Species (IAS) is now recognized as one of the greatest threats to the ecological and economic well-being of the country. The invasion events by alien pest organisms can be categorized into four consecutive events, including (a) Introduction, (b) Establishment, (c) Spread, and (d) Naturalization, with a series of sequential process. Plant Quarantine stations are established at various points of entry such as seaports, airports and land frontiers to implement the provisions of PQ Order, 2003. In addition to the alien invasive from across political borders, invasion of pests can also occur from one geographic location to another within the same country. These species are causing enormous damage to biodiversity and the valuable natural agricultural systems upon which we depend. Direct and indirect health effects are increasingly becoming serious and the damage to nature and environment is often irreversible. The impact is exacerbated by global change and chemical and physical disturbance to species and ecosystems. It is therefore necessary to understand the recent invasive pests in order to protect food crops from economic losses and to maintain sustainability of farmers.

The existing efforts at management of invasive pests to date often provide short-term effects, requiring constant vigilance, which can be costly as well as labour intensive task. The management process of invasive insects involves three discrete action levels including: (a) Preventive measures, (b) Post-quarantine measures and (c) Curative measures. Systematic implementation of import regulations and international cooperation in trade and commerce, early detection and taxonomic identification at the entry points will make India secure from such invasive species. This paper highlights the characteristics events of invasive pests covering the aspects of the common passage of entry of the invasive species, the steps involved in the introduction and establishment of new pests from foreign countries, economic impact on agro-ecosystems and their sustainable management programme by prevention, eradication and control in India.

BREEDING VEGETABLES FOR POWDERY MILDEW DISEASE RESISTANCE

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Vegetable crops are affected by large number of diseases and their management through chemicals even if successful, their indiscriminate use leads to numerous drawbacks such as deterioration of soil health and environmental pollution besides results in the development of resistance to the fungicides. Moreover, chemicals cause carcinogenic effect to the human being. Powdery mildew (PM) is a common and serious fungal disease that endangers the production of many vegetable crops primarily by pathogens viz., *Erysiphe pisi* in pea, *Leveillula Taurica* in capsicums, and *Podosphaera xanthii* and *Golovinomyces cichoracearum* in cucurbits. Therefore, breeding disease resistant variety(ies) is one of the excellent ways to solve this problem. Genetic bases of disease resistance and host plant resistance have significantly enhanced the efficiency of manipulating resistance genes in applied breeding programs that significantly develops high-yielding genetically resistant cultivars. The source of resistance and genetic information is essential for creating resistant lines. Three genes (er_1, er_2 and Er_3) have been described so far in *Pisum* germplasm and only er_1 has been widely used in resistance breeding. Slow mildewing pea variety Him Palam Matar-1 developed following pedigree method of selection is recently recommended for Zone-I comprising states of Himachal Pradesh, Uttarakhand and J&K. Another improved genotype 'DPP-SP-6' has been developed through hybridization with pod yield potential of 150- 175 q/ha and desired pod characteristics along with slow mildew reaction. Three powdery mildew putative pea mutants isolated from Lincoln and Azad P-1 namely, L-40-1014-1, L-0.3-139 and AP-0.3-129-2 with medium sized pods and could be utilized in future powdery mildew resistance breeding program. Resistant/tolerant varieties of cucumber viz., Poinset, Swarna Poorna, Phule Subhangi etc. are generally used for powdery mildew resistance breeding in cucumber. The conventional breeding is labor-intensive, and longer duration of breeding cultivars. The occurrence of PM is highly influenced by the environment that increases the difficulty of breeding PM-resistant varieties. Accordingly, molecular breeding has many advantages such as less environmental impact, laborsaving, and a greatly shortened period. The cloning and molecular mechanism of cucumber PM resistance genes are the prerequisite and would lay the foundation for molecular breeding for disease resistance The introgression of different genes for resistance to powdery mildew using MAS combined with traditional backcross breeding could offer an effective strategy to enhance the durability of resistance to diseases in these crops. Recently, pea variety Him Palam Matar-2 with er_2 gene has been developed through marker assisted breeding. The pyramiding approach may provide multiple barriers to powdery mildew development that would enable to overcome the common breakdown of the single gene-controlled resistances.

Day 3, November 08, 2023

Auditorium, College of Veterinary Sciences, Khanapara, Guwahati

Session X

HORTICULTURE FOR FOOD, PHARMACEUTICAL AND COSMETIC INDUSTRIES

Chair : Dr Bidyut C. Deka, Vice Chancellor, Assam Agricultural University, Jorhat, Assam

Co-chair : Dr Gopal Lal, Member (Agriculture), Cauvery Water Management Authority (CWMA), Ministry of Jal Shakti, New Delhi

INTRODUCTION TO HORTICULTURAL THERAPY ITS ROLE AND APPLICATION IN IMPROVING BODY, MIND AND SPIRIT

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Horticultural therapy is a professional practice that uses plants and gardening to improve mental and physical health. The therapeutic benefits of garden environments have been documented since ancient times. Today, horticultural therapy is accepted as a beneficial and effective therapeutic modality. Horticultural therapy helps improve memory, cognitive abilities, task initiation, socialization and language skills. Horticultural therapy (HT) programming, can be used as one method to "a more natural, effective, and chemical-free pathway to wellness." The general purpose of horticultural therapy is to improve a person's physical and mental well-being. Horticultural activities also serve as a source of relaxation, enjoyment, accomplishment, satisfaction and affirm that people need a good relationship with nature to lead healthy lives. It is not an overstatement that the field of horticultural therapy (HT) changes lives of both the therapist and those they serve. Horticultural therapists have a foundation of knowledge in plant science, human science, and horticultural therapy principles and experience in the application of horticultural therapy practices.

Horticultural therapy is fast becoming a vigorous profession. Research social interaction and communication has found the benefits of rehabilitation through horticulture are enormous. Horticultural therapy helps: People with mental health disorders and helping people develop social skills, improve physical mobility, and regain confidence. It is slowly but surely becoming more widely recognized as an efficacious form of therapy- A Magical Therapy for Healthy Life. Emerging evidence shows that the benefits of including horticultural therapy activities encompass meaningful engagement, self-expression, mental stimulation, and socialization. While evidence describes horticultural therapy as an appropriate to treat a range of conditions and to improve overall wellbeing in older adults, to date there are few controlled clinical trials. More randomized controlled trials and other rigorous systematic analyses of the therapeutic benefits of horticultural therapy, and as compared to other therapies, is needed. There is a growing interest in horticulture therapy research and more people are using horticulture therapy. Therefore, it is important to rigorously examine the benefits of horticulture therapy and incorporate them when they are working with patients. Additionally, there is a need to collaborate with policymakers, government, educators, researchers, hospitals, retirement homes, public, and non-profit organizations and help people who need horticulture therapy but are not aware of the benefits. Using a horticultural therapist to guide and support all inpatient rehabilitation clinicians in gardening activities broadens the reach of horticultural therapy and the scope of the role of the horticultural therapist. Horticultural therapy uses the activities associated with horticulture such as gardening, plant propagation, plant care, visits to natural environments and gardens and parks.

Lead Paper

POTENTIALITY OF SECONDARY HORTICULTURE IN INDIA

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There are many horticultural crops, including fruits, vegetables, spices, flowers, mushrooms, bamboo, plantation crops, and non-food crops, including medicinal and fragrant plants. Through crop diversification, these crops' potential in India as a lucrative, feasible, and long-term replacement for the rice-wheat cropping system and their comparative advantage in securing livelihoods were recognized thirty years ago. From 94.07 in 1991–1992, India produced 334.60 million tons of horticulture crops in 2021–2022. It is now widely accepted that horticulture must expand considerably faster and higher to attain a growth rate of 4% in agriculture.

According to the official projection from the Ministry of Agriculture and FW 2021, India produces 102.03 million tonnes of fruits annually, accounting for 11.56 per cent of global production. The production of bananas peaked at 32.59 million tonnes during the same time, with mango coming in second at 20.26 million tonnes, citrus coming in at 14.56 million tonnes, papaya coming in at 5.78 million tonnes, guava coming in at 4.36 million tonnes, grapes at 3.18 million tonnes, apples at 2.81 million tonnes, pineapple at 1.73 million tonnes, and sapota coming in at 0.91 million tonnes. In terms of vegetable production, potatoes came in front with 48.56 million tonnes, followed by tomatoes (21.17 million tonnes) and onions (26.09 million tonnes India accounted for 14.0% of the world's vegetable production in 2020–21, with production of 199.88 million tonnes. According to reports, India has the highest productivity rates in the world for grapes (21.2 t/ha), peas (10.29 t/ha), and cassava (35.0 t/ha). India is known as "the land of spices" because it produces and exports the most spices worldwide, at 81.24 lakh tonnes annually. India has made considerable strides in producing cut flowers and decorative plants in a short time. India produced 2.09 million tonnes of loose flowers and 7.9 lakh tonnes of cut flowers during 2020-21.

It is still insufficient to satisfy the rising population's fundamental nutritional needs despite reaching new heights in fruit and vegetable production, like in Brazil and China. Depending on the commodity, postharvest losses for fruits and vegetables have been estimated to be between 6 and 36% in India. Utilizing the enormous potential of secondary horticulture throughout various postharvest and processing procedures could help solve a fraction of this problem by reclaiming a sizable amount of the substantial postharvest losses of these perishables. Under the umbrella of secondary horticulture, numerous opportunities for the total utilization of harvested horticultural produce during processing can be explored. These opportunities will link the food, pharmaceutical, and cosmetic industries by converting waste into wealth. Some important aspects of secondary horticulture are discussed in this paper.

RECENT DEVELOPMENTS IN MANAGEMENT OF PESTICIDE RESIDUES IN HORTICULTURAL CROPS

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The presentation would describe the current scenario of food safety at domestic and international trade in relation to fruits and vegetables. In India, in the last 10 years, a large number of new pesticides has received label claim from CIB&RC for usage in horticultural crops. The good agricultural practices (GAP) for their safe usage have been defined with recommendations of pre-harvest intervals after which the residue deposits are expected to dissipate to below the maximum residue limits (MRL). The MRLs of various crop-pesticide combinations have also been simultaneously established as a pre-requisite of their market introduction. Although many of the MRLs were earlier set by the Food Safety Standards Authority of India (FSSAI) in 2018 at the default level of 0.01 mg/kg, a recent coordinated approach between Ministry of Agriculture, Ministry of Health and Ministry of Commerce has mobilized harmonization of those MRLs with the Codex and the European Union (EU). This harmonization is anticipated to improve national and international trade of horticultural commodities to a great extent. Establishing product traceability is a big challenge for the horticulture industry, especially in the context of establishing GAP. Traceability is required at every process of production, processing and distribution. In India, a comprehensive traceability system has been established in table grapes at pre-harvest level, in which the entire supply chain is managed through an internet-based food safety/traceability system named Grapenet. Similar traceability is being developed in many of the fruits & vegetables under Hortinet program of APEDA, but those are mostly implemented at post-harvest levels. In all cases, residue testing, Agmark quality gradation and phytosanitary certification have been comprehensively integrated through active participation of all stakeholders.

The GAP recommendations are never successful unless those are communicated to farmers appropriately. Field level inspections and extension programs by the state horticulture department officials are necessary to implement the GAP recommendations at field levels. Location-specific weather advisories help in rationalizing and minimizing the pesticide applications. Besides frequent training programs for stakeholders are necessary to implement safe use of pesticides, which in turn minimizes the residues. In many crops, biointensive strategies are being implemented to minimize pesticide usage, which in turn is helping to minimize pesticide residues and improve the quality of horticultural commodities.

In table grape sector, the stakeholders' participation in residue control is noteworthy. There are controls on cultivation practices, pesticide applications, and formulation testing to avoid spurious materials, and training to develop food safety culture and GAP for small growers. In Maharashtra state, implementation of forward and backward linkages and cooperative farming has been found to be effective in residue control in several crops, e.g. okra, brinjal, green chilli, etc. Similar systems are necessary to implement in other fruits and vegetables.

Lead Paper

MELATONIN: A BIOMOLECULE FOR MITIGATING POSTHARVEST CHILLING INJURY IN FRUIT AND VEGETABLES

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The global postharvest losses in fruits and vegetables due to improper storage account for up to 2 million/year. Cold-storage comes out to be one of the best alternatives to preserve the quality of fresh produce by lowering the enhanced respiration and metabolic processes, ensuring long distance transportation without hampering the shelf life. However, prolonged storage of fresh horticultural commodity at cold-temperatures leads to the development of fruit-specific chilling injury (CI) symptoms, including discoloration in tomatoes, mealiness and wooliness in peaches and nectarines, superficial scald in apples, flesh browning in pineapples, skin streaks in bananas, skin lignification in kiwifruit, pulp browning in eggplant, and lesions in cucumbers. One such fruit facing the problem of CI is mango. Being climacteric in nature, it is harvested before attaining maturity followed by a speedily respiration process which limits its shelf life to 5-6 days. Thus, to lower the metabolic processes and preserving the fruit quality, cold-storage of mango becomes a necessity. However, in mangoes, prolonged storage at temperature lower than 13°C has been observed to develop CI, which is characterized by uneven ripening, water-soaked lesions, skin darkening, pitting, lenticel spotting, and gray scald. These symptoms deteriorate the fruit quality and affect the marketability. Melatonin (MT) is an indoleamine signaling molecule whose structure resembles that of tryptophan, indole-3-acetic acid, and serotonin, and possesses many beneficial functions in plants. MT has been previously reported to mitigate CI in fruits and vegetables including peaches, sweet cherries, litchi, tomato, avocado, zucchini, and banana. Our study aimed to mitigate CI in cold-stored mangoes by firstly optimizing its dose prior to storage and elucidating various pathways by which MT confers CI in four mango cultivars, 'Chaunsa', 'Gulab Jamun', 'Langra', and 'Dashehari'. The study found MT at 100 µM for 120 min to be the most effective concentration to maintain the postharvest mango quality for 28 d at 5 °C, followed by a simulation period of 3 d at ambient conditions. This dose was found to maintain a higher titratable acidity, fruit firmness, and ascorbic acid in contrast to lower respiration rate and ethylene production than the control. The study reported 'Langra' cultivar to respond best in providing chilling tolerance by reducing CI by 4.8-fold, when compared to 'Chaunsa', 'Dashehari', and 'Gulab Jamun', which lowered CI by 1.8-fold, 1.7-fold, and 1.1-fold, respectively. 'Langra' mangoes exhibited higher content of reactive oxygen species including H_2O_2 and O^{2-}. The higher CI mitigation in 'Langra' was attributed to the higher levels of adenylate energy charge, adenosine triphosphate, and adenosine diphosphate. These observations were justified by a higher unsaturated/saturated fatty acid ratio in 100 µM MT-treated 'Langra' cultivars, contributing to lower lipid peroxidation as compared to others. Additionally, a higher proline, polyamine, and GABA content in MT-treated 'Langra' mangoes added to the enhanced antioxidant system and energy levels to mitigate CI.

DROPPED IMMATURE FRUITS: A POTENTIAL SOURCE OF NUTRACEUTICAL

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Nutritional content in fruit is enormous. Physiologically dropped immature fruits are regarded as waste and discarded in the citrus orchard creating citrus waste disposal problem due to economic and environmental factors. Physiological dropping of fruits is a natural phenomenon in which immature fruits drop from stem-branch or ovary-stem junctions which are still green in color due to physiological reasons such as imperfect pollination, ovule dysplasia, degeneration, nutrient deficiency. An experiment was undertaken to identify and quantify bioactive compounds such as flavonoids, phenols and antioxidants from dropped fruits of varied sizes i.e., 8–24 mm size and to study the influence of different drying techniques, namely freeze drying and hot air oven drying on the assessed parameters. Flavonoids were quantified in high-performance liquid chromatography (HPLC). The antioxidant activity were investigated with three assays azino-bis [3-ethylbenzthiazoline-6-sulfonic acid]) (ABTS); 2, 2-diphenyl-1-picrylhydrazyl radical (DPPH); Ferric Reducing Ability of Plasma (FRAP) and total phenol content was determined. Freeze dried samples of 12 and 14 mm size retained maximum hesperidin flavonoid content (27.03% and 27.20%) as compared to the hot air dried samples (17.99%) and retained higher phenolic content ranged from 50.54–54.19 mg $GAEL^{-1}$. The antioxidant activity in freeze dried fruits was from 12.21–13.55 mM L^{-1} Trolox and 15.27–16.72 mM L^{-1} Trolox with ABTS, DPPH assay and FRAP values ranging from 7.31–9.07 mM L^{-1} Trolox. The results showed that waste fruits can act as potential source of bioflavonoids, especially hesperidin and antioxidants. Freeze drying technique can be adopted for retaining and quality extraction of bioactive compounds from immature dropped fruits for further use in nutraceutical industries. This study will help in reducing the environmental impact caused due to dropped fruits and its responsible management.

Lead Paper

SEED SPICES AS COSMETICS, HEALTH AND AWARENESS

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India is well known as “Land of Spices” across the world since ancient times. The country is the largest producer, consumer and exporter of seed spices on the Planet. These high value low volume crops are being exported to more than 130 countries from India. Our ancestors have been using spices and seed spices for adding taste and flavor in edibles and beverages. Seed spices have mainly originated in tropical parts of world and are primarily utilized for seasoning/ garnishing food, beverages, cosmetics, therapeutic/medicinal preparations lead to so many health benefits. The power of seed spices to impart biological activity is now slowly re-emerging as an area of interest for human health. Dietary choice remains the basis for maintaining a healthy lifestyle and well-being, despite remarkable advances in medicine and pharmaceutical drug development. Besides food being a lifestyle choice, age-old anecdotal reports from many cultures strongly suggest a role for diet as well as Indian spices in both preventive and therapeutic medicine. Besides spreading aroma, flavor and taste in our daily life, seed spices have numerous medicinal properties and used as carminative, appetizer, digestive, stimulant, tonic, spasmolytic, antipyretic, anthelmintic etc. Plant-derived substances have recently become of great interest owing to their versatile applications. Seed spices too are having many high value compounds and metabolites used in health benefits. Looking to the novel benefits of these important commodities promotion of research on development of value-added products of spices and other nutraceuticals, cosmeceuticals & non-culinary uses of spices, encouraging novel uses of spices and organic products for export purpose and high earnings and the demand of the time now. Here, various uses of seed spices in cosmetic and health industry are highlighted with their economic strength so that these crops can be exploited and utilized more and make healthy and prosperous India.

CREATION OF ROBUST CIRCULAR ECONOMY: PRODUCTION OF HIGH-VALUE COMPOUNDS AND INNOVATIVE FUTURE PRODUCTS FROM BANANA

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Banana is a pack house of nutrients and bio-active compounds with global acceptance. Banana flour and starches showed differences in functional and physico-chemical properties than other starches with its variation in ratio of amylose and amylopectin and shape of starch granules. The modification of starch through enzymatic, physical and chemical process, enhances the functional properties and increased the applicability of starch in food and non-food industries as thickening, gelling and binding agent. The incorporation of basil seeds in banana RTS beverages enhances the consumer acceptability with their unique nutritional benefits. Banana wine presents a distinct and aromatic alcoholic beverage with an appealing taste profile. Furthermore, banana wine can be processed into vinegar, adding a tangy twist to culinary preparations and can be a perfect alternative to cider and synthetic vinegar. Dehydrated ripe banana powder, a fruit sugar serves as a versatile ingredient for food applications, including baking, smoothies, desserts and health foods. Moreover, the extraction of non-starch polysaccharides from ripe banana puree and pomace offers potential applications in the food industry as a probiotic supplement. Banana generate huge volume of the biomass including pseudostem (30-34%), leaves, flower & bracts (5%) and rhizome (12-14%) after the harvest of fruits. Utilization with emphasis on secondary and tertiary processing and products like xylitol, cellulose, MCC, hydrogel needs to be discussed. Flower bracts which are rich in anthocyanin could also be used as a bio-colourant. XoS and FoS could be extracted. Pre biotic and Pro biotic foods, function specific targeted micro-encapsulated healthy foods could also be produced from banana. Besides, food applications, pseudostem could be potentially used for non-food industries for the extraction of cellulose, in textiles, handloom and other utility compounds. The growing importance on the concept of circular economy has a way to attain sustainable development in the fruit processing sector.

Lead Paper

ZERO WASTE HORTICULTURE AND TRENDS IN MINIMIZING POSTHARVEST LOSSES

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Horticultural crops are highly nutritious and finds major share of our daily diet. These are consumed in different forms worldwide as per their nature and consumption pattern. Recent days, global nutritional security for the increasing population is of crucial concern that leads to increase in production, quality improvement, food safety and product diversification. Consequently, a large amount of waste are generated at household, in the processing industries and supply chain of horticultural commodities creating environment pollution with extensive burden of landfills. Considerable awareness among public has come to dispose the fruit & vegetable waste (FVW) and floral wastes in an economic way of composting. However, these wastes showed magnificent potentiality of re-utilization in several industries owing to rich source of different bioactive compounds, phytochemicals, natural colourants, *etc*. Attention is being given to the use of agrifood wastes as the fruits, vegetables (peel, seeds, *etc*), flowers (petals, *etc*.) contain several groups of substances that are useful for development of functional foods. Sustainable research studies on extraction methods, utilization strategies, novel product development to replace harmful junk foods need to be taken up. India, owing to its vast arable land, diverse agro-climatic zones, and rich biodiversity, has umpteen variety of fruits and vegetables, which leads to enormous waste. Hence, it's right time to seriously focus to reduce postharvest losses by adopting proper management means like enhancing shelf-life, identify the sectors of horticultural waste generation, working out sustainable recycling strategies, potential use of recycled products leading to reduction in postharvest losses for the betterment of the skyrocketing population, with the assurance of green environment and sustainable ecology. A circular economy approach must be formulated integrating various technologies for converting horticultural *waste* into diverse economic products leading to zero waste horticulture.

Day 4, November 09, 2023

Auditorium, College of Veterinary Sciences, Khanapara, Guwahati

Session XI

EXPLOITING EMERGING TRADE OPPORTUNITIES

Chair : Dr S. K. Malhotra, Project Director, ICAR-Directorate of Knowledge Management in Agriculture, New Delhi

Co-chair : Dr J. Dinakara Adiga, Director, ICAR-Directorate of Cashews Research, Puttur, Karnataka

STRATEGIES FOR BOOSTING EXPORT OF HORTICULTURAL PRODUCE AND PRODUCTS

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Horticulture plays a pivotal role within India's agricultural landscape, making a substantial contribution to the value of output from agriculture. The country holds the second position globally in the production of fruits and vegetables. Bangladesh, UAE, Nepal, Netherlands, Malaysia, Sri Lanka, the UK, Oman, and Qatar stand as significant export destinations for India's fresh fruits and vegetables. Despite the impressive growth of the horticulture sector in India, the country's global trade share remains disproportionately small, accounting for a mere 1% of the overall trade in fruits and vegetables worldwide. Indian horticultural products often face trade barriers in developed nations, including tariff restrictions and stringent phyto-sanitary requirements. Particularly, the spices have suffered considerably due to non-compliance with essential food safety standards mandated by European nations, the United States, and other importing countries. Nevertheless, India maintains a robust seasonal advantage in the production of dried onions, cucumber/gherkins, shelled cashew nuts, dried capsicum, coriander, cumin, and turmeric. It is imperative to transform this seasonal comparative edge into a sustained competitive advantage throughout the year. Additionally, addressing constraints related to production and productivity, post-harvest practices and processing, market intelligence, logistics, and export-related challenges is crucial to bolstering the horticultural export performance. Effective policies are required to facilitate the investment in advanced agricultural technologies and logistics to ensure the desired quality and cost effectiveness. Value chain analysis on export-oriented commodities would provide valuable insights into the issues hindering exports and realizing the untapped export potential.

Lead Paper

HARNESSING INDIA'S GI FRUITS: FROM FIELDS TO MARKET

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Geographical Indications (GIs) are distinctive marks used to designate products originating from specific geographical regions, known for possessing unique qualities or a reputation linked to their place of origin. They are vital for preserving traditional fruit varieties and indigenous species. In 1999, India implemented the Geographical Indications of Goods Act, significantly enhancing the value of products in domestic and international markets. Currently, India has 478 registered GI products, with 152 related to agriculture and food, including 48 for fruits. Maharashtra leads with 13 GIs, and Karnataka follows with 7, covering various fruits like mango, citrus, banana, grape, pineapple, and litchi, as well as others like strawberry, guava, custard apple, fig, pomegranate, sapota, kokum, aonla, makhana, and apricot.

GI tags assure smaller Indian producers in lesser-known export regions, making overseas sales more accessible. In the fiscal year 2023, India celebrated a milestone, recording $750 billion in exports due to streamlined procedures and the certification of high-quality products associated with GIs. India actively promotes GI tagging, fosters exports, and provides legal support through Intellectual Property for India, while the Agricultural and Processed Food Products Export Development Authority (APEDA) actively facilitates the export of GI-tagged fruits. Noteworthy success stories include the export of Assam Lemon to the UK and Italy and three GI mango varieties (Fazli, Khirsapati, and Laxmanbhog) from West Bengal, along with one GI mango variety (Zardalu) from Bihar to Bahrain and Qatar. APEDA also collaborates with foreign retailers to organize in-store promotional programmes in importing countries, further enhancing exports.

Geographical Indications (GIs) hold significant potential for bolstering exports, yet several challenges and factors contribute to both their success and failure. The effectiveness of GI-tagged products is rooted in their ability to guarantee quality, differentiate themselves in the market, and expand export opportunities. Government support and streamlined procedures have resulted in remarkable export growth in certain regions, with the Department for Promotion of Industry and Internal Trade (DPIIT) providing guidelines for financial aid in line with the National IPR Policy.

Unlocking the full potential of GI-tagged fruits faces challenges like counterfeits, lax enforcement, and suspicions of favouring large corporations. Advocates argue that GI tags empower exporters and offer a competitive edge. To maximize benefits, the government should raise awareness, create a comprehensive policy framework, and support producers through initiatives like India GI events. Establishing a dedicated oversight group is crucial to combat infringements. In conclusion, heightened awareness, capacity-building, and stringent enforcement are essential to realize the potential of GI tags while preserving their integrity.

A QUEST FOR SELF-RELIANCE IN CASHEW NUT: ISSUES AND STRATEGIES

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Production of cashew is concentrated in warm humid regions of globe viz., Africa (30), Asia (12), Latin America and Caribbean regions (14). Every year cashew growing area has been increasing exponentially not only for delicious nut but also for reasonable income with minimum crop management practices. Phenomenal growth in cashew production is registered at global level with CAGR of 2.29%and in India production is growing at CAGR of3.18%. Global production of raw cashewnuts is estimated to be 46.6 lakh MT during the year 2022-23 with Ivory Coast remained the world's largest producing country with a production of 12 lakh MT. Although, India occupied largest area under cashew cultivation (20.30%), it contributes only 14.8 % in production due to low productivity. In order to fulfil the demand of raw cashew nuts about 64.9% of the total processed quantity is imported, primarily from African countries. Import of raw cashewnut was around 6.99 lakh MT in the beginning of the century and now increased to the tune of 13.32 lakh MT which shows tremendous growth in the processing sector and consumption pattern. Export of cashew kernel was around 1,01,866 MT during the year 2012-13 and has declined to 47,560 in the last fiscal. Major factors for decline in export of cashew kernels from India are better price in the domestic market, aggressive gain of Vietnam's share in the international market, reduction in the export incentives offered by GoI, new entry of African countries in the global kernel market, etc. The decline in exports and price slump has not set alarm bells ringing, though. An increase in per capita consumption of cashew kernels from 5 grams to 230 grams over the last two decades has helped the cashew processing industries to sustain despite a steep decline in international demand. In fact, domestic prices are 15 per cent higher than the rates in international market, according to exporters.In order to reduce the dependency on imported raw nuts and to be self-reliant several strategies must be adopted especially with regard to enhanced productivity and area expansion including replacing old and senile orchards which contribute to more than one-third of cashew area. The development of high yielding export quality varieties, high density planting, canopy management strategies, soil and nutrition management as well as pest management play a vital role. The adoption of high yielding varieties and high-density planting system have the potential to double the productivity of cashew in the country. Application of Artificial Intelligence(AI) and drone technologies hold promising prospects for addressing issues related to self-reliance in raw nut production. Achieving self-sufficiency in raw nut requirement can reduce the burden on exchequer to the tune of Rs. 8,000 crores per year.

Lead Paper

POTATO SEED: AN OPPORTUNITY FOR INDIAN SEED INDUSTRY

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The availability of virus-free planting material is a prerequisite for micropropagation and seed production of the clonally propagated potato crop. The Government of India is committed to ensuring the timely availability of certified seeds to the farmers cultivating different crops. However, for high-volume high-seed rate crops like potatoes, the production and supply of good quality certified seeds is a challenge. Annually India requires 5.4 million tons of potato tubers as seeds. The challenge becomes even more complex as the vegetative mode of propagation makes the seed vulnerable to several pathogens in its multiplication process and the seed multiplication ratio (SMR) of 1:6 is very low. Farmers, especially marginal and small farmers, rarely store their harvests as seed for the next growing season. Often, they buy seed potatoes every season, making the seed replacement rate (SRR) almost 100%. However, there is no institutional mechanism to monitor the quality of seed potatoes being marketed. Most often, degenerated produce is sold as seed, especially to small and marginal farmers who lack finances. The seed alone comprises over one-third of the total cost of production of potatoes. There is a huge gap between the requirement and supply of certified seed potatoes in India. The Central Potato Research Institute of the Indian Council of Agricultural Research produces about 3,000 tons of nucleus and breeder seed every year and supplies 80% of it to the states and other agencies for its multiplication. There is an excellent transformation in the overall potato portfolio across the sectors in the country and farmers need to rationalize their production as per the requirement of various categories of potatoes. Seed sector needs to be reformed/ structured by pooling the land holdings of small and marginal farmers and creating FPOs to make potato a profitable venture especially to small and marginal farmers. Involvement of SAUs, KVKs, Private sector companies, Growers associations, Cooperative societies and Progressive growers for multiplication of breeder seed in three assured multiplication cycles by Govt. of India.

QUALITY SEEDS IN ONION AND GARLIC - OPPORTUNITIES IN DOMESTIC AND EXPORT MARKETS

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Onion (*Allium cepa*, L.) and garlic (*Allitem sativum*, L) and belong to Liliacese family is the most important bulbus vegetable crops in term of domestic and export market as well as intake through out the word particularly in South Asia. These are used in various way like in all curies, fried, boiled, soup making pickle etc., as well as after dehydration, in the form of powder and flanks as spices. They also have medicinal values to control different human discases. Bharat has secured second position in the world after China in respect of production and productivity. Mostly, onion is grown in the country in three seasons: kharif, late kharif and rabi in the states of Maharashtra, Madhya Pradesh, Gujrat, Rajasthan, Kamataka, Andhra Pradesh, Bihar, Utar Pradesh, and West Bengal. The contribution of kharif and late tharif seasons' onion is 30-35 % and the rest 65-70 % is from rabi season. Garlic is produced in rabi season only in the states of Madhya Pradesh, Retusthan, Gujrat, Haryana, Uttar Pradesh; except in Nilgiri hills whereas summer crops also tak, As per the first advanced estimate of 2022-23, onion was grown in 17.92 thousand ha. and production was 310.05 lakhs metric tons. Garlic was grown in 4.07 thousand ha., with production of 33.69 metric tons. Seed is the basic, most important agri-input in any crop production system contributes around 30-35 % in comparison of other inputs. On the country, around 75 and 25 onion and garlic varieties are respectively notified by central and states govt for different locations and seasons. Out of these maximum demanded onion varieties; for kharif is Agrifound Dark Red, L-$83, Bhima Dark Red, Pusa Red, Baswant Red, and for rabi is Agrifound Light Red, NHRDF Red, NHRDF Red -2, NHRDF-3, NHRDP-4 and NHRDF Fursungi, Arka Kalyan, Arka Niketan, Bhima Shakti, Bhima Raj, Bhima Super, Bhima Kiran, Arka Sheema, Arka Bindu and Agrifound Rose. In the group of organized sectors, only NHRDP is maintaining the seed chain of their varieties onion (8 nos.) and garlic (11nos.). The recommended seed rate of onion is 6-8 kg/ha and garlic seed bulb is So/ha. Around 14000 Q and 1,00,000 tons garlic seed bulbs are required per year respectively. 90% seed production of onion is done by farmers/farmer groups of unnotified varieties without following good agricultural practices and 10% by organized sector (NHRDE, ICAR institutions, SAUs, NSC, MAHABEES etc.). However, Garlic seed bulbs are produced only by NHRDF and notified garlic varieties are Agrifound White, Yamuna Safed 2,3,4,5,7, Agrifound Parvati, Agrifound Parvati-2, Yamuna Purple - 10, Bhima Onkar and Bhima Purple, The export potential of both bulbus crop is recognized by various importing countries and same was export after permission of Exim Committee, Ministry of Agriculture and Farmers Welfare, Govt. of India by seed traders to Bangladesh, USA, Sri Lanka, Arabian, Europcan & African countries etc.

ORAL PAPERS

Day 2, November 07, 2023

Hall-II, College of Veterinary Science Campus, Assam Agricultural University, Khanapara, Guwahati

Session I

GENOMICS FOR TRAIT SPECIFIC BREEDING

Chair : Dr S. K. Singh, Director, ICAR-Indian Institute of Horticultural Research, Bengaluru, Karnataka

Co-chair : Dr A.S. Dhatt, Additional Director of Research, Punjab Agricultural University, Ludhiana

Session II

ELITE GERMPLASM AND VARIETY DEVELOPMENT

Chair : Dr. K. B. Kathiria, Vice Chancellor, Anand Agricultural University, Anand, Gujrat

Co-chair : Dr Pritam Kalia, Former Head, Vegetable Science, ICAR-IARI, New Delhi

Session III

USE OF ROOTSTOCKS IN HORTICULTURE AND INNOVATION FOR SUSTAINABLE HORTICULTURAL PRODUCTION

Chair : Dr S.K. Mitra, Former Dean, BCKV, Kalyani, West Bengal

Co-chair : Dr Bikash Das, Director, ICAR-NRC Litchi, Muzzafarpur, Bihar

Session IV

STRATEGIES FOR MINOR COMMERCIAL CROPS AND URBAN AND PERI-URBAN HORTICULTURE

Chair : Dr K.V. Prasad, Director, ICAR-Directorate of Floricultural Research, Pune, Maharashtra

Co-chair : Dr S.K. Sharma, Former Director, ICAR-CIAH, Bikaner

ORAL PAPERS

Day 3, November 08, 2023

Hall-II, College of Veterinary Science Campus, Assam Agricultural University, Khanapara, Guwahati

Session V

HORTICULTURE IN NORTH-EASTERN INDIA

Chair : Dr K. Suresh, Director, ICAR-Indian Institute of Oil Palm Research, Nr Jawahar Navodya Vidyalaya, Pedavegi, Andhra Pradesh

Co-chair : Dr S.P. Das, Director, ICAR-National Research Centre for Orchids, Pakyong, Gangtok, East Sikkim

Session VI

MANAGEMENT OF BIOTIC AND ABIOTIC STRESSES

Chair : Dr K.B. Hebbar, Director, ICAR- Central of Plantation Crop Research Institute, Kasaragod, Kerala

Co-chair : Dr Vijay Mahajan, Director- ICAR-Directorate of Onion and Garlic Research, Pune, Maharashtra

Session VII

HORTICULTURE FOR FOOD, NEW INITIATIVES AND DEVELOPMENTS FOR MINIMIZING POST- HARVEST LOSSES AND EMERGING TRADE OPPORTUNITIES

Chair : Dr R.K. Pal, Ex-Director, ICAR- National Research Centre on Pomegranate, Pune- Solapur Highway, Solapur, Maharashtra

Co-chair : Dr Dinesh Kumar, Head, Food Science and Post Harvest Technology, ICAR-IARI, New Delhi

Session I : Genomics for Trait Specific Breeding

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DEVELOPMENT OF TRAIT-SPECIFIC GERMPLASM FOR YIELD, QUALITY AND STRESSES IN INDIAN CAULIFLOWER

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Trait-specific germplasm development is essential for breeding varieties/hybrids for high yield, quality attributes, and tolerance to crop stresses. Cauliflower provide livelihood, dietary minerals and glucosinolates. Despite highly thermo-sensitive nature and genotypic compartmentalization as Early, Mid-early, Mid-Late and Late groups, cauliflower could attain notable spatial and temporal expansions. However, development of germplasm for yield and quality traits *viz-a-viz* biotic stresses is pre-requisite to balance consumer-grower-ecology trios.

The present study was attempted to develop germplasm in Indian cauliflower through distant hybridization, inter- and intra-group hybridization and recurrent breeding. Two wild relatives namely *Diplotaxis erucoides* and *D. gomez-campoi* were crossed with cauliflower and generated BC_1F_1 and BC_2F_1, respectively. These populations show promise to introgress *Alternaria* leaf spot resistance. Inter-and intra-group hybridization (eight combinations) followed by selections was performed for inbred development from 2015-16 to 2022-23 at Division of Vegetable Science, ICAR-IARI, New Delhi. Total 181 new inbred lines were developed including 80 of early, 72 of mid-early and 26 of mid-late groups. The target traits were plant type 3, blanching habit, white, smooth or fine texture, compact curds, dwarf stature, curd doming trait, solid knobs, steam length flea beetle, disease resistant and curding at high temperature (>25 ºC). The promising genotypes were DC-315-1-2-15, DC-315-6-7, DC-323-4-6, DC-108, DC-232-2 (Early), DC-30-7-1, DC-303-3-5, DC-30-3-10, DC-315-12 and DC-303-1-2 (Mid-early) and DC-15-30-1, DC-30-07, DC-33-1-11, and DC-303-1 (Mid-late). Of these, 100 genotypes characterized using 29 morphological traits. Diversity and PCA analysesusing R-software revealed significant diversity for important traits. Variability was established using molecular analysis (SSRs, GBS). B-carotene (*Or* gene) biofortification programme resulted in promising lines namely Or-4, Or-5, Or 325, Or-84-18-19 and Or-1-1. Athocyanin (*Pr* gene) bio fortification (PA × PPCF-1, PK× PPCF-1) advanced to $F_{2:4}$. The set of trait-specific germplasm in all maturity groups shows promise in breeding varieties/ hybrids for quality, wider plasticity and stress tolerance.

OL-103

GENETIC VARIABILITY AND CHARACTER ASSOCIATION STUDIES IN WILD BRINJAL OF NE REGION OF INDIA

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Fifteen diverse genotypes of wild brinjal (*Solanum gilo* R) collected from different parts of N.E. region of India and were planted in randomized complete block design, during winter season. Genetic variability, heritability, genetic advance, correlation and path coefficient for nineteen important quantitative traits. The magnitude of PCV was higher than the corresponding GCV for all the characters. The highest value of PCV and GCV was recorded for solasodine content (PCV=33.51%, GCV=33.48%) followed by fruit girth (PCV=23.76%, GCV=22.54%). High heritability coupled with high genetic gain was observed for plant height, number of fruit per plant, fruit weight, and fruit girth, fruit yield per plant, solasodine, total carbohydrate, total phenol, ascorbic acid, total alkaloid, flavonoid, terpenoid, phytosterol and total protein. Selection on the basis of these characters would be more effective for the improvement of wild brinjal. High significant correlation of fruit yield was recorded with fruit weight, fruit girth and number of fruit per plant both at genotypic and phenotypic level. Maximum positive direct effect on fruit yield per plant was imposed by days to first fruit set, followed by number of fruit per plant, fruit weight, fruit girth at genotypic level; indicated that these are the real independent characters and have maximum contribution towards increase in fruit yield per plant.

OL-108

GENOMICS ASSISTED BREEDING IN MANGO FOR FRUIT QUALITY TRAITS USING HIGH DENSITY GENOME WIDE SNPs

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Genomics-assisted breeding was initiated by using genomic and phenotypic information to increase the selection efficiency in mango improvement program. An association panel of 128 mango accessions and commercial hybrids were

assessed for fruit quality and yield decisive traits viz., fruit length, fruit width, fruit thickness, fruit weight, pulp weight, peel weight, stone length, stone width, stone thickness and stone weight on a quantitative scale. The maximum variation was recorded for fruit thickness (CV: 73.25%) followed by pulp and peel weight. Correlation analysis indicated that fruit weight and pulp weight were positively correlated (R=0.96). Similarly, stone length was correlated with fruit length (0.89) and pulp weight with fruit length (R=0.7). This panel was genotyped using Genotyping-by-Sequencing (GBS) technology from which around 9,00, 232 SNPs with known chromosomal locations were defined and filtered for GWAS. Genotyping data covered the genome at an average density of 1 marker per 22.5 kb which also showed a moderate to high diversity for the observed traits. Maximum variants were recorded in Chr 1 (76652) and least in Chr 20. Maximum SNPs were recorded in upstream (33.449%) and downstream genes (30.577%), indicating variations in cis acting regulatory elements which are crucial for gene expression. Linkage disequilibrium (LD) was recorded to be as high with r^2>0.6, on average, for 20 kb mean distance between markers. In the GLM analysis using TASSEL version 5.2 with K=5, 4083 SNP markers associated with the fruit traits. Markers identified in the BLINK and TASSEL models were selected as significant and consistent markers. Three SNPs *viz.,* SNC_058137.1_3967144, SNC_058138.1_9694033 and SNC_058138.1_9694033 were significantly associated with traits viz., fruit thickness, peel weight and stone width, respectively and explained the phenotypic variance upto 99.8%, 25.83% and 98.88%, respectively. These marker-trait associations indicate the potentials for genomics assisted selection in mango.

OL-52

ASSESSMENT OF QUALITATIVE AND QUANTITATIVE MORPHOLOGICAL TRAITS PERTAINING TO YIELD IN LETTUCE *(LACTUCA SATIVA L.)* GERMPLASM

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In the present scenario individuals are more focussed in maintaining a healthy and well balanced diet by including nutritious green leafy vegetables in their food habits. Lettuce is one of the most nutritious and important salad vegetable crop which is consumed worldwide contributing significantly to the nutritional content as it is eaten raw where most nutrients are retained as compared to other cooked vegetables. The present study aimed at identifying and assessing the genetic

potential of lettuce germplasm for future breeding programmes. Thirty eight lettuce germplasms were collected from different indigenous and exotic sources and were characterized with respect to important yield traits. Morphological characteristics were evaluated based on IPGRI descriptors and a considerable level of variation was displayed by various genotypes. The 38 genotypes were grouped into different types of lettuce *i.e.* two genotypes were of iceberg/heading types, 6 butter head, 20 loose leaf types, 7 cos or romaine and 3 stem lettuce types. Significant differences were observed among all the lettuces genotypes. Delhi Selection 13 performed best among all the genotypes for most of the traits under study. A high genotypic and phenotypic coefficient of variation was observed for number of branches followed by ascorbic acid content and total chlorophyll. High heritability with high genetic gain was recorded for total chlorophyll, plant height, ascorbic acid content and number of branches. However, high heritability with moderate genetic gain was observed for yield per plant and number of leaves indicating selection of these characteristics for improvement. Principal component analysis (PCA) was also employed and a perusal of biplot showed how the different genotypes can be grouped into four clusters on the basis of the scores obtained using PCs.

OL-77

USE OF MARKER ASSISTED SELECTION FOR THE DEVELOPMENT OF ROOT-KNOT NEMATODE RESISTANT CANDIDATE ROOTSTOCKS FOR LOW-CHILL PEACH

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Plant parasitic root-knot nematodes are one of the major problems in the low-chill peach industry in the sub-tropical regions of India. These nematodes thrive well in warm, sandy soils and feeds on the peach roots. This lead to gall formation around the roots which results in decline in tree health and fruit production. This necessitates the use of root-knot nematode resistant rootstocks for low chill peach. Among the different low-chill peach rootstocks available, 'Flordaguard' an inter-specific hybrid of Chico 11 × *Prunus davidiana* has been observed to impart improved resistance to root-knot nematode but, it has poor nursery characters under the warm subtropics of India. Hence, interspecific hybridization of 'Flordaguard' peach with a widely used 'Sharbati' rootstock (susceptible) was performed to develop a broadly adaptable root-knot nematode resistant peach rootstock F_1 progeny. The F_1 progeny was advanced to F_2 and BC_1F_1progenies. Around 350 individuals from F_2 and BC_1F_1progenieswere inoculated with nematode culture and were classified into 6 different classes (immune, highly resistant, resistant, moderately resistant, susceptible, and highly susceptible)

on the basis of root galling index. Segregation ratios of 3:1 and 1:1 have been observed in the F_2 and BC_1F_1 progenies, respectively for the resistance: susceptible individuals. Moreover, chromosome specific highly polymorphic InDel markers were designed after the whole genome resequencing (IlluminaHiSeq 4000 Sequencing System ~ 40x) of both the parents and were amplified on the genomic DNA extracted from F_2 populationto locate locus associated with the resistance to root knot nematode in peach.

OL-56

ELUCIDATING THE GENETICS OF POST-HARVEST SHELF-LIFE OF CUCUMBER FRUIT AND IDENTIFICATION OF ASSOCIATED QTLS AND CANDIDATE GENES

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Cucumber is a perishable vegetable crop with limited storability and development of genotypes with extended shelf-life will help in reducing post-harvest loss. One natural variant, DC-48 with extended shelf-life was used to understand the genetics of the associated traits, identify the genomic regions and associated candidate genes. Scanning electron microscopy revealed difference in structure of the epicarp in the genotypes. Programmed cell death (PCD) and appearance of senescence related a dark spot (SRDS) in the epicarp of the cucumber fruit with low shelf-life was also detected. Retention of green colour, absence of any shrinkage, retention of fruit firmness and slow change in the pH of the endocarp were important traits associated with extended shelf-life. Retention of green colour is governed by single recessive genes while the remaining traits were polygenic. One QTL detected through QTL-seq on the chromosome 4 was associated with retention of green colour spanning over a region of 4.32 Mb approach.Conventional mapping in F_2 progenies with PCR based markers also identified two QTLs in the same region. RNA-seq and RT-PCR analysis at two different developmental stages revealed two genes in the QTL region namely, *Csa_4G000860* with unknown function and *Csa_4G016490* with acyl-transferase activity in the early and late developmental stages of the fruit, respectively associated with retention of green colour.Two PCR based markers, InDel861 and InDel016 closely linked with retention of green colour can be used in marker assisted back-cross introgression. This study provides greater insight about the molecular network associated with extended shelf-life in cucumber.

OL-49

ELUCIDATING THE POTENTIAL OF CHILLI LINES FOR HIGHER BIOACTIVE COMPOUNDS, SHELF-LIFE AND THEIR SUITABILITY FOR PHYTONUTRIENT INDUSTRY

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Chilli is one of the most widely grown vegetable cum spice crops in India. It is mostly used for its pungency and also has many pharmaceutical values. In the present study, 58 chilli lines were evaluated for bioactive compounds, pungency, colour, yield related traits and shelf life. Observation from 5 randomly selected plants from each line was taken for yield related traits and biochemical parameters. Sensory evaluation for pungency and colour was carried out at mature stage on a 0-5 point scale rating. A total 10 freshly harvested red ripe fruits in each line were kept in perforated LDPE pouch in ambient condition for storage study. The mean value of yield related traits, capsaicin and total carotenoid content was determined and data was analyzed using R Studio. The results significantly varied among the lines as observed from the mean values. Dark black fruits were observed in Dinhata Local 1 and dark orange fruits in Kakchai (KC). Total carotenoids content was found to be highest in IRCM 73 (182.78±3.6 µg g-1) and lowest in Arka Swetha (23.94±1.2 µg g-1). The capsaicin content was in the range between 1117-3744 µg g-1. The highest capsaicin content found in line Sikkim 2 (3744.50±57.6 µg g-1) followed by IRCM 73 (3538.50±74.5 µg g-1) and the lowest in Hyb. Sri Wonder (1117.17±97.7 µg g-1). The line Tufanganj Local had lowest PLW value (32%) as compared to Kashi Abha (PWL 75%). Positive correlation was found for sensory evaluation for pungency and capsaicin content. The investigation showed that the line IRCM-73 have high commercial value for extraction of both carotenoid and capsaicin and Dinhata Local 1 for anthocyanin extraction which will be suitable for food and phytonutrient industry.

OL-135

APPLICATION OF GENOMICS FOR INTROGRESSION OF DISEASE RESISTANCE GENE(S) FROM WILD GERMPLASM IN MELON

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Melons are considered as healthy food due to lower calories, sodium, fat, and high potassium, Vitamin C and Vitamin A (orange fleshed) content leading to

increasing consumption worldwide. Production of commercial elite varieties faced many constraints due to fungal and viral diseases. Improvement in yield, quality and resistance to diseases is normally achieved by selecting genotypes with desirable character combinations existing in the nature or by hybridization but it may be time consuming approach. Genomic assisted breeding to introduce new genes from wild or related species into commercial varieties for improvement of specific traits especially disease resistance and fruit quality traits facilitate rapid improvement. Novel sources of ToLCNDV resistance were identified from DSM132 (*C. melo* var. *callosus*) and snapmelon (*Cucumismelo* var. *momordica)* accessions DSM-11 & DSM-19. Complementary gene interaction between two independent genes was responsible for ToLCNDV resistance in DSM 132 when inheritance pattern was studied with highly susceptible line Pusa Sarda (*C.melo*var.*inodorus*). The complete genomes of two parental lines (Pusa Sarda and DSM 132) and two extreme bulks (S- bulk and R- bulk) were re-sequenced. A major QTL differentiating Pusa Sarda and DSM 132 is located in genomic region on chromosome 6and a 0.9 Mb (900 Kb) area is considered the candidate QTL related with ToLCNDV resistance in melon.In the identified QTL region, 397 homozygous SNPs between the Pusa Sarda and DSM 132 genomes were discovered. The identification of 44 non synonymous variants (SNPs) resulted in the classification of five variants (five SNPs) as high impact variants with stop gain effect. Annotation of variants revealed that there are 44 non synonymous variants located in/associated with 27 protein-coding genes. Among the 27 genes, six genes appeared to be associated with Begomo virus resistance. For mapping of ToLCNDV resistance gene from other source DSM-19 (snap melon), 3 CAPS primers were designed from position interval of ToLCNDV QTL in chromosome 11 between D14 and D23 markers and 1 CAPS marker could be identified for association with susceptibility factor. Novel source of Fusarium wilt resistance from Indian melon germplasm was identified from sanapmelon line DSM-11-6.Two functional SCAR markers Fom2- R408 and Fom2- S342 developed from LRR domain of Fom-2 gene were identified and validated which could be used for selection of resistant plant during backcrossing for introgression of fom-2 gene into commercially susceptible cultivars. Based on fruit quality traits and resistance to Fusarium wilt, selections were made from backcross population of (Kashi Madhu X DSM-11-6) and characterized with validated molecular markers for presence of Fom-2 gene. The molecular mapping of population derived from cross Kashi Madhu X DSM-11-6 could identify 7 QTLs for average fruit weight, 5 QTLs for yield per plant, 4 QTLs for fruit length, 3 QTLs for days to first pistillate flower anthesis and cavity length, 2 QTLs for flesh thickness and 1 QTL for ovary length, ovary shape index and fruit diameter. The mapping study for fruit quality traits could identify 6 QTLs for total soluble solids, total acidity and malic acid 4 QTLs for fructose; 2 QTLs for citric acid and glucose and 1 QTL for sucrose and total sugar. Two hundred eight RILs were developed from the contrasting parents for climacteric fruit ripening behavior and 19 lines were selected for better fruit quality traits and shelf life. New genomic resources and information will be quite helpful for melon improvement programme in future.

OL-149

ELUCIDATION OF NOVEL DROUGHT-RESPONSIVE GENES FROM TUBER TRANSCRIPTOME OF CASSAVA UNDER DROUGHT STRESS

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Cassava (*Manihotesculenta carntz*) is the major starchy root crop grown in the tropical part of the world. Two cassava clones contrasting for their drought tolerance capacity (8S501- drought tolerant and H97-drought sensitive) were selected and grown in the field for studying the agronomical and molecular changes in both the clones under drought stress conditions. A reduction in number of tuberous roots per plant, tuberous root length, average single tuber weight and tuber yield per plant was observed under drought stress when compared with control conditions and also significantly lower mean values were observed for the sensitive clone H97 than that of the tolerant clone 8S501 when measured at 60 days of stress. Transcriptome sequencing of the tuber tissues of the two clones was done at 60 days of imposing drought stress. Different genes belonging to various groups like aquaporins, transporter genes, growth regulator related genes, calcium binding and mineral transfer-related genes, transferase genes and transcription factors were differentially expressed in the tubers under drought stress. Comparative transcriptomics revealed that acyl-CoA oxidase, primary-amine oxidase, glutathione peroxidase, vesicle transport, glutathione peroxidase, late embryogenesis abundant protein related, histone demethylase, BR-signaling kinase, palmitoyltransferase, DNA mismatch repair protein, heat shock protein related, starch/sucrose metabolic pathway related and MFS transporter genes were differentially expressed in the tubers of the tolerant clone 8S501 relative to the susceptible clone H97.

OL-19

BREEDING FOR HIGHLY ADAPTED ONION CULTIVARS UNDER INDIAN CONDITIONS

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Bulb onion has a biennial life cycle in which bulb formation occurs in the first year followed by flowering in the next year. Day length is a key environmental

factor to induce bulbing and exposure to low temperature is responsible for flowering. Onion cultivars adapted at different latitudes exhibit a wide variation for the minimum critical day length required to form bulbs and low-temperature exposure for flowering (bolting). In India, onion is cultivated throughout the country from 8-42 N° latitude, however maximum area is between 12-25 N° (South and Central India). About 55-60% bulb production comes from crop grown during Rabi season (Nov-May) and 40-45% from Kharif (June-August) and late Kharif (September-November) seasons. The cultivar breed for particular region or season did not perform ideal at other locations or in seasons for example cultivars adapted to Southern and Central India show high pre-mature bolting if grown under North Indian conditions. Cultivars grown during kharif and late kharif seasons are highly susceptible to pre-mature bolting and suffer significant yield losses. Cultivar should be adapted to particular region and season of cultivation to achieve high bulb yield. To accelerate the development of highly adapted cultivars, there is an urgent need to identify the genes responsible for bulb formation and pre-mature bolting in tropical short-day onions. We studied the transcriptomic changes occur due to bulbing and pre-mature bolting in Indian cultivars and identified the candidate genes associated with them. We found that members of *FLOWERING LOCUS T* (*FT*) gene family *viz*. *AcFT1*, *AcFT2* and *AcFT4* are involved in bulbing and flowering regulation. This information will provide new insights about the molecular mechanism of bulbing and flowering regulation, in addition it will allow breeders to devise genomic assisted breeding approaches to breed highly adapted cultivars in India.

OL-35

MOLECULAR MARKER BASED CHARACTERIZATION OF CYTOPLASM AND RESTORER OF MALE STERILITY (MS) LOCUS IN INDIAN ONION

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India is a leader in onion area and production with productivity of 17 tons per hectare. Productivity is far lower compared to other onion growing countries such as US, Europe, Japan etc. The primary reason for low productivity is the non-availability of onion hybrids. Mostly open-pollinated varieties are cultivated in India. The cytoplasmic-genic male-sterility system has been extensively employed to produce onion hybrids. Molecular marker-assisted characterization of the cytotypes and genotyping at the restorer-of male-fertility (Ms) locus is important for the accelerated breeding of onion hybrids. Conventionally, it is cumbersome and laborious to identify CMS and maintainer lines due to its biennial and out-crossing nature. To accelerate breeding efforts, marker-

assisted selection (MAS) plays a pivotal role. With this background, the current study was conducted by taking thirty-five commercial OPVs to identify their cytoplasm and fertility-restorer locus. Twenty-four healthy bulbs of each cultivar were selected and grown as per recommended practices. The leaf tips of 2-3 cm were excised for the isolation of DNA of individual plants. Six PCR-based markers were used for cytoplasm and Ms locus identification. Further, the fertility status of every plant was documented with the naked eye, microscopically and through acetocarmine staining for authenticity. The results revealed that the Indian onion population possesses N and S types of cytoplasms. The S-cytotype is considered stable and preferred mechanism for F_1 development. The Ms-specific markers assessed all types of genotypes. It was observed that the fertility status of onion plants based on anther/pollen colour and shape was not in line with molecular results. The establishment of this fundamental information would be the solid foundation for further hybrid breeding to enhance productivity under a rapidly changing climate.

OL-91

SCREENING OF CARROT (*DAUCUS CAROTA L.*) GENOTYPES FOR HEAT TOLERANCE

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Carrot is one of the most popular and commonly consumed vegetable crops belonging to family Apiaceae. It is widely cultivated for its edible tap roots containing various bioactive compounds like carotenoids and dietary fibres which significantly contributes to human health. *Alternaria blight* caused by *Alternaria dauci* is one of the most destructive foliar diseases which causes serious damage up to the extent of 45-60% yield loss. Therefore, present study was undertaken to screen the carrot germplasm against Alternaria blight at Punjab Agricultural University Ludhiana, during 2021-22 and 2022-23 under natural epiphytotic and artificial conditions. The data was recorded for the different traits and subjected to ANOVA for variability analysis. Out of 60 genotypes, screened under natural and artificial conditions, PC-160, PC-165, P-16 and P-41 were found to be resistant with disease severity less than 10%. Ten genotypes were found to be moderately resistant whereas the remaining genotypes had susceptible disease reaction.

GENOME EDITING FOR IMPROVEMENT OF QUALITY AND PROCESSING TRAITS IN TOMATO

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Tomato is an important vegetable crop in the world for both fresh consumption and making processing products such as ketchup, sauce, paste etc. Tomato is rich source of nutrients and possesses health beneficial compounds. The narrow genetic base of tomato poses serious challenges in breeding. Hence, with the advent of clustered regularly interspaced short palindromic repeat (CRISPR)-associated protein9 (CRISPR/Cas9) genome editing, fast and efficient breeding has become possible in tomato breeding. Many traits have been edited and functionally characterized using CRISPR/Cas9 in tomato such as plant architecture and flower characters (e.g. leaf, stem, flower, male sterility, fruit, parthenocarpy) fruit ripening, quality and nutrition (e.g., lycopene, carotenoid, GABA, TSS, anthocyanin, shelf-life), disease resistance (e.g. TYLCV, powdery mildew, late blight), abiotic stress tolerance (e.g. heat, drought, salinity), C-N metabolism, and herbicide resistance. CRISPR/Cas9 has been proven in introgression of de novo domestication of elite traits from wild relatives to the cultivated tomato and vice versa. In our country, most tomatoes are consumed as fresh for vegetable purpose, and hardly < 1% is utilized for making processed products compared to the developed countries like Italy (64.02%) and Spain (39.41%). Hence, there is a need of suitable varieties for processing purpose to sustain the processing industries in the country. Earlier some varieties were developed in the country but currently these varieties are not suitable for processing due to lack of processing parameters specially high total soluble solid (TSS) (> 5.5°Brix) required by processing industries. To address these issues, we applied genome editing technology for enhancing TSS content in tomato. We selected two candidate genes namely the vacuolar invertase inhibitor gene *SlINVINH1* (*Solyc12g099200.1*) and the vacuolar processing enzyme *SlVPE5* (*Solyc12g095910.1*) and downloaded the sequences from the tomato genome sequence database. Both the genes negatively regulate the sugar accumulation and involved in enhancing TSS content in tomato. The guide RNAs were designed using CRISPR direct tool (https://crispr.dbcls.jp) and constructs were prepared for transformation and regeneration of plants in tomato cv. Kashi Aman background. We hope that genome edited tomato lines would be regenerated with enhanced TSS content which would be suitable for processing purpose.

OL-36

INDUCED PARTHENOGENESIS – A NOVEL APPROACH FOR THE INDUCTION OF GYNOGENETIC HAPLOIDS AND DOUBLED HAPLOIDS IN AFRICAN MARIGOLD

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Marigold (*Tagetes spp*.) is one of the most popular and highly remunerative loose flower crops grown in India. The share of F_1 hybrids has increased immensely during the past decades. Most of the commercial hybrids of African marigold are doubled-flower type (Petaloid) and sterile in nature. Hence, *in vitro* gynogenesis (*in vitro* ovule/ovary culture) along with parthenogenesis (induction of haploid embryo from egg cell by pollination with irradiated pollen followed by *in vitro* haploid embryo rescue) is the only viable option for efficient induction of haploids and doubled haploids from the petaloid-types male-sterile hybrids/lines. For the first time, we assessed the effectiveness of the induced parthenogenesis approach in the induction of gynogenetic haploids in marigolds. The effects of different doses of gamma irradiation (0,100,200,300,400,500 Gy) on pollen viability and germination were assessed in French marigold genotype 'Pusa Deep'. The irradiated pollen of 'Pusa Deep' was used to pollinate the flowers of two African marigold genotypes, DAMH-24 and DAMH-55.The pseudo-fertilized ovaries were then cultured under in-vitro conditions to rescue the haploid embryos. Among the various doses, the gamma irradiation dose of 400Gy was found to be the most effective dose in minimizing pollen viability and germination. The induced parthenogenesis approach was found to be effective in inducing the gynogenic response by initiating direct regeneration/germination from the pseudo-fertilized ovaries as compared to the control. The irradiation treatment of 400Gy gave the highest % direct regeneration in the pseudo-fertilized ovaries of the African marigold genotypes, hence considered to be the optimum dose. Among the two genotypes, DAMH-24 showed a better response than DAMH-55 during the *in vitro* gynogenesis studies. The gynogenetically induced shoots were characterized using morphological and cytological approaches for the detection of the ploidy levels.The putative haploids were treated with anti-mitotic agents for the diploidization of chromosomes and the development of doubled haloids.

OL-115

MUTATION BREEDING: STANDARDIZATION OF LD_{50} AND GR_{50} OF GAMMA RAYS FOR THE POMEGRANATE CULTIVARS

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As we know perennials like pomegranate have a long juvenile phase which makes crop improvement program long term program. To develop any new variety/ hybrids through breeding or evolution process needs a long period. But variability in any crop is of utmost important. In this context, creation of variability through mutagens will help to create variation in shorter duration. Hence use of physical or chemical mutagens is the possible ways to induce variability. Among different mutagens gamma radiations are the common and safer mutagen in comparison to other physical mutagens. Prior to use of any mutagen determination of LD_{50} is most important concept which represents the dose at which 50% mortality will be observed. LD_{50} should be adopted to induce favourable mutations, till date, no study was found on optimum LD_{50}. In this preview, the present study was conducted to determine LD_{50} of most popular cultivars Bhagawa and Solapur Lal for vegetative propagules. The study consists of different treatments dosage ranging from 10 - 60gy. The percent sprouting and growth rate has been calculated, and subjected for statistical analysis. A linear Probit regression model was developed to determine the mean LD and GR of both the genotypes. The lethal doses (LD_{50}) for acute and chronic levels of irradiation have been identified for Bhagwa and Solapur lal cultivars. Variations were observed between the genotypes and the doses. The established LD and GR doses from this study can be utilized in large-scale mutagenesis breeding programs for generating a wide range of mutants.

OL-167

STUDY ON DIFFERENTIAL GENE EXPRESSION AND PATHWAY ANALYSIS FOR FLOWER COLOR IN TUBEROSE (*AGAVE AMICA*)

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Tuberose (*Agave amica*) is an important ornamental crop cultivated commercially for cut flower and loose flower production due to its aesthetic, charming fragrance

and longer vase life. Flower colour in tuberose is one of the major aesthetic determinants and is the major trait contributing to its high ornamental value. To understand a molecular mechanism underlying flower colour formation, comparative transcriptomics analysis was carried out in tuberose cultivar Arka Vaibhav which has white-coloured flowers, and Pink Sensation which has Pink coloured flowers. *De novo* transcriptome assembly was performed using Trinity software as reference sequence is not available for tuberose. Around 155772 unigenes were detected and to study Differentially Expressed Genes (DEGs) between Arka Vaibhav vs. Pink Sensation, differential expression analysis was carried out using EdgeR and unigenes with P values ≤0.05 and a foldchange (log2FC) ≥ 1 were designated as significantly differentially expressed genes. A total of 13512 unigenes were differentially expressed (5114 are up-regulated and 8398 are down-regulated), and functional pathway enrichment analysis of DEGs using Fisher's exact test resulted in over and under-representation of 17 and 6 pathways, respectively. To further explore the genes involved in colour-related pathways, KEGG combined pathway analysis was carried out for DEGs, we identified 3 unigenes that were deferentially expressed in each carotenoid biosynthesis (ko00906) and anthocyanin biosynthesis (ko00942) pathways, as earlier studies reported carotenoid and anthocyanins are the major pigments responsible for flower colour in tuberose.

Session II : Elite Germplasm and Variety Development

OL-89

CUSTARD APPLE BREEDING IN INDIA – PRESENT STATUS AND WAY FORWARD

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Annona is one of the 130 genera of the Annonaceae family and it has 120 species, of which 6 having pomological significance. Annonaceous fruits exhibit morphological affinity to one another but each one is unique and has got distinct for fruit shape, size, skin surface, pulp, colour, texture, flavour and taste. Among the edible annonas, cherimoya, sugar apple and hybrid between these two, atemoya, are most popular. In recent years, these fruits have emerged as important fruits in several tropical and sub-tropical countries. In India, custard apple is grown in Maharashtra, Chattisgarh, Rajasthan, Gujarat and Andhra Pradesh commercially on a large scale and mostly Balanagar is the predominant cultivar grown in these states. Besides, the custard apple varieties such as APK-1 from TNAU, Phule Janaki and Phule Purandar from MPKV and TP-7 and Dharur-6 from VNMKV, Parbhani are also grown in the respective states. Red Sitaphal, Pink's Mammoth, African Pride, Gefner, Washington -70005 and Washington – 98797, Island Gem and Mammoth are considered to be notable introductions. Arka Sahan is an interspecific hybrid (*A. atemoya*) and (*A. squamosa*) that was released from ICAR-IIHR for commercial cultivation in India. This hybrid has covered sizable area and area under this hybrid is increasing every year due to its excellent quality and acceptance. However, Arka Sahan needs assisted pollination to get good size, shape and for higher yield. The ICAR-IIHR has been serving as National Active Germplasm Site for Annonaceous fruits and conserving more than 34 accessions. Efforts are being made to develop the self fruitful varieties with high quality and coloured varieties also. This paper would focus on the research and development of Annonaceous fruits in India.

OL-32

SELECTION OF ELITE DARJEELING MANDARIN (*CITRUS RETICULATA* BLANCO) GERMPLASM FROM EASTERN HIMALAYAN REGION OF WEST BENGAL

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Darjeeling mandarin (*Citrus reticulata* Blanco) is one of the important cash crops for the farmers of Sikkim and Darjeeling hills. The crop is grown in hills since time immemorial. For most farmers, it is the only source of income that sustains their livelihood. However, the area and productivity under Darjeeling mandarin is decreasing at an alarming rate. One of the primary reasons for less productivity is lack of planting material. There is no proper registered variety or elite germplasm selection in Darjeeling mandarin. As a result, use of unselected mother plants for propagation is common practice in Darjeeling and kalimpong areas of West Bengal. The study aimed to identify elite germplasm in Darjeeling mandarin; fruits were harvested during the fruiting season of November-February, 2021-2022. A total of 160 accessions were identified from 17 major Darjeeling mandarin areas of Darjeeling and Kalimpong district of West Bengal. Eight important characters were recorded for elite horticultural traits, i.e. Fruit weight (g), Pulp (%), Juice (%), TSS ° Brix, TSS: TA ratio, No. of seeds, Yield/ Plant. Scoring was given from the scale 1 to 5 on the basis of above horticultural traits. Germplasm OL- Mirik and PTL- Mirk had recorded the highest score of 31 and 30, respectively. Therefore, these germplasms can be further evaluated for selection of elite germplasm and conservation for future breeding programmes.

OL-30

MORPHOLOGICAL, BIOCHEMICAL AND MOLECULAR CHARACTERIZATION OF JACKFRUIT GERMPLASM

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A survey was conducted under the Cooch Behar, Alipurduar, Jalpaiguri, and Darjeeling districts with an aim to study the different morphological, biochemical characters of local selected jackfruit germplasms followed by IPGRI descriptors

and molecular characterization was done using thirty DNA based markers. Wide range of variations were noticed for tree vigour, surface of trunk, crown shape, shape of leaf blade, fruit shape, flake shape, flake texture, seed shape, trunk circumference, leaf blade length, leaf blade width, fruit length, fruit diameter, stalk diameter, fruit weight, rind weight of fruit, number of flakes per kg of fruit, weight of flakes, total soluble solids, titratable acidity, total sugar, reducing sugar. High GCV (>20%), along with high heritability (>60%) and high genetic advance (>20%) was observed for different characteristics. Out of thirty SSR primers, thirteen produced polymorphic bands. Two major groups were formed through diversity analysis using SSR markers. From the result obtained JP 4 and JP 8 were found to have a better fruiting characteristic. CB 8 and DJ 3 were found to have good organoleptic quality for fresh consumption with high TSS, moderate acidity. The variation of different parameters including the molecular characterization of germplasm under the study indicates the scope of future crop improvement programme of jackfruit germplasms under the selected area.

OL-72

OPTIMIZATION OF PHYSICAL AND CHEMICAL MUTAGEN BASED ON LETHALITY AND GROWTH REDUCTION IN DRAGON FRUIT CULTIVARS

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Dragon fruit being a vine cactus commonly known as ‘pitaya’ is a weather resilient crop, rich in vitamin-C and antioxidants. The increasing demand of dragon fruit necessities more focused research on its better establishment. Non availability of trait specific genetic sources is the major limitation in breeding of dragon fruit in India, thus, concerted effect is needed to develop varieties for specific traits (self-staking, dwarfness, high TSS, varying pulp colour, thorn less and photo insensitive). The chances of crop improvement through conventional breeding are a limitation in dragon fruit as some of the species are self-incompatible in nature. Hence, induced mutation can be a way forward for creating genetic variability in dragon fruit. The radio sensitivity of two dragon fruit cultivars *viz.,* red and white were assessed by irradiating with physical mutagen *i.e*., gamma radiation (cobalt-60) at 100 Gy to 3500 Gy. The seeds of dragon fruit were treated with chemical mutagens *i.e*., EMS (0.2% to 3%) and sodium azide (0.01% to 0.06 %). The result from the variance analysis showed significant difference ($P<0.05$). The mean lethal dose (LD) and growth reduction (GR) values for red and white cultivars were assessed using a linear regression model. The findings revealed that the lethal doses for gamma radiation on dragon fruit cultivars were 3358.561 Gy and 2839.330 Gy for LD_{50} in cv. red and white, respectively. The

raise in dose of gamma radiation to 3500 Gy had significant negative effect on growth attributes and survival rate of dragon fruit seedlings. The GR_{50} value for seedling height, shoot and root length was observed at 604.18 Gy, 814.60 Gy and 469.65 Gy in red cultivars, whereas at 806.14 Gy, 926.00 Gy and 683.23 Gy in white cultivars. Generally, the growth and survival rate of dragon fruit was higher at lower dose of EMS and sodium azide. The lethal doses (LD_{50}) for EMS and sodium azide were2.685% and 0.052% in red cultivar, while 2.791 % and 0.053 % in white cultivars, respectively. The GR_{50} value in red cultivar for EMS treatment were 0.68 %, 0.86 %, 0.48 % and in white cultivar 0.98 %, 1.08% and 0.89 % for seedling height, shoot and root length, respectively. In sodium azide treated population, the GR_{50} value in red cultivar was 0.036 %, 0.043%, 0.030 % and in white cultivar 0.052%, 0.064 % and 0.037 %for seedling height, shoot and root length, respectively. Induced mutation through radiation and chemical mutagens is the important method to create the trait specific variability in the existing genetic material. The findings of this study can be utilized in large-scale mutagenesis breeding programme of dragon fruit.

OL-45

METABOLOMICS-AIDED TECHNIQUES FOR CHARACTERIZATION AND IMPROVEMENT OF NATIVE INDIAN BANANA

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The native Indian bananas are quite diversified. In India, the native gene pool of bananas comprises of dessert type, cooking types as well as the plantain types. The diversity of bananas attributes to the diverse geographical as well as agro-ecological strata. Shifting of growers' preferences towards profitability,dynamic consumer preferences and a substantial increasing pressure of several biotic and abiotic stresses, the native bananas are moving towards a threat of extinction. Still there is a specified demand for the native Indian bananas owing to their ethnic specificity and distinct flavour composition. Triploidy coupled with sterility and vegetative parthenocarpy hinder the targeted improvement of cultivated bananas. Though, biotechnology on the present-day context is contributing a lot in various banana improvement programmes, still advanced tools like metabolomics may be employed. Mass Spectroscopy – based untargeted metabolomics techniques are being employed for characterisation of native banana genotypes. In thestudyconcerned, a native banana 'Majhaulia Collection' which taxonomically

belongs to ABB Pisang Awak groupwas characterised using GC-MS technique with a target on its distinct flavour. For qualitative comparison, another native Pisang Awak banana namely,'Nepali Chinia, ABB' was analysed. The common metabolites in'Majhaulia Collection, ABB' was recorded to be 73.49%, whereas 65.27% was in 'Nepali Chinia, ABB'. Exclusively, metabolites such as Banana oil (7.11%), Ethaneperoxoic acid (16.28%), Tridecanol (1.84%) and Tetradecanoic acid (1.28%) were observed in 'Majhaulia Collection, ABB' whereas, Phthalic acid (28.87%), Heptadecanone (1.50%) and acetamide (4.37%) were observed in the ripe pulp of 'Nepali Chinia, ABB'. 'Majhaulia Collection, ABB' was screened for reaction against the pathogen *Fusarium oxysporum* f.sp. *cubense*(Foc-Race-1) and TR4under pot-culture condition along with 'cv. Rose, AA'as resistance and 'Kanthali, ABB' as susceptible check. The genotype 'Majhaulia Collection, ABB' was recorded with a resistant reaction against the infection. Likewise, in the study undertaken for assessing the breeding potential, the banana accession 'Majhaulia Collection, ABB' was recorded to be female fertile with response to artificial pollination, but male sterile under the natural condition. In the recent future, the native banana 'Majhaulia Collection, ABB' may be established as an outstanding breeding material for Indian bananas with distinct flavor, consumer acceptability, *Fusarium* wilt tolerance as well aspotential but parthenocarpic female genotype employing metabolomic-aided techniques.

OL-61

IMPROVING RIND AND ARIL COLOUR OF POMEGRANATE CV. JALORE SEEDLESS THROUGH HYBRIDIZATION

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Pomegranate (*Punicagranatum* L.*)* is an economically important fruit crop of arid and semi-arid regions theworld over. Globally, India is the largest producer of pomegranate both in area and production.Wider adaptability, higher economic returns in shorter time and export demand are driving forces for area expansion under pomegranate cultivation in arid and semi-arid regions of India including Rajasthan. More than 90 per cent of the area is occupied by variety Bhagwa due to attractive fruit colour, size and good quality.However, large area under single variety is a matter of concern because any epidemic incident may vipe out entire plantation resulting in supply crisis. The variety Jalore Seedless from Rajasthan is widely adapted to harsh climatic conditions. It is high yielding with bigger fruit size, vigorous, higher juice and aril content and soft seeded butits rind and aril colour areless attractive as it is yellowish which lacks consumer appeal. With the above background, hybridization program was initiated during 2017

to impart attractive rind and aril colour in variety Jalore Seedless. The variety Jalore Seedless was crossed with two coloured variety Mridula and Bhagwa in reciprocal cross combinations. The seedlings of F_1 plants were evaluated for desired fruit characteristics. The fruiting started in third year from F_1 plants revealed that the only F_1 derived from the cross between Jalore Seedless x Mridula had the desired fruit colour and size; therefore 20 such F_1 plants were multiplied by hard wood cutting and planted at two locations in Jodhpur and Pali for further screening. The data were recorded on fruit morphological parameters, rind and aril colour, juice and aril content, juice TSS, PH and EC. Screening of the hybrids for three years resulted in selection of three superior hybrids(JSM-2, JSM-10 and JSM-17) based on desirable rind and aril colour, fruit weight, TSS, number of fruits per plant and fruit yield.

OL-54

UNVEILING THE RICHNESS OF AVOCADO (*PERSEA AMERICANA* NILL.) GENOTYPES FROM SOUTHERN KARNATAKA

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The major emphasis of this work was to conduct an exhaustive survey of avocado diversity existing in the southern region of Karnataka to characterize and evaluate the elite genotypes for yield and quality parameters. After a detailed survey work for around five years from 2017 to 2021, a total of 39 genotypes were selected and evaluated for their yield and quality parameters. There was a clear and distinctive variation for various analysed parameters among the genotypes. The genotypes ranged from pyriform to obovate in shape, light green to purple in colour, small size fruits to bigger one, similarly distinctness was also found in the quality parameters. The genotype VAR 13 exhibited good fruit characters like fruit weight (689g), fruit length (14.09cm), fruit volume (530ml) and SIG 21 recorded maximum pulp weight (501g) and fruit length (199.57mm) whereas MYV34 showed highest pulp: seed ratio (6.40). The TSS ranged from 4.00 ^{0}brix to 10.00 ^{0}brix in genotypes SIG 27 and MNI 20 respectively. There was a significant variation in the fat content among the evaluated genotypes. The genotype SCD 23 recorded highest fat content (10.25%) whereas least was reported in SNB 24 (4.58%). VNT 14 had highest amounts of total sugars (3.68%). The genotype MYS 35 showed highest number of fruits (700) whereas VAR 13 recorded maximum yield (240kg). The results indicated the predominance of West Indian race and probable natural crosses between West Indian and Guatemalan trees, resulting in the representation of characters of both the races.

STATUS OF SEEDLING MANGOES OF BIHAR AND ITS CONSERVATION STRATEGIES

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Almost all the current commercial mango cultivars in India are the result of selection from the natural seedling population using the conventional breeding system with traditional knowledge which evolved with more and more towards conservation of genetic diversity. In Bihar state of India, many mango seedlings are found growing in the orchards/ backyards and as the crop is highly cross-pollinated, it exhibits a lot of variability in morpho-physico-chemical traits and for selection of the elite seedling genotypes, farmers play an important role and with the help of the breeder they can pave the way for maintaining the local germplasm. Recently, concerned with the sharp decline in the seedling mangoes in many districts of Bihar, a survey was conducted in the 12 districts (of Bihar) by ICAR-CISH, Lucknow in collaboration with Bihar State Biodiversity Board (BSBB), Patna. The aim of the study was to find out reasons for the decline of indigenous seedling mangoes in Bihar, to study the genetic variability among mango seedlings, to select elite mango genotypes and further formulate its conservation plan,

After grouping of seedling clones on the basis of possession of desirable characters, 28 seedling types were characterized which revealed the existence of a great variability like *Chorbi* (sweet at unripe stage), *Nakubi* (with prominent beak), *Badwaria* (matures in August), *Piri* (Yellow at ripening), *Rajbhog* (high yielder with thin peel and stone), *Rari* (bearing even after 200 year old trees, bunch bearer, honey like taste),*Laru ka Mithua* (high yielder with less sweet), *Sajmania* (late maturity, high yielder). The superior characters were also recorded in the seedling of *Kishanbhog*, *Sipia*, *Langda, Dashehari* and the yield varies from 1000-3000 fruits per tree, four seedling type had average fruit weight of 500-750 g, two genotypes found having shelf life of 10 days, three were fibrless, one genotypes ripened in October besides two identified as *Baramasi* mango.

Thus, they not only contribute to biological diversity, but can also be used for crop improvement programme or for varietal selection. These selected clones will definitely broaden the genetic base of mango in not only in Bihar but also in the country as awhole and may offer the scope for choice of selection of varieties by the farmers and ultimately the conservation of the valuable germplasm.

OL-148

DEVELOPMENT OF COCOA (*THEOBROMA CACAO* L.) VARIETIES TOWARDS SELF SUFFICIENCY IN PLANTATION SECTOR OF INDIA

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Cocoa (*Theobroma cacao* L.) is one of the beverage crops of the world, introduced to India along with Tea and Coffee in Western Ghats hills and plains region having sub tropical humid climate with high rainfall and short dry spells. Systematic improvement programs were carried out at CPCRI, Regional Station, Vittal from 1960 onwards. The demand for dry cocoa beans by the Indian chocolate industry is 60,000 MT as against 27,000 MT current productions. So, to identify hybrids with best quantitative and qualitative characters, to select hybrids suitable for different cropping models and regions, two sets of trials were carried out with different cross combinations. In the first experiment, 25 genotypes including parents and progenies with 2 replications with six trees per plot were planted at a spacing of 2.7 m x 5.4 m under arecanut at Vittal, Karnataka were evaluated for high dry bean yield. Best performing hybrids were selected and evaluated as comparative yield trial (CYT) under coconut at CPCRI, Kasaragod, Kerala and taken to multi location trial (MLT) at AICRP Centre, Veppankulam, Tamil Nadu from 2008 onwards. Growth characters, plant height, girth and canopy area was measured in 12-15 year old trees. Stabilised pod yield per tree per year was compiled over 6 years and pod observations were recorded from 5 pods each from trees. Fermented single dry bean weight and dry bean yield per tree per year were composed, quality in percentage of fat content and their industrial value with shelling and nib recovery percentages were also recorded and analysed with WASP statistical software package. In the second experiment, 14 hybrids were evaluated in progeny trial specifically to high dry bean yield and pod rot resistance, followed by CYT and MLT in Andhra Pradesh and Gujarat. The agro climatic conditions, rainfall distribution patterns, humidity and crop cycles were different in each centres. From the first experiment, VTLCH 1 was selected as an adaptive and productive variety and from the second experiment VTLCH 2 was selected as variety which exhibited high dry bean yield along with tolerance to black pod rot in high rainfall region. They produced an average of 45-55 pods per tree per year in an optimal canopy of 15-20 m^2 in the mixed cropping system both under arecanut and coconut, with dry bean yields of 1.5-3.0 kg/tree/year respectively. Both the hybrids recorded single bean weight of more than 1 gram, 10-15 percent shell, 85-90 percent nib recovery and more than 50 percent fat, which made them suitable for chocolate industry. Since Govt. of India has an agenda of area expansion of cocoa both

in traditional and non-traditional zones, these hybrids will be suitable in the respective regions to double farmer's income and to achieve self sufficiency in the cocoa sector.

OL-22

VARIABILITY IN VEGETATIVE AND FLOWERING TRAITS OF GERBERA EVALUATED BY MULTIVARIATE BIPLOT ANALYSIS

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The diversity analysis of gerbera was carried out during 2022-23 at HAU, Hisar based on vegetative and flowering traits. The significantly early flower bud initiation was observed in Ankur whereas Stanza took the maximum number of days. Maximum stalk length was observed in Ankur and minimum was observed in White house. Large value of stalk diameter was found in Atlanta while least was observed in Dana Ellen. The maximum flower diameter was recorded in Rosalin while the minimum was expressed by Brilliance. The maximum disc diameter was recorded in Rosalin and minimum by Intense. Rosalin recorded maximum number of ray florets while minimum was achieved by Dana Ellen. The maximum length of ray floret was found in Rosalin and minimum was recorded in Dana Ellen. Maximum water uptake by flowers in Ankur which was found statistically at par with Silvester while minimum was recorded in White house. The variety Rosalin showed maximum fresh weight and minimum was recorded in White House. Phenotypic and genotypic coefficients of variation were higher for bud initiation, number of leaves per plant and plant spread at 45 days of planting and disc diameter whereas least values had been expressed by water uptake, stalk diameter, leaf width at 45 days of planting. Multivariate hierarchical clustering as per Ward's method while considering vegetative and flowering traits simultaneously observed that Atlanta, Stanza , Rosalin and Silvester formed the first cluster followed by cluster of Brillance, Ankur, White house and Golianth. Remaining two varieties Dana Ellen with Intense form the last group. Acute angles of stalk diameter had been observed with plant spread, water uptake and plant height at 100 days of planting with number of leaves per plant, leaf length, leaf width, length of ray floret. Leaf length at 100 days of planting had maintained acute angles with disc diameter, plant spread at 100 days of planting, flower diameter whereas bud initiation had expressed with stalk length, fresh flower weight, days to first flower. The biplot analysis had observed the cluster of leaf width, length of ray floret, plant height at 100 days of planting, leaf length, number of leaves per plant and adjacent cluster was of flower diameter, disc diameter, plant spread along with leaf length at 100 days of planting.

OL-116

DISCRIMINATION AND RECLASSIFICATION OF CITRUS GERMPLASM BASED ON IONOME SIGNATURE

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Fourteen germplasm of citrus were assessed for their ionome signatures using Inductively Coupled Plasma Mass Spectrometry (ICP-MS). Hierarchical clustering and principal component analysis (PCA) of ionome profile of fourteen germplasm revealed four groups of clustering. It was also found that some of the germplasm could be easily identified using some elements as marker. Further, the two way hierarchical clustering analysis yielded five groups of elements. From the study an ionome signature based classification of citrus germplasm has been proposed for the first time. Classification of genus Citrus is one of the major contentious subjects as the genus has one of the largest species wealth. Many attempts were made in the past to classify genus citrus using morphological and molecular traits. The present attempt will pave faster and cheaper way of finger printing and classification.

OL-66

DEVELOPMENT OF PROMISING ASTER LINES THROUGH CONVENTIONAL BREEDING

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Aster [*Callistephus chinensis*(L.) Nees] is a popular herbaceous, annual loose flower crop belonging to the family Asteraceae and is native to China. Aster is commercially cultivated for cut flowers as well as pot-mums and bedding plants also. During 2022-23, an attempt was made for evaluation of different varieties/ accessions of aster for commercial traits, at ICAR-DFR, Pune. Data on vegetative parameters indicated that maximum plant height was recorded in Phule Ganesh Purple (80.2 cm) whereas the minimum plant height was observed in Arka Archana (34.0 cm). The cultivar Phule Ganesh Pink was superior with respect to flower head diameter (6.3 cm), stalk length (31.1 am), and required minimum days for 50 % flowering (71.0 DAP). DFRAA-2 was found to be superior with

respect to number of flowers per plant (62.4), and weight of 10 flowers (46.3 gm). The cultivars Arka Nirali (3.0 cm) and Arka Advika (3.1 cm) recorded minimum flower head diameters distinctively due to their pseudo ray floret arrangement. The minimum stalk length was recorded in DFRAA-1 (11.1 cm). The branches were dense in Phule Ganesh White, Phule Ganesh Purple, Arka Kamini, and Arka Shubhi whereas, Arka Advika, Arka Nirali, Arka Archana, Arka Poornima, Arka Shashank, DFRAA-1 and DFRAA-2 showed the medium branch density. Overall, the data on flowering parameters revealed that the cultivars, Phule Ganesh Purple and DFRAA-2 were the most suitable cultivars for cut and loose flower production in aster, respectively.

OL-40

ROOT TRAITS AND PHENOTYPING STRATEGIES FOR ORIENTING VEGETABLE BREEDING TO CLIMATE CHANGE

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Roots are crucial organs for acquisition water and nutrients from the soil and can be targeted to genetic improvement to enhance vegetable productivity under a range of climatic conditions. Vegetable breeding programmes aimed at modifying root traits can result in unique, more stress-tolerant cultivars and improved yield potential by increasing the capacity of the plants for resource acquisition. Selection for root architectural traits in breeding programs has been limited by the lack of appropriate root phenotyping strategies.Though vegetable crops possess wide variability for root traits and greatly vary in agronomic practices but a very limited progress has been reported on root system architecture assessment of these crops.With the advances in imaging and sensor technologies, root phenotyping tools are becoming more precise and accurate. The new age root phenotyping tools include a wide range of novel automated, high thorough-put and high resolution imaging techniques, such as minirhizotron, computed tomography, X-ray tomography, magnetic resonance imaging and NMR imaging to capture root system architecture for obtaining fairly correct estimation. Technical advances in acquisition, management and processing of the resulting large root trait data sets is becoming progressively critical. Developments in automated image analysis approaches promise to alter the root phenotyping scenario. Thus, there is urgent need to identify root traits relevant to vegetable improvement, review root phenotyping strategies and discuss their advantages, limitations and practical applications for vegetable breeding programs targeted on developing climate resilient and more resource efficient cultivars.

OL-78

GENETIC DIVERSITY AND DEVELOPMENT OF TRAIT SPECIFIC ONION VARIETIES

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Onion is a long-cultivated vegetable crop that originated in Central Asia. Almost everywhere in the world, onions are cultivated because of their culinary, nutritional, medicinal and health benefits. Using traditional breeding methods, breeders and farmers have been working to enhance onion yield for years. While it is currently difficult to meet growing customer demand and deal with unfavourable climate conditions. Due to its biennial life cycle, cross-pollination, and inbreeding depression, it has been challenging to characterise significant traits. Consequently, the recently available onion genome sequence and the use of contemporary molecular breeding techniques will help researchers to overcome those challenges and speed up the development of the onion crop.

ICAR-DOGR, Pune has been identified as National Active Germplasm Site for onion and garlic germplasm collection and conservation in the country. Extensive germplasm surveys have been done from 16 states of the country in collaboration with ICAR-NBPGR as well as several lines of onion have been introduced from different countries through ICAR-NBPGR. A gene pool of dark red, light red, white and yellow onion types has been collected. A total of 1429 germplasm accessions are being maintained at ICAR-DOGR consisting of 325 (dark red), 518 (light red), 309 (white), 35 (yellow), 9 (rose type), 62 (multiplier type), 89 (lines of 18 *Allium* species) and 82 (exotic).

In India, about 74 onion varieties have been released from different public sector organizations and their number is expected to increase in future. Based on genetic improvement and selection in the germplasm, ten onion varieties have been released at national level. Among these Bhima Super, Bhima Red, Bhima Raj, Bhima Dark Red, Bhima Shubhra and Bhima Safed are suitable for *kharif* season whereas, Bhima Shakti, Bhima Kiran, Bhima Light Red and Bhima Shweta are suitable for *Rabi* season. Bhima Shakti, Bhima Red, Bhima Raj and Bhima Shubhra are also suitable for *late kharif* which indicates that these varieties have wide adaptability in changing climate. All the ten onion verities have been notified by CVRC and in farmers' demand. Out of ten, nine onion varieties have been registered with PPV&FRA for their protection. One dark red onion unique line 'DOGR-1203-DR' has been registered as genetic stock for very early maturity and uniform neck-fall with ICAR-NBPGR whereas, one pink multiplier onion unique line 'DOGR-1549-Agg' registered as genetic stock for earliness and suitable for both *rabi* and *kharif* season.

UNRAVELING VARIABILITY, CORRELATION AND PATH RELATIONSHIPS IN TOMATO (*SOLANUM LYCOPERSICUM* L.)

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The investigation involved the assessment of twenty-five distinct tomato genotypes for yield and other significant horticultural traits over a span of two years (2022-23). The study documented substantial genetic diversity for the genotypes, as indicated by various genetic variability parameters, underscoring the potential for selective breeding. Notably high heritability and genetic advance were observed for key attributes such as the number of fruits per plant (97.91, 91.93), yield per plant (98.93, 89.21), TSS: Acid ratio (99.45, 85.44), number of fruit clusters per plant (99.82, 77.87), thousand seed weight (99.37,65.38), lycopene content (99.57, 57.76), number of fruits per cluster (99.49, 54.24) and number of seeds per fruit (89.29,54.07), signifying the influence of additive gene action. Correlation analysis revealed a substantial positive association between yield per plant and various factors including the number of fruits per plant (0.896, 0.910), plant height (0.887, 0.902), harvest duration (0.800, 0.902), number of fruit clusters per plant (0.882, 0.889), number of fruits per cluster (0.839, 0.844), thousand seed weight (0.837, 0.843), number of seeds per fruit (0.795, 0.843), fruit length (0.789, 0.795), fruit width (0.771, 0.780), fruit firmness (0.481, 0.488), pericarp thickness (0.477, 0.482), lycopene content (0.303, 0.305), TSS : Acid ratio (0.299, 0.302) and TSS (0.283, 0.289), at both the phenotypic and genotypic levels. The path coefficient analysis demonstrated that for yield per plant, attributes such as fruit length (1.502, 0.515), number of fruits per plant (0.682, 0.495), days to first picking (0.428, 0.037), average fruit weight (0.412, 0.336), harvest duration (0.124, 0.057), plant height (0.076, 0.068) and thousand seed weight (0.052, 0.022) held significance at the phenotypic and genotypic levels, respectively. In conclusion, this study highlighted the substantial genetic diversity among the examined tomato genotypes, indicating their potential utility in future breeding programme.

OL-7

UNVEILING CAPSAICIN DIVERSITY IN ANDAMAN ISLAND CHILI PEPPERS: A COMPREHENSIVE HPLC ANALYSIS

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This study presents a comprehensive analysis of capsaicin content in chili samples collected from diverse regions of the Andaman Islands, including South, North, and Middle Andaman. A total of 15 chili samples, with five samples from each region, were examined using High-Performance Liquid Chromatography (HPLC) to quantify capsaicin levels. The Scoville Heat Unit (SHU) values were also determined to assess the pungency of the chili samples based on their capsaicin content. To optimize capsaicin extraction, three different solvents including methanol, ethanol, and acetone were employed, aiming to achieve the highest recovery rate.

Among the solvents tested, acetone exhibited the highest average recovery of capsaicin at 2112.112 µg/g, accompanied by a SHU value of 38018.01. Ethanol yielded the second-highest average recovery of 21.01.116 µg/g with a SHU of 37820.10, while methanol resulted in a lower recovery of 1229.36 µg/g with a SHU of 22128. These findings indicated that acetone and ethanol were more effective solvents for capsaicin extraction than methanol. The potential variety with the highest capsaicin content was observed in the sample SAC-1 from South Andaman, registering an impressive 12900.48 µg/g, with a corresponding SHU of 232208.78. The second-highest capsaicin content was found in sample NAC-3 from North Andaman, with 104.62.65113 µg/g and a SHU of 188327.72.

Overall, the study highlights the significant variation in capsaicin content among chili samples from different regions of the Andaman Islands. The solvent type used for extraction influenced the recovery rates, with acetone demonstrating the highest efficiency. These findings contribute to a deeper understanding of capsaicin distribution in chili peppers across the Andaman Islands and offer insights into optimal extraction methods for capsaicin quantification.

FLOWER, TRUE SEED TRAITS AND QUALITY CHARACTERIZATION OF SELECTED VARIETIES AND WILD SPECIES OF SWEET POTATO

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Sweet potato (*Ipomoea batatus* (L.) Lam.) is an important nutrient dense tuber crop. Planting material of sweet potato as stem cutting is bulky and faces constraints of production and transport. Sexual seeds of sweet potato can form alternate like true potato seeds. Hence, laboratory and fields experiment were undertaken at ICAR-Central Tubers Crops Research Institute, Thiruvananthapuram during 2023 in selected varieties and wild species of sweet potato for seed traits. Two related species (*Ipomea trifida*, *Ipomea sagittifolia) and* four varieties (Bhu Sona, Sree Kanaka, Sree Arun and Bhu Krishna of sweet potato formed the experimental materials of the present study. Investigations were undertaken to unravel key flower traits and seed quality characters and seedling vigour with an objective to identify and assess genetic purity of the varieties/species and their planting value for crop improvement purpose. Bhu Sona showed large flower with longest petal (4 cm) and highest anther filament length whereas sepal length was high in Bhu Krishna. The seed descriptor analysis revealed the differences between wild species and cultivated varieties. Lowest seed size recorded in *Ipomea trifida* and large true seed among the experimental lot was Bhu Krishna followed by Bhu Sona. The seeds of *Ipomoea trifida, Ipomoea sagittifolia,* Bhu Sona, Sree Kanaka, Sree Arun and Bhu Krishna showed colours of rock, yellow metal, black, brown pod, seal brown and grey respectively as per Hunter Lab colorimeter; whereas under colour grab app, above genotypes recorded with colours of dark faded brown orange, brown orange, black, black brown, orange black brown orange and black, respectively. The *ipomea sagettifolia* which is a wild relative of sweet potato recorded highest phenol concentration and lowest was registered in Sree Arun. Characterization of seed quality (seed germination, seedling growth and vigour of the seedlings) indicated that both wild species and Bhu Krishna variety recorded high vigor parameters. Seed coats of sweet potato genotypes differed drastically. *Ipomoea sagittifolia* showed hairy seed coat and others possess smooth seed coat. The texture analysis indicated that the *Ipomoea sagittifolia* showed a highest value of 237.15 and greater rupture because the seed coat was harder than other varieties. The observations of root length and dry matter production of wild and cultivated sweet potato varieties revealed that the Sree Kanaka variety showed high value of seedlings dry matter production with good vigour. The preliminary descriptor and other characterization data generated will be utilized for developing breeder seed standards for varieties.

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CIM-SURAS: A MENTHOL RICH, ERECT GROWTH HABIT, SUCKER PRODUCING AND HIGH YIELDING PEPPERMINT (*MENTHA PIPERITA* L.) VARIETY

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Peppermint (*Mentha piperita* L., Lamiaceae), is an essential oil-bearing crop cultivated in temperate and sub-tropical countries for perfumery and aroma industries. The plant is vegetatively propagated through runners derived from mother stalks of plants, resulting in a low genetic base. Induced mutagenesis is a unique and supplemental breeding approach to overcome the limitations of a low genetic base. A few popular varieties, namely Kukrail, Tushar, Pranjal and CIM-Madhuras, have already been released for commercial cultivation. However, all of those have creeping growth habit, propagation only by runners, low oil content, low oil yield, and higher than 5% menthofuran content. Due to these drawbacks of previously released varieties, CSIR- CIMAP has used CIMAP/MPS-36, a half-sib seed progeny of variety Kukrail, served as the mother genotype for mutation breeding using different doses of gamma irradiation to develop a peppermint variety CIM-Suras with erect growth habit, sucker-producing ability, and increased oil yield with high menthol and low menthofuran content. Variety CIM-Suras displayed novel and industrially useful characteristics, i.e. high menthol (68–78%) content with low menthofuran (0.2-0.8%) content, sucker generating, erect growth habit, flower-bearing and an increase in oil content (0.5-0.6%) and oil yield (120-130kg/ha). This cultivar could be a sustainable solution to bottlenecks of already released peppermint varieties. Further, dementholisation (DMO) can be used as peppermint oil and to extract menthol from oil.

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EVALUATION OF SAPOTA GENOTYPES FOR CULTIVATION IN THE EASTERN PLATEAU AND HILL REGION OF INDIA

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A sapota varietal experiment was conducted under rainfed condition for fifteen fruiting seasons (2003-2018)with three Phases of five years each with varieties:

'Murabba', 'Cricket Ball', 'Bhuripatti', 'Kalipatti','Jhumakiya', 'Mahayoti', 'PKM-1', 'DHS-1' and 'DHS-2'. Based on the initial five fruiting seasons' (Phase I),"Murabba' and 'Jhumakiya' were found to be promising while in Phase II and III, 'Murabba' and 'Cricket Ball'yielded significantly higher. The cumulative yields in the Phase-I correlated poorly to overall cumulative yields(2003-2018). However, yields during phase II and III strongly correlated to the overall yields for sapotavarieties. This showed that recommending a sapota variety based on 10 years of data is equally effective as thatof 15 years indicating the scope of shortening of varietal recommendation duration. Our study also indicatedsignificant increase in the fruit weight and pulp content (%) along with increasing tree age. 'DHS-1', 'DHS-2',and 'Murabba' produced the largest fruits. The pooled data showed that sapota variety 'DHS-1' and 'Murabba'had significantly higher pulp (%). The variety × phase interaction was also a significant source of variabilityamong all characteristics except for number of seeds, TSS and acidity. The stability analysis based on regressioncoefficient (b i) revealed that all the sapota varieties had a stable yield with regression coefficient near to one.After the evaluation, it was found that 'Murabba' and 'Cricket Ball' performed best among the varietiescompared and is suitable for commercial cultivation in the East India Plateau (EIP) region of India.

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SOIL PROPERTIES AND YIELD OF APPLE UNDER CLIMATE RESILIENT NATURAL FARMING PRACTICES IN COLD DESERT OF SPITI VALLEY

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Agriculture/horticulture is the mainstay of the local economy of cold desert region of Spiti valley and shares a delicate balance with the geo-climatic conditions of this cold desert region. The valley has a very difficult terrain and hostile climate, with huge seasonal variation in the climatic conditions, and is characterised by sub-zero winter temperatures (upto -30 degree C), high summer temperatures (>30 degree C), and average annual rainfall of 170 mm. Apple and pea are the main cash crops. Apple cultivation has picked up in lower parts of Spiti due to rising temperatures and is replacing the traditional crops, and is considered as an

important source to increase the economy of tribal farmers. However, increasing use of agro-chemicals can adversely affect the fragile agro-ecosystem of the valley and raise the input costs. Further, the resource-poor smallholder tribal farming communities are most vulnerable to the risks of climate change due to the remote locations and poor adaptation capacity. Keeping this in view, an experiment was laid at the Experimental and Demonstration farm of Krishi Vigyan Kendra - Lahaul and Spiti II at Tabo to study the effect of low cost, local input based and ecologically safe Natural Farming (SPNF) on soil properties and apple yield in comparison to Conventional Farming (CF; recommended doses of fertilizers). Under SPNF, two practices viz. (a) pea (SPNFP) and rajmash (SPNFR) were sown in the basin as live mulch, and (b) straw mulch in basin (SPNFS), were applied. Pea and rajmash seeds were treated with beejamrit before sowing. Hyoscyamus niger (Khurasani ajwain or black henbane and locally known as thuklang) was used in preparation of Agniastra (as bio-insecticide). No difference was observed among the treatments w.r.t. available soil nutrients. The data on soil temperature at 2:30 PM at surface (5 cm depth) and sub-surface (10 cm depth) shows that the mulches (live mulch as well as straw) moderated the soil temperature. During peak summer, mulching decreased the day temperature upto 60C, and during sudden cold weather events, the mulch maintained higher day soil temperatures. The straw mulch under natural farming (SPNFS) maintained higher soil moisture (upto 8 %, w/w) during the season, in comparison to that in conventional system without mulch. Live mulches (pea and rajmash) recorded higher moisture content, when the basins were completely covered with their foliage. The highest dehydrogenase enzyme activity was found under SPNFP (63.9 µg TPF g-1 h-1). Although all the treatments were statistically at par w.r.t. fruit yield of apple, the yield varied form 26.9 Mg ha-1 under control to 32.5Mg ha-1 under SPNFP.

OL-69

REVITALIZATION OF UNPRODUCTIVE HIGH DENSITY PLANTATION OF MANGO VAR. DASHEHARI

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An experiment was conducted on 22-23 years old overcrowded and unproductive high density mango plantation var. 'Dashehari' at 2.5 X 2.5 m (S1) and 2.5 X 5.0 m (S2) during 1992-93 for improving the productivity and quality. In subsequent years trees become overcrowded and attained 6-7 meter height, 2.5-3.90 m canopy spread having canopy volume of 18-70.08 m3. Further, the trees were

also infested with stem borer, leaf webber, anthracnose, rusts widely with least light interception. The cumulative effect of all these factors leads to the decline in productivity of HDP orchard after 12-15 years. Moreover, the total light interception was recorded in side orchard was least (400-500 lux) as against 9,000-10,000 lux on the top of the canopy. Hence, in order to revitalize the productivity of orchard, plants were subjected to canopy reorientation programme through severe pruning. The study revealed that pruning improved sun light interception within the tree canopy which has been reflected in the results, the canopy volume was significantly higher in S2 (16.19, 17.45 and 26.84 m3) as compared to S1 (11.99, 13.49 and 12.04 m3) during 2019-21, respectively. Further, the P3 (2.5 m) pruning intensity exhibited significant effect and noted maximum canopy volume 15.16 to 22.33 m3 from 2018 to 2021 respectively. However, canopy volume was recorded maximum (30.56 m3) in 2.5 X 5.0 m spacing with 2.5 m pruning height (P3) with mulched basin (S2P3M2) during 2021. Earliest flowering and fruiting were noted in tree pruned at 2.5m height while as in severely pruned trees (P1), 1.5 m pruning height no or negligible flowering and fruiting recorded during first three consecutive years i.e. 2016, 2017 and 2018. Significantly maximum number of fruits per tree and yield were recorded (28.28, to 54.27 fruits per tree) and (8.28 and 12.00 kg/tree) respectively S2 spacing in 2018, 2019, 2020 and 2021 respectively. The findings revealed that to revive the mango HDP orchard it should be pruned at 2.0 m height with mulching to maintain moisture level in 2.5 X5.0 m spacing.

OL-10

EXPLORING THE PROSPECTS OF SOIL-LESS ACCLIMATIZATION IN BANANA (*MUSA* SPP.) CV. GRAND NAINE

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In-vitro-grown banana plantlets need to undergo acclimatization in order to adapt to *ex-vitro* conditions before being transferred to the field. Conventional acclimatization generally involves more space, time, and high demand for water, nutrients, labour, and a protected environment to adapt to the *ex-vitro* condition. The present study aims at determining the effectiveness of soil-less acclimatization in banana both during primary and secondary hardening in terms of cost, time duration for acclimatization, physical and physiological attributes of *in-vitro* derived banana plantlets. Acclimatization of *in-vitro* derived plantlets of banana cv. Grand Naine was accomplished in two different methods namely

completely through hydroponics (S_1) and partially through hydroponics (S_2) i.e., primary hardening under conventional method and secondary hardening under hydroponics along with control (C). Banana plantlets acclimatized through soil-less substrate (S1 and S2) had established well and exhibited improved growth compared to conventional hardening. When compared to the conventional method, the hardening duration in soil less acclimatization has been shortened by 15 days, and the cost of hardening was reduced by 30% when compared to that of conventional hardening adopted by commercial tissue culture companies. In terms of physical and physiological parameters, both S1 and S2 presented faster and better growth compared to the conventional method (C). Plant height, total number of leaves, leaf area, root length, and number of roots were increased by 2.94, 1.05, 219.34, 12.03, and 2.44 folds in S1 compared to the control (C). Similarly in S2, the growth parameters were increased by 1.72, 0.26, 11.09, 6.74, and 1.70 folds respectively as against control. Biochemical analysis revealed that photosynthetic activity and pigment content (Chlorophyll a, b, and carotenoid) of *in-vitro* derived banana plantlets acclimatized through hydroponics (S1 and S2) recorded better values compared to conventional methods.

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THIOUREA IMPACT ON GROWTH OF JACKFRUIT (*ARTOCARPUS HETEROPHYLLUS* L.) CV. CHANDRA PLANTS

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An experiment entitled “Effect of thiourea on growth and development of Jackfruit (*Artocarpus heterophyllus* L.) cv. Chandra” was carried out during the year 2022-23 at the Department of Fruit Science, College of Horticulture and Forestry, Jhalrapatan, Jhalawar in the newly established orchard of Jackfruit cv. Chandra. The experiment had 9 treatments including control, viz. No Thiourea (control), Thiourea 0.25 %, Thiourea 0.50%, Thiourea 0.75 %, Thiourea 1.00 % , Thiourea 1.25 %, Thiourea 1.50 %, Thiourea 1.75 % and Thiourea 2.00 %. The treatment was applied thrice as a foliar spray during second week of June, August and October. The experiment was laid out in Randomized Block Design with three replications. Among different treatments, application of Thiourea 2.00% was found significantly superior over other treatments with respect to better growth parameters such as plant height (17.84%), rootstock girth (21.82%), scion girth (21.34%), number of leaves per plant (26.55%) and leaf area (32.88%).

OL-25

INTERCROPPING OF SEED SPICES WITH GUAVA TREE

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The traditional farming systems, currently in vogue in semi-arid and arid regions of the country, are largely subsistence in nature and are need based. Besides, they are not necessarily efficient in utilization of resources for a given location. This leads to loss of precious natural resources. Sustainability and profitability of framing systems particularly of marginal and small holding facing serious challenges due to declining trend of per capita low availability and shrinking size of operational holdings. To overcome this a field experiment was carried out during 2016-17 to 2019-20 at ICAR-NRC on Seed Spices, Ajmer to investigate the response of intercrop combination (seed spices with guava) for increasing productivity, sustainability and profitability. The experiment comprises of 11 treatments *viz*., Fenugreek + Guava, Coriander + Guava, Nigella + Guava, Anise + Guava, Ajwain + Guava, Sole Fenugreek, Sole Coriander, Sole Nigella, Sole Anise, Sole Ajwain and Sole Guava are laid in randomized block design with three replications. Results based on three years pooled data revealed that, out of eleven different treatments, sole crops treatment alone recorded highest yield compared to inter crop treatments, however after perusal of data related to economics of production it was observed that fenugreek + guava inter cropping was found most remunerative as it recorded highest net returns and B: C ratio (Rs.105903.00 and 1.82). Thus inter cropping of fenugreek with guava is suggested for getting higher net return and B: C ratio, higher system productivity and profitability.

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SOIL ORGANIC CARBON STOCKS AND FRACTIONS IN DIFFERENT ORCHARDS OF NORTH EASTERN HILL REGION OF INDIA

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Experiment was conducted during the year 2018-2023 to estimate soil organic carbon stocks and fractions in different orchards at ICAR-Sikkim Centre. The

oxidizable organic carbon (Mg C ha^{-1}) in soils (0-15 cm soil depth) of the selected fruit orchard was highest in peach (20.91) followed by kiwi (20.58), citrus (20.16), guava (20.10), pear (19.71), plum (19.66) and lowest in mandarin (19.61). The similar trend was observed in the entire soil layer (15-30, 30-45, and 45-60 cm). Active carbon pools (Mg ha^{-1}) in soils in 0-15 cm layers of different fruit orchard was significantly higher in citrus (15.48) followed by kiwi (15.45), peach (15.08), guava (14.42), mandarin (13.56), pear (13.40) and lowest in plum (12.57). Here also similar trends in active carbon pool were observed in all the below ground different soil profile. The very labile fraction of carbon (C $frac_1$) contributed the largest percentage of total soil organic carbon, leading to the more active carbon pool in the surface soil can reasonably be used as good indicator for assessing soil for its crop productivity. Passive carbon pools in soils (Mg ha^{-1}) in 0-15 cm soil layer of different fruit orchard was highest in peach (9.98) followed by guava (9.80), kiwi (9.75), pear (9.42), mandarin (8.56), citrus (8.46) and lowest in plum (8.26). After four years of the experiment the carbon pool index, lability index and carbon management index were calculated for recognition of best fruit orchard production system to sequester more carbon in the mid hill of Sikkim. The lability index was highest (0-15 cm) in kiwi orchard (1.64) followed by peach (1.57), guava (1.56) and lowest in plum (1.32). As mentioned above the similar trend for lability index was also observed in other soil depth. The carbon pool index was also higher in kiwi (1.15) followed by peach (1.14), guava and citrus (1.11) and lowest in mandarin and plum (1.08). Finally, the carbon management index was higher in kiwi orchard (186.96) followed by peach (180.55), citrus (179.82), guava (173.16), pear (161.32), mandarin (154.44) and lowest in plum (142.56). Among the orchards, kiwi orchard had greater amount of total soil organic carbon, carbon pool index, lability index and higher carbon management index and hence, considered the best orchard production system to sequester carbon in the Sikkim Himalaya. The second and third position was achieved by peach (180.55) and citrus (179.82) with respect to carbon management index.

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EFFECT OF SEVERITY OF PRUNING AND DIFFERENT FERTILIZER APPLICATION ON GROWTH AND YIELD OF CUSTARD APPLE

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The experiment was carried out during the year 2019-20 at Shivar Block, Central Research station, Akola. An experiment was laid out in a factorized randomized block design (FRBD) with nine treatment combinations and three replications comprising of three pruning intensities *viz.,* 20 cm, 15 cm, control and three application of INM viz., I_1 - 75% RDF(194g:94g:94g NPK/plant)

+100g AM +100g *Azotobacter* +100g PSB +0.50Kg neem cake at onset of monsoon, I_2 - Half N(97g) +Full P&K(94g:94g)+100g AM +100g *Azotobacte*r +100g PSB +0.50Kg neem cake - IstApplication.1/4 N(48g) - IIndApplication and 1/4 N(48g) - IIIrd Application. Regarding the application of pruning of 20 cm from tip showed the better performance in terms of plant height, number of shoots per branch, canopy of plant, leaf area, days to flowering, number of fruits per plant, yield, In respect of integrated nutrient management application (Half N(97g) +Full P&K(94g:94g)+100g AM +100g *Azotobacte*r +100g PSB +0.50Kg neem cake - IstApplication, 1/4 N(48g) - IIndApplication, 1/4 N(48g) - IIIrd Application, respectively at one month interval) showed better performance in terms of plant height, number of shoots per branch, spread, canopy of plant, leaf area, days to flowering and yield. Amongst the combinations of pruning and integrated nutrient management, the combined application of 20 cm pruning + Half N(97g) +Full P&K(94g:94g)+100g AM +100g *Azotobacte*r +100g PSB +0.50Kg neem cake - IstApplication, 1/4 N(48g) -IIndApplication, 1/4 N(48g) - IIIrd Application showed the better performance in terms of plant height, number of shoots per plant, spread, canopy of plant, leaf area and yield in custard apple cv. Balanagar.

OL-28

IMPROVE YIELD AND QUALITY OF NAGPUR MANDARIN BY MECHANICAL PRUNING IN HIGH DENSITY PLANTING

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Nagpur Mandarin is an important and major fruit crop grown in Central India and area under this crop is 1.47 lakh hectares. The average productivity of the Citrus in India is around 7.5 t ha^{-1}. The average productivity of Citrus in Israel is around 35t ha^{-1}. The major component of limiting the productivity of citrus in India viz. quality planting materials, planting on raised bed, high density planting, use of pruning, use of drip irrigation and fertigation. Area under high density planting of Nagpur mandarin is increasing day by day. Pruning of Nagpur mandarin crop is an essential for canopy management and for improving the quality production. Mechanical citrus pruning machine is used first time in Central India for pruning of Nagpur mandarin orchards. For standardization of pruning time and severity of pruning, tractor drawn pruning machine was used during December-January for *Ambia bahar* on five year old high density (6m X 3m spacing) Nagpur mandarin orchard. *Ambia bahar* fruits of Nagpur mandarin are harvested up to last week of November. December and January is a rest period and again *ambia bahar* flowering are emerge during February. For the standardization of time and severity of pruning, three pruning time (First week of December, third week of December and first week of January) and four pruning levels (8ft from ground level, 10 ft from ground level, 12 ft from ground level and no pruning) was tested

during 2013-14. From the result it is revealed that flowering was observed in all treatments. Significantly more number of fruits was recorded in pruning was performed at 10 ft above ground level (652.66). As regards the fruit yield per plant, significantly higher fruit yield (117.85 kg per plant and (32.63 t ha^{-1} was recorded in treatment pruning performed at 10 ft height from ground level followed by pruning performed at 12 ft height from ground level. Significantly maximum fruit weight was recorded in treatment pruning at 10 ft height from ground level (180.33 g) followed by pruning at 12 ft height from ground level (169.77g). However, significantly bigger fruit size was recorded in treatment pruning at 10 ft height from ground level (83.70mm) followed by pruning at 12 ft height from ground level (76.40mm). Time of pruning also had significant result in case on fruit yield and fruit size. Pruning performed during first week of December resulted significantly maximum number of fruit per plant (602.91), fruit yield per plant (99.57kg per plant) and yield per ha (27.78t ha^{-1}). As regards the fruit size, significantly maximum fruit weight (166.25) was recorded when pruning was performed during third week of December, However, significantly maximum fruit diameter (77.30mm) was recorded in first week of December. In addition to the fruit yield and quality, number of branches and leaves was increased in pruned plants as compared to the un-pruned plants. Staking with bamboo is required in un-pruned plants whereas no staking is required in pruned plants. Fruit development was observed inside the canopy and hence it was uniform and bigger size and fruits are protected from sun burn in pruned plants as compared to the unpruned plants.

OL-71

INNOVATIVE APPROACHES IN POMEGRANATE PRODUCTION FOR HIGHER YIELD AND BETTER QUALITY FRUITS

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The symbol of abundance and fertility, Pomegranate (*Punica granatum* L.), is an important fruit crop of arid and semi-arid regions of the world. Being originated from Iran (PCO), it has its natural habitats in India besides Pakistan and Afghanistan (SCO). The adage, "*ek anarsaubimar*" states the significance of enormous nutritional and immense medicinal values of pomegranate. World over, it is grown over 6 lakh ha with an estimated annual production of 6 million tonnes. India is the largest producer and consumer of pomegranate. During 2021-22, India has grown pomegranate over 2.76 lakh ha with an annual production of 31.48 lakh tonnes and productivity of 11.40 t/ha. Pomegranate is basically deciduous in nature. However, it behaves as evergreen, partially deciduous and deciduous in tropical, sub-tropical and temperate zones

respectively. India is the only country in the world, where pomegranate fruits are available throughout the year. It becomes feasible through crop regulation during ambia, mrig or hasthbahar. Bahar treatment in pomegranate helps to realize to uniform flowering of trees.With the objective to assess the yield potential and quality, crop regulation experiments involving innovative approacheswere carried out at ICAR-NRCP during 2018-2023.Multi-stem training system with four stems/tree has been found to be superior compared to other training systems for enhanced yield. Foliar spray of Ethrel @ 200pppm followed by Ethrel @ 600 ppm at one week later was found highly effective with 92.5% defoliation over single spray of Ethrel @2000ppm, on 9 days after spray.Light pruning of pomegranate by removing shoots upto 6" from the tip before defoliant spray has been highly effective over the unpruned trees for flower bud initiation, yield. Foliar spray of GA3@50ppm on 30 and 60 DAA was found to be superior with better grade fruits and increased yield of 25-30% over the control. Foliar application of 2,4-D@20ppm has been highly effective in control of flower drop (post-set drop) over the control with minimum flower drop. Fruit Thinning has been highly effective in enhancing the fruit yield besides fruit size and grading. Light thinning in pomegranate by removing the surplus setting of fruits helped to obtain optimum yield with better quality.Innovative approaches viz., four stem training system, split application of ethrel, light pruning of shoots, foliar spray of 2,4-D, GA3 spray, fruit thinning, etc have paved the way for enhanced yield and improved quality of pomegranate fruits.

OL-74

BOOSTING FRUIT CULTIVATION IN ASIAN SUBTROPICS AS A WAY FORWARD FOR GLOBAL FOOD AND NUTRITIONAL SECURITY

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The sufficient availability food is of greater concern over the other aspects of global food and nutritional security. The sufficiency is linked further to the production and trade of food across the geographical and administrative boundaries at national or international level. Asian food security issues are serious because half of the world's population resides here; people have high dependence on plants for food and livelihood. Comparative progression of transcending population and the availability of plant derived nutritional foods have been presented which reflects suboptimal availability of per capita fruits throughout the Asian subtropics. Corresponding progressive metamorphism towards the dependence on high-fat, high-sugar, and high-calorie fast foods and the alarming escalation in the health and nutritional issues has been portrayed. Further, as the changing climatic scenario is inducing intense shift in the fruit production agro-ecological situations in both the humid and arid subtropical regions, the problems and potentials of the region have been elaborated.

Threats to the issues of the horticultural production system, livelihood of the associated farming community, nutritional disorders, and trade policy issues have also been discussed in this presentation. Need for carbon-neutral orchard management practices, cluster farming and marketing initiatives and the way forward for strengthening the four pillars of food and nutritional security are presented using suitable analytical tools.

OL-83

GROWTH, BIOMASS, AND NUTRITIONAL RESPONSES OF PUMMELO SEEDLINGS TO THE COMBINED EFFECTS OF HUMIC ACID AND MICRONUTRIENTS

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To evaluate the combined effects of humic acid and micronutrients on plant growth, biomass and mineral nutrient contents in leaf, stem and roots, two months old pummelo seedlings were treated with five different levels of humic acid (0, 1, 2, 3, 4 and 5 ml per litre) and six different dosage of citrus micronutrient formulations (0, 0.5, 1.0, 1.5 and 2g per litre). The pummelo seedlings were grown for 4 months (120 days) under glasshouse condition at ICAR-Indian Institute of Horticultural Research, Hesaraghatta, Bengaluru during 2022. The nursery experiment was laid out in factorial completely randomized design (fCRD) with 4 replications. The results showed that the plant height, stem girth, number of leaves, biomass, root traits and mineral nutrient contents in leaf, stem and roots of pummelo seedlings were significantly affected by humic acid and micronutrient formulation spray (IIHR Citrus Special). Better seedlings growth *viz,* plant height, stem girth, root fresh biomass, total plant fresh biomass and dry biomass of pummelo were recorded with drenching of 2 ml/litre of humic acid and 2g per litre of foliar application of micronutrient formulation once in 20 days interval. However, these parameters were decreased with increasing the level of humic acid beyond 2 ml per litre. Further investigations of the mineral nutrient concentrations in leaf, stem and root showed that both humic acid drenching and micronutrient spray, the concentrations of majority of the nutrients were remarkably influenced, particularly 2 ml per litre of humic acid and 2 g per litre of citrus special. The growth, biomass, and nutritional results of pummelo seedlings indicated that 2 ml per litre of humic acid and 2 g per litre of citrus special can improve the growth, plant and root biomass and vigour of the seedlings which would be very much helpful for early planting and better establishment in the field.

OL-75

DEMONSTRATION OF REJUVENATION TECHNOLOGY OF KHASI MANDARIN

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Khasi mandarin orchards were selected at Sohkhowai, Nongpoh, RiBhoi district of Meghalaya, during 2020 to set up the experiment to rejuvenate the declined and semi declined Khasi mandarin trees. The rejuvenation technologies of citrus orchards was demonstrated in Nongtrylaw village of Sohkhowai, Nongpoh, by selecting 75 number of bearing plants in the near decline stage with reduced numbers and size of fruits. In the orchard 50 numbers of Khasi mandarin plants were selected which were applied with the recommended doses of FYM and fertilizers. Although no apparent significant disease and pest infestation was observed during the study period, prophylactic spray with neem oil and Trichoderma application was done on these plants. In the same citrus orchards, another 25 plants were marked/tagged as control with prevailing farmers practice (no FYM or fertilizers or plant protection materials). The average plant height of citrus in the demonstration site is 4.64 m in the treated plants and 4.35 m in the control site. Plant height, collar diameter, fruit weight, number of seeds per fruit, total soluble solids, rind thickness and juice content were non-significant between the treatments. Application of recommended dose of NPK fertilizers and micronutrients (Zinc and boron) fertilizer significantly influenced the number of fruits per trees to a tune of 26 per cent. Following the recommended practices farmer can able to earn an additional income of ₹ 1200/- (@8.0 per fruit for 150 fruits on an average). The result indicated better plant growth in treated trees followed by increased number of fruits in systematically managed/ treated trees as compared to control trees during the course of study.

OL-76

EFFECT OF BUNCH TRIMMING ON YIELD AND QUALITY IN BANANA VAR. GRAND NAINE

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Bananas (*Musa* spp.), are one of the top 10 world food crops contributing to cash and food crop in tropics and subtropics. In Maharashtra, nearly 60% area under banana is concentrated in Jalgaon district and other districts growing bananas

are Parbhani, Khandesh and Thane. By removing the terminal hands, it may be expected that dry matter would be redistributed among the remaining hands of the bunch thus helping to increase the size of the remaining hands. Keeping the above aspects in view the present investigation was carried out during the year 2019-20 and 2021-22 at Agriculture Research Station, Achalpur under Dr. Panjabrao Deshmukh Krishi Vidyapeeth, (M.S.), India to evaluate the effect of bunch trimming on yield and quality of banana crop. The experiment consisted of five different retention of hands treatments was repeated four times in RBD viz. 6, 7, 8, 9 and 10 hands immediately after opening of last hand. Non-significant effect found in plant height, stem girth, number of leaves, peel weight and pulp to peel ratio in banana. Significantly maximum length of fruit (20.19 cm), girth of fruit (13.80 cm), fruit weight (170.28 g) and pulp weight (115.50 g) recorded in retention of 6 hands per bunch. Whereas, significantly the maximum number of fruits/bunch (151.22), bunch weight (23.78 kg) and yield (105.59 t/ha) was noticed in banana by retention of 10 hands per bunch. Excellent export quality, maximum net return and B: C ratio observed in retention of 9 hands per bunch followed by 8 and 7 hands per bunch.

OL-81

INFLUENCE OF PRE-SOWING SEED TREATMENT WITH ORGANIC INPUTS AT VARYING INTERVALS ON GERMINATION AND GROWTH ATTRIBUTES OF PAPAYA (*CARICA PAPAYA* L.) UNDER POLYHOUSE CONDITION

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Poor seed germination and inadequate quality planting materials are among the major challenges facing global papaya production. Therefore, a trial was carried out under polyhouse condition during 2022-23 at ICAR-CISH-RRS, Malda, West Bengal to ameliorate the germination of papaya seeds with the help of organic liquid manures for production of organic healthy planting materials.Two varieties of papaya (Red Lady and Ranchi Local) were soaked in different organic inputs (Panchagavya, Jeevamruth, Amritpani, Beejamruth, Cow dung slurry and Cow urine) at varying intervals (12 or 24 hours) while control seeds were either sown untreated or soaked in tap water for 24 hours prior to sowing or soaked in hot water (50 ˚C) for 10 minutes followed by soaking in tap water for 24 hours. The experiment was conducted as factorial CRD with 15 treatments having 3 replications per treatment. Results revealed stimulative effect of seed priming on germination and growth attributes of papaya, regardless of the variety. Prior to sowing, seeds, which were soaked overnight, performed better than those soaked for 24 hours. Among the different seed priming techniques used, soak-

ing of papaya seeds in 2 per cent Panchagavya for 12 hours, not only resulted precocity of germination, but also enhanced germination percentage, seedling vigour, root and shoot growth. Thus, it was concluded that the overnight seed soaking in 2 per cent panchagavya solution provided a promising seed treatment to enhance seed germination and early growth in organic production of papaya followed by overnight seed soaking in 100 per cent Beejamruth.

OL-59

STUDY OF PHENOLOGICAL GROWTH STAGES OF LITCHI (*LITCHI CHINENSIS* SONN.) CULTIVAR DESHIUSING THE BBCH SCALE IN INDO-GANGETIC PLAINS OF INDIA

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Litchi (*Litchi Chinensis* Sonn.) of sapindaceae family is one of the important sub-tropical fruit crops of India. The phenological development and yield in litchi is greatly influenced by temperature fluctuation. Thus, an experiment was undertaken for two consecutive years to study the phenological development in an early litchi variety deshiusing extended BBCH scale during 2019 to 2021 at experimental plot of Bihar Agricultural University, Sabour that experiences subtropical climate and lies in Indo-Gangetic plain of India. The times, duration of phenophases and prevailing temperature at each phenological stages of litchi were recorded as per extended BBCH scale. 7 out of 10 principal stages were studied, starting with bud development (stage 0) and ending with maturity of fruit (stage 8). The scale involves the growth stages of the plant using a three-digit numerical system from initiation of vegetative bud dormancy to fruit harvest such as bud, leaf and shoot development, inflorescence emergence, flowering, fruit development and maturity including all phenophases and secondary growth stages as well. Pictures of all phenophases were taken to see the morphological difference among them and date of start and end of phenophases were noted. The initiation of 1st vegetative flush started after 30-35 days after harvest. The vegetative bud development (Stage 010) started in last week of June to first week of July. Flowering duration of 29-32 days in the month of February and maturity period from fruit development to maturity was 40-45 days in the variety for the year under study. Effect of temperature fluctuation on initiation and end of phenophases was noted in both the years.

OL-85

WEED MAT TECHNOLOGY FOR PINEAPPLE CULTIVATION

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Pineapple (*Ananus comosus*), the State Fruit of Tripura, is a very popular fruit crop. In recognition of the premium quality of variety Queen grown in Tripura 'Geographical Indicator (GI)' has been awarded in 2015.To produce premium quality fruits weed mat technology was used. Raised beds of dimension 100 m length x 1 m width and 15-20 cm height are prepared and organic manure @ 300 g/plant and Urea, SSP and MOP 18g, 25g and 15g/plant, respectively is applied. Raised beds are covered with woven polypropylene black weed mat (1.5 m width and 100 m long). Edges are pressed with mud to protect from high wind blow. Suckers weighing 500-600 g are planted in the month of September. Raised Bed double row high density planting with spacing 40 cm (plant to plant) x 60 cm (Row to Row) + 90 cm/1.0 m (Bed to Bed).Pineapple requires less irrigation. However, during dry spell (November to mid-March) in the 1st year (Planting Year) at fort night interval and in the 2nd year and successive years' sprinkler irrigation is beneficial during Dec-Jan. and Feb.-March (2-3 times). NPK (19:19:19) foliar sprays at 7th or 8th months after planting, and again at 30 and 60 days after fruit set. Zn (0.4%) + B (0.1%) sprays at 40 and 50 days after fruit set. Plant growth was better compared to the control and fruit weight ranged from 1.2-1.5 Kg in queen with TSS 17.5-18.5 0B and in Kew weight ranged from 1.5-2.5 kg with TSS 15.5-16.50B. Whereas, in control, the respective values were 0.5-0.8 kg weight with TSS 11.5-13.50B in Queen and 0.8-1.2 kg with TSS 8.5-10.50B.

OL-87

UNLOCKING THE SECRETS OF POMEGRANATE FRUIT CRACKING: A COMPREHENSIVE STUDY OF IRRIGATION LEVELS AND CHEMICAL TREATMENTS

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The present study investigated the role of different irrigation levels in combination with chemical sprays on alteration in fruit cracking linked enzymes

in pomegranate rind. Bhagawa variety devoid of irrigation for 20 days (DI) at fruit maturity stage was treated with foliar sprays of three sources of calcium (2.5%), Abscisic acid (ABA 90µM), Gibberellic acid (GA 60ppm), Boric acid (BA 0.3%) and combination of $CaCl_2$(2.5%)+BA(2.5%)+GA (60ppm)+ ABA (90µM) followed by over irrigation for 4-5 days. Fruit samples were collected from regularly irrigated (RI), DI and over irrigated plants (OI) and rind was used for analysis. On an average of irrigation level, rind of OI plants showed significantly high activity of cell wall loosening enzymes such as betagalactosidase (2.96 umole/mg/h) and polygalacturonase (87.96 umole/g/h). Activity of peroxidase (29.5 nmole/min/g), catalase (68.54nmole/min/g), malondialdehyde (3.46 nmol/ml), ascorbate peroxidase (41.46U/L)was also significantly high compared to DI and NI plants. In contrast, cellulose content (38.7%)was significantly low in rind of OI plants compared to NI plants (52.3%).In OI plants, combination treatment reduced the activity of total peroxidase, ascorbate peroxidase and catalase showing reduced stress level in rind. sCalcium chloride and GA_3 treatment significantly increased cellulose content. The activity of cell wall loosening/softening enzymes viz. polygalacturonase and betagalactosidase decreased by $CaCO_3$, Ca $(NO_3)_2$ and GA_3 treatment. The study revealed that cracking linked enzymes gets highly activated under OI conditions. Calcium,GA_3 and combination treatments maintained and improved rind health under OI conditionsand hence can be beneficial to reduce fruit cracking in pomegranate.

OL-155

STANDARDIZATION OF BRANCH BENDING IN GUAVA FOR YIELD AND QUALITY UNDER HOT AND HUMID CLIMATE OF EASTERN INDIA

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In guava, production of new shoots is one of the most important factors determining the crop load, as it bears flowers on new shoots/laterals. Emergence of large number of shoots on a branch ensures profuse flowering and heavy fruiting. Shoot production in guava can be intensified by branch architecture manipulation practices, such as, branch bending which suppresses the apical dominance and activates the dormant lateral buds. However, the response of a plant to bending varies with the genotype and time of bending. Therefore, a field experiment was carried at the research farm of ICAR-IIHR-Central Horticultural Experiment Station, Bhubaneswar, Odisha to study the comparative response of guava var. Arka Amulya to winter and summer branch bending. The experiment was laid out in a Randomized Block Design with five treatments consisted of branch bending during January, February, May, and June, and without branch bending as control. Branch bending was found effective for controlling the shoot

vigour and enhancing flushing, flowering, and yield, when practised during January, February, and May, however, effects were more pronounced when branch orientation was manipulated during winter months. January branch bending produced the shortest shoots (flowering: 38.75 cm, vegetative: 50.48 cm) and recorded the maximum value for the flushing intensity (28.91 shoots m^{-1} branch), flowering intensity (57.91 %), and fruit yield (38.46 kg $tree^{-1}$). Winter branch bending resulted in higher yield gains (70.87-81.59 %) over the control (21.18 kg $tree^{-1}$) as compared to summer months (11.99-42.21 %). All the treatments of branch bending caused a significant improvement in various fruit quality attributes, however, May and June treatments excelled in the performance. June bending produced the best quality fruit in terms of total soluble solids (11.35 ºB), total sugar (7.85 %), reducing sugar: 5.29 %, bioactive constituents (vitamin C: 197.39 mg 100 g^{-1}, total phenolic content: 117.29 mg GAE 100g^{-1} FW, total flavonoid: 52.74 mg QE 100 g^{-1} FW), and antioxidant capacity (ferric reducing antioxidant power: 25.12 mM $Fe_{(II)}$ 100 g^{-1} FW, scavenging activity: 66.85 %), followed by May bending.

OL-80

EFFECT OF IBA ON ROOTING AND GROWTH IN LEMON (*CITRUS LIMON* BURM) CUTTINGS

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The present experiment was conducted at CCS Haryana Agricultural University, Hisar during the year 2022-2023 with the objective to find the optimum dose of IBA for cuttings in lemon. The six different concentrations of IBA were 0 (water dip), 600. 1200, 1800, 2400 and 3000 ppm IBA. The experiment was laid out in completely randomized design which was replicated thrice by taking ten cuttings per replications. The results revealed that most of the parameters studied were influenced significantly by IBA concentration. The earliest sprouting (16.45) occurred in 3000 ppm IBA, sprouting percentage (99.90) and rooting percentage (77.53) was noted at 2400 ppm IBA. Among shoot and root growth factors, 3000 ppm IBA treatment performed better in average length (19.93 cm), average diameter (3.41mm), total number of roots (30.00), average length of roots (9.96 cm). Whereas cuttings under control treatment gave poor results in all the parameters. The length of longest root (23.88 cm) was recorded in 1800 ppm IBA treatment. In most of the shoot growth parameters treatment 2400 and 3000 ppm were found at par. In root growth parameters, 1800, 2400 and 3000 ppm IBA treatment were found at par. Overall 3000 ppm IBA, 2400 ppm IBA and 1800 ppm IBA perform well in most of the parameters.

OL-109

GRAFTING SUCCESS AND SEEDLING GROWTH OF LOQUAT SCION AFFECTED BY DIFFERENT ROOTSTOCKS AND GRAFTING TIME

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The present investigations was carried out at Experimental Farm of Division of Fruit Science, SKUAST-Kashmir, Shalimar Campus, Srinagar (Jammu and Kashmir) during 2022 to find out best rootstock and grafting time for loquat scion. The experiment comprised four rootstocks (BA-29, Quince seedling, Loquat seedling and Kainth seedling) grafted with loquat scions at three grafting times (10th March, 20th March and 30th March) with cleft grafting, replicated thrice under Randomised Block Design. Observations recorded depicts that earliest bud burst (24th April) was recorded on loquat seedling grafted on 10th March whereas lowest number of days to bud burst (44 days) was observed with loquat seedling grafted on 20th March along with highest grafting success (86.66%), scion girth (10.48 mm), plant height (47.73 cm) and number of branches (2.10). Maximum rootstock girth (11.95 mm) was measured in BA-29 grafted on 20th March. Highest and lowest stock-scion ratio was recorded in BA-29 grafted on 10th March and loquat seedling grafted on 20th March, respectively. Maximum survival plant was recorded on loquat seedling grated on 20th March (73.33 %). From the present study, it is concluded that loquat seedling grafted on 20th March performed best for most of studied vegetative parameters.

OL-112

EXPLORING THE AIR LAYERING IN GRAPE WITH CONCENTRATIONS OF IBA

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Grape rootstock propagation typically involves the use of hardwood cuttings, and wedge grafting is employed to join scion material from commercial grape varieties with these rootstocks. In the establishment of new vineyards, it's common practice to perform at least two out of every three grafts on rootstocks. After a few months of successful grafting, only one of the grafts is retained

per planted rootstock location, with the others being removed. In light of these practices, our present investigation was made at Nursery of ICAR-NRC for Grapes with focused on "Studies on the impact of IBA Concentrations on Grape Air Layering." To carry out this research, various IBA concentrations were applied: Control (T_1), IBA 1000 ppm (T_2), IBA 1500 ppm (T_3), IBA 2000 ppm (T_4), IBA 2500 ppm (T_5), and IBA 3000 ppm (T_6). Practice of air layering was done on 7-month-old rootstocks that had been grafted approximately 1.5 months prior. Observations were recorded on various morphological and biochemical traits from each replication. The results demonstrated that the treatments with varying IBA concentrations significantly influenced most of the shoot and root characteristics in comparison to the control. Notably, the 3000 ppm IBA treatment exhibited superior results for numerous morphological traits, including enhanced rooting, growth, and success rates of the layers. Conversely, the control treatment yielded the least favourable outcomes.

OL-117

A COMPARATIVE ANALYSIS ON PROPAGATION TECHNIQUES OF *BASELLA ALBA* L.

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An attempt has been made in the present investigation to study the performance of five propagating materials viz. normal seeds, scarified seeds, two node cuttings, four node cuttings and tip cuttings to grow out and perform in three growth media viz. soil only, sand only and soil + sand(1:1) mixture. The experiment was laid out in Completely Randomized design having three replicates. A total of 15 treatment combinations were under study. The treatment combination comprised of two factors viz. Factor 1 = M (Media) and Factor 2 = P (Propagating material). Survivability percentage was highest (100%) in 4 nodes cutting in soil followed by 2 nodes cutting in sand and tip cutting in sand. Length of the vine was maximum in tip cutting in soil throughout the period of experiment.. Girth of the stem was highest in 2 node cutting in sand during the initial growth stage, however at 45 days after sowing (DAS) it was highest in seed sown in sand +soil(1:1). Number of nodes on the stem was highest in tip cutting in soil due to it's rapid stem formation and throwing out of new shoots from the nodal points. The maximum internodal length was observed in tip cutting at soil as compared to others. Result of number of nodes and internodal length at different DAS are corelated and noted that with rise in the number of nodes, the internodal length also increased. Increment in number of side shoots was highest in seed sown in soil and least in scarified seed in sand. Number of leaves/plant was highest in 4 nodes cutting in sand at

15 DAS, however at 30 DAS total no of leaves/plant was highest in tip cutting in soil. Length and width of leaf was highest in seed in sand + soil media (1:1). Number of prominent veinlets was highest in 4 nodes cutting in sand + soil (1:1). Total leaf area was highest in scarified seed in sand +soil (1:1) Number of lateral roots was highest in tip cutting in sand and least in 2 node cutting in sand at 45 DAS. Average weight of the roots/plant was higher in seed sown in sand +soil (1:1) having more stouter roots. Edible fresh weight /plant was highest in seed grown in sand +soil (1:1) and least in scarified seed in sand. In the present findings, soil+sand mix was a better option than soil alone due to optimal holding of water and maintenance of turgor pressure in the leaves. It may be concluded that growth media significantly influenced the growth and ultimately the yield in Basella. Strong correlation existed among the growth media and propagating materials under study. The highest yield was observed in seed grown under sand+soilmix(1:1) ,followed by tip cutting,4 node cutting and 2 node cutting.

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STIONIC COMPATIBILITY OF ROUGH LEMON WITH DIFFERENT CITRUS ROOTSTOCKS

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The Rough lemon of Assam, with its distinctive appearance and tangy flavour, holds a special place in the cultural heritage and economy of the region. As an integral part of Assamese cuisine and with potential applications in the pharmaceutical and cosmetic industries, this citrus variety continues to be relevant to both local consumers and potential export markets. Its significance is likely to persist as demand for unique and traditional produce continues to grow, contributing further to the livelihoods of the rural people of Assam. Rough lemon is typically propagated through seeds, resulting in a long juvenile phase, delayed flowering and fruiting. Considering the monopolized propagation of Rough lemon, there is a necessity for an alternative approach to achieve early economic production and quicker returns. Therefore, a study was conducted to assess the compatibility of various citrus rootstocks with Rough lemon by adopting wedge grafting technique at AAU–Horticulture Research Station, Kahikuchi, Assam under subtropical climatic conditions. Eleven different rootstocks namely Rangpur lime, Italian rough lemon, Troyer Citrange, Kachai lemon, Godha Rough lemon, Khasi papeda, NRCC–1, NRCC–4, Alemow, SFS, X–639 were selected for the study and 30 grafts in each treatment and replication were taken as sample size. Healthy scions of Rough lemon were used for grafting on one year old seedlings of different citrus rootstocks raised in black polythene bags. The investigation revealed that Rough lemon has better graft compatibility with

rootstocks such as Godha Rough lemon, NRCC–4, Troyer Citrange, resulting in higher graft take (91.31%, 84.78%, 83.51%) and survival rates (88.61%, 79.47%, 80.69%) respectively, as well as better stionic growth.

OL-150

QUALITY PLANTING MATERIAL PRODUCTION OF CASSAVA THROUGH SEED VILLAGE

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Cassava is the most popular tuber crop among all tropical tuber crops. It has enormous potential in India for food security and industrial uses due to its ability to grow in marginal and waste lands where other crops do not survive. Cassava can produce more calories per unit area and drought tolerance is mainly due to its in built physiological mechanism to shed the leaves under adverse moisture conditions. In India, cassava is grown in an area of 0.183 million ha with a production and productivity of 6.94 million tonnes and 37.93 t ha^{-1} respectively. Cassava is propagated through vegetatively through done from stem cuttings and because of the low multiplication rate as compared to cereals and pulses, the high yielding varieties released in the research institute takes many years to reach the farmers. The non availability of quality planting materials at the time of planting continues to remain as a major stumbling block in the fast spread of high yield varieties and their adoption by the farming community. An attempt was made to produce quality planting material production of cassava through farmer participatory approach as seed village programme. The quality planting materials improved varieties of cassava viz., Sree Jaya, Sree Athulya, Sree Vijaya and Sree Reksha were distributed to farmers of Salem district in Tamil Nadu during 2020 and 2021 by ICAR-Central Tuber Crops Research Institute, Thiruvananthapuram, Kerala.Quality planting material of cassava stems were distributed to farmers for covering an area of 50 cents of each and total of 30 farmers selected and covered 6 ha area. The cultivation of cassava was carried out the under the guidance and the field inspection and direct supervision of scientists ICAR-CTCRI, Sreekariyam, Thiruvanathapuram, Kerala. Farmers got an average tuber yield of 6.50 kg and 5.50 kg per plant with an average number of tubers 7.50 per plant in Goodamalai and Narasinghapuram village respectively. Improved varieties of cassava produced significantly higher average tuber yield of 68.70 t ha^{-1} and 53.68 t ha^{-1} at Goodamalai and Narasinghapuram respectively. The net income benefit – cost ratio was 5.58:1 in the Goodamalai and 4.75:1 in Narasinghapuram. In both the location farmers could also produce 1.50 lakhs stems of improved varieties of cassava from 6 ha area within one season which were distributed to neighboring farmers

and near by districts for covering an area 100 ha.seed village programme is a novel, demanding and highly practical approach which needs to be encouraged to facilitate production and timely distribution of quality seeds of improved varieties of cassava for self sufficiency at village level.

OL-53

COMMERCIALIZATION OF SUSTAINABLE PLANT TISSUE CULTURE TECHNOLOGIES IN BIHAR

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Lack of availability of quality, disease-free and genuine planting material of horticultural crops at reasonable price is one of the major constraints faced by the growers of the Eastern India which affects the overall production and productivity of these crops. Tissue culture is seen as an important technology in many countries for the rapid production of disease-free and quality planting material of horticultural crops. Although the tissue culture industry began in Eastern India over a decade later than it did in the rest of the nation, its growth in recent years has been exponential, and the facilities being built are on par with the best in the nation. The tissue culture laboratory in Bihar Agricultural University, Sabour is one of the leading tissue culture laboratories in the country for commercial production of quality planting material of horticultural crops. With an annual production and sale of 10 lakh plants, the laboratory is currently involved in large-scale commercial production of disease-free planting material of the banana cultivar Grand Naine. An efficient regeneration protocol through somatic embryogenesis and organogenesis has been also developed for different cultivars of pineapple and many ornamental crops with higher multiplication rate in our studies. These technologies are now being commercialized for large scale production of quality planting materials. Furthermore, the laboratory is also involved in the standardisation of efficient tissue culture protocols for different cultivars of strawberry, litchi, mango, dragon fruit and other horticultural crops which includes threatened and endangered cultivars of banana viz. Malbhog, Alpan, Chinya and Kothia. These protocols will prove to be very effective for area expansion of Horticultural crops in Eastern India. This paper is aimed at critically analysing our ongoing tissue culture research activities and the potential role and scope of sustainable tissue culture technologies for commercialization and in preserving threatened and endangered genotypes.

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STANDARDIZATION OF EMBRYO RESCUE TECHNIQUE IN MANGO

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Improvement programme in perennial crop like mangois very much challenging for fruit breeders. Heavy fruit drop (≈ 99.9%) in mango limits the varietal improvement work especially at the time of inter-varietal as well as inter-specific hybridization. Post-zygotic endosperm abortion and embryo degeneration are limit the wide crosses in mango. In such cases, embryo rescue can be a potential technique to rescue immature embryos well before their degeneration to get successful hybrids from the wide crosses in mango. Research from 2021 to 2022 sought to create an embryo rescue method for mango cv. Amrapali. The results showed that surface sterilizing immature mango embryos for 25 minutes with $HgCl_2$ (0.1%) led to a survival rate of 60.74%, with minimal death (6.74%) and contamination (32.30%). When culturing immature embryos (15–50 days old) on establishment media, embryo establishment increased with embryo age, with 45–50 days old embryos having the highest success (90.03% establishment, 96.54% germination), followed by 35–40 days old embryos. Woody plant medium containing casein hydrolysate (2.5 g l^{-1}) and glutamine (0.4 g l-1), with or without coconut water (100 ml l^{-1}), was the best base media composition for establishment, germination, and regeneration of plantlets. The best root and shoot initiation was achieved with B5 media and comparable additions. Following regeneration, sub-culturing plantlets to PGR-based basal media enriched with BAP (1.0-1.5 mg l^{-1}) and GA_3 (1.0 mg l^{-1}) produced considerable root and shoot lengths (15.32–15.45 cm and 11.63–12.30 cm, respectively), as well as rapid vegetative growth. This medium also facilitated fast plantlet growth, making them ready for primary hardening in 46 days. During primary and secondary hardening, survival rates were around 60-91.67%, confirming that 45-50 days old embryos had the highest regeneration capacity, followed by 35-40 days old ones. Optimal conditions included surface sterilization with $HgCl_2$ (0.1%) for 20-25 minutes, followed by culturing in Woody plant media fortified with casein hydrolysate (2.5 g l^{-1}) + glutamine (0.4 g l^{-1}) with/without coconut water (100 ml l-1).Subculture in Woody plant media with GA_3 (1.0 mg l^{-1}) + BAP (1.0-1.5 mg l^{-1}) was advised for robust vegetative growth.

TECHNOLOGY FOR THE VERTICAL EXPANSION OF NURSERY UNDER PROTECTED CONDITIONS USING SOILLESS ROOTING MEDIUM

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The vertical expansion through air-layering of the nursery was developed to utilize the available vertical space in the greenhouse and the vertical growth of plants. The multiplication of clonal rootstocks including (M9, Pajam, T337, T339, MB-9, P-22, and M-27) was done by using this technique. Apple rootstocks having a diameter of (5 mm and above) at 30 cm (1.0 ft) above ground level were selected and wounding/incision was given by sharp knife/blade and rooting hormones IBA (2500 ppm) was applied to the wounded portion. The wounding is done to the targeted region to expose the inner stem for applying the rooting compound. The operation was started from the second week of June till the last week of August. Black colour polybags filled with rooting medium have been fastened at the points where rooting needs to be initiated. A lightweight substrate (Cocopeat) with having high water holding capacity was used. Staking was done with the help of bamboo sticks to hold the bags in a proper position. watering at regular intervals was done to keep the rooting media moist. Sufficient rooting has been recorded in all the rootstocks. From the data, it is revealed that the highest number of additional rootstocks (3.9) was harvested in MM-106, whereas the minimum number of per rootstock (2.1) was harvested in M-27. Maximum root length (15.83cm) was recorded in M9-Pajam and minimum (9.67cm) in rootstock M9-T339. Maximum root dia (2.39mm) was recorded in MM-106 and minimum (1.10mm) in rootstock B-9. Maximum root dry weight (3.70g) in treatment in rootstock MM-106 and minimum (1.80g) in rootstock B-9. This technology will be very useful in promoting the vertical expansion of the nursery in greenhouse conditions and no. of plants per unit area can be increased 3-4 times without utilizing any extra inputs. One more additional benefit of this technology is that under greenhouse conditions a plant attained a sufficient girth, above (5mm) and all the daughter plants are suitable for budding operation. The budding has been done to about 75% of plants with an almost 95% success rate. This technology not only produced the additional 2-4 plants but also the budded plants which added further advantage to this technology that budded plants with well-developed root systems are produced in one year of the nursery cycle. The technology has been replicated in farmer's field in open field conditions and promising results.

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STUDIES ON AVAILABLE MICRONUTRIENT STATUS OF DIFFERENT COFFEE GROWING SOILS OF INDIA

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The productivity of coffee plant is significantly influenced by soil qualities. The coffee growing soils of the hills and plateaus of Western Ghats are developed in hot humid tropical climate. These soils are generally deep to very deep, low activity clay, with acid reaction. The chemical environment and the availability of nutrients have a major impact on crop production when the physical condition of the soils is favorable for the plant. Micronutrients perform specific and crucial roles in plant metabolism. Micronutrient deficiencies can result in metabolic disturbances that have an impact on coffee production and beverage quality. Boron availability in the soil is primarily related to soil reaction, it is most available at low pH, and conversely it is easily leached from acid and sandy soils. Boron deficiency is relatively common in acid and sandy soils, owing to low supply of total boron instead of low availability of the boron. Among plantation crops, coffee is most sensitive species to B deficiency and being very responsive to B fertilization. Plant response to B is probably very dependent upon the time of B application. To assess availability of micronutrients along Boron (B)status of traditional coffee growing are as in South India, total of 6,537 soil samples were collected representing the coffee growing regions of Karnataka, Kerala and Tamil Nadu. Samples were processed and analyzed for micronutrients viz., zinc (Zn), copper (Cu), boron (B), iron (Fe) and manganese (Mn)by using the standard procedures. The soil analytical data of Zn content has concluded that, In Karnataka, Hassan district (22%) soils were more deficient than the other districts (0-16%). In Kerala, the deficiency of available zinc was more in Wayanad (15%) compared to Idukki (8 %) district. Most of the districts of Tamil Nadu had sufficient level of available zinc except Namakkal and Nilgiris (14 and 19% deficiency). The Zn deficiency can be corrected by foliar spray of properly neutralized solution of zinc sulphate (0.2%). The available copper content in these soil was ranged from 0.3 to 430 $mgkg^{-1}$ and the deficiency was recorded in only 6% samples. The soil analytical data revealed that, deficiency of available boron was reported in 35% of the soil samples and its distribution was nearly the same in all the states (32-36%). In Karnataka state, Hassan was found to be higher B deficiency (40 %) followed by Kodagu (36%), Chikmagalur (34%) and Chamarajanagar (30%) districts. In Kerala state, Idukki district higher B deficiency was recorded (39 %) compared to Wayanad (31%) district. Similarly,

in Tamil Nadu state, Nilgiri district had higher B deficiency (42 %) and Namakkal had the least (10%) B deficiency. Whenever available B deficiency is observed, foliar spray of 0.3% boric acid or 0.5% borax is recommended for supplying the B nutrient to plants. Pre blossom foliar spray of B nutrient, along with other micronutrients aid in augmentation of growth and productivity of coffee plants. The coffee growing soils of India were found to be well supplied with the micronutrients like Fe and Mn, in case any deficiency of these micronutrients, foliar sprays/corrective measures suggested.

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PARTHENOCARPIC MANGO MATURES AND RIPE EARLIER THEN NON-PARTHENOCARPIC MANGO (*MANGIFERA INDICA* L.)

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The mango (*Mangifera indica* L.) is one of the major fruit crops of tropical and sub-tropical regions of the world especially in Asia. Apart from being consumed as fresh fruits, mangoes are extensively processed into various value added products such as pulp, squash, candies, pickles etc. making their cultivation a profitable proposition to the growers. Dashehari mango is one of the leading mango varieties of North India and area under this variety is increasing in other parts of the country also. The variety is relished due to its pleasant taste, aroma and high pulp content. In this study Dashehari mango were harvested during last week of May and subjected to natural ripening. Fruits ripe in 5-10 days with 19% loss in total moisture content. Fruits were found two types of stones (a) having well developed large cotyledon, radicle and plumule. Such stones germinate and give rise to seedlings (b) parthenocarpic stones having undeveloped cotyledon, radicle and plumule, incapable of producing mango seedlings. Temperatures fluctuation during flowering and fertilization period, lead to production of parthenocarpic fruits, by reducing pollen viability and pollen tube growth or by causing embryo abortion in various fruits. Parthenocarpic fruits mature and ripe earlier than normal fruits. Further, in stoned fruits the cotyledon size increased with size of the stone while in parthenocarpic fruits the cotyledon size significantly does not alter significantly.

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NEXT GENERATION MOLECULES FOR INCREASING HORTICULTURAL CROP PRODUCTION

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A molecule is the compound that is made up of atoms that are held together by chemical bonds. Newly emerged synthetic compound are now used in the field of horticulture for enhancing production and productivity. It is estimated that it costs about 150-200 million to discover a new product, test it thoroughly for its action and its safety for the environment, and develop manufacturing techniques for its synthesis. It takes an average of 10 to 15 years to do this so it is small wonder that, worldwide, only about 12 chemicals are introduced each year. However, these chemicals are key to the efficient production of food. New molecules are preferred over old molecules as it is more promising and durable, environment friendly, required in less quantity and have less residual effect. New class of hormones, synthetic chemicals, nano particles etc has been playing important role in the horticultural field. These new molecules show effective biological response to avoid abiotic and biotic stress in the era of climate change. Need of new molecules is to increase productivity of crops, for improvement in efficiency of input use (cost saving), increase in crop intensity, tolerance against diseases etc. Brassinosteroid is a new class (sixth class) of plant hormone. It is extracted from rapeseed pollen. The BR is biosynthesised from campesterol. The yield of brassinosteroids from 230kg of Brassica napus pollen was only 10 mg. Brassinosteroids helps in enhancing yield by 20-30 %. It also helps in avoiding stress. Fruit set increased by 0.5 to 2.5 times. It regulate cell cycle and consequently cell division and hence, increasing production.Jasmonates act as plant defence against environmental stress, which is derived from *Jasminum grandiflorum*. Reports depict the increase in anthocyanin content in fruits. Salicylic acid (SA) is synthesized from phenylalanine. It is a monohydroxy benzoic acid. SA also induces specific changes in leaf anatomy and chloroplast structure. SA is involved in endogenous signalling, mediating in plant defence against pathogens. SA increases the shelf life, reduces disease incidence, alleviate chilling injury, act as an antioxidant and reduces browning in fruits and vegetables. Certain molecular compounds like Hexanal have been reported to extend the shelf life up to 52 days in mango. The hexanal sprayed mango trees remain green and fruits are shiny and retained in the trees itself for 2-3 weeks longer when other trees have already been harvested. New generation polyamine is low-molecular weight organic compound having two or more primary amino groups, linear polyamines perform essential functions in all living cells examples are putrescine, cadaverine, spermidine and spermine. Nano Molecules is new in the field of Nanotechnology. It is the branch of technology that deals with dimensions and tolerances of less than 100 nanometres, especially the manipulation of individual atoms and molecules. Nanoparticle based sensors/assays to detect contaminants in foods or monitor

changes in packaging conditions or integrity. Nano sensors are used to detect the presence of gases, aromas, chemical contaminants and pathogens, detection of food adulterants, allergens or contaminants. Some Nanoparticles used in disease and pest management (Crop Protection) like Biopolymer nanoparticles,Metallic nanoparticles, Nano composites like Chitosan, Silver nanoparticles, Silica nanoparticles, Copper nanoparticles, Zinc nanoparticles, Chitosan Silver NP etc. The application of new generation molecules may improve the physiological efficiency of the crop growth and development mainly on delaying senescence, ethylene regulation, chlorophyll retention, pest and disease resistance, postharvest shelf life and quality in fruit crops. The time of application, crop stage, dosage, age of crop, plays an important role for effective utility of new molecules. However, the availability, toxic effect and cost were the limiting factors of these molecules are still needed to be explored. New molecules are is an ecofriendly and improved approach for increasing horticultural crop production. The promotion of these molecules are must require to fetch the maximum income from the crop.

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STUDIES ON SPREAD, ACCEPTANCE AND PROFITABILITY OF ICAR-IIHR RELEASED BRINJAL AND CHILLI HYBRIDS IN SOUTH INDIA

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ICAR-IIHR developed many superior high yielding vegetable hybrids have made great impact at the national level due to its higher yield potential coupled with good quality fruits and tolerance to major diseases. Thespread, acceptance and economic feasibility of ICAR-IIHR released brinjal hybrid “Arka Anand,” and high pungent chilli hybrid “Arka Haritha”were studied based on survey carried out in South India (Tamil Nadu, Kerala, Karnataka, Andhra Pradesh and Telangana). The per centof area spread was 1.26 % to covered an area of 2850ha in Arka Anand brinjal at South India. In case of chilli hybrid “Arka Haritha”, maximumspread was 1,05 % and it was covered an area 3160 ha in South India. The reasons for spread and acceptance of brinjal hybrids are listed here based on farmers (adopters) opinion (i) High yielding capacity (86.6 %) (ii) Cluster and continuous bearing (80.0%) (iii) Good fruit quality (73.3%) and (iv) Resistant to bacterial wilt (70 %) The main reasons for non-adoption of brinjal hybrids in farmers field are (i)Less market demand (Colour and shape @84.3%) (ii)Less consumer preference (80.0%) (iii)Not aware of this hybrid (70.0%) (iv) non-availability of quality seeds at their location (60.1) and (v) Poor storage life (52.1%).Economic impact study on Arka Anand hybrid in comparison with Private hybrid revealed that there was an improvement in yield (12.3%v)was noticed in Arka Anand when compared to private hybrid. Moreover, it was observed 13.2 % lesser cost of production with the B:C ratio of 1:2.49 was noticed in Arka Anand.

The reasons for spread and acceptance of chilli hybridsare listed here based on farmers (adopters) opinion (i) Medium to High pungent fruits (76.7%) (ii) High yielder (70.8%) (iii) Attractive dark green fruits (62.5 %)and (iv) Less incidence of powdery mildew diseases (34.1 %).Further, It was noticed that 70.8 – 76.7% of the farmers accepting ICAR-IIHR released Chilli Hybrid "Arka Haritha"in South Indiabecause of its high yielding potential coupled with good level of pungency. In case of economic benefit,12.9 % higher yield,13.6 % lesser cost of production coupled with higher cost benefit ratio of 1:3.31 was observed.

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PERFORMANCE OF NAGPUR MANDARIN ON RAISED BED AND CONVENTIONAL FLAT SYSTEM

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Nagpur mandarin is one of the most important commercial cvs and occupied an important place in Central India and adjoining parts. As Citrus is a sensitive fruit crop for water logging and *Phytophthora* is an important disease in all the Citrus spp. The loose soil favours better root growth for all the mandarin plants on raised bed. Water stagnation does not take place and thereafter *phytophthora* root rot problem can be minimized by using this plantation method. This may also prove the most efficient appropriate method in replant soils.The inter cultivation in the furrow space do not affect or damage the root system of citrus plant on the raised bed.Threfore an experiment of Nagpur mandarin was initiated 2019 on raised bed with 2m width, 1.5 feet height and compaired with conventional flat system in black clay soil at experimental farm of Central Citrus Research Institute,Nagpur. The plant height was recorded maximum on raised bed system 3.58m whereas in flat bed system noted to be minimum (2.79m). The overall canopy was recorded to be significantly maximum i.e. 8.53 m^3 in raised bed whereas about half growth was recoreded in flat system. The available soil micronutrient was recorded higher in raised bed i.e. 248.37kg/ha and 1919.12kg/ha N and K respectively as it was minimum in flat system. The fruit yield was noted significantly higher (14.94 t/ha) in raised bed as compaired to flat system (11.28 t/ha) of the second year fruiting. Juice percentage i.e. (52..29%) was maximum noted in raised bed system as compaired to flat system(47.68%). Whereas, rind thickness i.e.3.69mm and number of seed in fruits 2.58 noted minimum in raised bed and other fruit quality data did not showed much variation. During study the *phytophthora* population density (propagule/cc soil) was recorded minimum (2-3) on raised bed whereas it was noted maximum (30-40) and clearly indicated better potential with respect to disease intencity on bed as *phytophthora* propagule counts were taken from soil rhizophere near trunk. This study indicated significantly better growth, higher fruit yield and less *phytophthora* incidenceon raised bed tree as compaired to conventional flat system plantation.

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TAPPING THE UNTAPPED POTENTIAL OF MINOR HORTICULTURAL CROPS FROM MEWAR REGION OF RAJASTHAN

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The region has two climatic zones the first zone is Sub Humid Southern Plain and Aravallis High hills. The zone extends in the southern part of the state in Bhilwara, Rajsamand, Sirohi, Udaipur and Chittorgarh districts. The zone receives 700- 900 mm rainfall. The second zone is Humid Southern Plain This plain characterized by hills and valley fills is spread in the southern part of the state in Durgapur, Banswara and Pratapgarh districts. This zone receives 900-1000 mm rainfall. This region has lots of horticultural biodiversity. There is huge horticultural potential and the region has become a natural home for custard apple, jamun, mango and jack fruit beside some other fruits and vegetables like spine gourd and balankakari which have unique identity of the region. Some of these fruits are naturally growing in the forest area are providing livelihood to local tribal population. In some of these horticultural crops we have identified promising germplasm, characterized it for further use and developed complete value chain for commercial exploitation. Our interventions have provided lot of employment and economically empowerment to tribal community particularly women. Here an attempt has been made to show how small scientific interventions can improve the livelihood and economy of a region through local horticultural wealth

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STATUS AND PROSPECTS OF AVOCADO CULTIVATION IN INDIA

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Avocado (*Persia americana*) is a native to tropical America. It was originated in Mexico and Central America, possibly from more than one wild species. The

early Spanish explorers recorded its cultivation from Mexico to Peru. Avocado production increased almost 1100 percent as compared to 1961. Avocado is the most nutritive among fruits. The pulp is rich in proteins (up to 4%) and fat (up to 30%), In India, Avocado was introduced in Bangalore and hill stations like Kallar near Nilgris, Palani hills of Kodaikanal, Shrevaroy hills of Yercaud, Coorg during 1912 and 1940. Later the seedlings of those varieties spread over humid subtropical region but remain neglected. The avocado cultivation has gained an overwhelming popularity during last one decade due to nutritional properties of the fruits. Presently around 7000 tones of avocados annually and the production is increasing rapidly as more and more areas is being brought under cultivation. The agro- climatic conditions prevailing in various parts of the country appear to be favorable for bringing more areas under avocado. Recently several varieties belonging to all three horticultural races i.e., West Indian, Guatemalan and Mexican have been introduced in India. Some varieties such as Arka Supreme, TKD-1, Arka Ravi were released from CHES (IIHR), Chettalli (Coorg) and HRS station Thayangudusai (TN). CHES (IIHR), Chettalli standardized the cleft grafting method for multiplication of avocado. Avocado is planted at a distance of 6 to 8 meters depending on the vigor of variety and growth habit. Avocados need heavy manuring, and application of nitrogen has been found to be most essential. In general, young avocado trees should receive N, P_2O_5 and K_2O in the proportion of 1:1:1 and older trees in the proportion of 2:1:2 .The fertilizers should be applied in two split doses. Grafted avocado platns starts bearing at 3-4 years after planting .There is specific problem in fruit set as far as avocado is concerned. Thus both A & B types should be planted in the orchards for proper pollination and sufficient number of pollinators should be encouraged by keeping honey bee boxes. The studies conducted at CHES, Chettalli revealed that *Apis cerena* was the major pollinator followed by *Apis florea*, *Tetragonula* sp. and ants. Avocado plants seedlings start bearing five to six years after planting while grafted plants start yielding in 3-4 years. Mature fruits of purple varieties change their colour from purple to maroon, whereas fruits of green varieties become greenish-yellow. Harvesting is done manually and bruising and exposing fruits to direct sunlight should be avoided. The yield ranges from 100 to 500 fruits per tree. In Sikkim, fruits are harvested during July to October. In Coorg, fruits are available from June to October, while in Tamil Nadu July-August is the peak harvest time. Presently, there is no organized marketing system for avocado as the production is small and production areas are scattered. Avocados are mostly produced in Coorg, Chikmagalur, Shivamogga, Kodaikanal, Lower Palani hills, Kallar and Wayanad. The most consuming centres include Bangalore, Goa, Mumbai, parts of Tamil Nadu and Kerala. Fruits of 700 g are preferred for export market while for domestic market 400-500 g fruits are preferred. In Kodaikanal area, the fruit maturity starts in the month of March and continues up to January. The peak harvesting season is June to August. Thereafter the production decreases with marginal production in January. There is no production in March in this area. The production in Ooty shows similar trend. In Kodaikanal area during peak season 40-50 tonnes avocados are available every day. While peak harvest production in Ooty area is about 5-10 tonnes per day. In Gundlupet, H D

Kote, Kodagu, Hassan and Chikmaglur, the maximum production is 3-5 tonnes per day in peak season. The whole sale price in these growing regions varies as per the arrival of the produce. The price is highest (Rs 260/-) in the month of Feb-March when there is negligible production, while it is lowest in August when the arrival of the produce is highest. The demand of avocado is manly in metro cities like Chennai, Bengaluru, Mumbai, Delhi and Ahmadabad. The retail prices vary from Rs. 150 to Rs 400/ per kg. The lowest average prices are in Bengaluru and Chennai and highest prices are in Delhi and Mumbai. It is estimated that presently there is demand of 20 tonnes avocado per day in India which is mainly confined to major cities. Avocado is mainly used fresh, in sandwich filling or in salads. It can also be used in ice creams and milk shakes and the pulp may be preserved by freezing. Several products of avocado i.e. Arka avocado chutney, Arka avocado bread spread, Spray dried avocado powder have been developed by ICAR-IIHR, Bangalore.. The area is rapidly growing the subtropical region viz. Maharashtra, Karnataka, Tamil Nadu, North Eastern States etc. of the country. The seminars, workshops, field days, awareness programmes, demonstrations etc. conducted by ICAR-IIHR, Bangalore during last one decade played a vital role in popularization of avocado in the country. Visualizing the demand and rising popularity of avocado at domestic and international level, there is good scope of Avocado cultivation in India. There is need to provide suitable technological backup to fulfil the requirement of growers, processing industry and consumers.

OL-68

SYNTHETIC SEED PRODUCTION OF MINOR HORTICULTURAL CROPS FOR CONSERVATION, UTILIZATION AND COMMERCIALIZATION OF GERMPLASM

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One of the most exciting applications of plant biotechnology is synthetic seed, which has the potential to improve horticultural crops both now and in the future.

By encasing the plant propagules, artificial seeds can be successfully created in a variety of plant species. This method has been deemed advantageous due to its low cost of plantlets, cost-effective delivery system, straightforward methodology with high potential for mass production, promising method for the direct use of artificial seedlings *in vivo* and large storage capacity. Additionally, it promotes refining the encapsulating matrix for the mass production of synthetic seeds. Encapsulation and somatic embryogenesis techniques in plant biotechnology produce a novel and potentially useful tool for efficient and economically advantageous larger-scale propagation, breeding, *in vitro* conservation, non-embryonic synthetic seed production and exchange and distribution of germplasm. The creation and advancement of synthetic seed technology has been examined and confirmed as an authentic method of propagation in a number of economically significant horticultural crops. It has also been suggested as a potent tool for mass propagation of elite plant species with high commercial value. These synthetic seeds would also serve as a means of delivering new plant lines created using biotechnological tools directly to the greenhouse or field. They are also thought to be a high-volume, low-cost production technology that is simple to transport and handle while in storage and that has the potential to be stored for an extended period of time without losing viability. This maintains the genetic uniformity of plants. Therefore, synthetic seed would serve as an advanced biotechnological tool for further conservation of minor fruits and other endangered germplasm.

OL-63

SMART AGRONOMIC PRACTICES FOR ENHANCING FRUIT QUALITY IN POMEGRANATE IN ARID CLIMATE

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Pomegranate cultivation in north-western Indian states particularly arid Rajasthan is comparatively new but the R & D support made paradigm shift from traditional to commercial cultivation with current acreage expansion to greater than 20,000 ha. However, the prevailing environmental factors such as intense solar radiation, high wind speed, and abrupt temperature fluctuations between day and night during the ripening period can significantly affect fruit quality which consequentially hampers the marketability, at both domestic and international market. The sustained higher profitability of a pomegranate orchard relies heavily on the production of a greater proportion of high-quality fruits, a goal achievable through the implementation of effective management

practices. The objective of this study is to provide supplementary knowledge regarding the response of pomegranate trees to various management practices under arid field conditions, with the aim of enhancing both marketable fruit yield and quality. In this study, four separate and simultaneous experiments were conducted in the same orchard, focusing on: (i) the response of seedlings derived from tissue culture, air layering, and cutting; (ii) the impact of crop load; (iii) crop regulation; and (iv) the application of organo-mineral fertilizers containing potassium (OMF-K) and phosphorus (OMF-P). The comprehensive study presented in this endeavour has effectively addressed and dispelled various misconceptions while confirming the fact that growth and fruit quality remain consistent regardless of the method of asexual propagation used. Any variations in fruit quality observed among plants raised from different types of planting material of the same variety can be attributed to differences in management practices implemented in the orchard. The management of crop load at an optimum level i.e., 80 fruits per plant emerges as a crucial cultural aspect for achieving higher marketable yields and superior-grade fruits with the best quality. Additionally, adopting a staggered crop regulation strategy from June to September allows for an extended harvesting season of four months, starting from the last week of November and continuing until March. This represents a significant improvement compared to the standard regulation, which typically spans only two months and is associated with a higher risk of fruit cracking. Soil application of the indigenously developed OMF-K in two equal splits, along with the recommended N and P through inorganic sources, significantly reduced fruit cracking by 6.23% compared to the recommended NPK through inorganic sources (26.9%), while maintaining similar physicochemical quality attributes. Overall, these findings provide valuable insights for pomegranate growers and emphasize the importance of effective management practices in optimizing crop load, extending the harvesting period, and utilizing appropriate fertilization strategies to enhance fruit quality.

OL-27

CONSERVATION AND SUSTAINABLE EXPLOITATION OF INDIGENOUS FERNS OF ANDAMAN AND NICOBAR ISLANDS FOR COMMERCIAL USE

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The fern flora richness in Andaman and Nicobar Islands is well evident by distribution of 126 species belonging to 60 genera and 37 families. Out of these, seven are endemic to these Islands viz., Sphaeropteris albosetacea,

S. nicobarica, Lindsaea andamanica, L. *rutlandia*, L. *tenera*, Pronephrium makaikeuim and Sphaerostephano skurzii. Among the non-endemic fern species 44 are not found in mainland India but extend their distribution to South East Asia including Myanmar, Thailand, Malaysia and Sumatra. The fern flora of Andaman Islands is distinctly different from that of Nicobars, which show similarity with Malayan flora. Among the 37 fern flora distributed in the island, 6 dominant families are Lindsaeaceae, Thelypteridaceae, Pteridaceae, Polypodiaceae, Aspleniaceae and Aspidaceae. Though the Island is rich in fern biodiversity they are neglected, less cultivated and underutilized. Ornamental utilization of the native ferns of the Island is one of the great avenues for economic growth in the Island. Since many of the ferns are endemic and have wide ornamental utilization, they will open up export opportunities and the growing demand for indoor plants in the world will fetch higher income both in domestic and international markets. The fern species collected, conserved and evaluated resulted in identification of potential species like *Adiantum tenerum*, *Asplenium falcatum*, *Asplenium nidus*, *Blechnum orientale*, *Davallia denticulate*, Lindsaea *endsifolia*, *Microlepia speluncae* var. *speluncae*, *Microsorium punctatum*, *Nephrolepis biserrata*, *Nephrolepis exaltata*, *Nephrolepis hirsutula*, *Palhinhaea cernua* Syn. *Lycopodium cernuum*, *Phlegmariurus phlegmaria*, *Pterisvittata*, *Sphaeropterisalbo- cetaceae* , *Sphaeropterisnicobarica*, *Tectariam* that are important for exploitation for commercial utilization.

OL-16

SYNTHESIZED ZINC OXIDE NANO-FERTILIZER TO ENHANCE BIOMASS PRODUCTION AND YIELD IN VEGETABLE CROPS

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Application of zinc containing fertilizers would become essential for the plant growth and development and to contribute better zinc nutrition for crop plants and higher dietary intake of zinc in human population. Recently, applications of engineered nanoscale nutrients have received considerable attention due to its high surface area to volume size ratio, exhibit improved uptake by plants and have potential to boost crop production. The present study was made for synthesis of zinc nanoparticles which were used as nanofertilizer to enhance biomass production and yield in some vegetable crops. ZnO Nanoparticles (ZnO NPs) were synthesized by chemical processes based on transformation in an aqueous solution and synthesized zinc nanoparticles were characterized for

confirmation of size, shape, surface structure, crystalline nature, and study of elemental proportion. The synthesized ZnO NPs were used as source of zinc fertilizer and its effect on the growth, biomass production and yield of cabbage, cauliflower and chili was studied. Plant height, root length and dry matter yield differed markedly between different levels of ZnO NPs and $ZnSO_4$ (a common source of Zn supplement). Results indicate that foliar application of ZnO NPs recorded significantly higher plant height, root length and biomass production both at 45 DAP and crop maturity. Significantly higher yield of cabbage (32.8%) and cauliflower (22.8%) was noticed in crops sprayed with 250 ppm ZnO NPs over the control while in chili, spraying ZnO nanoscale nutrient at 250 ppm significantly increased yield to the tune of 22.65% as compared $ZnSO_4$ @ 2500 mg/lt. Zinc contents were partitioned into leaves, stump and roots and it was found that the uptake of zinc was substantially higher in all the crops sprayed with ZnO NPs compared to control. Spraying ZnO nanoscale particles showed promotory effect on acid and alkaline phosphatise enzymes and dehydrogenase activity in rhizosphere which helps in enhancement in microbial activity, nutrient mobilization and availability of nutrients for plants uptake. The study addresses the positive effect of ZnO NPs and opens new door for its use as source of zinc fertilizer in plant nutrition of vegetable crops.

OL-42

FLOWER REGULATION IN POMEGRANATE UNDER HOT ARID CLIMATE

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Pomegranate is a promising fruit crop of hot arid regions. It flowers continuously with three distinct flowering seasons (ambe, mrig and hasta bahar) which may not be desirable commercially. Therefore, the present study was conducted to regulate flowering for optimization of fruit yield and quality. The flower regulation was carried out through water stress and ethrel application. There were ten treatment combinations including ambe bahar (Jan.-Feb.), late ambe bahar (March-April), mrig bahar (June-August), hasta bahar (Sep.-Oct.), ambe + mrig bahar, ambe + hasta bahar, late ambe + hasta bahar, mrig + hasta bahar, ambe + mrig + hasta bahar and control (natural flowering). Among the treatments, significantly higher fruit weight was found in mrig bahar (257.41 g) followed by hasta bahar (240.38 g) as against control (180.97 g). The significantly maximum fruits yield/plant were observed in mrig bahar (14.99 kg) followed by mrig + hasta bahar (11.13 kg) and hasta bahar (10.87 kg) as compared to minimum in control (4.65 kg). Significantly lower fruit cracking was observed in ambe bahar (8.50%) followed by late ambe bahar (9.33%) while maximum in control (22.50%). Maturity index was found significantly maximum (45.45) in hasta bahar followed

by mrig bahar (40.12) as compared to control (27.44). Aril colour was varied from light pink to dark red while rind colour varied from light red, red to dark red among different flower regulation treatments. In conclusion, mrig bahar found highly suitable under hot arid climate to get improved yield and quality.

OL-14

EFFECT OF GENOTYPES ON GROWTH, YIELD AND QUALITY OF CHERRY TOMATO UNDER PROTECTED CULTIVATION

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The cherry tomato is a type of small tomato believed to be an intermediate genetic admixture between wild currant-type tomatoes and domesticated garden tomato. It can be said that Cherry tomatoes are named for its shape which resembles a cherry. Sometimes sold on the vine, the vegetable can range from a thumb tip up to the size of a golf ball and can be red, yellow, orange, green, or almost black, range from spherical to slightly oblong in shape. These tomatoes are prized by chefs for their juiciness and thin skin, which causes the fruits to pop in mouth when eaten. The affordable veggie can be eaten as is after a quick rinse and doesn't require peeling, seeding, or even chopping. Earlier it was being seen in foreign countries but in India it is gaining popularity very fast. Its cultivation under open field condition is affected by certain biotic and abiotic factors but under naturally ventilated polyhouse condition its performance is 2-3 times better and fruiting time is enhanced by 2-3 months. Considering the above points the present investigations were planned and conducted under polyhouse conditions at Indian Institute of Vegetable Research, Varanasi from 2019-20 to 2021-22 i.e. continuously for three years to see the performance . Nine cherry tomato genotypes received under AICRP for protected condition trial was evaluated in Randomized Block Design with four replication. All the Agronomic practices were followed time to time for better crop stand. The observations were recorded at periodic intervals on growth, yield and quality characters. The pooled data of the three years from 2019-20 to 2021-22 shows that better growth, maximum yield 2.86 kg per plant, maximum yield 915.2 q/ha, maximum net profit Rs.7,49,620 and maximum B:C ratio 4.53 was recorded in the genotype CPCT-214. This ratio was significantly higher than the check and other genotypes tested.

OL-21

VARIETAL RESPONSE OF TURMERIC (*CURCUMA LONGA* L.) FOR SPACING UNDER PLASTIC MULCHING

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The experiment was carried out at the University of Agricultural Sciences, Raichur Karnataka, India during 2020-21 and 2021-22 using two popular varieties of Turmeric (*Curcuma longa* L.). Salem and Kedaram varieties which were subjected to know their response of fresh rhizome yield under varied planting geometry with 45 x 30 cm, 30 x 30 cm spacings under plastic mulches of 25 and 30 micron thickness. Both the varieties were also grown without mulched condition. The pooled results of the experiment for fresh rhizome yield, growth parameters and yield characters varied significantly. The Variety Kedaram resulted in significantly higher yield of 15.38 t/ha.(T_3=Kedaram , 30 x 30 cm, Plastic mulch of 30 micron) whereas, Salem expressed the higher yield of 13.89 t/ha.(T_8=Salem, 30 X 30 cm, Plastic mulch of 30 micron). However, both the varieties under unmulched condition have resulted in higher fresh rhizome yield during the experimentation period. The higher rhizome yield response of both varieties under the experiment might be attributed to the higher plant population under 30 x 30 cm spaced crop of turmeric than 45 x 30 cm.

OL-67

DEVELOPMENT OF GRAIN AMARANTHUS VARIETIES WITH HIGH NUTRACEUTICAL QUALITY AND YIELD FOR COMMERCIAL CULTIVATION

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This experiment was conducted at University Orchard, at Department of the Vegetable Science Horticultural College and Research Institute, Tamil Nadu Agricultural University (TNAU), Coimbatore. The grain amaranthus genotypes derived from National Bureau of Plant genetic resource (NBPGR), New Delhi and also collected from other parts of Tamil Nadu

The field study included thirty six grain amaranthus genotypes, under randomized block design with three replications at the spacing of 15x10 cm. Amaranthus is one of the few multipurpose crop which can supply grains and tasty leafy vegetables of high nutritional quality as a food and animal feed and also used as ornamental plants because of attractive inflorescence coloration. Amaranthus grains are highly nutritious rich in Protein , carbohydrates, vitamins and minerals and other essential amino acids compared with other cereal crops like barley , wheat etc. All twenty genotypes were differed for qualitative and quantitative characters viz. plant growth habit (spreading, erect and drooping), leaf colour (pinkish green, yellowish green, green and reddish green), inflorescence colour (yellowish green, pink and yellow), stem colour (yellow, yellowish green and reddish green), Inflorescence spininess (smooth and spiny) and seed colour (creamish, pale yellow and orange). The quantitative characters like plant height, leaf length, leaf width, inflorescence length, seed yield per plant, seed yield per plot. The nutritional quality like protein, carbohydrates, fibre, vitamins and minerals rich in the grain amaranthus .The results on quantitative and qualitative characters revealed that genotype EC- 359440 gave better performance for yield and yield contributing characters followed by IC –582977 and IC- 519515 Among the genotypes, EC-359440 recorded early flowering and early maturity, significantly high inflorescence length and seed yield.

OL-13

EFFECT OF DROUGHT PERIOD ON WATER STATUS, STARCH, TRANSPIRATION LOSS AND PIGMENT STATUS OF CYMBIDIUM HYBRID “PINE CLASS MOON VENUS” LINN.

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To understand fully the ecological importance of drought an experiment was conducted. Water content of roots, pseudo-bulbs and leaves; relative turgidity, water potential and transpiration rate of leaves gradually decreased as the period of drought increased. The carotene content of leaves increased slowly as the period of drought extended. The chlorophyll content reduced after 30th days of imposition of drought. Starch content of leaves at different stages gradually increased up to 20th days and then thereafter decreased slowly. However, the starch content of pseudo-bulbs at different growth stages consistently decreased throughout the drought period. The dry and fresh mass weight increased as the period of drought prolonged.

SATELLITE-BASED ASSESSMENT OF HORTICULTURAL YIELD VARIATION IN EASTERN BRAHMAPUTRA VALLEY

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The advent of sophisticated satellite sensors that have the capacity to monitor a large area at a time with minute details of small farm holders has made it possible to understand the agricultural/horticultural productivity of remote areas like the North Eastern part of India. In this present study, we demonstrate the potential of Landsat 9 sensors viz. Operational Land Imager-2 (OLI-2) and Thermal Infrared Sensor-2 (TRS-2) in assessing horticultural production of two districts of Eastern Brahmaputra valley of Assam state namely Dhemaji and Lakhimpur. This region of India has great genetic diversity and is one of the richest sources of fruit crops. Horticultural crops in this area are predominantly grown on the dykes of ponds for fish cultivation or in the small homestead garden just to meet the family's need which makes it more difficult to identify them in satellite images. The technique we adopted here is to classify different fruit crops using spectral-temporal features describing phenological changes in vegetation over changing seasons. The approach is based on remotely sensed data specifically the Normalized Difference Vegetation Index (NDVI) representing total Chlorophyll content. Vegetation index differencing between different fruit crops helps to delineate particular fruit plantations within fragmented tropical landscapes. Satellite Image Time Series (SITS) based crop type classification has been used on NDVI temporal profiles. Major fruit crop types of the study area have been classified using SITS-based classification during the 2022-23 growing season. We have compared four cloud-free Landsat images, the NDVI and temporal profiles. The results showed that satellite data-based yield estimates were in agreement with that of field survey-based estimates and the accuracy of the result largely depends on the quality of the ground-truthed data. High-resolution satellite imagery like Landsat 9 can be used to make predictions for small area horticultural activity which we frequently find in states like Assam where horticulture plants are mostly found in homestead gardens. Overall classification accuracies derived from the differences of the NDVIs vary from 85% -90% which can be improved further including more satellite scenes from different growing seasons. The same methodology can be adopted to classify and yield estimation for vast agricultural lands cultivated with crops having similar phenological traits. The finding of the present study can provide a reliable and efficient methodology for creating and updating crop inventories.

OL-106

PERFORMANCE OF COLOCASIA IN DIFFERENT TREE BASED AGROFORESTRY SYSTEM IN TERAI REGION OF WEST BENGAL

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The rising trend of human population exerts a great pressure on the stabilizing agro ecosystems for their food, fodder and fuel woods. According to FAO, 56 out of 117 developing countries didn't have sufficient land resources to meet their daily requirements with using low inputs. As productive lands are dwindling year to year, marginal farmers are forced to use fragile croplands and forest lands for agriculture. Even if, it is observed that traditional farming is not so profitable due to aberration of climate. To meet such targets, there is an urgent need to adapt integrated land use systems with proper improved technologies leading to multiple production comprising both tangible and intangible benefits. Agro forestry systems seem to be beneficial for enhancing productivity and land sustainability. Keeping in view the importance of agro forestry system as a sustainable cropping system, the present investigation is focused on the growth and productivity of colocasia as horticultural crop having tolerance to shade with *Anthocephalus cadamba*, *Swietenia macrophylla*, *Areca catechu* based agro forestry system along with open field condition in terai region of West Bengal.

OL-111

EFFECT OF FOLIAR APPLICATION OF NUTRIENTS ON GROWTH AND FLOWERING OF ORCHID (*DENDROBIUM*) UNDER NVPH

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Orchids, the most spectacular among flowers, are unique with their versatility in colour, form, size, shape and longer life span of the plant and flower. *Dendrobium* is considered as the second largest genus of orchids and found well under tropical climate. In view of the easiness in management practices and ready availability of hybrids from private importers, *Dendrobiums* now occupy

major area under orchid cultivation in the tropical states of India. Looking to the typically tropical climatic conditions of the South Gujarat, *Dendrobium* appears to be high potential crop. Further, there is lack of adequate information on management practices, right from planting to handling of harvested blooms that is an important factor in yield and flower quality of *Dendrobium* spikes. Besides, application of nutrients in optimum proportions, quantity is the key factors in regulating growth and flowering in cut flowers. Thus, the need was realised to standardise nutritional requirement for optimum plant growth of *Dendrobium*, hence this experiment was designed. The research was carried out at Floriculture Research Farm, ASPEE College of Horticulture, NAU, Navsari (Gujarat) during the year 2019-2021. Twenty seven treatment combinations of comprises of foliar application of N (200, 300 and 400 ppm), P (50, 100 and 200 ppm) and K (200, 300 and 400 ppm) were evaluated in CRD design with factorial concept and replicated thrice. The results shown that foliar spray of N, P and K @ 400, 200 and 400 ppm, respectively two times per week on plant increased spike yield and better flower quality. According to the pooled analysis, significantly maximum plant height (cm), number of leaves per plant, spike length (cm), rachis length (cm), floret size (cm), number of spike per plant, number of spike per plot and 500 m^2, vase life (days), leaf analysis of P and K content, was found best in the combination of N_3 (400 ppm) P_3 (200 ppm) and K_3 (400 ppm) (T_{27}).

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IMPACT OF CARBON DIOXIDE FERTILIZATION ON GROWTH AND TUBER YIELD IN CHINESE POTATO [*PLECTRANTHUS ROTUNDIFOLIUS* (POIR.) SPRENG.]

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Climate change warnings include the impending increases in atmospheric CO_2 concentrations and consequent influence on crop productivity. The growth and yield performances of Chinese potato (*Plectranthus rotundifolius),*a versatile aromatic tuber crop of the tropics were evaluatedunder elevated CO_2concentrationsat College of Agriculture, Vellayani, Thiruvananthapuram, Kerala during October to March 2020-21. The experiment was laid out in CRDwith six treatments [different substrates as sources of CO_2,s_0: no substrate, s_1: cow dung, s_2: coir pith, s_3: cow dung + coir pith (2:1), s_4: s_2 + *Pleurotus* 1g kg^{-1} + N + P (2% w/w) and s_5: s_3 + *Pleurotus* 1g kg^{-1} + N + P (2% w/w)], replicated thrice. Cuttings of Chinese potato were planted in grow bags placed in trenches that werekept covered from 4.00 pm to 10.00 am daily to trap and facilitate CO_2

fertilization. The study revealed that the amount of CO_2released varied with the substrates, the highest being in the treatment involving cow dung + coir pith + *Pleurotus*(s_5),nearly double the initial concentration in the second week. The increased CO_2 enhanced vegetative growth and, the biomass production conformed to the trend of CO_2release, the lowest being in the no substrate application. Senescence was early but tuber formation did not happen. The elevated CO_2 contributed more to the photo assimilatory area, chlorophyll content and biomass production,at the expense of tuber development which may be attributed to the influence of the higher temperatures with increasing CO_2 levels.

OL-131

EFFECT OF NPK BRIQUETTES AND NANO UREA ON YIELD OF TOMATO

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A field experiment was conducted by Krishi Vigyan Kendra, Sonitpur to study the use of NPK briquettes and Nano Urea and its effect on yield of Tomato variety Anup. The experiment was carried out at farmer's field during Rabi season 2022-23. The study was conducted in 0.3 ha of land where 0.1 ha was cultivated through farmer's own practice, 0.1 ha was cultivated by application of NPK briquettes through fertilizer deep placement (FDP) and 0.1 ha was cultivated by application of recommended basal dose of fertilizers + Nano urea as first and second split. A significant increase in yield can be seen in the plot where recommended dose of fertilizers in the form of NPK briquettes are applied. The yield recorded in this plot was found to be 365.32 q/ha. The yield of the plot where basal dose of fertilizers + Nano Urea as splits was applied was found to be 360.56 q/ha. The lowest yield was recorded in farmer's practice i.e. 348.02 q/ha. The weight of a single fruit was found to be highest i.e. 109.928 g in fertilizer deep placement plot (FDP) followed by 106.435 g in Basal+ Nano urea applied plot and 103.82 g in farmer's practice plot. The gross income amounted to Rs 38000, Rs 24000 and Rs 14000 respectively for FDP plot, Nano Urea+ Basal dose of fertilizer applied plot and Farmer's practice plot respectively. The benefit cost ratio was calculated to be 4.4:1, 3:1 and 1:3 respectively for FDP plot, Nano urea+ basal dose applied plot and Farmer's practice plot respectively.

OL-58

PHYTOREMEDIATION OF INDUSTRIAL AND MUNICIPALITY WASTE WATER USING LOTUS (*NELUMBO NUCIFERA*) IN LAB SCALE

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This study focuses on exploring the phytoremediation of composite industrial effluent originating from various industries in the Sodepur region of West Bengal, India. The research involves the utilization of the sacred lotus plant (Nelumbo nucifera) for this purpose. The research conducted batch-mode phytoremediation experiments over a duration of 30 days. Three different concentrations were selected for the experiments, including distilled water as a control, 100% composite industrial effluent, and 100% municipal wastewater. The results of the study indicate that the *N. nucifera* plant played a significant role in reducing the levels of both physicochemical and heavy metal pollutants present in the composite industrial effluent and municipality waster. Specifically, the study observed the highest removal rates for various pollutants in the composite industrial effluent concentration treatment. The maximal removal percentages were biochemical oxygen demand (BOD): 85.35%, chemical oxygen demand (COD): 75.25%, total Kjeldahl's nitrogen (TKN): 78.56%, cadmium (Cd): 55.45%, copper (Cu): 89.76%, chromium (Cr): 65.58%, lead (Pb): 75.95%, zinc (Zn): 81.33%. These findings highlight the effectiveness of *N. nucifera* in significantly reducing these pollutants in the composite industrial effluent. Furthermore, the study assessed various plant growth attributes of the selected N. nucifera plants. These attributes included fresh plant biomass: 560.70 ± 5.13 g per plant (excluding flowers), chlorophyll content: 5.01 ± 0.20 mg per gram of fresh weight, plant height: 141.02 ± 3.25 cm. These growth characteristics provide valuable insights into the health and development of the *N. nucifera* plants used in the phytoremediation experiments.

OL-125

EFFECT OF SOILLESS MEDIA IN ROOF TOP GARDENING

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Urban and peri-urban horticulture (UPH) helps to make cities greener and also contributes to food security, employment, waste management and community

well-being. Roof Top gardening (RTG) is one of the best solutions for self-reliance in urban areas ***eg***. cities and metros. The major constraints in the urban areas are limited availability of productive lands, fertilizers and irrigation water. Therefore, soilless media is adopted as artificial soil by replacing the natural soil system. Here the chances of pests, diseases and weeds are eliminated. The changing health concern of people also demands high quality food. Plants grown in soil less culture has consistently superior quality, high yield, rapid harvest, and high nutrient content. Moreover, soilless growing media are easier to handle and may provide a better growing environment compared to soil. Under this context, the experiment was conducted to study the effect of soilless media ((sand + coco peat + vermicompost + vermiculite + perlite (1:2:2:0.25:0.25)) in Roof Top Gardening (RTG) of Kamrup (M) district. Considering all parameters, soilless media showed the best result significantly in plant height (33.22 cm), plant spread (34.77 cm), shelf life (7.3 days), yield/box (2.9 kg), net return/box (Rs.103.8) and B:C Ratio (2.8) as compared to readymade potting soil (Check) and soil (Farmer's Practice) for various crops *eg*. Broccoli, Lettuce, Gerbera and Chrysanthemum.

OL-126

EVALUATION OF BIOFORTIFIED SWEET POTATO VARIETIES FOR ITS GROWTH, YIELD AND ECONOMIC PERFORMANCE UNDER ASSAM CONDITION

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An on-farm testing under Krishi Vigyan Kendra, Baksa was undertaken to evaluate the performance of two biofortified sweet potato varieties (Bhu Sona and Bhu Krishna) against a check variety Dergaon Red during 2021-22. The trial was conducted on three different locations of the Baksa district following scientific cultivation practices. Statistical analysis of the growth and yield characters shows significant difference between the three varieties. The variety Bhu Sona exhibited highest Vine length (214 cm), tuber length (18.6 cm) and average yield (16.7 tonnes/ha). In some significant yield characters like marketable tuber yield per plant and tuber yield per plant, the two biofortified varieties were at par with each other. The check variety exhibited highest tuber weight (152.3 g) and early harvesting period (109.3 days) which was also at par with Bhu Sona. The economic analysis reflected a maximum gross income of Rs. 253500 per hectare in Bhu Sona which was 26.8% more than the check variety. The variety Bhu Krishna also exhibited a 14% increase in gross return from the check variety. The trial indicated that the cultivation of varieties Bhu Sona and Bhu Krishna were beneficial in economical aspect to the farmers.

OL-127

PERFORMANCE OF NO-TILL GARDEN PEA (*PISUM SATIVUM*) UNDER RICE FALLOW AREAS OF KOKRAJHAR

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One of the major constraints of low productivity & profitability in Kokrajhar district is the continuous growing of rice-fallow practice. Hence, growing of no-till garden pea under rice- fallow could be a potential option for enhancing productivity, profitability & cropping intensity of the district. Therefore, an experiment was conducted by Krishi Vigyan Kendra (KVK), Kokrajhar during 2021-22 & 2022-23 to test the feasibility of the cropping sequence in terms of productivity & economics in rice-fallow areas. The result of the study revealed that the average yield of rice was found to be 4.52 t/ha, while average of two years rice equivalent yield under rice-garden pea cropping sequence was found to be 12.02 ton/ha, respectively which was significantly higher than rice-fallow & the yield increased by 165%. The highest net return & B- C ratio was recorded under rice-garden pea cropping sequence (Rs. 151640/ha & 2.62) as compared to rice-fallow (Rs. 39860/ha & 1.65), respectively. Moreover, the soil organic carbon & available nitrogen were substantially enhanced due to inclusion of legume crop in rice based cropping sequence & the highest values of these parameters were found under rice-garden pea cropping sequence. From the study, it may be concluded that rice-garden pea could be a promising cropping sequence to increase cropping intensity, productivity & soil fertility of Kokrajhar district.

OL-51

WILD EDIBLE FLORA AND MUSHROOMS FOR HEALTH AND NUTRITIONAL SECURITY IN TRIBAL DOMINATED AREAS OF ASSAM

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Wild edible flora and mushrooms can offer a wide range of nutritional and health benefits. The wild edible flora as well as mushrooms can indeed be a valuable

source of food and medicine for rural tribal-dominated areas of Assam, as they have been used by many indigenous communities as food and source of medicine for centuries. Wild edible flora and mushrooms can indeed be a valuable source of food and medicine for rural tribal-dominated areas of Assam, as they have been by many indigenous communities around the world for centuries. These wild edible flora and mushrooms often contain a variety of essential nutrients, including vitamins, minerals, and antioxidants. They are high in fibre, low in calories, are a good source of plant-based protein and often add diversity to the diet, offering unique flavours and texture to the food. Apart from nutrients, the wild edible flora and mushrooms often contain a variety of health benefits. Many wild edible plants and mushrooms are rich in antioxidants, which can help combat oxidative stress and reduce the risk of chronic diseases. Besides they also contain unique phytochemicals, which have specific health-promoting effects. In remote areas, where healthcare facilities may be scarce, wild edible flora having medicinal properties can serve as a valuable resource for addressing common health issues. Besides nutritional and health care, the collection and sale of wild edibles can provide income-generating opportunities for tribal communities, contributing to their economic well-being. They also help in creating avenues for small-scale entrepreneurship. Moreover, the use of wild edibles is often deeply intertwined with the culture and traditions of indigenous communities, helping to preserve their way of life. The wild edibles also contribute to biodiversity and environmental conservation, sustainability, and habitat protection. In conclusion, wild edible flora and mushrooms have the potential to improve food security, nutrition, and healthcare in rural tribal-dominated areas of Assam, while also offering economic opportunities and preserving cultural traditions. However, it's crucial to approach their use with a focus on sustainability and responsible practices to ensure the long-term well-being of both the communities and the environment.

OL-152

EVALUATION OF THE RELATIONSHIP BETWEEN NDVI & CURCUMIN IN TURMERIC USING REMOTE SENSING

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Precision agriculture is being increasingly used as a tool to forecast yield, monitor plant stress, and optimize agricultural management activities. However, implementation of this technology in the case of medicinal plants is wanting. The objective of the study was to understand the applicability of satellite remote sensing-based yield estimation techniques to estimate secondary metabolites

with pharmacological qualities such as curcumin, based on the performance of the spectral index, NDVI (Normalized Difference Vegetation Index), by the determination of statistical relationships. Correlation and regression analysis was conducted for the parameters such as NDVI and DAS (Days after Sowing) when such values occurred, against pre-harvest (wet weight) and post-harvest (dry weight) curcumin, for the entire crop cycle, per crop growth stage, and for every iteration of satellite imagery acquisition. Results indicate a strong positive relationship between NDVI values and the post-harvest (dry weight) curcumin during the vegetative growth stage, with the R and R2 values being above 0.7 and 0.5 respectively, thus allowing consideration of remote sensing-based monitoring and yield prediction techniques for the estimation and monitoring of secondary metabolite yields.

OL-130

IMPACT OF CLIMATE VARIABILITY IN OFF-SEASON TOMATO PRODUCTION IN DHUBRI DISTRICT OF ASSAM

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Vegetable production can help farmers to generate income, which will eventually take the edge off poverty and malnutrition. Tomato is one of the most important vegetables in Dhubri, Assam. But tomato production is sensitive to hot and wet growing conditions and is characterized by extreme sensitivity to erratic weather conditions. In the dry season (October to February), there is abundant supply of tomatoes creating a market glut but in the wet season (March to June), yield is low, hence, there is limited supply in the market with poor quality contributing to drastic price fluctuations. Production of off-season (rainy season) tomato under rain shelter house condition studies were initiated at the Seed Production cum Demonstration farm of Krishi Vigyan Kendra, Dhubri, Assam Agricultural University, Dhubri, Haldibari. The experiment was laid out in randomized block design with 3 treatments *viz.,* T_1 Anup, T_2 Abhimanyu and T_3 TO 1156. In the first year (2021-22), hybrids Anup, Abhimanyu and TO 1156 were evaluated for total yield and disease incidence. The results revealed that Anup performed best in terms of total fruit yield (574 q/ha), as compared to other entries (396 q/ha and 236 q/ha total yield in Abhimanyu and TO 1156, respectively). Infestation of Bacterial wilt (*R. solani*) was observed during the period and was found lower (12%) in Anup as against Abhimanyu (20%)

and TO 1156 (27%). In the second year (2022-23), Anup, Abhimanyu and TO 1156 were tested. The results revealed that rain shelter tomato cultivation has extended the fruit availability from last week of April to first week of July. The results revealed that Anup performed best in terms of total fruit yield (546 q/ha), as compared to other entries (340 q/ha in Abhimanyu and 233 q/ha in TO 1156). Plants damaged by Bacterial wilt was noticed and found lower (13%) in Anup as against Abhimanyu (15%) and TO 1156 (16%). These studies have offered probability of raising rainy season (off-season) tomato crop and augmenting fruit availability period by using lesser chemical methods to control wilt.

OL-145

RESOURCE CONSERVATION TECHNOLOGIES FOR COMMERCIAL CULTIVATION OF HIGH VALUE VEGETABLES IN EASTERN INDIA

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Development of crop and region-specific resource conservation technologies (RCTs) like drip irrigation, mulch, reduced tillage and modified planting and fertigation patterns is a prerequisite for enhancing crop yields and for maximizing the resource use efficiency. A research was conducted at ICAR-RCER, FSRCHPR, Ranchi, Jharkhand to standardise the resource conservation technologies for commercial cultivation of high value vegetables.Three independent experiments were undertaken to standardise the RCTs for different cropping systems. First experiment composed of three cropping patterns tomato-cabbage-moong; vegetable soybean-cauliflower-cow pea and capsicum-broccoli-french bean were evaluated under furrow irrigation, drip irrigation with mulch (reduced tillage) and without mulch (full tillage).Second experiment was on standardization of growth stage-based drip fertigation patterns and planting geometry for chilli, tomato and broccoli. The third experiment was on cauliflower - brinjal cropping system cultivated on flat bed, broad bed and ridge-furrow with and without polythene mulch.Various performance parameters like crop yield, water and economic water productivity, profitability and soil health were recorded over the three experimental years. The results revealed that the treatment drip+mulch+reduced tillage resulted in higherrice equivalent yield (11.1 t ha^{-1}), water productivity (17.8 kg m^{-3}) and economic water productivity (208.6 Rs m^{-3}) in vegetable soybean- cauliflower-cow pea cropping system. The best performance of chilli (14.4 t ha^{-1}), tomato (80.9 t ha^{-1}) and broccoli (31.3 t ha^{-1})was recorded at planting geometry (pp xrrxbpr) of 40x30x60; 40x50x60

and 40x30x60 cm. Chilli yielded best when uniform dose was applied in each fertigation, while application of lower dose during initial and developmental stage and increasing at mid and end stage resulted in better yields of tomato. Performance of broccoli was better when higher fertigation dose was applied during initial and developmental stage. Under these best treatments the water productivity and economic water productivity of chilli, tomato and broccoli were 5.2, 34.8& 15.8 $kgm^{-3}$and 104.1, 273.9 and157.7 Rs m^{-3}, respectively. These treatments recorded in higher nitrogen use efficiency, 40.5, 48.7 and 52.3 %, phosphorus use efficiency, 12.4, 17.2 and 15.5 %, potassium use efficiency 32.3, 52.1 and 39.6 % and B:C ratio of 1:1.7, 1:1.8 and 1:1.6 in case of chilli, tomato and broccoli, respectively. The yield of cauliflower and eggplant was significantly highest (40.4 and 29.8 t ha^{-1}) in mulched ridge-furrow. The polythene mulched flat-bed, broad-bed, and ridge-furrow systems registered 29.4, 28.2, and 29.7% increase in curd yield over their corresponding un-mulched planting systems. The polythene mulched broad-bed and ridge-furrow system registered 17.2 and 16.2% increase in eggplant yield over their corresponding un-mulched planting system. The soil moisture, soil temperature, soil available nutrient, soil microbial biomass carbon, dehydrogenase and acid phosphatase activity, soil quality and yield of crops performed better in mulched ridge-furrow planting.

The impact of development of resource conservation technologies will assist in development of entrepreneurships and wider impact on “Per Drop More Crop” mission under National and State Horticulture missions for commercial cultivation of high value vegetable crops in Eastern India.

OL-163

ORNAMENTAL CROPS AS POLLINATOR-FRIENDLY HABITATS: INVESTIGATING THEIR ROLE IN POLLINATORS CONSERVATION AND BIODIVERSITY ENHANCEMENT

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Pollinators, including bees, play a crucial role in various ecosystems, ranging from agricultural lands to forests. As global food demand continues to rise, agriculture has becomeincreasingly dependent on these pollinators. The decline in pollinator populations raises significant concerns about the sustainability of pollination services in agriculture. Depletion of floral resources and habitat loss are among the most significant drivers of pollinator decline. Pollinator health

is a vital element of managed and natural landscapes. Flourishing pollinator populations are not only vital for maintaining healthy food systems but also for promoting the overall well-being of ecosystems. Recent years have witnessed a surge in global awareness about the issue of pollinator decline.Wild bees and other pollinators have been recognized as highly efficient pollinators of crop plants. To mitigate habitat loss, restoring patches of floral resources with nutritious floral rewards has emerged as a feasible solution. Ornamental plants, readily available and adaptable, offer a continuous option for the restoration of these floral patches. Therefore, studies were undertaken at research farm of ICAR DFR Pune to assess the pollinator's diversity and their foraging ecology on 624 genotypes of ornamental crops including chrysanthemum (155), roses (184), gladiolus (88), tuberose (36), marigold (25), aster (12), other pollinators-friendly ornamental species (109) etc. We recorded115 species of pollinators and flower visitors on different ornamental plants. Abundance and dominance of these pollinators were further investigated using various diversity indices. Species specific DNA barcodes have also been developed for major pollinator species. Based on the foraging ecology of pollinators, we identified three chrysanthemum genotypes (OPCH-12-7, OPCH Double White, DFR C-2), four aster genotypes (DFR-Ento-9, DFR-Ento-11, DFR-Ento-12, DFR-Ento-13), two marigold genotypes (DFR-M-12, KAU-M-46) and three gladiolus genotypes (DFR No. 74, DFR Glad-2, Gunjan) as pollinator-friendly varieties. Besides these crops, pollinator-friendly genotypes of other ornamentals including Balsam; Cosmos, Golden rod; Salvia and Tulasi have also been identified. This valuable empirical data was also used to create a unique database "Pollinators on flower crops" to make the researchers, students, policy makers and general public aware about our native pollinator fauna. Pollinator-friendly genotypes hold promise for enhancing pollinator health and supporting habitat restoration. Pollen from bee-friendly flora can be used as a supplementary diet for honey bees during dearth seasons. Furthermore, the multiplication and marketing of such bee-friendly flower crops present opportunities for entrepreneurship and additional income generation, particularly for rural youths and women in farming communities

Session V : Horticulture in North-Eastern India

OI-129

EXPLORATION OF SOME POTENTIAL WILD EDIBLE FRUITS OF THE NORTH EASTERN INDIA

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North East India is well known for its favourable climate and ecosystem due to which a wide range of fruits both in wild and semi wild condition in both plains and hills are found to be sheltered in this region. Most of the habitants in this region belong to the tribal community and thereby native fruits and vegetables are the main component of their daily life. Apart from the major crops, ample of indigenous and wild fruits are present in the region consumed by the local folks which are rich in vitamins, minerals, medicinal properties *etc.* some of the important wild fruits found in the North eastern states are Juglans regia L., Melastoma malabathricum L., Rubus ellipticus, Baccaurea saipda, Ficus semicordata, Citrus medica, Citrus macrocarpa, Garcinia cowa, Citrus macroptera, Phoenix sylvestris, Artocarpus lakoocha, Spondias pinnata, Docynia indica, Syzygium jambos, Antidesma bunius, Baccaurea ramiflora, Myrica esculenta, Saurauia roxburghii Wall., Citrus latipes, Calamus tenius , Ficus glometra Roxb., Glycosmis arborea and many more. These wild edibles possess huge potential in providing medicinal and nutritional security to the mankind. Despite of presence of almost all vitamins and minerals, most of them remained undercover due to the lack of awareness regarding their importance, market demand and knowledge of bio-prospecting and value addition which may help in exploring the possibilities of utilizing these species to mitigate the challenges of climate change and biological stresses. In this regard, once a systematic study is done, the fullest use of these crops can be started through value addition. These fruits can be processed into jams, jellies, pickles, juices, marmalades *etc.* through organized processing, which will help in enhancing additional income of farmers as well as on-farm conservation of these valuable hidden germplasm. Hence, a review has been done to study and present collective information together on indigenous or wild fruits found in the entire North East India.

OL-114

MAPPING OF POTENTIAL SITES FOR PINEAPPLE CULTIVATION IN EAST GARO HILLS DISTRICT OF MEGHALAYA USING GEOSPATIAL TECHNOLOGY

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The diverse agro-climatic condition of Meghalaya provides a great potential for the cultivation of different horticultural crops, particularly temperate and sub-tropical fruits. Pineapple (Ananas comosus) is a major crop with lots of nutritional importance. It is grown substantially in different locations of Meghalaya and has the highest production among the fruit crops of the state. East Garo Hills district occupies an area of around 1443 km² where the total pineapple production is 15486 MT. This study was taken up to map potential sites for pineapple cultivation in East Garo Hills district of Meghalaya using geospatial technology. The parameters that were taken into consideration for the identification of suitable sites were elevation & slope (physiographic parameters), temperature & rainfall (climatic parameters), soil texture, soil depth, soil drainage, pH, soil organic carbon, K2O and P2O5 (soil parameters). All the parameters were assessed by using multi criteria analysis. Weightage of (0-100) to each layer and rank (0-10) to each suitability class were assigned and weighted overlay analysis was carried out in ArcGIS. The analysis was carried out in culturable wastelands which were identified using Sentinel-2 satellite imagery and visual image interpretation technique. The potential sites that have been identified for growing pineapple in EGH district was found to be 27744.51 ha out of which 11313.52 ha was moderately suitable and 16430.10 ha was marginally suitable. The results will enable the horticulture department in expansion of pineapple in EGH district of Meghalaya.

OL-18

INDIGENOUS HORTICULTURAL CROPS OF NORTH EAST INDIA AND POSSIBILITIES IN THEIR COMMERCIALIZATION

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The North-East India is well-known for its rich diversity of flora, fauna, cultures and traditional knowledge systems. The region falls under the Indian Eastern

Himalayan region where agriculture is the main occupation of the communities and their livelihood is supplemented by utilization of wild crop species from the nearby forests. Traditional agriculture in North-East India follows mixed cropping pattern through multi-cropping, crop rotation, use of multipurpose nitrogen (N)-fixing trees, along with protection of semi- domesticated and wild biodiversity, including medicinal plants, wild edible fruits and vegetables, fodder plants and other useful species. The indigenous traditional technologies of hill cultivation practices are complex farming system and for ages were sustainable. The most remarkable feature of Jhum cultivation is that more than 50 various crops of cereals. vegetables and fruits which is grown in one Jhum fallow field in a mix cropping and sequential cropping system maintaining four to five canopies of crops at a given time. These crops provide not only basic food but also the much needed nutrients for maintaining health. Further, these indigenous fruits and vegetables also contain medicinal properties which are widely used even to this day by the local traditional healers. Some of these indigenous crops can be identified and cultivated in commercial scale for the economic upliftment of the people in the region. This paper presents some of the plant species either domesticated or grown in Jhum fields which are consumed as food providing nutritive security possibilities of their commercial cultivation

OI-133

MORPHOLOGICAL EVALUATION OF LOCALLY AVAILABLE TARO (*COLOCASIA ESCULENTA* L.) CULTIVARS OF KOKRAJHAR DISTRICT FOR GROWTH AND YIELD POTENTIAL

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Taro probably one of the world's oldest crops is an important crop species in the district but its cultivation and consumption still lie within the less privileged farmers of the rural areas. It is cultivated for its tubers, tender leaves and inflorescence. It is also observed that their nutritional value is very high and is nutritionally superior to other root and tuber crops in protein, mineral and vitamin contents. However, documentation of its genetic diversity and differentiation in the district is very weak. Several morphological types are found in upland and hilly slopes of the district, but their identification and morphological studies are not very clear, and their agronomic potentiality further needs to be exploited. In this context a field investigation was undertaken by collecting 4 local cultivars namely Abor, Pehle, Daomasar and Duradema from Debitola and Kachugaon

blocks of Kokrajhar district. The diversity was evaluated based on growth and yield traits of plant (plant spread, height, number of side shoots), leaves (Leaf size, leaf blade margin, Petiole juncture colour, petiole colour) and corm (Corm size, average corm weight, cormel size, average cormel weight and yield against well-known variety Panchamukhi grown in the district.

The results indicated significant differences for all the characteristics studied. 'Panchmukhi' recorded highest value for plant height (134.4cm), leaf size (2244.0 cm2), corm breadth (8.10cm), average corm weight (2036.00g) and average yield (2248.33g/plant). Petiole length was recorded highest in Cv. Deraduma (95.23 cm). Cv. Daomasar was recorded with maximum plant spread of 144.5 cm and numbers of side shoots (5.67 nos.). Highest corm length (20.23cm), cormel length (13.24cm) and cormel weight (98.25g) was recorded maximum in Cv. Abor.

OL-44

HORTICULTURE AND LIVELIHOODS OF HILL WOMEN IN NORTH-WESTERN HIMALAYAS : A CASE STUDY OF APPLE CULTIVATION IN HIMACHAL PRADESH

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Women constitute nearly half of the population in the mountainous regions of Himachal Pradesh having composite social profile – striking a careful balance between domestic and livelihood activities. More than ninety per cent of the mountainous population inhabits rural areas. Mountain specificities which consist of habitats, society and their interactions, and adaptations can prove to be constraints as well as opportunities. Comparative economic growth or development and dynamism in socioeconomic structure are due to interlinked different land-use systems including agriculture, horticulture, forestry, and tourism. Rural women play a pivotal role in sustainable development of their areas and form an integral part of subsistence rural economy, by playing multiple roles in the society as an integral part of hill economy, therefore addressing gender issues is crucial for the sustainable development of hilly areas. Irrespective of age or health, hill women are traditionally required to perform domestic tasks and participate in various farm operations, from sowing to postharvest operations. Women in farming in the region are a vital asset, as they perform important multiple tasks. They continue to live in dependence for many of their basic needs while also being inextricably linked with natural

resources and the environment, thus having to cope with the harsh climate conditions by developing mountain specific adaptations. Hence, for sustainable apple farming interventions will be discussed, regarding, encouragement of women's involvement in family decision making as well as access to income for management of household activities, recognition to their contributions, ensuring access to higher education and awareness towards modern horticultural developments. Further the paper calls for urgent need for development of strategies to address gender-based challenges in apple farming, thereby proving beneficial towards a progressive approach to horticultural farm operations, thereby striking the right balance towards better conservation of cultural heritage with a blend of hi-tech horticultural interventions.

OL-102

ETHNO-MEDICINAL SIGNIFICANCE, PHYTO-CHEMICAL DIVERSITY AND THERAPEUTIC PROSPECTS OF *DACTYLORHIZA* ORCHIDS

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The Orchid genus *Dactylorhiza* is having a global distribution of 75 species with 58 found in Europe, North Africa, and the Middle East and out of these 02 [*D. hatagirea* (D. Don) Soo and *D. kafiriana* Renz.] in India. Traditional medicines practitioners used to utilize the plant's tubers, known as 'salep', to address a range of ailments. From postnatal weakness in women to alleviating intestinal disorders and diarrhea, *Dactylorhiza* 'salep' usually been a versatile remedy. Evidences suggest its application for enhancing sexual vitality, combating erectile dysfunction, and fostering vigour etc. The wider amplitude of pharmacological potential of *Dactylorhiza* species is due to its rich and unique reservoir of phytochemicals, including cyanin, orchicyanin II, orchicyanin I, dactylorhins A–E, and dactyloses A–B. These compounds collectively exhibit a wide spectrum of therapeutic potentials and actions. Extracts derived from the tuberous roots of various *Dactylorhiza* species have demonstrated promising attributes such as anti-cancer, anti-inflammatory, hepato-protective, and neuro-protective alongside aphrodisiac effects. Despite having immense potential, *Dactylorhiza* orchids remain relatively under-explored in research and development endeavors towards product development. This paper is an attempt to introspect into the multifarious pharmacological roles of *Dactylorhiza* spp., and have a deep drive towards its phyto-chemical landscape enabling us to shade the light on its therapeutic applications since time immemorial. By doing so, it paves the way to move forward with focused R&D strategies in harnessing its full phyto-medicinal potentials for a wider application in a greater canvas.

OL-29

CHARACTERIZATION AND BIOCHEMICAL ANALYSIS STUDIES OF BLACK PEPPER (*PIPER NIGRUM* L.) GERMPLASM GROWN UNDER ARECANUT PLANTATION IN LOWER BRAHMAPUTRA VALLEY ZONE OF ASSAM

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Black pepper (*Piper nigrum* L.) known as king of spices is an important spice crop of the world. It originated in Western Ghats of South India and is now cultivated in more than 25 nations. The importance of local genotypes and landraces as a contributor to the gene pool of modern varieties with high economic value is well known. Though many varieties of black pepper were released for cultivation in different parts of India, only a few varieties are found suitable for North-East India, especially in the state of Assam where black pepper is grown as an important cash crop. This study was undertaken during 2013-2022 to evaluate 13 local black pepper genotypes for their growth, yield, yield attributing traits and quality under Assam conditions of India. Significant differences were recorded among the accessions for most of the characters studied. DUS guidelines were also followed to study the important qualitative traits. Quality traits studied show that accession IC-0599142 was found to be much higher for piperin (5.60%), essential oil (3.70%) and oleoresin (9.60%) content than the popular check variety, 'Panniyur 1' which has also high moisture (15.50%) content, the accession, IC-0599150 recorded 43.62% higher dry pepper yield indicating its superior yield potential. The result of this study indicates the importance of collection and characterization of local germplasm.

OL-95

HARNESSING MICROBIAL CONSORTIA: AN INNOVATIVE STRATEGY FOR IMPROVING TURMERIC CULTIVATION

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Turmeric (*Curcuma longa*) is an economically important spice crop renowned for itsmedicinal properties and culinary uses. However, achieving optimal growth

and yield in turmeric cultivation poses challenges due to biotic and abiotic stresses. In recent years, the application of microbial consortia has emerged as a sustainable and effective strategy to improve turmeric productivity while reducing reliance on chemical inputs.Some of the most important microbial consortia includes *Bacillus altitidinus*FD48 and *Paenibacillus taichungensis* will produce antimicrobial compounds and stimulate plant growth by producing phytohormones, leading to increased turmeric productivity. *Azotobacter chroococcum,*nitrogen-fixing bacteria convert atmospheric nitrogen into plant-available forms, thus enhancing soil fertility and providing an additional source of nitrogen for turmeric plants. *Trichoderma longibrachiatum* EF5 act as biocontrol agents, suppressing the growth of varioussoil-borne pathogens and protecting turmeric plants from diseases, *Glomus intrradicus (*Mycorrhizae) establish symbiotic associations with turmeric roots, enhancing nutrient and water uptake. The utilization of these microbial consortia represents a promising approach to improve turmeric growth and yield sustainably. By enhancing soil fertility, acting as biocontrol agents, and promoting nutrient uptake, microbial consortia effectively address the challenges faced in turmeric cultivation. Embracing this eco-friendly and cost-effective strategy has the potential to revolutionize turmeric production, contributing to food security, environmental conservation, and agricultural sustainability.

OL-124

EFFECT OF VARIOUS DOSES OF INORGANIC FERTILIZERS ON GROWTH AND YIELD OF DRAGON FRUIT (*HYLOCEREUS POLYRHIZUS* L.) IN ASSAM CONDITION

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The present work was carried out in five Krishi Vigyan Kendras of different districts of Assam, *viz.* Dibrugarh, Jorhat, Nagaon, Nalbari and Chirang; to standardize the fertilizer requirement by dragon fruit plants in Assam condition. The growth and yield parameters recorded over two years revealed that the growth as well as the yield attributing characters were significantly influenced on application of Urea: SSP: MOP @70: 90: 40 g per plant in first year followed by Urea: SSP: MOP @ 150:150:300 g per plant from second year onwards (Treatment 2) as compared to the other treatments such as T0: Control, T1: 53:68:30 Urea, SSP, MOP g/plant(1st year) and 113:113:225 Urea, SSP, MOP g/plant (2nd year) and T3: 88:113:50 Urea, SSP, MOP g/plant(1st year) and 188:188:375 Urea, SSP,

MOP g/plant (2nd year).The Maximum stem diameter of 6.3 cm after 2nd year of establishment was found on application of T2 dose along with the maximum number of fruits per pole (25.82), maximum average fruit weight (272.04 g) and highest annual yield per pole (7.103 kg) as well as maximum fruit volume (279.6 cc) and the highest pulp:peel ratio (4.11). Therefore, considering the significance of T2 dose of fertilizer in various districts of Assam, it can be concluded that treatment T2 can be considered as the appropriate dose of fertilizer to be considered for Assam condition.

OL-88

DUS CHARACTERISTIC FEATURES OF NEW FARMER POMEGRANATE VARIETY "SHARAD KING"

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Pomegranate (*Punica granatum* L.), is one the most important nutritional and medicinal rich commercial fruit crops play a vital role in sustainable development and livelihood security of arid and semi-arid regions. Diversification of varietal cultivation is need of the hour to breakdown the single varietal (Bhagawa) dominance and its consequences in pomegranate. In this context, newly identified farmer variety "Sharad King" has been characterized for in total 43 characters including 38 DUS traits as per PPV&FRAguidelines and additional 5 fruit quantitative characters, to identify the most important DUS characteristic features of the variety and its suitability for the commercial cultivation. The variety has been evaluated at Tupewadi, Aurangabad for two consecutive years (2021-2022) and its mean performance was compared with the standard check variety (Bhagawa). The examined new variety was found to have uniform bearing with better fruit size (302.19g), medium thick rind (4.33mm) and medium fruit maturity (160-170days after anthesis) in comparison to Bhagawa (280.49g, 3.95mm, 177-187days). Two sample T-test analysis has showed the presence of significant difference for fruit maturity (days after anthesis), number of arils/ fruit, 100Seed weight(g), seed length(mm), seed width(mm), calyx width(mm), petal length(mm), petal width(mm), leaf blade width(cm), petiole length(mm) andpetiole width(mm) characters which is recorded to be 160-170days, 747.26, 1.37g, 6.22mm, 2.44mm, 14.78mm, 26.36mm, 21.36mm, 1.95cm, 4.68mm, 1.06mm in "Sharad King" and 177-187days, 575.91, 1.56g, 7.05mm, 2.68mm, 12.45mm, 23.18mm, 19.04mm, 1.61cm, 3.90mm, 0.75mm in "Bhagawa" varieties respectively. The identified characters indicate the suitability of this new variety for commercial cultivation.

OL-122

"SEED PORTAL" UNDER THEME ARTIFICIAL INTELLIGENCE/ DIGITAL AGRICULTURE

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Vegetables are an important source of food and nutrition and provide regular cash income. To reap the advantage of offseason vegetable cultivation in Meghalaya, especially in winters, seed germination and further crop establishment is a biggest hurdle which affects crop yield and quality. To overcome these challenge, ICAR-Indian Institute of Horticultural Research, Bengaluru in association with ICAR-KVK, East Khasi hills taken up the trail of Jiffy cocopeat plugs. They are manufactured from coconut coir, which provide an ideal medium for seed germination. They offer uniformity in size and shape, reduced transplant shock, and enhance water efficiency. Cocopeat plugs also contribute to disease control, easy handling, and reduced weeding efforts in nurseries. Their ability to retain and slowly release nutrients further supports the growth of healthy seedlings. This intervention was tried for lettuce seeds in soil/nursery bed and in jiffy plugs. Lettuce seedlings were sown in the jiffy plugs as well as in nursery bed as control in 3rd week of November to compare the results. Jiffy plugs took just nine days to germinate while the soil/nursery bed took 15 days; the germination percentage and establishment in the main field were 90% and 85% followed by 72% and 66% respectively in jiffy plugs and soil/nursery bed. With respect to yield, the quantity of lettuce leaves produced by the jiffy plugs seedlings was 200gm/plant and 130gm/plant in seedlings sown in nursery bed. In summary, Jiffy cocopeat plugs are indispensable in horticultural nurseries, promoting sustainable and efficient practices for seedling propagation.

OL-132

IMPACT OF HERBS AND WILD PLANTS IN TRADITIONAL FOOD ITEMS OF MISHING COMMUNITY OF LAKHIMPUR DISTRICT OF ASSAM

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The Mishing is an ethno-tribal group of people dwelling in the plains of Assam with second largest population in the state. According to Indian Census report

2011, the total recorded population of the tribe is 5, 87,310. The Lakhimpur district is witnessing an important section of their population basically in the fertile plains of the river mighty Brahmaputra and in its major tributary Subansiri. The tribe is culturally one of the rich ethnic groups in Assam. They are still maintaining their unique socio-cultural practices along with varied customs and beliefs. The tribal ethnicity is integrated towards nature, the people consume various herbs and other wild plants along with their food as age old practise. The present investigation deals with the commonly used herbs and other wild plants that are habitually used by the mishing people in various food items of vegetarian or in non-vegetarian diet. The tribal rituals and various religious practices are also linked with the herbs and plants with medicinal values.

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HORTICULTURE INTEGRATION TO UPSCALE THE INCOME OF FARMERS: THRIVING SUCCESS STORIES

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In Karnataka State, the Integrated Farming System (IFS) has emerged as a holistic approach to sustainable agriculture, intertwining multiple farming practices to optimize resource use. This synergy not only enhances productivity but also bolsters economic stability for farmers. This study provides a comparative analysis of three distinct farmers, each exemplifying the integration of traditional knowledge and innovative farming methods to achieve remarkable results in IFS. Firstly, Shri Chandra Shekar from Beleyur, Sagara, Shimoga district, transitioned from a professional engineering career to farming. Over 12 years, with strategic diversification and land expansion, he expanded his income from Rs. 1, 90,500 (from 3.5 acres in 2008-2009) to animpressiveRs.13lakhsin2018-19(froman11-acrelandholding) and Rs.16lakhs in 2021-22. His farm flourished due to innovative rubber value additions, horticulture crop interventions like pineapple and a comprehensive approach to bio-resource management. Shri. Shambu Shankara Rao of Mandarti, Udupi district, with 30 years of farming experience, displayed the potency of amalgamating traditional and novel agricultural techniques. Over a decade, Rao witnessed aten- foldsurgein his income, rising from Rs. 1,23,000 in 2008-09 to Rs. 13,35,174 in 2018-19 and Rs. 14,50,000 in 2021-21. This growth was attributed to his multi-storied cropping pattern, innovative cashew processing, and sustainable agricultural practices. Lastly, Shri T. K. Manjanna from Thimlapura, Tiptur in the Tumkur district, epitomizes the strength of modern farming in the central dry zone. Over a time span from 2010 to 2021, his income trajectory moved from Rs. 1,83,300 to Rs. 5, 27,000. Manjanna's 2-acre farm witnessed diversification with the introduction of horticulture, dairy, apiary practices, and vermi-composting.

Furthermore, his sustainable methods produce 23-25 tons of bio-mass annually, enhancing soil fertility with the annual incorporation of approximately 15 tons of natural fertilizer. Collectively, these case studies spotlight the transformative power of integrated farming, showcasing how informed strategies combined with sustainable practices can yield remarkable economic and environmental benefits, even on limited land. Together, these success stories provide a panoramic view of Karnataka's agricultural dynamism.Theyunderscorea common theme: the transformative power of integrating age-old wisdom with contemporary innovations. As India continues to prioritize sustainable and resilient farming practices, the experiences and successes of such farmers will undoubtedly guide and motivate the broader farming community towards a prosperous and sustainable future.

OL-79

DOUBLING FARMERS' INCOME THROUGH CPRV MODEL: CASE STUDIES OF ADVANCED CITRUS CULTIVATION IN MAHARASHTRA

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At a time when controversies are rife about the possibilities of doubling farmers' income, success stories of farmers practicing advanced citriculture in Maharashtra following the CPRV Model, tend to provide a strong ray of hope to the farmers, researchers and policymakers of India. The authors have developed a four pronged strategy (CPRV) for enhancing farmers' income and in the light of that model, have studied the cases of 11 successful citrus growers of Maharashtra. The strategies of cost minimization (C), productivity maximization (P), risk minimization (R), value addition and marketing (V) when applied individually or in combinations have helped farmers to double their income. Value addition and marketing contribute much more in real income followed by cost minimization and productivity maximization whereas, the risk minimization strategy act as safety net from any negative externalities. Mr. Prashant Khursunge, Mr. Avinash Falke, Prakash Baromase, Mr. Shrikant Nerkar, Mr. Shridhar Wani of Nagpur; Mr. Gopal Belsare of Amravati; Mr. Keshavraoji Bhakte, Mr. Manojrao Bhonge, Mr. Shalikraoji Kshirsagar of Wardha; Dr. Chandrsekhar Raut of Yavatmal and Mr. Sandip Padalwar of Nanded have adopted scientific citrus farming technologies of ICAR-Central Citrus Research Institute, Nagpur and increased the production & productivity of their orchards, minimized cost of cultivation and risk, thus increasing their income from a range of Rs.1 lakh/year to Rs. 4.17 lakh/year and Rs.4.50 lakhs/year to Rs. 27.75 lakhs/year. Farmers have expanded their orchards and nursery business. Disease-free planting materials, timely IPM measures, fruit drop control advisories, nutrient and water management technologies of ICAR-CCRI have transformed the lives of these citrus growers.

OL-12

CHARACTERISING FRUIT DROP OF SIKKIM MANDARIN AND THEIR ORGANIC MANAGEMENT STRATEGIES

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Citrus is one of the most prominent and important fruit crops of North-East India in general and Sikkim in particular. Flower and fruit drop are the two major concerns bothering citrus farmers the most in recent times. Due to climate change and other abiotic/biotic factors, citrus production is facing decline in the state of Sikkim; farmers are reporting the problem of post-bloom drop and pre harvest drop with the intensity of considerable economic losses. We studied the phenology of Sikkim Mandarin flower and fruit development. Flower initiation starts from end of January and lasts upto early March. Mid February to early April is the peak time of flowering and pollination. Fertilization and fruit set extends upto mid April to early May. Early flower and fruit drop takes place upto mid May. It was observed that palnts of <5 years age showed less fruit drop compared to 5-10 years , followed by 10-15 years and maximum drop was exhibited by plants of >15 years age. Fruit development is the longest period which extends upto early January (nearly ten months). Pre-harvest fruit drop causes the most economic damage and it occurs just prior to harvesting during November to January. We recorded variation in flower and fruit drop of citrus in spatio-temporal context. For Sikkim mandarin, under ICAR-RC NEH Region, Sikkim center, Gangtok condition we recorded 63.88 ± 2.36 % of fruit set. Maximum drop was during the final stages of fruit development. Mean fruit diameter (cm) of the retained fruits and the dropped fruits during fruit growth and development in Sikkim Mandarin differed significantly. Flowering and fruit attributes of Sikkim Mandarin was significantly influenced by foliar application of different sea weed saps. Boron content in both soil and fruit tissues was recorded in significantly lower concentration of the critical limit. Total phenol and antioxidant activities of Sikkim Mandarin fruit was significantly influenced by foliar application of different sea weed saps. Production and economic efficiency was positively influenced by foliar application of different sea weed saps. Sea weed saps can be efficiently used for controlling flower and fruit drop in Sikkim mandarin.

OL-165

HARNESSING THE POWER OF GINGER: OPPORTUNITIES AND CHALLENGES FOR ASSAM'S FARMERS

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Ginger is an important spice crop grown in Assam in a variety of soils and climates. Assam is the third largest producers of ginger in India producing 170.73 thousand tonnes in 2021-22 and contributing 7.69 per cent of total ginger production in the country. The crop is grown mainly in the districts of KarbiAnglong, DimaHasao, Golaghat, Tinsukia and Nagaon. The paper examines the opportunities and challenges associated with ginger cultivation in Assam. It examines the existing status of ginger cultivation in the state and provides an overview of the current production and marketing systems. The paper also discusses the potential for improving ginger cultivation in the state and provides some policy measures for improving the economic status of the ginger growers. The study revealed that farmers were not aware of the government subsidy schemes and other incentives available for ginger cultivation. The identified major constraints faced by the farmers were lack of technical knowledge and market prices, limited access to credit, susceptible to pest and diseases, lack of proper post-harvest management and inadequate mechanisation. The study concluded that there is vast potential for increased ginger production in Assam if the farmers are provided with adequate technical knowledge, improved variety of seeds, integrated pest and disease management, irrigation facilities, processing units and access to government subsidies and incentives. By overcoming the challenges through strategic interventions and capitalizing on the opportunities, ginger cultivation in Assam can thrive, benefitting the farmers and the state economy as well.

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VITAMINS BASED DIVERSITY ANALYSIS OF WILD EDIBLE *SOLANUM* SPECIES OF NORTHEAST INDIA

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The north eastern hills of India have varied agro-climatic conditions with abundant rainfall, offering immense scope to grow several underutilized vegetables.

Some of these vegetables maintained naturally in nature while, people from this region harvested seasonally for their family requirement, even some times maintained in their backyard also. Out of these underutilized or rare vegetables, the wild *Solanum* species (wild brinjal) consumed in their daily dishes. Some times, dishes prepared with wild brinjal fruits (berries) are preferred most during special occasion even they don't know its nutritional properties. In view of regular consumption of wild brinjal by the indigenous people, its nutritional contents such as Vitamin A, C, E, B1, amino acid, proline etc. were studied at College of Horticulture and Forestry, CAU, Pasighat, Arunachal Pradesh. This research was carried with 11 wild *Solanum* species collected from NEH region of India to evaluate above nutritional composition following standard biochemical analysis methods. The outcome of the study indicates, the maximal vitamin A content was recorded from *S. villosum* (11.69±0.08µg/g) while minimal was observed from *S. mammosum* (3.30±0.09µg/g). Contradictorily, highest amount of vitamin E was obtained from white berry of *S. gilo* (15.82±0.58µg/g) whereas lowest amount was acquired from *S. nigrum* (7.67±0.30µg/g). For vitamin C, *S. ferox* observed maximum amount (1.06±0.061 mg/g) and *S. spirale* recorded the maximum quantity of vitamin B1 (0.17±0.007 mg/g) whereas the minimum amount of vitamin C was obtained from *S. spirale* (0.03±0.004 mg/g). The highest amount of free amino acid (3.57±0.03 mg/g) and methionine (2.32±0.004 mg/g) were obtained from *S. macrocarpon* while maximal amount of proline was obtained from *S. nigrum* (294.81±2.66µmole/g).

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PERFORMANCE OF DIFFERENT SWEET ORANGE AND GRAPEFRUIT VARIETIES IN NORTH EASTERN REGION OF INDIA

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This experiment was conducted at ICAR-CCRI, Regional Research Centre for Citrus, Biswanath Chariali, Assam, during 2019-2022. Nine different sweet orange and grapefruit varieties viz., Natal, Valencia, Pera, Jaffa, Westin, Mosambi, Star Ruby, Red Blush and Marsh seedless, which were budded on rough lemon rootstock were evaluated for yield and fruit phyisco-chemical parameters. A significant variation among cultivars and species was noted in fruit physico-chemical parameters. In sweet oranges, the highest fruit weight was noted in Natal (195.2 g)on a raised bed planting system, which was at par with Valencia (184.4 g) and Jaffa (181.8 g), while in grapefruit, Marsh Seedless recorded the maximum fruit weight (418.3 g). Similarly, juice content was recorded as the

maximum in Natal and Valencia (48.0%). Segment/fruit did not vary significantly. Significant variation in seeds/fruit was observed, and the lowest seeds/fruit was noted in Pera (4.60) and Valencia (5.70), while it was maximum in Jaffa (13.33). Fruit quality and yield of sweet orange and grapefruit on both beds were comparable. In sweet oranges, maximum TSS (10.06 OB) and yield (31 t/ha) were recorded in TM-33 (Mosambi), followed by Cutter Valencia (28 t/ha). In grapefruits, Marsh Seedless registered the minimum seeds/fruit (1.00) and maximum TSS (7.33 °B) and juice content (36.3%), while maximum yield (13.40 t/ha) was noted in Red Blush on a conventional flat system. In conclusion, among the studied species and varieties, the performance of Mosambi and Cutter Valencia sweet orange was found most superior in terms of fruit yield and quality under the plains of Northeast India.

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OL-8

DEVELOPMENT OF RESISTANCE AND RESURGENCE IN INSECT PESTS OF POTATO AGAINST PESTICIDES IN NORTHERN INDIA

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The chaotic uses of unauthentic pesticides either low dosing or over dosing, improper applications, repeated uses of same group of pesticides lead to the development of resistance against most of the commonly used insecticides through natural selection pressure. Similarly, pest resurgence is one of the important aspects related to indiscriminative use of these pesticides. Beside the use of pesticides no other potent pest management option is still able to produce quick knock down effect against insect vector population buildup on potato crop. Therefore, farmers are using different pesticides without proper care as per its appropriate doses in field conditions, resulting resistance, resurgence and residues in agro ecosystem. Potato (*Solanum tuberosum* Linn.) is an important cash crop in India. It is cultivated under different eco-environmental conditions for local consumption and also available throughout the year. Insecticide resistance and resurgence of the most commonly used insecticides is a serious issue against common vectors whitefly and leafhopper on potato crop. Therefore, Field experiments were conducted to record the resistance and resurgence effect of commonly used insecticides like imidacloprid, thimethoxam and oxy-demeton methyl against whitefly, *Bemisiatabaci (*Gennadius) and leaf hoppers *Amrasca beguttula beguttula* sida on early planted potato (K.Pukhraj) crop. No resurgence of whitefly and leafhopper was noticed after the application of recommended and slightly higher doses of Imidacloprid 17.8 SL and Thimethoxam 25% WG except it's under doses. While Oxy-demeton Methyl 25 EC sprayed crop showed high degree of resurgence. The sub lethal doses of imidacloprid and thimethoxam and all the doses of oxy-demeton methyl were recorded negative and no increase in potato yield over control.

OL-9

MONITORING BASED SIMPLE AND EFFECTIVE MANAGEMENT STRATEGY FOR GRAPEVINE STEM BORER, *CELOSTERNA SCABRATOR*

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Celosterna scabrator (Coleoptera: Cerambycidae) was reported for the first time as a pest of grapevines in 1968 by Upasani *et al*. Since then, it has been a major pest of grapevines in Maharashtra and Karnataka states of India. The yield loss due to *C. scabrator* was estimated to be 30.10-56.26% in infested vines. A simple and effective management strategy based on regular monitoring and manual removal of grubs of *C. scabrator* was developed and validated at farmers' vineyards in Nashik between February 2020 to February 2022. The monitoring was carried out at 10 days interval during December to April to observe two symptoms, viz., (i) appearance of wet patch on main trunk or cordon during early morning hours, (ii) initiation of presence of frass near the plant. The manual removal of *C. scabrator* grubs was done using wire, screwdriver or scissors. The experiment was conducted in seven *C. scabrator* infested vineyards at Sarole Khurd, Nashik and the level of infestation ranged from 6.15 to 20.35% before imposing the management. After following this practice for two fruiting seasons 2020 and 2021, the infestation level ranged from 0.17 to 0.55 per cent during 2022 resulting in total 96.84 per cent reduction in the infestation and total savings of Rs. 1.88 lakh per year in these seven vineyards. This was also validated at Nashik and Solapur during October 2021-April 2022 in two other farmer vineyards and the level of infestation was 12.25 & 22 per cent, respectively. The strategy provided 100% control of *C. scabrator* and resulted in yield statistically at par with healthy vines and significantly superior over infested untreated vines.

OL-37

MEALY BUGS FAUNA OF AGRI-HORTI ECOSYSTEM OF ASSAM

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Mealy bugs are the most serious pest of agri-horti ecosystem and it is very much difficult to control only because of their waxy protective covering. Twelve

(12) numbers of mealybugs sample collected from different hosts under a survey programme carried out in four districts of Assam viz., Jorhat, Nagaon, Sonitpur and Majuli representing three agro-ecological zones. The insect samples were studied under Zeiss Axiostar plus Trinocular microscope after processing. From the extensive survey programme, three species of mealybugs, viz., pink hibiscus mealy bug, Maconellicoccushirsutus (Green); cotton mealy bug, Phenacoccussolenopsis Tinsley and papaya mealy bug (PMB), Paracoccusmarginatus Williams and Granara de Willink were recorded from different districts of Assam. Out of twelve different mealybug's samples, PMB, P. marginatus dominated the other two species by its presence in nine different samples from six locations under four districts. The morphometric observations of PMB, (P. marginatus) samples collected from different locations and hosts were done under microscope. Out of nine different length related morphological parameters, - first instar nymph length, FINL (0.423 ± 0.009mm); second instar female nymph length, SIFNL (0.756 ± 0.026mm); adult female length, AFL (2.485 ± 0.011mm); second instar male nymph length, SIMNL (0.768 ± 0.015mm) and third instar male nymph (pre pupa) length, TIMNL (0.981 ± 0.005mm) of Khutikatia, Nagaon (Sample code: CBZNK) showed highest values. Amongst all nine different breadth related morphological parameters, - adult female breadth, AFB (1.560 ± 0.013 mm); second instar male nymph breadth, SIMNB (0.448 ± 0.014 mm); third instar male nymph (Pre pupa) breadth, TIMNB (0.466 ± 0.011 mm) and fourth instar male nymph (Pupa) breadth, FIMB (0.438 ± 0.022 mm) of Dekargaon, Sonitpur (Sample code: NBPZ) showed highest values.

OL-100

METABOLIC PROFILING OF TOMATO DEFENCE RESPONSE AGAINST *RALSTONIA SOLANACEARUM* AND IMPARTING RESISTANCE THROUGH ROOT-STOCK GRAFTING

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Tomato (*Solanum lycopersicum* L.) is one of the most important horticultural crops of the world. Its production is severely affected by bacterial wilt disease caused by *Ralstonia solanacearum.* This pathogenic bacterium causes wilt disease in more than 200 plant species. One of the most eco-friendly approaches to control bacterial wilt disease is through host resistance. The tomato cultivar Hawaii 7996 (H7996) is well known for its stable resistance against the pathogen *R. solanacearum* (Grimault *et al.,* 1994). In order to unravel the underlying defence mechanism, liquid chromatography mass spectroscopy (LC-MS) combined with multivariate data analysis was used to identify the metabolites playing

a crucial role in the defence mechanism of tomato against *R. solanacearum*. Several secondary metabolites with varying fold changes were identified in H7996 such as flavonoids, terpenoids, saponins, glycoalkaloids, organic acids, that may play pivotal role in the defence system. Moreover, this study aimed at exploring grafting in tomato using the resistant rootstock H7996 and susceptible cultivar Marmande to check for the efficacy of grafted plants against bacterial wilt. Wilting assay following challenge inoculation of *R. solanacearum* showed a significantly lower progress of the disease in resistant rootstock H7996 and Marmande scion grafted plants in comparison to non-grafted Marmande plants. The colonization of *R. solanacearum* was also recorded in both grafted and non-grafted tomato plants which showed significant reduction of pathogen load in the scion of grafted plants in comparison with non-grafted stem, indicating grafting as a potential and sustainable tool against this dreadful disease.

OL-140

BREEDING FOR BACTERIAL WILT RESISTANCE IN HOT PEPPER AND EGG PLANT

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Bacterial wilt disease caused by *Ralstonia solanacearum* is one of the most serious threats for crop production. Molecular analysis of isolate of Bhubaneswar (hot spot region) showed it belongs to Phylotype I, race I and biovar 3. Exploring host plant resistance is the best advocated strategy tocombat this disease. In peppers, IIHR-B-HP-130 has been identified to be highly resistant (95.55%resistance). This accession has been explored as root stock and found promising in managingbacterial wilt through grafting, which showed less wilting (0 to 8.33% PDI). Genetic inheritancestudies showed resistance is governed by digenic with complementary gene action in IIHR-B-HP130 x CM334 F2 population. Advanced populations were developed through single seed descentmethod and 242 F4 families of IIHR-B-HP-130 × CM334 were screened where in only 28 F4families were found to be highly resistant. Through molecular analysis, two SSR markers (CAMS336 and Hpms034) were identified to be associated with bacterial wilt resistance for MAS. Ineggplant resistant sources were identified and through pure line selection of IC0598430, 'ArkaNeelachal Yodha' in large round background was developed for commercial cultivation. Resistantgenetic resources were explored as root stocks and an increase of yield by 33.46% to 69.23 %along with reduced severity of bacterial wilt was observed in grafted eggplant on CARI-1rootstock. Polygenic recessive control of resistance was found in Arka Neelachal Shyama x CARI1 F2 population. Further 165 RILs were developed through single seed descent method and through BSA-QTLseq approach of resistant and susceptible bulks, a major QTL on chromosome 8 (20 to60 Mb) was identified conferring resistance for bacterial wilt.

OL-144

SCREENING OF CARROT (*DAUCUS CAROTA* L.) GENOTYPES FOR HEAT TOLERANCE

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Carrot is a cool season crop having significant nutritional value due to the presence of high content of vitamins, minerals and bioactive compounds. Global warming and high temperature cause morphological, physiological, biochemical, and molecular changes that adversely affect plant growth stages and productivity, and ultimately yield.Therefore, in the present investigation, forty-five genotypes of carrot were evaluated at Punjab Agricultural University, Ludhiana, India for heat stress tolerance under field conditions during 2021-22 and 2022-23. Genotypes were sown under high-temperature conditions i.e., in the first fortnight of August and under normal conditions i.e., in the second fortnight of September. The data was recorded for the different traits and subjected to the pooled analysis of variance (ANOVA). The genotypes differed significantly in the days taken for germination, shoot weight, root weight, plant weight, root/shoot ratio, shoot length, root length, root diameter, core diameter and total root yield. Among the genotypes tested PC-100 performed highly superior under high temperature stress conditions recording an average yield of 116.12 q/acre than control i.e., Pusa Vrishti (96.45 q/acre) followed by DJ-CR-12, Ab-S-30, and CP-CR-69 i.e.,trac 108.67, 98.78 and 91 q/acre, respectively. These genotypes can be released as a variety or used in the breeding programme for the development of improved cultivars and hybrids.

OL-104

MAPPING OF ANTHRACNOSE (COLLETOTRICHUM SP.) FRUIT ROT RESISTANCE GENES IN CAPSICUM

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The *Capsicum annuum* L. is the widely cultivated *Capsicum species* amongst the five domesticated *Capsicum* genus. The genus belongs to Solanaceae and is native to Mexico and Central America. The *C. annuum* comprises of both hot pepper (chilli) and sweet (bell pepper) with fruits of numerous sizes and shapes. The Indian chilli is valued for its high standard colour and pungency.

The intensive cultivation in time and space resulted in the emergence of severe disease outbreak. The anthracnose ripe fruit rot unlike other diseases deteriorates yield and quality to the extreme of aflatoxin. To reduce the nuisance of fungal food contamination and accelerate the chilli productivity a virulent local isolates of *C. Truncatum* 'IIHR Ct-1' were deployed in the experiment. The isolatewas able to infect the susceptible accessions including the parent IHR4491.The mapping of mortal populations with the abundant SNPs using Diversity Array technologies, Canberra, Australia using the DArTSeq™ technology produced 19 SNPs (QTNs; Quantitative Trait Nucleotides) which were significantly associated with anthracnose fruit rot resistance and spread across the twelve chromosomes of *Capsicum*. The search in pepper pan genome identified PR protein and transcription factor groups such as NBS-LRR regions. The five receptors *i.e*., CCR4 or STPKs, LRR-RLKs, GsSRK, TIR and CRK were identified on the anthracnose resistant regions which were associated with pattern recognition receptor (PRRs) that were activated by the *Colletotrichum* sp. to produce PAMP-triggered immunity (PTI) on resistant lines.

OL-57

PHYTOPLASMA CHARACTERIZATION AND IDENTIFICATION OF THEIR ALTERNATIVE HOSTS IN ROSE (*ROSA* SPP.)

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Rose is attributed to its popular use as garden plant, pot plant, cut flowers and many value added products.The rose plants are infected with different groups of phytoplasmas which exhibit a wide range of specific and non-specific symptoms. On a survey to the different rose fields, disease incidence of 12.5 to 87.5% of phytoplasma-suspected symptoms of flat stem, little leaf, flower malformation and phyllody were recorded in rose genotypes of four states of India. PCR assay for phytoplasma detection was standardized with rose samples by selection of various combinations of nested primer pairs of 16S ribosomal gene and secA gene. Best amplification results were achieved in nested PCR assay employing different primer pairs In addition, a multiplex PCR assay was also optimized for consistent identification of phytoplasma in rose samples by employing primer pairs of 16S rRNA and secA genes together in a single PCR reaction by optimizing annealing temperature at 55°C. Phytoplasmas association was confirmed in nested PCR assays in all the 16 symptomatic rose genotypes using primer pairs of 16S rRNA, sec A and rp genes.Virtual RFLP comparison of of the *16S rRNA*secA and rp gene sequences of rose *a* varieties confirmed the association of '*Candidatus* Phytoplasma Australasia' (16SrII-D) phytoplasma subgroup in

both the symptomatic rose varieties in the present study.Leafhoppers collected from rose fields at New Delhi (*Empoasca motti* and *Hishimonus phycitis*) and Uttar Pradesh (*H. phycitis*) were tested positive with 16SrII-D subgroup of phytoplasma and suggested these as putative vectors. In addition, five weed species from New Delhi and four weed species from Uttar Pradesh growing in the symptomatic rose fields were also tested positive for phytoplasma using 16S rRNA gene–specific primer suggestive as alternate hosts.

OL-142

PREVALENCE AND CHARACTERIZATION OF DRAGON FRUIT STEM CANKER CAUSED BY *NEOSCYTALIDIUM DIMIDIATUM*, AND IDENTIFYING EFFECTIVE FUNGICIDES FOR ITS CONTROL

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Fungal infections, particularly stem canker induced by *Neoscytalidium dimidiatum*, present a substantial menace to red-fleshed dragon fruit (*Hylocereus polyrhizus*), resulting in the development of cankers and lesions on both the stems and fruits. Stem canker thrives in high-humidity environments and mainly affects young shoots and fruits, posing challenges for growers as fruits are the economic parts, resultingin poor preference among the consumers. A rapid roving survey was conducted in the redfleshed dragon fruit growing areas of Tumakur, Bengaluru Rural, and Chikkaballapur districts of Karnataka. The incidence of stem canker was found in all seven surveyed plantations however its severity varied from 2% to 70%. The disease exhibited distinctive symptoms, including small circular sunken orange lesions, black pycnidia, and stem deterioration. Thirty-two isolates resembling Scytalidium fungus were conclusively identified as N. dimidiatum, showing initial white growth that darkened over seven to eight days, along with dark brown conidia in chains within the mycelium. Furthermore, the fungus produced white to olivaceous aerial mycelium, chlamydospores, and arthroconidia chains. Initially, the conidia were hyaline, ellipsoidal to globose, measuring 4.210 µm × 2.6 3.4 µm, and featured muriform septa. Importantly, pathogenicity tests confirmed their ability to cause stem canker in H. polyrhizus. Molecular analysis of the ITS region (OR512149) revealed an exact 100% genetic match to N. dimidiatum (OQ829631). This marks the first documented occurrence of stem canker in H. polyrhizus attributed to N. dimidiatum in Karnataka. Moreover, an in vitro assessment was conducted to evaluate the effectiveness of five fungicides. Among which, three fungicides such as 12% Carbendazim + 63% WP Mancozeb (SAAF), Thiophanate methyl 70% WP

(Roko), Metalaxyl - 4% + mancozeb - 64% (Ridomil mz) confirmed complete inhibition of the fungus at concentrations of 100, 250, 500, 1000, 1500, and 2000 ppm. Moreover, Copper oxychloride (blitox) demonstrated 100% inhibition of the fungus only at concentrations of 1000, 1500, and 2000 ppm. In vitro evaluation showed promising results, however subsequent field trials are imperative to validate their effectiveness against the fungus.

OL-94

PREVALENCE OF PLANT- PARASITIC NEMATODES IN HORTICULTURAL FIELD OF JORHAT

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The presence of the plant-parasitic nematodes in horticultural crop may account for yield suppression. Therefore, a survey of plant-parasitic nematode was conducted to assess the frequency and abundance of plant-parasitic nematodes associated with horticultural crops in the Experimental field of Department of Horticulture, AAU, Jorhat during Rabi and Kharif season, 2022-2023. Analysis of 200 soil and root samples collected from the root rhizosphere of different vegetable, fruit and ornamental crops showed the presence of root-knot nematode (Meloidogyne incognita), reniform nematode (Rotylenchulus reniformis), root-lesion nematode (Pratylenchus spp.), lance nematode (Hoplolaimus spp.), spiral nematode (Helicotylenchus spp.), stunt nematode (Tylenchorhynchus spp.) along with Criconema spp., Xiphinema spp, Longidorus spp., free-living nematodes, mycophagous nematodes and predatory nematodes. Among all the isolated plant-parasitic nematodes, root-knot nematode (Meloidogyne incognita) was found to be more abundant with prominence value of 136.7, 81.3 and 76.3 in vegetable crops, fruit crops and ornamental crops, followed by Helicotylenchus spp. and Rotylenchulus reniformis. The prominence value of reniform nematode (Rotylenchulus reniformis) was found to be 90.5, 54.1 and 54.1 in vegetable crops, fruit crops and ornamental plants respectively.

OL-141

EFFECT OF BRASSICACEOUS HOST CROPS ON THE LIFE TABLE AND DEMOGRAPHIC PARAMETERS OF DIAMONDBACK MOTH, *PLUTELLA XYLOSTELLA* (L.) (LEPIDOPTERA: PLUTELLIDAE)

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In order to develop effective management strategies for combating insect pests, it is crucial to construct a life table and examine demographic factors. The diamondback moth (DBM), *Plutella xylostella* (L.) (Lepidoptera: Plutellidae), is a notorious pest that impacts brassicaceous plants worldwide. This research aims to explore how different host plants impact the fitness of *P. xylostella* in controlled conditions. The highest percentage of egg hatching (96.67%) occurred on cabbage, with the longest total development period observed on cabbage (20.11±1.34 days) and the shortest on mustard (18.75±0.94 days). Female *P. xylostella* laid significantly more eggs on mustard (234.38±30.81 eggs) and cabbage crops (231.43±54.65 eggs). According to the GGE biplot analysis, cabbage emerged as the most preferred host, while knol khol was the least favored by *P. xylostella*. The biotic potential of *P. xylostella* reared on brassica hosts was as follows: broccoli (1.06×10^{28}) > mustard (7.70×10^{27}) > cauliflower (8.77×10^{26}) > knol khol (6.20×10^{24}) > cabbage (3.97×10^{24}). The age-specific survival rate (S_{xj}) varied among different developmental stages, and there was an overlap in the survival curves, suggesting varying growth rates among individuals. The life expectancy (e_{xj}) at age zero was found to be the highest when reared on mustard (23.50 days). Analyzing demographic parameters using the TWOSEX MS chart, the *r* value for *P. xylostella* was at its lowest on knol khol (0.14) and highest on mustard (0.20). Likewise, the R_0 was highest for mustard (62.5±1.94) and lowest for knol khol (17.7±0.74). The population doubled in size approximately every 3.57±0.036 days on mustard, whereas it took about 5.01±0.111 days on knol khol. These findings suggest that mustard and cabbage are preferred hosts for *P. xylostella*, while knol khol exhibits relative resistance to this pest.

STUDY ON SUBSTRATE DECOMPOSING FUNGI OF MUSHROOM AND THEIR MANAGEMENT BY GRAS CHEMICALS

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Mushrooms cultivation in recent years has gained momentum both at state and National level. It is a rich delicacy with vitamins, minerals and antioxidants having both nutraceuticals and medicinal property useful in minimizing the risk of numerous chronic diseases and boosting immunity. One of the challenges in the cultivation of mushroom is the prevalence of substrate decomposing (SD) fungi during the spawn running period which in turn reduces the production drastically. The present study aims to isolate the substrate decomposing fungi from the mushroom growing farms of the Karbi Anglong district. In an attempt to manage these two SD fungi viz. Trichoderma viride and Aspergillus flavus, five GRAS chemicals namely Boric acid, Calcium carbonate, Potassium bicarbonate, Sodium bicarbonate, Sodium chloride each ranging from 1-5% concentrations along with Chemical check (0.5% Carbendazim 50WP) and Control check respectively were studied both in vitro and in vivo condition to check their efficacy against these SD fungi. Under in vitro condition performance of Sodium Bicarbonate (5%) was found to be the best (0.71cm) followed by Potassium bicarbonate 5% (0.74cm) and Sodium bicarbonate (1.06cm). The growth under chemical check was (0.70cm) and full growth in control plate was observed. Next, based on all the results of the experiment under in vitro condition, this experiment was further carried out in the mushroom house to see the efficacy of these three promising GRAS chemicals against the SD fungi under in vivo condition along with control and chemical check (0.5% Carbendazim 50WP). The Disease incidence was scored on a 0-5 scale (Bhardawaj, 1992). The percent disease index showed that Potassium Bicarbonate (5%) was the best (18.6) followed by Sodium Bicarbonate (5%) (22.6) against both the SD fungi.

OL-139

BIOCHEMICAL BASIS OF HOST PLANT RESISTANCE TO ASH WEEVIL, *MYLLOCERUS SUBFASCIATUS* GUERIN-MENEVILLE (COLEOPTERA: CURCULIONIDAE) IN WILD *SOLANUM* SPP.

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The study was aimed to identify host plant resistance sources *Solanum* species against the dreaded brinjal pest, ash weevil, *Myllocerus subfasciatus* Guerin-Meneville. A total of 84 brinjal genotypes (both cultivated & wild) were screened for feeding preference/non-preference against ash weevil under field as well as in-vitro conditions. Of these, all the cultivated and five wild genotypes (bitter brinjal, *Solanum gilo* Raddi; black nightshade, *Solanum indicum* L.; African eggplant, *Solanum macrocarpon* L.; Ethiopian eggplant, *Solanum aethiopicum* L.; Dutch eggplant, *Solanum acculeatissimum* Jacq.) were found highly susceptible to the ash weevil. The other wild species namely tropical soda apple, *Solanum viarum* Dunal; nipple fruit (= cow's udder) *Solanum mammosum* L.; European nightshade, *Solanum nigrum* L.; cockroach berry, *Solanum capsicoides* Allioni; Brazilian nightshade, *Solanum seaforthianum* Andrews; Turkey berry, *Solanum torvum* Sw.; sticky nightshade, *Solanum sisymbriifolium* L. am exhibited complete resistance to ash weevil by showing leaf feeding damage ranged from zero to <1.00 (when scored on 0.00 to 10.00 scale). This study helped to identify the feeding antixenosis (feeding non-preference) as major component of resistance in these wild genotypes against *M. subfasciatus*. Response of ash weevil to these wild/ cultivated genotypes and their volatiles are discussed in detail. We identified that the specific sesquiterpene β- selinene is abundant in resistant genotypes (*S. mammosum*, *S. sisymbriifolium, S. nigrum, S capsicoides).* The other sesquiterpenes namely, γ-Amorphene, β-Ocimene, β-copaene, α-bergamotene, sesquisabinene, germacrene D and α-muurolene were abundantly found in the resistant wild *Solanum* species. In addition to the above compounds, n-Eicosane; trans-1,4-dimethyl cyclooctane; 7,7-diethyl heptadecane; P-Isopropyl benzaldehyde; 2-hexyl-1-decanol; 2,4,6-trimethyldecane; diemthyl dodecane; 2,6- dimethyl decane; ethyl benzoate; 2-methyl-1-decanol and 4-ethyl acetophenone were also found to be the key contributing compounds for resistance against ash weevil *M. subfasciatus*.

OL-128

EFFICACY ASSESSMENT OF FUNGICIDES AGAINST RUST DISEASE OF GARDEN PEA

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The garden pea is a popular vegetable cultivated extensively in the riverine area of Dhemaji district due to its high market price compared to other vegetables. The tender green pods are marketed which can be harvested in 3-5 flush. But the occurrence of pea rust caused by the autoecious fungus *Uromyces viciae–fabae*is a major constraint that is favoured by the warm and humid climatic conditions of the Dhemaji district. All green parts of the crop including the pods are affected by the fungus and hinder the farmers from carrying out multiple picking of the crop which leads to low economic returns. To address the problem an on-farm testing was conducted from 2019 to 2021 to assess the efficacy of Propiconazole 25% EC in the management of Pea rust considering Mancozeb 75 WP as check along with farmer's practice which involves injudicious use of pesticides. The study revealed that the treatment involving Propiconazole 25EC recorded the least (5.06 %) Percent Disease Incidence (PDI) followed by Mancozeb 75WP (9.13 %)and the maximum incidence was recorded in farmer's practice (13.27%). The reduction in disease incidence over check was found to be 44.57 %. The findings may be concluded that the systemic fungicide Propiconazole 25EC was effective in the management of the rust pathogen of Pea.

OL-138

EFFECT OF BOTANICALS IN MANAGEMENT OF SEPTORIA LEAF BLIGHT OF CHRYSANTHEMUM (*CHRYSANTHEMUM MORIFOLIUM,* RAMAT CV "RATLAM SELECTION") IN PUNJAB

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The study on Septoria leaf blight of Chrysanthemum genotype "Ratlam Selection" was conducted at Research Farm, Department of Floriculture and

Landscaping, Punjab Agriculture University, Ludhiana during 2022 and 2023. Six botanicals namely *Azadractica indica, Syzygium aromaticum, Allium sativum, Moringa oleifera, Murraya koenigii and Terminalia arjuna* were evaluated against *Septoria chrysanthemi*. The experiment was conducted for two years *i.e.* 2022 and 2023 consequently. The disease symptoms were first observed in the month of August. Simplest extraction method that is direct extraction in ethanol also called solid-liquid extraction (SLE), was used botanicals sprays were carried out at weekly interval after the appearance of first symptoms on the plant. The data revealed that *Allium sativum* @0.2% percent was found to be highly effective against *Septoria chrysanthemi* followed by *Syzygium aromaticum* @0.2%, *Azadractica indica* @0.2%, *Murraya koenigii* @0.2 %, *Moringa oleifera* @ 0.2% and *Terminalia arjuna* @ 0.2 percent. The highest yield was observed in plants treated with *Allium sativum* and minimum in plant treated with *Terminalia arjuna*. The minimum disease control was observed in disease control of (32.35%) was observed in *Terminalia arjuna* and maximum of disease control of (78.70%) in *Allium sativum.* The size and duration of flower also varied but were not affected by the progression of the disease. All the treatments were found significantly superior over control.

OL-166

ASSESSING THE EFFICACY AND RESIDUE DYNAMICS OF CHLORANTRANILIPROLE IN MANAGING EARIAS SPECIES IN OKRA UNDER FIELD CONDITIONS

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Earias species, a major borer pest poses a substantial threat to global okra production, causing significant economic losses. In this study, we aimed to assess the bioefficacy and residue dynamics of chlorantraniliprole 18.5 SC sprays in okra crops under field conditions at Eastern Himalayan region (EHR). Two different doses (25 and 50 g a.i. ha^{-1}) of Chlorantraniliprole were evaluated for their effectiveness in controlling *Earias*species infestations and improving marketable fruit yield. Both doses were found to be equally effective, resulting in a significant reduction of this borer population by over 80%. Furthermore, the application of Chlorantraniliprole 18.5 SC demonstrated no phytotoxic effects on the okra plants. This chemical also exhibited a negligible impact on the beneficial spider and coccinellid beetle populations that are vital components of

the okra ecosystem. The study analysed chlorantraniliprole residues in okra fruit, extracted them with ethyl acetate, and cleaned them using primary secondary amine (PSA) and magnesium sulfate. The estimated limit of quantitation (LOQ) was determined to be 0.01 mg kg^{-1}, with average percentage recoveries ranging from 83.33% to 89%. The study revealed that Chlorantraniliprole residues in okra fruit had relatively short half-lives of 3.22 and 3.12 days for the 25 and 50 g ai ha^{-1} treatments, respectively. Additionally, dietary exposure assessments based on average daily consumption revealed that the residues consistently remained well below the maximum permissible limit (MPI). These findings enumerate valuable insights for establishing an effective spray schedule for chlorantraniliprole in *Earias* management within okra cultivation, ensuring both pest control and food safety.

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OL-11

PEEL OF BOTTLE GOURD (*LAGENARIA SICERARIA*) IS SUPERIOR BEYOND PULP IN BIOACTIVE CONTENT, ANTIOXIDANT AND ENZYMATIC ACTIVITIES

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Fruit of bottle gourd (*Lagenaria siceraria*) are commonly used for food and health benefits. The objective of this study was to determine the antioxidant (catalase and ascorbate peroxidase) and browning enzymes activity (peroxidase and polyphenol oxidase) in peel of bottle gourd fruit “Kashi Ganga” and also in the pulp. Notably, it was observed that bottle gourd peel showed significantly higher bioactive compound content, antioxidant capacity and enzyme activities over the fruit pulp which is generally consumed. The antioxidant capacity was almost 2-fold stronger in peel (91%) over pulp (43%). Importantly, antioxidant enzymes activities were 2.84 (catalase) and 5.67 (ascorbate peroxidase) fold higher in peel over pulp. The chlorophyll content in bottle gourd peel was 4-fold higher than the pulp. No significant difference in browning enzyme activity polyphenol oxidase and peroxidase were recorded. Higher cellulose content in fruit peel (1.15g/100g FW) over pulp (0.5g/100g FW) was found. Quality attributes like total phenolics and flavonoids content was also found significantly higher in fruit peel (73 and 22 mg GAE/100 gFW and 12.6 and 4.3 mg RE/100g FW, respectively) over pulp. This indicates that health benefits can be enhanced by including peel along with pulp in diet.

TRANSITION TO MECHANIZATION – BOON OR BANE FOR INDIAN CASHEWNUT PROCESSING SYSTEM

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Consumer perception of cashew has shifted from a 'luxury' commodity to that of a 'health and necessity' commodity. Technological innovation in conversion process in to premium grade kernels, traceability, strong supply chain linkages and adherence to international food safety standards are important factors for the competitive business in cashew. The cashew industry ranks third in the world production of edible nuts with a total production of 4.87 million MT of raw nuts during the last fiscal and its estimated value in excess of US$ 7.53 billion. An increased annual growth of cashew consumption @ 7.2 % in the world and rising domestic demand for superfoods with nutraceuticals to boost immunity, is propelling the growth of cashew industry in this country.

Increased processing facility and export of cashew kernels were not accompanied by domestic production and import of raw cashewnuts become imperative. During 60's traditional method of 'Pan roasting' replaced by drum roasting method and oil bath roasting seldom followed. Cost effective steaming mode is in practice in majority of the units due to financial and environmental benefits. India's low labor costs enabled it to sustain this method and maintain a quality advantage in the industry. But now, crisis of work force griped the cashew industry and switching over to mechanization in order to remain competitive in the global market.

A new era in cashew processing system started with the introduction of automated machinery in the line of processing viz., rotary grading system; hydro cleaning; revolving type conditioning unit; grade specific deshellers; steam dryers and mist chambers; pneumatic peelers; size and colour sorters; shrink packaging; roasters and coating machine; expellers for CNSL; extruder and vacuum fryer for cashew apple based snack foods etc., drastically reducing the cost of processing and reflected on economy. Increased competition for labour and advances in mechanization has changed the processing scenario in this country. Investment and capital cost are rising and financial barriers for small and medium level processing is growing.

Environmental concerns will impact the cashew industry owing to energy and environmental audit on processing plants. Emissions into the air and water in particular will be of more concern and development of highly efficient boilers and CNSL extraction plants will become imperative. Fully automated processing with bulk production drastically reduced the cost of processing and margin increased due to strong domestic market for 'broken' kernels.

While India has a legacy of leadership in the global cashew industry, it must continuously reassess its comparative advantages in order to remain competitive. Overall, India distinguishes itself in the cashew sector by maintaining high quality with good manufacturing practice. Currently available cashewnut processing equipment involves striking a balance between change in the quality of the end product and saving time and labor. It is essential to build up internationally competitive business environments and promote enterprises to make the cashew industry an engine of the economic growth.

OL-20

COMPARATIVE STUDY ON EFFECT OF POMEGRANATE PEEL POWDER AS NATURAL PRESERVATIVE AND CHEMICAL PRESERVATIVES ON QUALITY AND SHELF LIFE OF MUFFINS

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This research work aims to investigate the potential of utilizing pomegranate peel powder as a natural preservative in muffin preparation. The *in-vitro* antifungal activity of pomegranate peel powder (8% PPP), potassium sorbate (0.1% PS) and calcium propionate (0.5% CP) was assessed against *Penicillium* sp. and *Aspergillus* sp. using poison food technique. The PPP showed the anti-fungal activity by delaying the growth of microorganism on media plate similar to the PS and CP. The effect of utilization of PPP on quality characteristics and microbial stability of muffins were compared with the muffins with chemical preservatives (0.1% PS and 0.5% CP). The microscopic structure of batter showed decrease in the number of air cells and area due to incorporation of PPP. The increase in the weight (32.83 g), and decrease in the height (31.3mm), volume (61.43cm^3), specific volume (1.67cm^3/g) and baking loss (10.19%) were observed in muffin with PPP. The 418.36% increase in fibre content, 14.46% and 18.46% decrease in carbohydrates and energy value was observed in muffin with 8% PPP as compared to control respectively. The increase in the total phenols, total tannin, *in-vitro* antioxidant activity was found in muffins added with 8% PPP. During the storage of muffins at room temperature, the moisture content of muffin with PPP was reduced from 17.04% to 13.23% which was higher than the rest of the treatments.

OL-15

INFLUENCE OF NITRIC OXIDE ENRICHED CARBOXYMETHYL CELLULOSE – CHITOSAN COMPOSITE COATING ON STORABILITY OF *JAMUN* FRUIT

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Jamun (*Syzygium cuminii)* skeels is an underutilized fruit crop indigenous to Indian subcontinent. Although it is considered as a minor fruit, the demand of jamun is increasing over the years due to its rich phytochemical composition, antioxidant potential and several medicinal values, especially against diabetes. The present study was conceptualized to extend the storability of jamun fruit at ambient condition. In this experiment, ripe jamun fruits were harvested and immediately transported to the laboratory. Healthy uniform fruits were selected for the experiment and were treated with carboxymethyl cellulose – chitosan bilayer coating at 0.5%, 1.5% and 2% concentrations, following incorporation of sodium nitroprusside (1.0 mM and 1.5 mM) as nitric oxide donor. Control fruits were treated with distilled water. Following air drying, fruits were stored at ambient condition in corrugated fibreboard boxes. The results revealed that fruits treated with 1.5% carboxymethyl cellulose – chitosan bilayer coating enriched with 1.0 mM sodium nitroprusside was highly beneficial in preserving fruit quality during 6 days of storage. This treatment delayed loss of anthocyanins in the fruit peel and pulp, compared to control. The loss in fruit weight and disease incidence was also highly suppressed by this treatment. Reduced membrane lipid peroxidation and higher retention of bioactive compounds was also noted. Therefore, sodium nitroprusside enriched carboxymethyl cellulose – chitosan bilayer coating can be potentially used to extend storability of jamun fruit during storage at ambient condition.

OL-17

NUTRACEUTICAL AND BIOCHEMICAL PROFILING OF KHEJRI (*PROSOPIS CINERARIA*) PODS AT DIFFERENT DEVELOPMENTAL STAGES FOR UTILIZATION AS FUNCTIONAL FOOD

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Khejri (*Prosopis cineraria*) is a multi-function leguminous tree and life-line tree of *Thar* Desert. Its seedlings grow naturally and found abundant under

inhospitable hot arid climatic. It is extensively promoted as an environmental service plant and important component of arid farming systems. The tender pods (s*angri*) used widely both fresh and dehydrated for vegetable culinary, and sold at high prices (@ Rs. 200 & 800/kg, respectively). Studies indicated that *sangri* possesses a number of potent bioactive compounds including polyphenols, alkaloids, tannins, saponins, and flavonoids. It has also been reported by several researchers that khejri pods possess numerous medicinal properties such as antidiabetic, hypoglycemic, anticancer, anti-inflammatory, antiasthmatic, antihypercholesterolemic as well as innumerable other pharmaceutical properties. Potential functional foods can be developed from the khejri pods owing to its nutraceutical and pharmaceutical properties. Khejri tender pods are harvested between 10-25 days after setting to utilize for vegetable, dehydration and pickle purpose. Specific pod developmental stage in which maximum numbers of bioactive compounds are accumulated is required to be identified for making functional food or health supplement from khejri pods. Therefore, the present study was carried out in khejri variety Thar Shobha. Tender pods were harvested at 10, 15, 20, 25, 30 and 45 days after setting and proximate, mineral analysis and bioactive compounds were estimated at each developmental stage. The results revealed that total phenolics (175.83 mg GAE/g), flavonoids (3.15 mg Cat.E/g) and antioxidants (174.68 CUPRAC mg AAE/g) were recorded significantly high in pods harvested after 10 days of setting. These parameters were gradually decreased in later stages of pod development *i.e.* at 15, 20 and 25 days of pod setting. Drastic reduction in bioactive compounds was recorded after 25 days and observed minimum phenols (50.42 mg GAE/g), flavonoids (1.12 mg Cat.E/g) and antioxidants (54.44 CUPRAC mg AAE/g) in 45 days of mature pods. Total sugars were quantified minimum (113.41 mg/g) at 10 days, however as the pod's maturity advanced, total sugars were significantly enhanced and reported maximum (270.09 mg/g) at 45 days. Reducing sugars followed opposite pattern, observed maximum at initial developmental stage (63.94 mg/g) and minimum (5.23 mg/g) at ripened stage. Proximate analysis disclosed that crude protein was estimated 17.02%, 15.79% and 18.79% at 10, 15 and 20 days maturity, respectively and significantly reduced (13.86%) at 45 days. Non-significant difference was observed in crude fibre (13.55, 11.44, 12.77, 12.97 %) during initial maturity stages (10, 15, 20 and 25 days), after that significantly higher amount of crude fibre was accumulated at 45 days (17.51%). In case of mineral analysis, significantly higher accumulation of iron, calcium, sodium and manganese was observed during initial pod development stages as compared to ripened stage. On the other hand, non-significant difference in magnesium, copper and zinc quantity was noticed throughout the pod maturity stages. It is concluded from the above study that khejri pods harvested at 10 and 15 days of setting possess maximum amount of therapeutic active biotic compounds, proteins and mineral contents. Therefore, to harness the maximum medicinal and pharmacological benefits and to develop functional food/health supplements, khejri pods should be harvested between 10 to 15 days after pod setting.

PHYTOCHEMICAL ANALYSIS AND ASSESSMENT OF NUTRACEUTICAL POTENTIAL OF *HIBISCUS ROSASINENSIS* GERMPLASM

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Hibiscus rosasinensis, a highly popular flowering plant is also being used for health promoting and medicinal properties and recently it is gaining popularity as tea supplements and also as beverage addition. It constitutes of germplasms having morphological variations with regard to flower colour and flower type in reference to number of petals.

The present study assessed twenty different germplasms of *Hibiscus rosasinensis* for their nutraceutical and therapeutically potential in form of phytochemicals consecutively for two years. Significant variation with regard to nutraceutical aspects like carbohydrates, protein, iron; pigments like carotene, carotenoids and anthocyanin and therapeutically potential like phenol, flavonoids and anti-oxidant activity were observed in different genotypes.Based on the obtained results, the germplasms of *Hibiscus* contain significantly higher nutraceutical properties in varying amounts owing to the presence of various phytochemicals like phenol, protein, flavonoids, carbohydrate, iron and anti-oxidants.

Among all twenty germplasms, considering nutraceutical potential, significantly higher level of carbohydrate and protein were recorded in the flowers of HG_{14}, (dark red) HG_1(dark pink)while higher level of iron content was present in red flowering germplasms viz., $HG_{12,}$(red) HG_{14},(dark red)and $HG_{8.}$ (Moderate red). With regard to pigments, germplasms $HG_{19,}$(yellow)HG_{20} (bright orange)and HG_{11} (crimson orange) werefound to be rich in carotenes while $HG_{18,}$ (orange) HG_6 (bright orange) and HG_{16} (yellow)in carotenoids. In case of anthocyanins, HG_{14} (dark red), HG15 (chocolaty) HG1 (dark pink) showed higher content. Phenols and flavonoids are important parameters for therapeutic use for immunity boosting. HG_1 (dark pink), HG_2 (red) and HG_6 (bright orange) genotypes were rich in total phenol while $HG_{14,}$ (dark red) HG_8 (moderate red) and HG_9 (pink) in total flavonoids. Referring to anti- oxidant properties, $HG_{14,}$ (dark red) $HG_{4,}$ (white with pinkish throat) HG_{19} (yellow), HG_{12} (red), HG_7 (white) and HG_{16} (yellow with red throat) have been identified with higher DPPH values (above 89%) for further exploitation as commercial application with regard to nutraceutical use.

OL-113

CISH MET WASH A NOVEL BIO-FORMULATION FOR EXTENDING THE SHELF LIFE AND CONTROLLING THE POST HARVEST DISEASES IN MANGO CV. DASHEHARI

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India is a home for variety of mangoes and is the largest producer in the World. Despite this, currently only 1.5% of mangoes are exported. This can be attributed mainly to poor shelf life and incidence of post-harvest diseases. In this backdrop, the ICAR-CISH, Lucknow has developed a formulation extracting the bio-metabolites from bacteria involve D-44 *Priestia aryabhattai* for shelf life and post-harvest diseases. The experiment was conducted on fruits following the standard operating protocol for the export of mango and mango fruits cv. Dasheahri were dipped in 2.5 % MET WASH solution for a specific period and stored at 13 °C. The quality parameters viz. TSS (°B), Acidity (%), Fruit firmness (lbs), Ascorbic acid (mg $100g^{-1}$), physiological weight loss (%), per cent disease index (%), and peel colour were assessed up-to 27 days at five days interval. The experiment on efficacy of MET WASH was initially conducted under *in vitro* conditions pathogenic isolate of *Colletotrichum gloeosporioides*. It was found that 2.5 % of MET WASH was effective in suppressing the pathogen and enhances the shelf life upto 27 days. There was significant difference in the TSS content and use of met wash delayed the ripening process and resulted in enhanced shelf life. Fruit firmness and ascorbic acid content was significantly higher in treated fruits compared to control. However, there was no significant difference with regard to acidity. The physiological loss of weight was significantly higher (7.48 %) in control while it was just 4.32 % in treated fruits. After 25 days of storage, there was significant difference in disease incidence (15.05 and 1.84 % respectively in control and treated fruits). The above findings clearly indicate the efficiency of MET wash in enhancing the shelf life and controlling the post harvest diseases in mango.

OL-62

NUTRITIONALLY ENRICHED CASHEW APPLE AND FINGER MILLET FLOUR BASED EXTRUDATES

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Finger millet and cashew apple pomace powder were utilized to extrude the snacks with high protein, calcium and other nutrient content. As finger millet being a nutricereal was used to develop ready to eat snack along with cashew apple pomace powder which is also rich in fibre and other bioactive components. Five different composite flour mixes were prepared by using CAPP, finger millet, corn flour, rice flour in varying proportions. Extrusion cooking was carried out using twin screen extruder at high temperature of 140^{0}C. Physical properties of the extrudates namely bulk density, expansion ratio, Water absorption index, water solubility index, colour, specific length was measured. Biochemical characterization was also carried out for total phenols, total flavonoids, total antioxidant activity, protein, crude fibre, and other mineral components. The results indicated that the bulk density ranging from0.10±0 to 0.19±0.003 and the expansion ratio varied from 1.90±0.03 to 3.50±0.03 the WAI and WSI were 6.39±0.09 to 8.57±0.12 and 10.50±0.29 to 17.39, respectively. The mix containing finger millet along with CAPP had the dark colour (with high L value). This study showed that the composite flour mixture of Cashew apple pomace powder and finger millet in the ration of T_3 (40%CF + 20%RF +30% FF + 10%CAPP) best suits to produce desirable quality of the extrudates.

OL-110

EVALUATION OF FERNS FOR CUT GREEN IN SOUTH GUJARAT CONDITIONS

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Ferns are herbaceous perennial foliage plants can grow well in humid and shady environments. They are excellent ornamental plant, which can provide greenery in a landscape as pot plant. Due to unique features of foliage, ferns can be also used as excellent fillers in flower arrangements, bouquets *etc*.In forest area of south Gujarat, various species of ferns are yet to be exploited for the landscape and commercial value. Hence, the study was aimed to collect the ferns available

in humid forest regions of South Gujarat and evaluate the performance of different fern species and to identify the suitable species for commercial cultivation of cut green. Eight species of ferns belonging to different genera *viz. Pteris ensiformis* 'Victoriae', *Nephrolepis exaltata*, *Polypodium phymatodes* L., *Nephrolepis exaltata* 'Childsii', *Pteris vittata*, *Polypodium punctatum*, *Nephrolepis cordifolia* 'Duffii' and *Nephrolepis exaltata* 'Sword fern' were collected and evaluated for growth pattern and suitability for cut green. All the collected genotypes of fern performed well and observed variation for qualitative parameters. Maximum plant height, plant spread in E-W direction, leaf longevity and vase life was noted in *Polypodium phymatodes* L. While highest plant spread in N-S direction and yield of cut green per plant was obtained from *Nephrolepis exaltata* with minimum leaf production interval. *Nephrolepis exaltata*, *Nephrolepis cordifolia* 'Duffii', *Nephrolepis exaltata* 'Childsii', *Polypodium punctatum* and *Polypodium phymatodes* L. were observed to be attractive for flower arrangements as well as in pot plant hence, found suitable for cut green production.

OL-31

EFFECTS OF DRYING METHODS AND BREWING CONDITIONS ON FLAVONOIDS, PHENOLICS, ANTHOCYANINS AND ANTIOXIDANT CONTENT IN ROSE TEA

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Commercially rose is grown for loose and cut flower production. The area under cultivation is constantly increasing. Mostly fragrant varieties are grown for loose flower production. The fresh flowers are highly perishable and farmers suffer huge losses during glut like situation or bumper production time. Therefore, there is a need to diverse the rose for value additions and development of processed products. The fresh petals can be dried and used for various purposes or making value added products like rose tea. The phytochemicals content present in rose might varies with the genotypes and methods of drying used for petals. Therefore, comparative evaluation of fresh, oven dried and shade dried rose petals for secondary metabolites and antioxidant properties were carried out at ICAR-Directorate of Floricultural Research, Pune. Rose genotypes were evaluated for various biochemical parameters and based on the results two genotypes were selected for development of rose tea. Petals of variety Night Time and Christian Dior were dried with two methods ie., shade drying and oven drying. Based on the results, it was observed that shade drying found to be effective higher for total phenols (0.36 mg/L), total anthocyanin (8.08 mg/l) and

total antioxidants (4.59 mM) in Night Time genotype. Dipping time needs to be standardized to understand the level of biochemical parameters in final product. Various dipping time were studied ranging from 30 seconds to 150 seconds. Based on the results it was observed that 120 seconds dipping found to be effective in getting maximum total phenols (0.37 mg/mL), total flavonoids (0.28 mg/mL) and total anthocyanin (6.96 mg/L) in final product. Rose petal quantity needs to be standardized to understand the level of biochemical parameters in final product besides aroma, colour and consistency of tea. Based on the results, it was observed that 1.0 g of dried petals was found to be effective in getting maximum total phenols (0.32 mg/ml), total flavonoids (0.18 mg/ml) and total anthocyanin (6.97 mg/L) in final product besides ideal aroma, colour and consistency.

OL-73

ASSESSMENT OF POTENTIAL MANGO HYBRIDS FOR BIOACTIVE COMPOUNDS

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Mango (*Mangifera indica* L.) is among the most important fruit crop of the world. Mango is now widely acknowledged as a health-fruit, comprising multiple bioactive components with a variety of health advantages, establishing mango as an economical functional fruit. ICAR-CISH is focusing on the development of nutraceutically rich, coloured and better-quality hybrid mango varieties. We have identified 26 promising mango hybrids i.e., *H-1190, H-2778, H-2939, H-2527, H-2805, H-2279, H-3991, H-1076, H-1077, H-1084, H-949, H-2040, H-2253, H-4065, H-1736, H-4092, H-4096, H-4265, H-4264, H-4263, H-4509, H-4504, H-4327, H-4295, H-2912* and *H-1206*. Bioactive compounds viz., total carotenoids, total phenols, total flavonoids, total antioxidants, ascorbic acid, total sugar content, TSS and acidity has been analysed in the fruit pulp of the promising mango hybrids. Result reveals that most of the above-mentioned hybrids are rich in one or other bioactive compounds.The hybrid H-4504 have highest carotenoids content (7.721 mg/100g) followed by H-2939 (7.245 mg/100g). The highest Antioxidants content was recorded in H-1076 (1.07 µmolTrolox/100g) followed by H-2253 (0.80 µmolTrolox/100g). Total phenol contents were higher in H-1076 (118.47 mg/100g), however, the Ascorbic acid content was observed maximum 151.47 mg/100g in H-4327. The highest total soluble solids (TSS) were recorded 26.9°Brix in H-2912 followed by 25.2°Brix in H-2939. Similar variations have also been recorded for flavonoids and total sugar contents. This study will help in the identification of bioactive compound rich mango hybrids having better quality to fulfil the increasing demand for nutritionally rich mangoes in the Indian as well as global market.

OL-84

HIGH RESOLUTION LC-MS CHARACTERIZATION OF PHENOLIC COMPOUNDS OF *HYGROPHILA SPINOSA* (KULEKHARA)

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This study reports qualitative profiling of the phenolic compounds in an underutilized leafy vegetables *Hygrophila spinosa* (Kulekhara) using ultra performance liquid chromatography with quadruple time of flight mass spectrometry. A total of 14 compounds, including 4 flavonols, 2 phenolic acids, 5 flavone, and 3 isoflavonoids were putatively identified based on high resolution accurate mass analysis with the data processing through UNIFI®, which is a comprehensive compound identification software solution. An in-house developed database comprising the secondary metabolites of phenolic compounds was used for the screening purpose, and each phenolic compound was identified based on the detection of the precursor ion and at least one characteristic fragment ion, each with less than 5 ppm of mass error. Flavones were the most abundant type of phenolics exhibiting 84% of the total phenolics in kulekhara leaves. Apigenin-7-O-Glucouronide was single predominant compounds in kulekhara, exhibiting 39% of the total phenolic. All these compounds were reported for the first time. Based on the results, it can be reflected that this underutilized plant might act as a potential functional food for the management of many bacterial infections.

OL-86

DEVELOPMENT OF BIO-FORTIFIED GENOTYPES IN GINGER AND TURMERIC FOR FOOD, PHARMACEUTICALS AND COSMETIC INDUSTRIES

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Ginger and turmeric are two of the most important spice crops in the northeastern states of India. The area and production under ginger and turmeric are 0.176 and 0.291 million ha and 1.89 and 1.06 million metric tonnes, respectively. The region contributes, 26.86% and 8.34% of the total production of ginger

and turmeric in the country, respectively. Oleoresin and curcumin are the most valued products of ginger and turmeric for the food and cosmetic industries. The key compounds responsible for the medicinal properties are gingerol and curcumin in ginger and turmeric, respectively. The varieties rich in curcumin and oleoresin content are getting higher market prices. To identify, the superior genotypes, 112 genotypes of ginger and 130 genotypes, including improved cultivars, were evaluated for yield and quality traits. The wider variability was observed for different yield and quality traits. In ginger, the plant height ranges from 41.80 cm to 75.80 cm; number of tillers from 2.0 – 3.2; and the stem diameter 0.52 - 0.90 cm. Oleoresin content varied from 3.03 to 7.76%; Crude fibre: 3.86 to 6.14%; Dry matter: 16.80 to 24.50%; and essential oil content: 1.0–2.90%. The high yielding accessions were identified as IC-584363 (450 g/plant), followed by ACC-391 (416.7 g), Vighinharta (400.0g) and RCGC-8 (383.3g). The highest oleoresin content was observed in RCGC-17 (6.74%), followed by RCGC-20 and Acc-22 (6.72% each). Similarly, in turmeric, the plant height ranges from 94.6–114.5 cm, yields 183.3–616.6 g/plant, dry matter 18.2-23.2%, and curcumin 4.7–7.6%. The high yielding genotypes were identified as IC-586774 (616.6 g), IC-586777 (600.0 g), and BSR-1 (516 g). Similarly, curcumin rich genotypes were Lakadong (7.6%) and Megha Turmeric -1 (6.8%).

OL-120

RESPONSE SURFACE AND ARTIFICIAL INTELLIGENCE BASED GENETIC ALGORITHM BASED OPTIMIZATION OF TOTAL PHENOLIC CONTENT (TPC) FROM POTATO PEELWITH ULTRASOUND ASSISTED EXTRACTION

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Potato peels are zero value waste generated during potato processing. They are a concentrated source of phytochemicals. The extraction of phenolics from this waste may add valuable products for the growing food industry due to their antioxidant and antimicrobial properties. Therefore, optimization of extracted parameters will be of great importance. Keeping this mind, here, total phenolic content from potato peel with ultrasound assisted extraction have been optimized first using response surface methodology based on central composite designs. Thereafter, artificial intelligence based genetic algorithm optimization technique was also applied for optimization of total phenolic content from potato peel. The

results were compared and it has been observed that genetic algorithm based optimization outperformed response surface based optimization procedure. The results were also validated in the laboratory condition.

OL-43

ENHANCING STABILITY AND BIOAVAILABILITY OF LAMINARIN AND FISH OIL THROUGH COACERVATION-BASED ENCAPSULATION WITH BANANA STARCH AND FABA BEAN PROTEIN

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Coacervation-based encapsulation of laminarin; a prebiotic polysaccharide, and fish oil; a rich source of omega-3 fatty acids, using a combination of banana starch (BS) and faba bean protein (FBP) were investigated. The encapsulation process involved the formation of coacervates with ultrasound assistance (50% and 100%) with varying duration (10 min and 30 min). This facilitates liquid droplets formed by the electrostatic interaction between oppositely charged biopolymers (BS- Anionic; FBP- Cationic). Noteworthy enhancement in yield was observed with increase in ultrasound treatment power from 50% to 100% ($P < 0.05$). The hygroscopicity measurements of the samples ranged from 4.72 to 13.79. Longer duration of ultrasound resulted to better encapsulation efficiency (i.e. up to 14.43% increase). Characterization of capsules based on their morphology, size, and zeta potential demonstrated that the coacervation-based encapsulation process effectively entraps laminarin and fish oil within the coacervate droplets. The encapsulation efficiency was found to be influenced by the concentrations of BS, FPB, and the bioactive compounds. The coacervate droplets demonstrated enhanced resistance to changes in pH and thermal stress. The particle size distribution analysis revealed the formation of uniform droplets with an average size suitable for industrial applications in food and pharma. This presents a promising approach for the development of functional food ingredients. The encapsulation process provides improved stability and controlled release properties and health benefits of laminarin and fish oil in various food formulations.

PERICARP WATER LOSS IS A VITAL MARKER OF POSTHARVEST BROWNING AND FRUIT QUALITY IN LITCHI

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Litchi is an important fruit crop in India and is popularly known as the 'Queen of Fruits'. The fruit is an item of impulse buying and visual appearance plays a major role in consumer decision to purchase. Successful postharvest management and marketing of litchi continue to be a challenge owing to highly perishable nature of the harvested fruit, specifically pericarp browning. While most research has emphasized on degradation of anthocyanin pigments, oxidative enzymes, temperature abuse, cellular compartmentation and pH, our study points to understanding the vital role of postharvest moisture loss in the manifestation of pericarp browning. To discuss this, we present the nature and extent of moisture loss from the litchi pericarp and fruit after harvest, and how it is positively correlated to red colour degradation from the pericarp. Our study found that there is rapid moisture loss from the pericarp and the quantum of loss accounts for 52.04% of the pericarp within 10 hours of harvest. This is when the first signs of browning are visible. Our data on postharvest moisture loss and its relation with colour retention or browning through correlation studies indicate that moisture loss is a vital marker of postharvest browning and fruit quality in litchi. Our results can be useful in devising appropriate postharvest strategies and protocols for successfully marketing litchi.

OL-65

INTEGRATION OF HOT WATER TREATMENT WITH QUARANTINE IRRADIATION TREATMENT REDUCED DISEASE INCIDENCE AND IMPROVED FRUIT QUALITY

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India being the major exporter of fresh mangoes to a wide range of countries has been exposing the fruits to different quarantine treatments as per the requirement of importing countries. Alphonso cultivar is the most preferred Indian mango variety by US consumers and has to be subjected to quarantine irradiation treatment (400 Gy) prior to shipment for ensuring the control of fruit fly. However, this treatment alone was found to be not effective in controlling the postharvest disease incidence of anthracnose during ripening and storage. In the current investigation, integration of hot water treatment (HWT of 55°C for 5 to 10 min) with the quarantine irradiation treatment was attempted to see its effect in controlling spoilage and maintenance of quality during storage at room temperature (27-33°C; 32-62 % RH) and optimum low temperature (13±1 °C; 80-85 % RH). No significant difference in physiological loss in weight (PLW) of the treated fruits was observed during storage at RT and 13°C but there was significant decrease in PLW of HWT integrated Irradiated mango fruits during ripening at RT after shifting from 4 weeks of cold storage. Integration of HWT slightly enhanced the ripening rate and improved the surface yellow colour development of irradiated mango fruits. Also, the integration of HWT prior to irradiation had significantly inhibited the anthracnose disease incidence during 2 weeks storage at RT and 4 weeks storage at 13°C. Further, this integration treatment also helped in better carotenoid development of pulp especially after the fruits were shifted to RT from cold storage for ripening.

OL-93

MATURITY STAGE DETECTION OF ASSAM LEMON USING CONVOLUTION NEURAL NETWORKS THROUGH IMAGE PROCESSING

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The Assam lemon (Citrus *limon* Burm.) is a seedless cultivar of lemon that is widely grown in India's north-eastern states and mostly in Assam. Assam lemon has tremendous economic prospects in Assam. However, this economic potential could be further increased if proper maturity stage detection of Assam lemon is done and outsourced to the other states of India. Timely detection of the maturity of fruits is a vital issue for farmers since it helps in proper storage and selling of the fruits. The traditional approach of detecting the maturity stage of fruits is a time-consuming and tedious task. Using advanced techniques in image processing and machine learning can help to automatically detect the maturity stage of Assam lemon. In this research work, Convolutional Neural Network (CNN) has been used to develop a system to automatically detect the maturity stage of Assam lemon using RGB images. This paper aims to carry out an experiment at lemon farms in Assam to determine the effectiveness of the system.

OL-146

FRUIT QUALITY AND JUICE NUTRITIONAL PROPERTIES OF NEWLY DEVELOPED CITRUS HYBRIDS (*C. MAXIMA* [BURM. F.] OSBECK × *CITRUS SINENSIS* [L.] OSBECK)

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The present study aimed to determine the variation in fruit quality traits and nutritional properties for fresh juice of 16 newly developed interspecific citrus scion hybrids (*C. maxima* [Burm. f.] Osbeck × *Citrus sinensis* [L.] Osbeck)

and parental genotypes. A significant variation in the fruit quality traits (fruit, weight, length, breadth, peel thickness, and juice per cent) was observed in the tested progenies. The contents of total soluble solids (TSS), titratable acidity (TA), and TSS-acid ratio at commercial maturity ranged from 8.93 ° to 11.47 °B, 0.72-1.84%, and 5.68 to 12.77 in the fruits of newly developed interspecific hybrids, while the ascorbic acid content varied from 37.86 to 71.15 mg/100mL of juice. The mineral nutrients concentration in the citrus fruit juice was observed in descending order of K, Cl, P, Ca, Mg, Na, Fe, Zn, Cu, and Mn. The citrus progenies evaluated significantly differed in respect of juice nutrients. Overall, the citrus hybrids namely SCSH-9-6/12, SCSH-9-10/12, SCSH-11-9/13, and SCSH-7-2/12 were found superior in respect of Fe and Zn content in the fruit juice. The antioxidant activity, and the contents of total phenol, carotenoids, lycopene, anthocyanins, flavonoids, and limonoids in the fruit juice too varied significantly, showing transgressive segregation, and some of the scion hybrids exhibited superior physico-chemical fruit quality and higher nutritional properties over parental genotypes.

OL-70

CHARACTERIZATION AND EXPLORATION OF UNDERUTILIZED BIO-ACTIVE RESOURCES OF MEDICINAL *DENDROBIUM* ORCHID FLOWERS

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Dendrobium, is a medicinal orchid species know as second largest group in the Orchidaceae family recorded over 1100 species in the world and about 82 species of *Dendrobium* has been reported in the states of North Eastern region of India. The *Dendrobium* plant is a widely recognized traditional Chinese herbal medicine renowned for its immunomodulatory, anti-tumor, anti-diabetic, and anti-oxidant properties. In the present study, *Dendrobium* orchid flowers have been aimed to explore for their neutraceutical potential such as bioactive phenolics, anthocyanins, carotenoids, vitamin E and amino acids through GC-MS, LC-MS/MS, micro- minerals through ICP-MS, and non-targeted bioactive compounds through LC-HRMS. The in- vitro antioxidant activity such as total antioxidant activity, DPPH, ABTS, Metal Chelation etc., of selected *Dendrobium* orchid flowers has studied to explore their neutraceutical potential. Bio active phenolics such as gallic acid (558 mg/kg), caffeic acid (436 mg/kg), Quercetin

(459.3 mg/kg), anthocyanins like delphinidin (874 mg/kg), petunidin (1342.2 mg/kg) and Vitamin E such as alpha tocopherol (1447 mg/kg) has reported. The quantification of amino acids showed the presence of lysine (28.1 mg/100g), leucine (2.37 mg/100g) and other few essential amino acids in the flowers of *Dendrobium*. The analysis of total 11 minerals through ICP-MS has the presence of essential minerals such as calcium, magnesium, Iron, Zinc etc. The antioxidant potential such as total phenol (15.84 mg/100g), flavonoids (25 mg/100g), total antioxidant activity, DPPH (IC50: 426 µg/mL), ABTS (IC50: 185 µg/mL and metal chelation activity has explored. The flowers of *Dendrobium* exhibited great antioxidant potential. The study non-target compounds through LC-HRMS have been reported total more than 100 major bio-active compounds of phenolics, flavonoids derivatives. In *Dendrobium* species, the elevated relative abundance of the potentially bioactive metabolites, namely gamma tocopherol, quercetin, caffeic acid and delphinidin suggests its suitability as potential functional food ingredients. Hence, the present study indicated that selected medicinally orchid species are superior reservoir of bioactive ingredients. The untargeted metabolomics approach will further unfold *Dendrobium* flowers nutraceutical potential. The findings of the study are expected to be valuable for floriculturists, food and drug scientists, and pharmaceutical industrial operators alike.

OL-96

VALORIZATION OF CASHEW APPLE AS A SOURCE OF NUTRIENTS

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The technological interventions in cashew production sector have helped to evolve improved varieties with better apple size. The substantially high apple nut ratio has become the characteristic feature of high yielding varieties. The excellent nutritional and sensory properties of cashew apple can be promoted for healthy living. The studies conducted with eight improved varieties revealed variation in apple weight, juice content and nutrient contents. Hence utilization of appropriate varieties ensures quality of products and its economic viability. The variety Priyanka recorded the highest fruit weight (137.49 g) and total sugar (19.44%). Vitamin C content was the highest in variety, Poornima (220.15mg/100g). Kerala is pioneer in production of juice and confectionery products from cashew apple. Appropriate processing steps are to be followed to bring out quality and palatable cashew apple products with significant nutritive qualities. Sago from tapioca, an optional staple food of the state, can effectively be utilized for removal of tannin. Non fermented juice products like syrup, carbonated drink; ready to serve juices can be commercially produced from the clarified juice. The detanned apples can be utilized for the preparation of candy, toffees, fruit bars, leather rolls, fruit preserves, jam, marmalades,

sweet balls and spicy pickles. The vitamin C content of 'Cashew Apple Syrup' (68.57 mg/100g) and 'Carbonated Cashew Apple Drink' (32.22 mg/100g) was found high. 'Cashew Apple Energy Bar' (200.44 Kcal), an energy rich product was also found feasible. The under exploited cashew apple can thus be an option for nutritional security and socio-economic empowerment of farming community.

OL-121

INFLUENCE OF FLORAL PRESERVATIVES SOLUTION WITH SUCROSE PULSING ON VASE LIFE AND QUALITY OF CUT LOTUS (*NELUMBO NUCIFERA* GEARTN.) FLOWERS

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Sacred lotus (*Nelumbo nucifera* Geartn.) is widely used for religious offerings and floral decorations. But the shortpost-harvest life of cut lotus due to rapid senescence, wilting, petal falling and blackening has been a limiting factor for the flower vendors. Therefore, the present experiment was conductedin May, 2023 to identify the best chemical preservativeto improve the vase life of cut lotus. Matured white lotus flowers were harvested atcompletely closed stage from the pond of Experimental Farm, Department of Horticulture, AAU, Jorhat. These flowers were immediately dipped in conical flasks containing 250 ml of preservative solutions [8-hydroxyquinonesulphate (8-HQS) at 100 and 200 ppm, citric acid at 25 and 30 ppm, silver nitrate ($AgNO_3$) at 20 and 50 ppm, silver nano particles (SNP) at 50 and 100 ppm and 6-benzyaminopurine (6-BAP)at 15 and 20ppm] andwere replicated thrice in a completely randomized block design. All the treatments along with control included20% sucrose solution. The treatment containing 8-HQS 200 ppm + 20% sucrose solution exhibited maximum increase in flower diameter (15.74 mm), maximum solution uptake (56.43 ml), maximum membrane stability index (59.15%),least electrolyte leakage (50.62%) and least fresh weight loss of flower (11.53%) leading to longest vase life (6 days)compared to control (2 days) of the cut lotus. The browning index (petal blackening) and petal falling index were also lowest for this treatment. These results concluded that, 8-HQS 200 ppm along with 20% sucrose solution could be commercially used for improving the vase life and post-harvest quality of cut lotus.

OL-123

ENHANCING THE NUTRITIONAL COMPOSITION OF KOMBUCHA BY INFUSING LOCALLY AVAILABLE HERBS AND FRUITS AS FERMENTABLE SUBSTRATES

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A robust mutualistic relationship between acetic bacteria and yeasts synergistically acts upon sugared tea, yielding the traditional beverage recognized as kombucha. This elixir has enjoyed longstanding popularity for its prophylactic and therapeutic attributes. The present investigation was chiefly concerned with assessing the alterations in the biochemical and nutrient profiles of kombucha derived from a blend of black tea and locally available plant parts. During the fermentation process, there was a gradual decline in both the pH and total soluble solids (°Brix) of the beverage. Simultaneously, the acidity levels steadily increased, reaching approximately 1.27%. Initially, there was an upward trend in alcohol content during the early stages of fermentation, which subsequently declined over an extended fermentation period. On the 15th day of fermentation, most treatment variants demonstrated an elevation in antioxidant levels, followed by a decline by the 21st day. It was observed that kombucha infused with starfruit exhibited elevated concentrations of iron, zinc, and manganese. The beveragecontained a higher proportion of lactic acid and gluconic acid, followed by acetic acid, oxalic acid, and citric acid. To evaluate the final products, a sensory analysis was conducted. Among the partially trained panellists, the kombucha prepared with a combination of tea and roselle garnered the highest overall acceptance ratings.

OL-136

SHELF-STABLE FOOD THROUGH COMBINATION PROCESSING WITH IRRADIATION

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Food goes through several steps before it reaches to the consumer. However, there persists every possibility of the perishable food to get contaminated at

any point in the supply chain. In order to minimize the wastage and to retain the product quality, a viable trend in processing field has been increasingly adopted towards the application of more than one technique up to its lesser extremity along with the use of combination preservation techniques. This trend towards effective processing can introduce shelf-stable, sterile products. Irradiation can be an integral part of the development of new systems that target through hurdle techniques and contribute to the maintenance of the expected and assumed degree of safety assurance. Shelf stability may be attained by a number of methods depending upon the property of the raw material and its end use. Perishable food items may be contaminated with foodborne microbial pathogens that could be eliminated by treatment with ionizing radiation. In such food the growth and potential toxin formation by spore forming bacteria will be inhibited by standard food technological methods such as by applying hot water treatments/ VHT, reduced water activity, lowering of pH with the application of acidulants, use of humectants, application of heat/drying, proper packaging, lowering of temperature etc. The present paper highlights the application of gamma irradiation for shelf life extension of some important fresh perishable crops and processed products including millets under Indian condition with special emphasis on West Bengal scenario.

OL-137

BLACK RAISINS: HEALTH BENEFITS, VARIETIES AND GRAPE DRYING

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Drying is a very old known practice of grape preservation, and it is believed that sun dried raisins were produced as long ago as 1490 BC. Presently, the USA, Turkey, Iran, China, India, Australia etc. are major raisin producing countries. Nutraceutical properties of raisins are decided by grape varieties, growing conditions, management of abiotic and biotic stresses, biochemical content of berries at the time of harvesting, adopted raisin making practices, storage, etc. Among different types of raisins, black raisins are found with higher nutraceutical properties. Black raisins are packed with antioxidant properties beside fairly good sources of calories, fibers, antibacterial activities,etc. Raisins are involved in the improvement of cardiovascular health as well as maintain a good oral health due to available antibacterial activities. Better colon function activity is also found related to raisin consumption. Even, gut microbiota could be affected by prebiotic content of raisins. Raisins have a low-to-moderate Glycemic Index and insulin index (II), making them a healthy choice for consumers having diabetes or insulin resistance. Consumer preference is most important factor decides the market return. Varietal expressions like seeded or seedless and long or

round lead to decide the grades as well as nutraceutical properties. The grape drying practices followed in a particular region depend on available resources, climatic conditions, grape type, market return and consumer preferences. Health-conscious consumer prefers the raisins produced without involvement of chemicals for pre-treatment of grape bunches. Drying on vine (DOV) and naturally dried grapes has own importance and can open new markets with endless opportunities.

OL-157

ADVANCEMENTS IN VAPOR ADSORPTION COLD STORAGE TECHNOLOGIES: A COMPREHENSIVE REVIEW

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The increasing global demand for energy-efficient and environmentally friendly cooling solutions has driven significant advancements in the field of vapor adsorption cold storage technologies. Vapor adsorption refrigeration systems (VAdRS) offer a promising alternative to conventional compression-based cooling systems by utilizing adsorbent materials to capture and release refrigerants, providing sustainable and clean cooling solutions. This review paper provides a comprehensive overview of the latest developments, challenges, and future prospects in vapor adsorption cold storage technologies. The review begins by elucidating the fundamental principles of vapor adsorption refrigeration, including the adsorption-desorption cycle, working fluids, and thermodynamic processes. It subsequently discusses the key components of adsorption systems, such as adsorbent materials, heat exchangers, and adsorption cycles. Recent advancements in adsorbent materials, including metal-organic frameworks (MOFs), zeolites, and activated carbon, are highlighted for their exceptional adsorption capacities, selectivity, and thermal stability. Furthermore, the paper explores various heat sources for driving the adsorption process, including waste heat, solar energy, and low-temperature heat sources. The integration of vapor adsorption refrigeration with renewable energy sources is discussed as a sustainable approach to reduce greenhouse gas emissions and enhance energy efficiency.

OL-158

DESIGN AND DEVELOPMENT OF INNOVATIVE SOLAR CYCLONE DRYER FOR DRYING MORINGA LEAVES

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Mahatma Gandhi Institute for Rural Industrialization (MGIRI) is an autonomous institute under the Ministry of MSME, Govt. of India with the main objective of providing S&T inputs in the rural sector. The Rural Energy and Infrastructure Division (REI), MGIRI has successfully developed various Solar driers as per the requirement of Rural Industries. Dried moringa leaves are rich in vitamins, minerals, and bioactive compounds hence have therapeutic use for various health ailments. Various electric and traditional solar dryers often entail prohibitive costs, lower efficiency and dependency on erratic grid power availability at farm levels. Hence, moringa leaves are mostly dried in open which degrades the quality, medicinal values and color which impacts their marketability in national and international markets. To address this problem, MGIRI has developed an innovative dedicated Solar/ Grid Forced Air Cyclone Dryer under KVIC, S&T projects for drying moringa leaves. Successful field trials conducted at various moringa horticulture farms and reports indicate substantial reduction in drying duration and increased efficiency, quality of drying. This Dryer consists of two flat plate solar thermal collectors (Electric heaters optional) attached to SPV powered blower mounted at the bottom of cyclone drying chamber with opening at the top. The hot air is sucked from the thermal collectors by the blower and forced into cyclone chamber where the moringa leaves gets agitated by this forced air and gets dried quickly. This dryer can also be used for various herbal and leafy materials like neem, tulsi etc. The other obvious advantages are of reducing energy and cost, minimizing environmental impact, and ensuring consistent drying conditions.

ANTHOCYANIN EXTRACTION, CHARACTERIZATION AND EVALUATION OF ITS ANTIOXIDANT POTENTIAL FROM GLADIOLUS (*GLADIOLUS GRANDIFLORA*) SPIKES: A POTENT NUTRACEUTICAL SOURCE

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Gladiolus (*Gladiolus grandiflora* Hort.) is one of the major cut flower producers across the globe which expresses orange, purple to blue due to anthocyanin flower pigments. The study under investigation is carried out to optimize the process parameters responsible for higher anthocyanin yield pertinent to Pusa Suhagin (PS) and Yellow Stone (YS) floral extracts.The Response Surface Methodology (RSM) coupled with Central Composite Design (CCD) optimized the process parameters for PS and YS gladiolus spikes that resulted maximum anthocyanin content of 40.45 g^{-1} DW and 31.26g^{-1} DW, respectively. LC-MS studies of PS and YS flower extract revealed the presence of major anthocyanins like pelargonidin, peonidin, cyanidin, and delphinidin along with petunidinin minor concentrations. Antioxidant capacity of PS and YS flower extract showed 84.63 % and 46.21 %, respectively, indicates that the flower extract can be used not only as a potent nutraceutical but also as a colorant in food industry.

ADVERTISEMENTS

Vision & Mission of
Coconut Development Board

Kalpavriksha, the *Tree of life* is being worshipped, revered and loved by the people across the globe. Dating from the 4th century B.C onwards there were sanskrit writings containing references to the coconut. During this 21st century, the *Tree of abundance* is providing hundreds of value added products with excellent nutritional qualities than any other available tree crops on earth. Today coconut is fast gaining repute for its medicinal values.

About CDB

The Coconut Development Board came into existence on 12th January 1981 with the objective to promote integrated development of coconut cultivation and industry in the country. CDB functions under the administrative control of the Ministry of Agriculture & Farmers Welfare, Government of India. Headquartered at Kochi in Kerala, CDB has four Regional Offices at Bangalore, Chennai, Guwahati and Patna. There are five State Centres situated at Pitapalli (Odisha), Kolkata (West Bengal), Thane (Maharashtra), Vijayawada (Andhra Pradesh) and Port Blair (A&N). A Market Development cum Information Centre (MDIC) has ben established in New Delhi. The Board has also set up a Technology Development Centre at Vazhakulam near Aluva in Kerala and a Field Office at Thiruvananthapuram and 10 Demonstration cum Seed Production Farms at various agro ecological locations in the country.

Vision

A fully developed and globally competitive coconut industry that contributes to food security, health and nutrition, remunerative price for the coconut farmer and enhanced export earnings for the country and to make India the global leader in value addition and processing in coconut sector.

Mission

- Rehabilitation of all senile and unproductive palms and promotion of commercial coconut seed gardens to meet the required quantities of good planting materials for the replanting program.
- Promoting value addition in coconut processing by focusing on high value coconut products and byproducts (both edible and non edible) with health and environmental friendly applications.
- Promoting coconut cultivation in non traditional belts by extending financial assistance to small and marginal farmers and thereby increasing production potential of coconut in the country.
- Demonstrating scientific productivity improvement practices in coconut gardens and intercropping for sustained income.
- Promoting the health attributes of coconut products through aggressive awareness campaigns and conduct of clinical trials through reputed research institutions.
- Conducting market promotional campaigns in the buying countries and niche markets by organizing exhibitions, trade fairs and buyer seller meets to improve market access to coconut products.
- Assuring remunerative prices for coconut and thereby doubling of farmers income mainly through Farmer Producer Organizations (FPOs).
- Promoting health friendly and demand oriented value added coconut products *viz*, virgin coconut oil, coconut oil, milk, milk powder, desicated coconut, neera, tender coconut water etc.
- Organizing skill development training programs and capacity building programs for the farmers/entrepreneurs for strengthening the coconut industry in the country.
- To explore markets for marketing of value added products in major cities by establishing coconut points, retailing networks etc.
- Integration of processing units to form product specific Consortium of Processors.
- Encourage e-marketing of products through authorized trading portals.

अधिक जानकारी के लिए बोर्ड की वेबसाइट देखें
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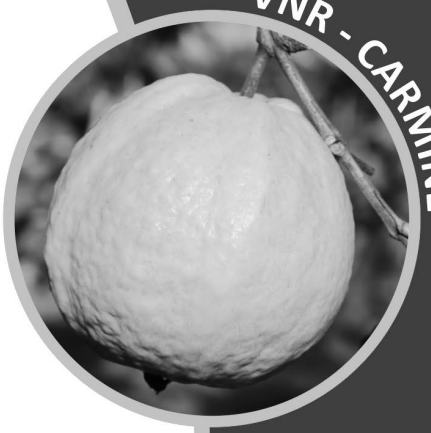

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Swasth Paudha- Khushal Bagicha

3 Star Top Most Rating

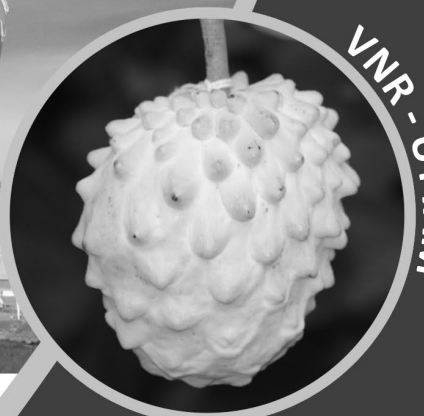
राष्ट्रीय बागवानी बोर्ड
NATIONAL
HORTICULTURE BOARD

VNR - BIHI

22 States - 300 Districts

> 4.5 Million Plants

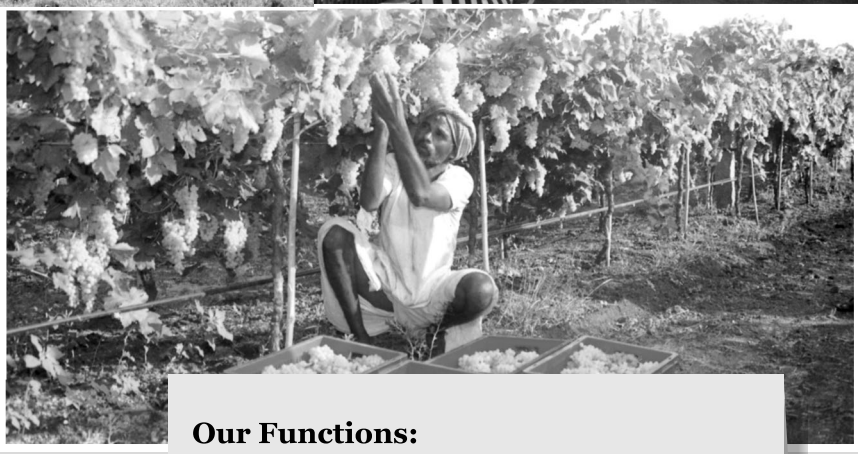
भारत की आज़ादी का अमृत महोत्सव



VNR NURSERY PVT. LTD.

Registered Office : **Corporate Center, Ring Road No.1, Raipur-492006 (C.G)**
R & D Center : **Village- Gomchi, Raipur (CG)**
Web.: **www.vnrnursery.in** Email : **info@vnrnursery.in** Join us on : **www.facebook.com/vnrnursery**
Customer service: **0771- 4350032 • Mob: 07389902330** Timings: **10 am to 6 pm**

National Bank for Agriculture and Rural Development



Our Mission: Promotion of sustainable and equitable agriculture and rural prosperity through effective credit support, related services, institution development and other innovative initiatives.

- **Research and Development on matter of importance pertaining to agriculture, agricultural operations and rural development including the provision of training and research facilities.**
- **Consultancy services related to Agriculture & Rural Development through subsidiary (NABCONS).**

Our Functions:

- Provide Credit/Refinance for production credit and investment credit to eligible banks and financing institutions.
- Development functions undertaken through Farm Sector Promotion Fund (FSPF), Financial Inclusion Fund (FIF), Watershed Development Fund (WDF), Tribal Development Fund (TDF) Rural Infrastructure Development Fund,(RIDF) etc.
- Supervisory functions in respect of Cooperative Banks and Regional Rural Banks.

Head Office Plot C-24, 'G' Block Bandra Kurla Complex, Bandra (East) Mumbai - 400 051

IPL Biological Limited: Forging a Sustainable Future through Microbial Innovations

In the ever-evolving landscape of agriculture, IPL Biological Limited has consistently emerged as a pioneer, harnessing the power of biological solutions to revolutionize farming practices. With an illustrious legacy spanning three decades in the agriculture industry, the company's unwavering commitment to research-based innovation has borne fruit in the form of ground-breaking indigenous microbial solutions. These solutions are tailored to the unique needs of the farming community, addressing global challenges, improving soil health, boosting crop yields, and ensuring safer, healthier, and more sustainable agriculture.

A 30-Year Legacy of Innovation: IPL Biological Limited not only embraces innovation but fosters it. With 30 years of experience in the agriculture industry, our journey is a testament to our dedication to solving complex challenges. Our innovative microbial solutions are a result of tireless research and development, with a steadfast mission to create a safer and healthier planet.

A Global Mission for a Safer Planet: Our purpose at IPL Biological Limited is to create a safer and healthier planet. We harness our research capabilities to provide sustainable, safe, and technological solutions to consumers worldwide. Our focus on restoring soil health is a crucial component of ensuring global food and nutritional security. By assisting farmers in regenerating their soil and increasing crop productivity, we contribute to delivering safe, healthy, and nutritious food to consumers. It's a mission encapsulated in our motto, "Microbial Innovation for a Better World."

Prioritizing Sustainable Farming Practices: At IPL Biological Limited, we place significant emphasis on sustainable farming practices. Our approach revolves around promoting Integrated Nutrient and Pest Management, which ensures balanced soil nutrients and effective pest control. What sets us apart is our commitment to reducing the use of synthetic substances through microbial-based solutions. This not only safeguards the planet but also secures the well-being of our customers.

Comprehensive Range of Crop Formulations: Farmers across the globe trust IPL Biological Limited for our comprehensive range of crop formulations. These formulations, available in various forms such as liquids, powders, granules, tablets, and water-soluble options, are meticulously designed to meet the specific needs of each crop. These tailor-made microbial solutions optimize farming efficiency and eco-friendliness while facilitating Integrated Nutrient and Pest Management. Rest assured, your crops are our top priority, and we are fully equipped to ensure their well-being.

Transforming Agriculture through Power of Microbes: IPL Biological Limited's microbial solutions offer a multitude of compelling advantages. They consist of potent microbes with a high Colony Forming Unit (CFU) count, ensuring their effectiveness. Their extended shelf life guarantees prolonged usability, and they are compliant with CIB and FCO standards, ensuring quality and safety.

Certified by OMRI, IMO, and Indocert, our products are a testament to our dedication to fostering sustainable agricultural practices. Expect incremental yield boosts, higher crop quality, and a substantial reduction in optimizing agri-input costing.

IPL Biologicals Limited

IPL BIOLOGICALS LIMITED

Leaders in Microbial Solutions

ENRICHING SOIL HEALTH, ENHANCING CROP YIELD, ENSURING SAFE FOOD

KEY FEATURES:

- High-Potency Microbial Strains
- Zero Contamination, High CFU count & Extended shelf life products
- Regulatory Compliant
- Certified by IMO, Indocert & OMRI

customerservices@iplbiologicals.com www.iplbiologicals.com

Bio-fertilizers | Bio-fungicides | Bio-insecticides | Bio-stimulants

Corporate Office: M2K Corporate Park, Sector - 51, Mayfield Garden, Gurugram, Haryana - 122003, India.
Tel. : 0124 4526000 | Customer Care No. : 1800 102 2472 | Find us at

Microbial Innovations for A Better World