

भा.कृ.अनु.प. – अखिल भारतीय समन्वित फल अनुसंधान परियोजना
ICAR-All India Coordinated Research Project on Fruits

वार्षिक प्रतिवेदन Annual Report 2021



भा.कृ.अनु.प.-भारतीय बागवानी अनुसंधान संस्थान
हेसरघट्टा लेक पोस्ट, बेंगलूरु - ५६००८९
ICAR - INDIAN INSTITUTE OF HORTICULTURAL RESEARCH
Hesaraghatta Lake Post, Bengaluru- 560 089



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Annual Report 2021



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Preface



I have great pleasure in presenting the progress of the All India Coordinated Research Project on Fruits for the year 2021. The highlights of the report are drawn from the results of the experiments conducted at different centres. During reporting period, a total of five accessions in banana, 8 Citrus, 10 in guava and 4 in jackfruit have been added to the existing germplasm collections.

Evaluation of promising clones of banana has revealed that BRS Selection *Popoulu sp.* under the plantain group (AAB) and NRCB selection-10, under ABB group have been more productive than their respective checks. In Citrus, application of 75 per cent recommended dose of N through vermicompost along with addition of *Trichoderma harzianum* (30-40 ml/plant) and *Azadirachtin* (1% at 3-4 ml/l as spray) and *Pseudomonas fluorescens* (30-40 ml/plant) has increased the yield (1.2 to 2.4 times the yield over control) for mandarin. Bagging of litchi fruit bunches with pink polypropylene bags at 25 days after fruit set has enhanced fruit yield (17.65 & 65.50 kg/tree) and fruit quality at Medziphema (Nagaland) and Neri (Himachal Pradesh), respectively. Evaluation of episomal tissue cultured plants of banana cv. Poovan has clearly indicated that, these plants are free from BSV incidence in different test locations except Kerala. Trials on integrated management of Citrus greening indicated that application of higher dose of phosphorus (50% more than the recommended dose) along with tetracycline hydrochloride (600 ppm), ZnSO₄ and FeSO₄ (each at 200 g/plant) has been effective.

I take this opportunity to thank all the scientists of the ICAR-AICRP centres in carrying out the research programme effectively and for timely submission of the reports.

I am very much grateful to Dr. Dr Trilochan Mohapatra, Secretary, DARE and DG, ICAR and Dr Anand Kumar Singh, DDG (Horticultural Science), who have been a source of inspiration. Without their constant guidance, encouragement and support, this pace of progress would not have been achieved. I would also like to thank Dr. B. K. Pandey, Assistant Director General (Hort. Sci.-II) and Dr. Vikramaditya Pandey, Assistant Director General (Hort. Sci.-I), ICAR, New Delhi and the former Directors, Dr. B.N.S. Murthy, Dr. M.R. Dinesh and Dr. Debi Sharma, Director (Acting), ICAR-IIHR, Bengaluru for their constant support.

I am equally thankful to all the Directors and Crop Coordinators of ICAR-CCRI, ICAR-NRC for Banana, ICAR-NRC for Grapes and ICAR-NRC for Litchi for their critical review of work done and suggestions in compilation of the report. I place on record my sincere thanks to Dr. Anil Kumar Nair, IIHR, Bengaluru for the hindi translation of executive summary.

I thank the staff of Project Coordinator (Fruits) Unit, ICAR-IIHR, Bengaluru Dr S Priya Devi and Dr. Sridhar Gutam for their efforts in bringing out this report and with high quality. Assistance of Dr. Jeevitha S, Ms. Shwetha H K, Ms. Shweta Maruti Sutagatti, Mr. Manjunatha C, Ms. Gouthami S, Mr. Nagaraja M R, Mrs. Sheela S, and Mrs. Kanthamma for their sincere and diligent work is acknowledged. My sincere thanks to all those who helped directly or indirectly in the preparation of the research report.

(Prakash Patil)

Project Coordinator (Fruits) Acting

Bengaluru
28 July 2021

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Acronyms and Abbreviations

AICRP	All India Coordinated Research Project	NAA	Naphthalene acetic acid
AM	<i>Arbuscular mycorrhiza</i>	NAGS	National Active Germplasm Site
B:C	Benefit to cost	NaOH	Sodium hydroxide
BA	Benzyladenine	NRCB	National Research Centre for Banana
BAP	Benzyladenine purine	CCRI	Central Citrus Research Institute
BBMV	Banana Bract Mosaic Virus	NRCG	National Research Centre for Grapes
BBTV	Banana Bunchy Top Virus	NRCL	National Research Centre for Litchi
BSV	Banana Streak Virus	P ₂ O ₅	Phosphorus (Phosphorus pentoxide)
CHES	Central Horticultural Experiment Station	PDI	Per cent Disease Incidence
CISH	Central Institute for Sub-tropical Horticulture	ppm	Parts Per Million
cv.	Cultivar	PRSV	Papaya Ring Spot Virus
DAP	Days After Planting	PSB	Phosphate Solubilising Bacteria
DARE	Department of Agricultural Research and Education	QRT	Quinquennial Review Team
DAS	Days After Sowing	RDF	Recommended Dose of Fertilizers
DDG	Deputy Director General	RH	Relative humidity
Dr.YSRHU	DR. YSR Horticultural University	SAU	State Agricultural University
EC	Electrical Conductivity	t/ha	Tonnes per hectare
EPN	Entamo-Pathogenic Nematode	TDZ	Thiadiazuron
ER	Evaporation Replenishment	TNAU	Tamil Nadu Agricultural University
FeSO ₄	Ferrous- Sulphate	TSS	Total Soluble Solids
FYM	Farm Yard Manure	UAS	University of Agricultural Sciences
GA	Gibberellic acid	VAM	Vesicular-Arbuscular Mycorrhizas
IAA	Indole acetic acid	Var.	Variety
IBA	Indole butyric acid	ZnSO ₄	Zinc Sulphate
ICAR	Indian Council of Agricultural Research	FN	Fortnight
IIHR	Indian Institute of Horticultural Research	CTV	Citrus Tristeza Virus
K ₂ O	Potash (Potassium oxide)	CMV	Cucumber Mosaic Virus
KAU	Kerala Agricultural University	DASS	Days After Second Spray
KNO ₃	Potassium Nitrate	IMTP	International Musa Testing Programme
MAP	Months After Planting	BSMYV	Banana streak Mysore virus
MnSO ₄	Manganese Sulphate		
MOS	Months After Sowing		
MT	Metric tonnes		
N	Nitrogen		

Executive Summary

The ICAR-AICRP on Fruits project has the objectives of identification and release of varieties and hybrids through multi-location testing (MLT); maintaining safety duplicates of germplasm besides evaluation and augmentation of germplasm with National Active Germplasm Sites (NAGS); evaluation of input-use-efficient technologies and assessment of plant health management technologies under different agro-climatic zones. Currently, the total number of centres under ICAR-AICRP on Fruits is 50 which includes 30 from state agricultural universities, 14 from ICAR institutes, 4 centres under central agricultural universities and one private centre and one under Government of Arunachal Pradesh. Among these, 23 centres are working on mango, 16 on guava, 13 on banana, 12 on Citrus, 9 on papaya, eight each on litchi and grapes, 5 on jackfruit and 4 on sapota. The budget allocation for the year 2020-21 was Rs. 23.80 crores of ICAR share and the progress made under this project at various centres is presented in brief herewith under various sub-heads.

Crop genetic resources

During reporting period, a total of five accessions in banana, 8 Citrus, 10 in guava and 4 in jackfruit have been added to the existing germplasm collections.

Crop improvement

Evaluation of promising clones of banana has revealed that BRS Selection *Popoulu sp.* has recorded an higher yield to the tune of 1.22 to 2.83 times (9.13 to 20.12 kg/bunch) under the plantain group (AAB). Similarly, under ABB group an increased yield of 1.09 to 2.11 times has been noticed with NRCB selection-10 (11.48 to 24.71 kg/bunch) with their respective checks at Arabhavi, Bhubaneswar, Jorhat, Kannara and Kovvur.

Evaluation of banana cultivars in non-traditional banana growing regions revealed that the cultivar Grande Naine has significantly recorded higher bunch weight (21.14 kg), yield (52.84 t/ha), finger length (19.00 cm) and B: C ratio (2:1) when planted in May at Pantnagar. However, at Port Blair maximum bunch weight (15.58 kg), yield (38.94 t/ha), finger weight (166.75 g), pulp weight (133.75 g), finger length (23.25 cm), finger diameter (16.08 cm) and shelf life (9.75 days) was recorded in the variety Monthan in July planting.

Among the different promising cultivars of mandarin evaluated, Nagpur mandarin at Akola (71.62 kg/tree), Khasi mandarin at Tinsukia (42.66 kg/tree) and Kinnow mandarin at Sriganganagar (69.93

kg/ tree) continued to be superior with respect to productivity and quality.

Among the different promising clones of sweet orange evaluated, superiority of clone no. 7 at Rahuri (56.05 kg/tree), clone TS₆ at Tirupati (46.44 kg/plant) has been recorded.

Among the coloured table varieties of grapes evaluated, superiority of Crimson Seedless, Manjari Shyama and Red Globe has been observed with respect to highest yield and quality parameters at Arabhavi and Pune (NRCG).

Among the evaluated juice varieties of grape, MACS 516 (ARI 516) was found superior with respect to yield and quality parameters (juice recovery, TSS & acidity) followed by Manjari Medika. Hence, recommended for cultivation in Maharashtra, Karnataka, Telangana and Tamil Nadu for juice purpose.

Among the new promising hybrids and selections of guava, CISH-G-1 was superior for yield (to the tune of 21.87 per cent) compared to check variety Allahabad Safeda (11.11 kg/tree) at Sabour.

Among the evaluated varieties of jackfruit, Palur-1 recorded maximum fruits per tree (49.0, 20.2 & 21.4 at Kovvur, Mohanpur and Periyakulam respectively). However, at Kannara and Jorhat, Muttom Varrikka has recorded the more fruits per tree (130 & 33 fruits/tree respectively).

Crop production

Studies on alleviation of soil moisture deficit in banana has revealed that soil moisture stress at flowering along with foliar priming with ASA (0.1mM), has significantly decreased negative effect of drought and recorded minimum yield deviation (14.45 to 19.00 % reduction as compared to irrigated control).

Trial on nutrient management under high density planting in mandarin has revealed that, application of 75 per cent N (Inorganic source) + 25 per cent N (Organic source- FYM) + P (100% through inorganic source) & K (100% K supplied through FYM) for the plants spaced at 6 x 6 m has been superior for yield parameter in Kinnow mandarin at Ludhiana (fruit weight of 208.1 g and yield of 141.09 kg/tree) and in Nagpur mandarin at Akola (323.6 fruits/ tree and 44.4 kg/tree). However, at Tinsukia, Khasi mandarin planted at 6 x 5 m with similar nutrient application gave maximum yield (35.33 kg/tree and 119.7 g). The

inclusion of organic sources has enabled enriching of soil health and nutrition and as well as improved leaf nutrient status.

In Citrus, application of 75 per cent recommended dose of N through vermicompost along with addition of *Trichoderma harzianum* (30-40 ml/plant) and *Azadirachtin* (1% at 3-4 ml/l as spray) and *Pseudomonas fluorescens* (30-40 ml/plant) has increased the yield (1.2 to 2.4 times the yield over control) for mandarin at Akola, Sriganaganagar and Tinsukia (102.1, 34.2 & 33.0 kg/tree respectively).

Trial to standardize the stage-wise requirement of nutrients in acid lime has revealed that application of 0:0:0, 30:40:10, 30:35:10, 20:25:30, 10:0:25 and 10:0:25 percent RDF of N: P₂O₅: K₂O for stage -I to stage - VI, respectively has consistently recorded increase in yield to the tune of 15 per cent as compared to control in Periyakulam for the variety PKM 1.

Trial to standardise the suitable organic source of nutrients in guava has indicated that, application of vermicompost (30 kg/plant) + *Azospirillum* culture+ PSB (@ 250 g/tree) has recorded as increase in the fruits per tree at Ludhiana (26.25%) and Sabour (34.51%) compared to control.

In guava, application of Arka Microbial Consortium (AMC) on guava has indicated that the treatment with application of 75 per cent recommended dose of N and P₂O₅ + AMC soil application (12.5 kg/ha) twice a year along with FYM has resulted in increased fruit yield at Sangareddy (15.98 kg/tree), Rewa (56.40 kg/tree) and Udaipur (45.39 kg/tree) in comparison to 100% RDF as soil application (11.64, 44.65 & 33.33 kg/tree respectively).

The trial to improve the productivity in litchi revealed that, the treatment involving girdling of branches with 2 mm level on 50 per cent primary branches has recorded maximum yield at Chettalli and Gangian (14.30 & 88.33 kg/tree), while at Neri, the maximum yield (25.88 kg/tree) was recorded in 4 mm girdling on 75 per cent primary branches.

Bagging of litchi fruit bunches with pink polypropylene bags at 25 days after fruit set has enhanced fruit yield (17.65 & 65.50 kg/tree) and fruit quality at Medziphema and Neri, respectively. The fruits were also free from sunburn, fruit cracking and borer infestation.

Application of N: P₂O₅: K₂O in the ratio of 25:50:15, 20: 25: 15 and 30:0:45 at after harvest, during fruit set and at marble size stage has recorded maximum yield (55.68 & 23.18 kg/tree) in Langra and Alphonso at Rewa and Vengurle respectively.

Trial for evaluating the effect of micronutrients in mango has revealed that soil application of RDF + 100 g ZnSO₄ + 50 g CuSO₄ + 50 g H₃BO₃ after harvest followed by foliar spray of 0.2% ZnSO₄ + 0.1% CuSO₄ + 0.1% H₃BO₃ (first spray at just before flowering and second spray at marble stage) has recorded significantly higher fruit yield to the tune of 2.3 times as compared to control (7.7 t/ha) at Bhubaneswar.

The seed germination and vigour index in papaya seeds was significantly higher in Module I (seed stored in airtight poly lined aluminium pouches at 15°C) at Anantharajupeta, Bengaluru and Coimbatore after 24 months of storage. Whereas, at Gandevi and Pune Module II (seed stored in airtight poly lined aluminium pouches at room temperature) exhibited significantly higher seed germination and vigour index compared to local practice thus provided the suitable method of seed storage.

Pruning of old sapota orchard by centre opening along with cutting of cross branches has recorded 35 to 38 per cent increase in yield over the check at Arabhavi (cv. Cricket Ball). However, at Gandevi topping terminal growth of 1.0m was superior over control in improving the productivity to the tune of 47.82 percent.

Crop protection

Surveys indicated the incidence of banana skipper butterfly (*Erionota torus*) at Jorhat (1-2%), Kannara (0-15 %) and Vengurle (0-5%). Across the centres, the incidences of new emerging pests viz., rugose spiraling whitefly (*Aleurodicus rugioperculatus*) was reported from Jorhat (5-6%) and Mohanpur (5.6-6.8%). Banana flower thrips (5-40%) and slug caterpillars (5-30%) were major pests of banana recorded at Kannara.

Among the various plant parasitic nematodes associated with banana, the overall frequency of occurrence for burrowing nematode (*Radopholus similis*), *Meloidogyne* spp and *Helicotylenchus* spp. in Karnataka was 100, 98.07 & 46.15% in both soil and roots, respectively. Whereas in Kerala, occurrence of root knot nematode (30-75% and 20-75%), burrowing nematode (30- 65% and 10-40%) and banana spiral nematode (10-30%) in both soil and roots, respectively was recorded. In Assam, incidence of *Meloidogyne* spp was 50.36-87% and 6.8-12% of occurrence in soil and root respectively. Whereas the frequency of occurrence of *Helicotylenchus* sp. was recorded as 23-100%. At West Bengal the root knot nematode *Meloidogyne* sp. was mainly observed with 50-90% frequency.

Among the different treatments, soil drenching of *Bacillus pumilus* @ 5 ml/l in polybags with TC plants 5 days before planting + *B. pumilus* enriched Farm Yard Manure @ 5 kg/plant at the time of planting and 2.5 kg/plant at 6 MAP has enabled for effective control of nematodes. The percent reduction of nematode population was to the tune of 16-23.4 % at vegetative stage and 7.3- 20.0% at shooting stage in 250cc soil and 12.43 -38.46% at vegetative stage & 11.42-33.82% at shooting stage in 10 g of roots at Arabhavi, Jorhat and Kannara as against standard check.

Among the various bio-intensive treatments evaluated for their efficacy in managing rugose spiralling whitefly in banana, foliar application of *Azadirachtin* 10000 ppm @ 3ml/l for three times at monthly intervals was effective for controlling leaf damage thereby recording 67.36 to 70.98 per cent reduction over control at Kannara and Periyakulam.

For the management of *Fusarium* wilt in banana, planting of disease-free suckers from disease free field with application of neem cake (250g/plant) along with dipping in carbendazim (0.2%) for 30 minutes followed by carbendazim drenching with 0.2% solution (2nd, 4th and 6th month after planting) and carbendazim injection @ 3ml of 2% solution (3rd, 5th and 7th month after planting) was effective (18.06 & 33.33 percent reduction in external wilt index and internal wilt index) at Kovvur.

Evaluation of episomal tissue cultured plants of banana cv. Poovan has clearly indicated that, these plants are free from BSV incidence at Arabhavi, Bhubaneswar, Coimbatore, Jalgaon, Mohanpur and Tiruchirapalli. However, Kannara 23.8 per cent had the BSV incidence.

For the control of fruit sucking moths, petroleum spray oil (2%) has been effective and recorded 2.2 to 2.9 times reduction in the fruit drop at Ludhiana and Tinsukia (48.8 & 38.50% fruit drop in check). Similarly, neem oil (1%) was effective at Rahuri and Tirupati in reducing fruit drop (2.1 to 3.3 times against control recoding 19.42 & 42.97% fruit drop).

Trials on integrated management of Citrus greening indicated that application of higher dose of phosphorus (50% more than the recommended dose) along with tetracycline hydrochloride (600 ppm), ZnSO₄ and FeSO₄ (each at 200 g/plant) has been effective, with disease severity ranging from 5.41 to 34.17 per cent in Akola, Ludhiana, Periyakulam, Rahuri, Tinsukia and Tirupati.

Biological control of (TMB) tea mosquito bug (*Helopeltis antonii* Signoret) in guava by application of *Beauveria bassiana* @ 12 g/l has showed minimum

damage at Bengaluru and Tinsukia (14.04 & 24.85% respectively), whereas the chemical insecticide lamda-cyhalothrin @ 0.05 per cent has recorded 10.46 & 36.80% as against 56.95 and 40.91 per cent respectively in control. TMB population ranged from 0.00 to 4.40 in different treatments as against 3.00-7.20 in control at Bengaluru, Lembucherra, Periyakulam and Tinsukia.

For the management of fruit fly in guava slow release pheromone formulation traps have significantly trapped highest number of fruit flies (390.6, 55.2, 47.3, 72.25, 82.0 and 256.95 fruit flies/trap/week) at Anantharajupeta, Lucknow, Ludhiana, Pantnagar, Periyakulam and Udaipur respectively compared to conventional trap.

Evaluation of different botanical formulations for the management of sucking pest complex in mango has revealed that among the botanical formulations, spray of *Azadirachtin* 10,000 ppm at 0.003 per cent (3 ml/l) has recorded maximum per cent reduction in mango hopper population at Ludhiana (89.86%). However, at Mohanpur and Paria same treatment has recorded maximum per cent reduction in mango hopper and thrips population (84.09 & 48.98 and 55.71 & 54.05%) respectively.

For the management of fruit fly in mango slow release pheromone formulation traps have significantly trapped highest average catch per week (201.00, 369.91, 92.00, 86.45 & 111.35 fruit flies/trap/week) at Anantharajupeta, Pantnagar, Periyakulam, Udaipur, Sangareddy as compared to conventional trap.

For integrated management of post-harvest diseases in mango, application of difenoconazole 25 EC @ 0.5 ml/l + hot water treatment (52 ± 1 °C for 10 minutes) was superior both in reducing the incidence and severity of anthracnose, shoulder browning, stem end rot and *Aspergillus* rot at Anantharajupeta, Bengaluru, Lucknow, Paria, Rahuri, Sabour, Sangareddy and Vengurle.

For the management of fruit fly in sapota, slow release pheromone formulation traps have significantly trapped highest number of fruit flies (63.4 fruit flies/trap/week) at Periyakulam compared to conventional trap (22.4 fruit flies/trap/week). However, in other locations viz., Arabhavi, Gandevi and Kovvur, the average catch per week was less (14.9, 55.6 and 6.7 respectively) in slow release pheromone traps than in their respective conventional traps (16.5, 260.0 and 18.0 respectively).

विशिष्ट सारांश

भा.कृ.अनु.प.—अखिल भारतीय समन्वित फल अनुसंधान परियोजना का उद्देश्य बहु-स्थानीय परीक्षण के माध्यम से किस्मों और संकरों की पहचान करना और उन्हें जारी करना; राष्ट्रीय सक्रिय जननद्रव्य स्थलों (एनएजीएस) के साथ जननद्रव्य के मूल्यांकन और वृद्धि के अलावा जननद्रव्य के सुरक्षित प्रतियों को बनाए रखना तथा विभिन्न कृषि-जलवायु क्षेत्रों के तहत आदान-उपयोग-दक्ष प्रौद्योगिकियों और पौध-स्वास्थ्य-प्रबंधन प्रौद्योगिकियों का मूल्यांकन है। वर्तमान में, भा.कृ.अनु.प.—अखिल भारतीय समन्वित फल अनुसंधान परियोजना के तहत केंद्रों की कुल संख्या 50 है, जिसमें राज्य कृषि विश्वविद्यालयों से 30, भा.कृ.अनु.प. संस्थानों से 14, केंद्रीय कृषि विश्वविद्यालयों के तहत 4 केंद्र और एक निजी केंद्र और अरुणाचल प्रदेश सरकार के तहत एक केंद्र शामिल है। इनमें आम पर 23, अमरूद पर 16, केले पर 13, नींबूवर्गीय फलों पर 12, पपीते पर 9, लीची और अंगूर पर आठ-आठ, कटहल पर 5 और चीकू पर 4 केंद्र कार्यरत हैं। वर्ष 2020-21 के लिए बजट आबंटन भा.कृ.अनु.प.के हिस्से का 23.80 करोड़ रुपये था और विभिन्न केंद्रों पर इस परियोजना के तहत की गई प्रगति को संक्षेप में विभिन्न उप-शीर्षों के तहत प्रस्तुत किया गया है।

फसल आनुवंशिक संसाधन

रिपोर्टाधीन अवधि के दौरान, मौजूदा जननद्रव्य संग्रह में केले के कुल पांच, नींबूवर्गीय फलों के 8, अमरूद के 10 और कटहल के 4 जननद्रव्यों को जोड़ा गया है।

फसल सुधार

केले के आशाजनक क्लोनों के मूल्यांकन से पता चला है कि बीआरएस चयन *पॉपौलस* जाति ने प्लांटैन गुप (एएबी) के तहत 1.22 से 2.83 गुना (9.13 से 20.12 किग्रा/गुच्छ) की उच्च उपज दर्ज की है। इसी प्रकार, एबीबी समूह के तहत अराभवी, भुवनेश्वर, जोरहाट, कन्नारा और कोवूर में संबंधित अनुपचारितों की तुलना में एनआरसीबी चयन-10 (11.48 से 24.71 किग्रा/गुच्छा) में उपज 1.09 से 2.11 गुना बढ़ी हुई पाई गई।

केले उगाने वाले गैर-पारंपरिक क्षेत्रों में केले की खेती के मूल्यांकन से पता चला है कि ग्रैंडे नैन प्रजाति ने पंतनगर में मई में लगाए जाने पर उच्च गुच्छा वजन (21.14 किलोग्राम), उपज (52.84 टन/हेक्टेयर), अंगुली की लंबाई (19.00 से.मी.) और लाभ:लागत अनुपात (2: 1) दर्ज किया है। हालांकि, पोर्ट ब्लेयर में अधिकतम गुच्छा वजन (15.58 कि.ग्रा.), उपज (38.94 टन/हेक्टेयर), अंगुली का वजन (166.75 ग्राम), गूदे का वजन (133.75 ग्राम), अंगुली की लंबाई (23.25 से.मी.), अंगुली का व्यास (16.08 से.मी.) और निधानी आयु (9.75 दिन) जुलाई में लगाई गई मोन्थन किस्म में दर्ज किया गया।

मूल्यांकन किए गए संतरे की विभिन्न आशाजनक किस्मों में से, अकोला में नागपुर संतरा (71.62 कि.ग्रा./पेड़), तिनसुकिया

में खासी संतरा (42.66 कि.ग्रा./पेड़) और श्रीगंगानगर में किन्नू संतरा (69.93 कि.ग्रा./पेड़) उत्पादकता और गुणवत्ता के मामले में बेहतर रहे।

मूल्यांकन किए गए मौसंबी के विभिन्न आशाजनक क्लोनों में से, राहुरी में क्लोन सं. 7 (56.05 कि.ग्रा./पेड़), तिरुपति में क्लोन टीएस6 (46.44 कि.ग्रा./पौधा) की श्रेष्ठता दर्ज की गई।

अराभवी और पुणे (एनआरसीजी) में उच्चतम उपज और गुणवत्ता मानकों के संबंध में अंगूर की रंगीन टेबल किस्मों का मूल्यांकन किया गया, जिसमें क्रिमसन सीडलेस, मंजरी श्यामा और रेड ग्लोब श्रेष्ठ पाई गई।

मूल्यांकन किए गए अंगूर की रस बनाने योग्य किस्मों में, एमएसीएस 516 (एआरआई 516) उपज और गुणवत्ता मानकों (रस प्राप्ति, टीएसएस और अम्लता) के संबंध में बेहतर पाया गया, जिसके बाद मंजरी मेडिका का स्थान था। इसलिए, रस के उद्देश्य से महाराष्ट्र, कर्नाटक, तेलंगाना और तमिलनाडु में खेती के लिए इसकी अनुशंसा की गई।

अमरूद के नए उन्नत संकरों और चयनों में, सबौर में अनुपचारित किस्म इलाहाबाद सफेदा (11.11 कि.ग्रा./पेड़) की तुलना में सीआईएस-जी-1 उपज (21.87 प्रतिशत तक) के संबंध में बेहतर था।

कटहल की मूल्यांकित किस्मों में से, पालूर-1 में प्रति पेड़ अधिकतम फल (क्रमशः 49.0, 20.2 और 21.4 कोवूर, मोहनपुर और पेरियाकुलम में) दर्ज किए गए। हालांकि, कन्नारा और जोरहाट में, मुट्टम वरिक्का ने प्रति पेड़ अधिक फल (क्रमशः 130 और 33 फल/पेड़) दर्ज किए हैं।

फसल उत्पादन

केले में मिट्टी की नमी की कमी को दूर करने के लिए किए गए अध्ययन से पता चला है कि एएसए (0.1 एमएम) के साथ पर्ण लेपन के साथ-साथ मिट्टी की नमी के दबाव से सूखे के नकारात्मक प्रभाव को काफी कम कर दिया है और न्यूनतम उपज परिवर्तन (सिंचित अनुपचारित की तुलना में 14.45 से 19.00: की कमी) दर्ज हुआ है।

संतरे में सघन रोपाई के तहत पोषक तत्व प्रबंधन से संबंधित परीक्षण से पता चला है कि 6ग6 मीटर की दूरी वाले पौधों के लिए 75 प्रतिशत नत्रजन (अकार्बनिक स्रोत) 25 प्रतिशत नत्रजन (कार्बनिक स्रोत- गोबर की खाद) फॉस्फोरस (अकार्बनिक स्रोत के माध्यम से 100:) और पोटाष (गोबर की खाद के माध्यम से 100: पोटाष) का प्रयोग लुधियाना में किन्नू संतरे (208.1 ग्राम का फल वजन और 141.09 कि.ग्रा./पेड़ की उपज) और अकोला में नागपुर संतरे (323.6 फल/पेड़ और 44.4 कि.ग्रा./पेड़) में उपज पैरामीटर के लिए बेहतर रही। हालांकि, तिनसुकिया में, 6ग5 मीटर की दूरी में लगाए गए खासी संतरे में समान पोषक तत्व के प्रयोग से अधिकतम उपज (35.33 कि.ग्रा./पेड़ और

119.7 ग्राम) प्राप्त हुई। जैविक स्रोतों को शामिल करने से मिट्टी के स्वास्थ्य और पोषण को समृद्ध करने के साथ-साथ पत्ती पोषक तत्व की स्थिति में सुधार हुआ है।

नींबूवर्गीय फलों में, *ट्राइकोडर्मा हर्जियानम* (30–40 मि.ली./पौधा) और *एजाडिरेक्टिन* (छिड़काव के रूप में 3–4 मि.ली./ली. पर 1:) और स्यूडोमोनास फ्लोरसेंस (30–40 मि.ली.) के साथ में केंचुआ खाद के माध्यम से नत्रजन की 75 प्रतिशत अनुशांसित खुराक का प्रयोग करने से अकोला, श्रीगंगानगर और तिनसुकिया (क्रमशः 102.1, 34.2 और 33.0 कि.ग्रा./पेड़) में संतरे की उपज (1.2 से 2.4 गुना अधिक उपज) में वृद्धि हुई है।

एसिड लाइम में पोषक तत्वों की चरण-वार आवश्यकता को मानकीकृत करने के परीक्षण से पता चला है कि क्रमशः चरण-1 से चरण-6 तक के लिए 0:0:0, 30:40:10, 30:35:10, 20:25:30, 10:0:25 और 10:0:25 प्रतिशत की दर से नत्रजन:फॉस्फोरस:पोटाष के अनुषंसित प्रयोग से पेरियाकुलम में तुलनीय किस्म की तुलना में पीकेएम 1 में लगातार 15 प्रतिशत की उपज में वृद्धि हुई।

अमरुद में पोषक तत्वों के उपयुक्त जैविक स्रोत को मानकीकृत करने के परीक्षण ने संकेत दिया है कि केंचुआ खाद (30 कि.ग्रा./पौधा) एजोस्पिरिलम संवर्ध पीएसबी (250 ग्रा./पेड़) के प्रयोग से लुधियाना (26.25:) और सबौर (34.51:) तुलनीय किस्म की तुलना में प्रति पेड़ में फलों की संख्या में वृद्धि में हुई है।

अमरुद के मामले में, अर्का माइक्रोबियल कंसोर्षियम (एएमसी) के प्रयोग से संकेत मिलता है कि गोबर की खाद के साथ वर्ष में दो बार नत्रजन और फॉस्फोरस की 75 प्रतिशत अनुशांसित अनुषंसित मात्रा + एएमसी के मृदा में प्रयोग (12.5 कि.ग्रा./हेक्टेयर) के उपचार से अनुषंसित उर्वरक के 100: को मृदा में प्रयोग (क्रमशः 11.64, 44.65 और 33.33 कि.ग्रा./पेड़) की तुलना में संगारेड्डी (15.98 कि.ग्रा./पेड़), रीवा (56.40 कि.ग्रा./पेड़) और उदयपुर (45.39 कि.ग्रा./पेड़) में फल-उपज में वृद्धि हुई है।

लीची की उत्पादकता में सुधार के लिए किए गए परीक्षण से पता चला है कि 50 प्रतिशत प्राथमिक शाखाओं के 2 मि.मी. के स्तर तक शाखा-वंकन से चेट्टल्ली और गंगियान (14.30 और 88.33 कि.ग्रा./पेड़) में अधिकतम उपज दर्ज हुई, जबकि नेरी में, 75 प्रतिशत प्राथमिक शाखाओं के 4 मि.मी. तक शाखा-वंकन से अधिकतम उपज (25.88 कि.ग्रा./पेड़) दर्ज हुई।

फलों के लगने के 25 दिनों के बाद गुलाबी पॉलीप्रोपाइलीन थैली से लीची के फलों के गुच्छों को ढकने से फल की उपज (17.65 और 65.50 कि.ग्रा./पेड़) और मेडजिफेमा और नेरी में फलों की गुणवत्ता में वृद्धि हुई है। फल धूप से होने वाली कालिमा, फलों के टूटने और बेधक संक्रमण आदि से भी मुक्त थे।

नत्रजन:फॉस्फोरस:पोटाष का 25:50:15, 20:25:15 और 30:0:45 के अनुपात में कटाई के बाद, फल लगने के दौरान

और गोटी के आकार वाली अवस्था में प्रयोग से लंगड़ा और अल्फांसो में अधिकतम उपज (55.68 और 23.18 कि.ग्रा./पेड़) क्रमशः रीवा और वेंगुर्ले में दर्ज हुई।

आम में सूक्ष्म पोषक तत्वों के प्रभाव का मूल्यांकन करने के लिए किए गए परीक्षण से पता चला है कि कटाई के बाद अनुषंसित उर्वरकों + 100 ग्रा. जिंक सल्फेट + 50 ग्रा. कॉपर सल्फेट + 50 ग्रा. बोरिक एसिड का मृदा में प्रयोग के बाद 0.2: जिंक सल्फेट + 0.1: कॉपर सल्फेट + 0.1: बोरिक एसिड से पर्ण छिड़काव करने से (पहला छिड़काव फूल आने से पहले और दूसरा छिड़काव गोटी के आकार वाली अवस्था में) भुवनेश्वर में अनुपचारित (7.7 टन/हे.) की तुलना में 2.3 गुना अधिक फलउपज दर्ज हुई।

पपीते के बीज में 24 महीने के भंडारण के बाद अनंतराजुपेट, बंगलूरु और कोयम्बतूर में बीज-अंकुरण और ओज-सूचकांक मॉड्यूल P (15° से. पर वायुरुद्ध पॉली लाइन वाले एल्यूमीनियम पाउच में संग्रहीत बीज) में काफी अधिक था। जबकि, गांदेवी और पुणे में मॉड्यूल P (सामान्य तापमान पर वायुरुद्ध पॉली लाइन वाले एल्यूमीनियम पाउच में संग्रहीत बीज) ने स्थानीय पद्धति की तुलना में काफी अधिक बीज-अंकुरण और ओज-सूचकांक प्रदर्शित किया और इस प्रकार बीज-भंडारण की उपयुक्त विधि प्रदान की।

चीकू के पुराने बाग के मध्य भाग को खोलकर और क्रॉस शाखाओं को काटने से अराभवी (क्रिकेट बॉल किस्म) में तुलनीय किस्म की तुलना में उपज में 35 से 38 प्रतिशत की वृद्धि दर्ज हुई। हालांकि, गांदेवी में 1.0 मीटर टर्मिनल शाखाओं को काटने से उत्पादकता में 47.82 प्रतिशत तक सुधार हुई, जो अनुपचारित से बेहतर थी।

फसल संरक्षण

सर्वेक्षणों ने जोरहट (1–2:), कन्नरा (0–15:) और वेंगुर्ले (0–5:) में केला फुदक तितली (एरियोनोटा टोरस) के प्रकोपों का संकेत दिया। सभी केंद्रों में, नए उभरते कीटों जैसे, रगोसस्परलिंग व्हाइटपलाई (एलेउरोडिकस रुगियोपरकुलैटस) का प्रकोप जोरहट (5–6:) और मोहनपुर (5.6–6.8:) में दर्ज हुआ। केले के फूल थ्रिप्स (5–40:) और स्लग कैटरपिलर (5–30:) कन्नारा में दर्ज किए गए प्रमुख कीट थे।

केले से जुड़े विभिन्न पादप परजीवी सूत्रकृमियों में, कर्नाटक में छिद्रक सूत्रकृमि (राडोफोलुस सिमिलिस), मेलाइडोगाइन जाति और हेलिकोटिलेंकस स्पीषीज़ की समग्र आवृत्ति मृदा एवं जड़ों में क्रमशः 100, 98.08 और 46.15: थी। जबकि केरल में, मृदा एवं जड़ों में जड़ गॉट सूत्रकृमि (30–75: और 20–75:), छिद्रक सूत्रकृमि (30– 65: और 10–40:) और बनाना स्पाइरल सूत्रकृमि (10–30:) का प्रकोप दर्ज हुआ था। असम में, मेलाइडोगाइन स्पीषीज़ का प्रकोप मृदा और जड़ में क्रमशः 50.36–87: और 6.8–12: थी। जबकि हेलिकोटिलेंकस स्पीषीज़ के प्रकोप की आवृत्ति 23–100: दर्ज हुई। पश्चिम बंगाल में जड़ गॉट सूत्रकृमि मेलाइडोगाइन स्पीषीज़ मुख्य रूप से 50–90: आवृत्ति के

साथ देखा गया था।

विभिन्न उपचारों में, बैसिलस प्यूमिलस से 5 मि.ली./ली. की दर से ऊतक संवर्धित पौधों के पॉली बैग की मृदा को बोने से 5 दिन पहले भिगोने से + रोपाई के समय बैसिलस प्यूमिलस से संवर्धित गोबर की खाद 5 कि.ग्रा./पौधा की दर से और रोपाई के 6 महीने बाद 2.5 कि.ग्रा./पौधे की दर से प्रयोग करने से सूत्रकृमियों का प्रभावी नियंत्रण किया जा सका। सूत्रकृमियों की संख्या में कमी का प्रतिशत अराभवी, जोरहाट और कन्नारा में मानक तुलनीय किस्म की तुलना में 250 सीसी मृदा में वानस्पतिक अवस्था में 16–23.4: और प्ररोहावस्था में 7.3– 20.0: तथा 10 ग्रा. जड़ों में वानस्पतिक अवस्था में 12.43–38.46: और 11.42–33.82: थी।

केले में रूगोस स्पिरिल्लिंग व्हाइटपलाई के प्रबंधन में, प्रभावकारिता के लिए मूल्यांकन किए गए विभिन्न जैव-गहन उपचारों में, एज़ाडिरेक्टिन 10000 पीपीएम से 3 मि.ली./ली. की दर से मासिक अंतराल पर तीन बार पर्ण छिड़काव पत्ती क्षति को नियंत्रित करने के लिए प्रभावी था, जिससे कन्नारा और पेरियाकुलम में अनुपचारित की अपेक्षा 67.36 से 70.98 प्रतिशत की कमी दर्ज की गई।

केले में फ्यूसेरियम विल्ट के प्रबंधन के लिए, रोग मुक्त क्षेत्र से रोग मुक्त कल्लों की रोपाई करने और नीम की खली (250 ग्रा./पौध) के साथ-साथ कार्बेन्डाजिम (0.2:) में 30 मिनट के लिए डुबोने के बाद कार्बेन्डाजिम के 0.2: घोल से भिगोने (रोपाई के दूसरे, चौथे और छठे महीने के बाद) और 2: घोल के 3 मि.ली. की दर से कार्बेन्डाजिम इंजेक्शन (रोपाई के तीसरे, पाँचवें और सातवें महीने) कोवूर में (बाहरी मुरझान सूचकांक और आंतरिक मुरझान सूचकांक में 18.06 और 33.33 प्रतिशत की कमी) प्रभावी था।

केले की पूवन किस्म के एपिसोमल ऊतक संवर्धित पौधों का मूल्यांकन ने स्पष्ट रूप से संकेत दिया है कि, ये पौधे अराभवी, भुवनेश्वर, कोयंबतूर, जलगांव, मोहनपुर और तिरुचिरापल्ली में बीएसवी के प्रकोपों से मुक्त हैं। हालांकि, कन्नारा में बीएसवी का 23.8 प्रतिशत प्रकोप था।

फल चूसने वाले पतंगों के नियंत्रण के लिए, पेट्रोलियम छिड़काव तेल (2:) प्रभावी रहा है और लुधियाना और तिनसुकिया में फलों की गिरावट में 2.2 से 2.9 गुना की कमी दर्ज की गई है (तुलनीय किस्म में फलों की गिरावट 48.8 और 38.50:)। इसी तरह, नीम का तेल (1:) राहुरी और तिरुपति में फलों की गिरावट को कम करने में (अनुपचारित के 19.42 और 42.97: की फल-गिरावट की तुलना में 2.1 से 3.3 गुना कम) प्रभावी था।

नींबूवर्गीय फलों के हरीतन रोग के एकीकृत प्रबंधन पर किए गए परीक्षणों ने संकेत दिया कि टेट्रासाइक्लिन हाइड्रोक्लोराइड (600 पीपीएम), जिंक सल्फेट और फेरस सल्फेट (प्रत्येक 200 ग्रा./पौधा) के साथ फास्फोरस की उच्च खुराक (अनुशंसित खुराक से 50: अधिक) का प्रयोग रोग के नियंत्रण के लिए प्रभावी रहा है, जिसमें अकोला, लुधियाना, पेरियाकुलम, राहुरी, तिनसुकिया और तिरुपति में

रोग की तीव्रता 5.41 से 34.17 प्रतिशत के बीच थी।

ब्यूवेरिया बेसियाना 12 ग्रा./ली. की दर से प्रयोग करने से अमरुद में चाय मच्छर कीट (हेलोपेटिसनटोनी सिग्नोरेट) के जैविक नियंत्रण (टीएमबी) ने बंगलुरु और तिनसुकिया (क्रमशः 14.04 और 24.85:) में न्यूनतम नुकसान दिखाया है, जबकि रासायनिक कीटनाशक लैमडा-साइहलोथ्रिन 0.05 प्रतिशत के प्रयोग से अनुपचारित के क्रमशः 56.95 और 40.91 प्रतिशत के मुकाबले 10.46 और 36.80 प्रतिशत दर्ज हुआ है। बंगलुरु, लेम्बुचेरा, पेरियाकुलम और तिनसुकिया में टीएमबी की आबादी अनुपचारित की 3.00–7.20 की तुलना में विभिन्न उपचारों में 0.00 से 4.40 तक थी।

अमरुद में फल मक्खी के प्रबंधन के लिए फेरोमोन फॉर्मूलेशन ट्रैप ने पारंपरिक ट्रैप की तुलना में अनंतराजुपेटा, लखनऊ, लुधियाना, पंतनगर, पेरियाकुलम और उदयपुर में सबसे अधिक फल मक्खियों (क्रमशः 390.6, 55.2, 47.3, 72.25, 82.0 और 256.95 फल मक्खियाँ/ जाल/सप्ताह) को फँसाया है।

आम में चूसने वाले कीट के प्रकोप के प्रबंधन के लिए विभिन्न वानस्पतिक घोलों के मूल्यांकन से पता चला है कि वानस्पतिक घोलों में, एज़ाडिरेक्टिन 10,000 पीपीएम 0.003 प्रतिशत (3 मि.ली./ली.) के छिड़काव ने लुधियाना में आम फुदक की संख्या में अधिकतम प्रतिशत कमी (89.86:) दर्ज की है। हालांकि, मोहनपुर और परिया में समान उपचार से आम के फुदक और थ्रिप्स की संख्या (84.09 एवं 48.98 तथा 55.71 एवं 54.05:) में अधिकतम प्रतिशत कमी दर्ज की गई है।

आम में फल मक्खी के प्रबंधन के लिए धीमी गति से निकलने वाले फेरोमोन फॉर्मूलेशन ट्रैप ने पारंपरिक ट्रैप की तुलना में अनंतराजुपेटा, पंतनगर, पेरियाकुलम, उदयपुर, संगारेड्डी में प्रति सप्ताह 201.00, 369.91, 92.00, 86.45 और 111.35 फल मक्खी/जाल/सप्ताह के उच्चतम औसत के रूप में फल मक्खियों को फँसाया है।

आम में कटाई-उपरांत बीमारियों के एकीकृत प्रबंधन के लिए, डाइफेनोकोनाजोल 25 ईसी 0.5 मि.ली./ली. की दर से प्रयोग + गर्म पानी से उपचार (10 मिनट के लिए 52 ± 1° से.) अनंतराजुपेटा, बंगलुरु, लखनऊ, परिया, राहुरी, सबौर, संगारेड्डी और वेंगुर्ले में एन्थ्रेक्नोज के प्रकोप और इसकी तीव्रता को कम करने, स्कंध के भूरेपन, तनाग्र सड़न और एस्पेरगिलस सड़न को कम करने के लिए बेहतर था।

चीकू में फल मक्खी के प्रबंधन के लिए, धीमी गति से निकलने वाले फेरोमोन फॉर्मूलेशन ट्रैप ने पारंपरिक ट्रैप (22.4 फल मक्खियाँ/जाल/सप्ताह) की तुलना में पेरियाकुलम में सबसे अधिक फल मक्खियों (63.4 फल मक्खियाँ/जाल/सप्ताह) को फँसाया है। अन्य स्थानों, जैसे अराभवी, गांदेवी और कोवूर में, धीमी गति से निकलने वाले फेरोमोन ट्रैप में प्रति सप्ताह औसत पकड़ कम (क्रमशः 14.9, 55.6 और 6.7) थी, जो उनके संबंधित पारंपरिक ट्रैप (क्रमशः 16.5, 260.0 और 18.0) की तुलना में कम थी।

Experimental Results

BANANA

1.2.1.(a).B.Collection characterization, conservation, evaluation and utilization of banana germplasm

The progress made in the banana germplasm collection and evaluation in the different centres is furnished here under

Arabhavi: A total of 61 accessions (Eight primary collection and 53 secondary collection) are being maintained in the field gene bank. Virus indexing of eight primary and 12 secondary collections through PCR (BBTV & BSMysV) and ELISA (CMV & BBrMV) revealed that all the tested accessions are free from all the four viruses. During the period, four accessions namely, Anaikomban (AA), Kodappanilla (AB), Karibale (AAA), Shanbale (ABB) were characterized as per the minimum descriptor of NRCB. The yield data of II ratoon crop revealed that the varieties like Sakkarebale (20.21 kg/plant) and Dwarf Cavendish (19.90 kg/plant) recorded maximum bunch weight. Maximum TSS content was recorded in Mitli (27.50°B), Sakkarebale (26.50°B) and Ney poovan (25.80°B). Field screening of germplasm accessions revealed that Sakkarebale (5.76), Mitli (7.19), Ney poovan (7.79) had less incidence of Sigatoka leaf spot.

Bhubaneswar: A total of 65 accessions (35 primary and 30 secondary collections) are being maintained at field gene bank. Two accessions, each one of culinary type (Satakosia Bantal) and dessert type (Mushika bahan) collected for high yield and good taste are included in the field gene bank. Among the ten culinary banana types evaluated, Paunshia Batisha recorded maximum yield (24.21 kg) and two accessions namely Gaja Bantal and Mendhi Bantal were having good cooking quality and marketability. Whereas, eight germplasm accessions namely Dakhinisagar, Nali Bantal, Panitarasa, Khanda Chini, Mazapuri, Banua, Sankarand and sankhtarasa were characterized as per the minimum descriptor of NRCB.

Coimbatore: A total of 165 accessions are being maintained after removing the 41 duplicate accessions at field gene bank. Survey has been made for trait specific germplasm collection for dwarfness, yield and fruit quality in Coimbatore District and two Karpooravalli variants (bearing 14-15 hands) free from diseases at field condition were collected from Padhuvampalli village of Sulur block and Devarayapuram village of Kinathukaddu block respectively. A new collection "Ragitchi" from Garo hills of Meghalaya, reported to be free from all biotic stresses was collected and planted for further

evaluation. During the reporting period, total of 85 accessions were evaluated for the presence of virus symptom. Of which, BBrMV incidence was recorded in Kothiah, Onkamannan, Suganthi, Ney Poovan, Grand Naine, Malai Ethen, Malbhog, Puttubale, Vannan, Jwaribale, Senna Chenkadali, Kathubale, Muthiah, Bhodibale, Karpooravalli, Pacha bontha bathesa. Whereas, BSV incidence was recorded in Motta Poovan, Chenichampa, Onkamannan and Kothia and none of the accessions were infested by CMV and BBTv. A total of 20 accession is being utilized in the breeding programme, of which six germplasm accessions (Kozhikode, Ney Poovan, Manoranjitham, Monthan, Kalibow, Rasthali) were newly added.

Gandevi: A total of 64 accessions are being maintained at field gene bank, of which minimum days taken for shooting (209 days) was recorded in Poovan (AAB) and minimum days taken for harvesting (324 days) and TSS (30°B) were recorded in Agilara (AAB). Maximum number of fingers per hand (165.33) was recorded in Parakuni (AAB) whereas maximum bunch weight (28.51 kg) was recorded in Gandevi Selection (AAA).

Jalgaon: A total of 86 germplasm is being conserved and maintained and only 16 genotypes were found to be unique accessions. All the accessions are under vegetative stage.

Jorhat: Eight accessions were evaluated of which BCB 1 was found to be high yielder with an average bunch weight of 21.4 kg.

Kannara: A total of 246 accessions, which includes two secondary collection are being conserved and maintained. Along with the passport data, two accessions namely Chavaniyankal Poovan (KNR 290) and Makkalepotty (KNR 303) were deposited to NAGS, ICAR-NRCB, Trichy. Characterization has been completed for 7 accessions in the main crop (Chingan (KNR 322), Chittoor (KNR 321), Progeny 185, Progeny 187, Progeny 188, Progeny 94, Progeny (Namwa khom x Matti) and 3 accessions in the first ratoon crop (Assam KNR 325, Progeny 95 and Tani). Six germplasm accessions have been utilized for dietary fibre content (Kunnan, Pisang Lilin), for plant fibre (Chenkadali, Ilavazha and Neypoovan) and for fig preparation (Kadali).

Kovvur: During reporting period, two new banana germplasm accessions viz., Seeded one and AkuArati were collected from Srikakulam and Nellore district respectively and included in the germplasm. Aku Arati has been collected for higher number of leaves and should be evaluated for its suitability for leaf industry. Among the different genomic groups

evaluated for bunch weight, Matti (AA) (11.00 kg), Yelekkibale (AB) (13 kg), Valery (AAA) (17.25 kg), PisangSeribu (AAB) (20.75 kg), Pachabonthabatteesa (ABB) (24.75 kg), FHIA-17 (AAAA) (21 kg), FHIA-01 (AAAB) (9 kg) and FHIA-03 (AABB) (21.75 kg) recorded maximum bunch weight in their genomic groups for plant crop.

Mohanpur: A total of six accessions were evaluated, of which two were in AAA genomic group (Tella Chakrakelli & Karim Kadali) and four accessions of AAB group (Ladan, Kallar Ladan, Chennali & Virupaskhi). Chennali showed highest bunch weight (12.30 kg), yield (30.75 t/h) whereas Virupaskhi recorded lowest bunch weight (8.2 kg). Highest TSS (23.30°B) was found in Kallar Ladan. Two accessions have been evaluated in the ratoon Crop-II and found that Martaman-IV showed better performance than Champa. Both are tolerance to Fusarium wilt and Sigatoka leaf spot (*Mycosphaerella eumusae*).

Pusa: A total of 74 accessions are being maintained at field gene bank and are being evaluated for yield and quality attributes along with the resistance to pest and diseases. Four accessions were characterized based on minimal descriptor. Scarring beetle incidence (2-10 beetles/terminal leaf whorl) was observed in

all the varieties while Pseudostem weevil incidence was observed only in cv. Grand Naine (AAA) and Chinia (AAB).

Port Blair: During the reporting period, 3 primary collections (includes the local banana accessions namely Korangi, Cheena Kela and Mitta Champa) and two secondary collections were done and are conserved at the experimental field. Totally 9 primary collections and 14 secondary collections are being maintained in the experimental field. The Korangi local banana is a table purpose variety with high TSS of 25.8°B and is suitable for perennial cultivation at home gardens and in plantation-based cropping system. Suckers of three local banana accessions namely LB 1, LB 2 and LB 3 (Korangi, Khatta Champa and Mitta Champa) and one wild banana seedlings of *Musa inandamanensis* have been submitted to NAGS centre NRCB.

Tiruchirapalli: As a NAGS centre, ICAR-Trichy has characterized the germplasm for identification of duplicates and till date characterization has been completed for Gandevi centre (100%) followed by Kovvur (91%), Bhubaneswar (85%), Kannara (75%), Coimbatore (66%) and IC number has been assigned for all the characterized germplasm (Table 1).

Table-1: Detail of identification of duplicate germplasm at AICRP centre for Banana

Centre	Completed so far (%)	Number of accessions available		Percent of secondary
		Primary	Secondary	
Arabhavi	0	8	53	87
Bhubaneswar	85	35	30	46
Coimbatore	66	157	49	24
Gandevi	100	10	80	88
Jalgaon	1	16	70	81
Jorhat	0	39	39	45
Kannara	75	62	182	74
Kovvur	91	22	89	97
Mohanpur	14	65	93	59
Pusa	1	74	0	0
Port Blair	0	6	8	57

1.2.2.(b).B. Clonal selection in banana

Intensive exploration programme for the selection of superior clones in commercial cultivars of the region for the characters (1) high yield, good finger size (2) tolerance to pest and disease (3) tolerance to abiotic stresses (4) tolerance to nematode and (5) Organoleptic evaluation was taken up.

Arabhavi: During the reporting period, exploration has been made in Belagavi, Bagalkot and Dharwad districts of Karnataka. Five clones of regional variety Rajapuri were collected based on higher yield and the clones were planted for further evaluation.

Bhubaneswar: No new clones were identified during the survey. The clones of Champa, Patkapura and Gajabantal registered 15 to 38 per cent, 35 to 40 per cent and 24 to 35 per cent increase in yield respectively when compared to their respective local checks. The clones of Champa and Gajabantal were observed to be 20 - 25 days early in shooting when compared to their respective checks.

Coimbatore: No new clones were identified during survey at Erode and Coimbatore districts. The selected Quintal Nendran clone (2014-CBE-1QN-PC2020) registered higher yield (23.41 kg/bunch) as compared to the check (Nendran) (11.94 kg/bunch),

but the selection registered longer duration (423 days) as compared to the check (346 days).

Gandevi: Among twenty clones collected during 2014, ten clones of Grand Naine were evaluated. Clone 2017-GND-1 was dwarf statured with lower pseudostem height (1.49 m), whereas minimum days to shooting (216 days) and days to harvesting (331.67 days) were recorded in clone 2017-GND-4. Highest bunch weight (20.69 kg) with maximum number of hands (9.67) and fingers per hand (170.0) were recorded in 2017-GND-6. Narmada and Navsari districts were surveyed and two Grand Naine clones (2020-GND-11 and 2020-GND-12) were identified for further evaluation.

Jalgaon: Prior selected two clones viz., 2019 JL PC₁ 2020 and 2020 JL PC₂ 2021 were evaluated. The clone 2019-JL PC₁-2020 registered bunch weight of 19.65 kg with yield attributing parameters viz., hands per bunch (7.80), fingers per bunch (126) and finger weight (148 g). The clone 2020 JL PC₂ 2021 recorded bunch weight of 20.63 kg with yield attributing parameters viz., hands per bunch (8.30), fingers per bunch (134) and finger weight (154 g). The clones were found to be free from major pests and diseases except CMV incidence (8.33 and 9.40 per cent respectively).

Jorhat: Survey was carried out in banana growing areas of four agro-climatic zones i.e. Upper Brahmaputra Valley Zone (UBVZ), Central Brahmaputra Valley Zone (CBVZ), North Bank Plains and Lower Brahmaputra Valley Zone (LBVZ) and two superior clones viz., 2021- AAU- (B)-1A (clone of Cheni Champa (AAB)) and 2021- AAU- (B)-2A (clone of Kach Kol (ABB)) with high yield and exhibiting tolerance to banana scarring beetle and pseudostem weevil were collected and planted for further evaluation.

Kannara: Survey was carried out in banana growing areas and eleven clones of Nendran (AAB), seven clones of Rasthali (Poovan, AAB) and three clones of Pisang Lilin (AA) were collected and planted for evaluation. The plants are in vegetative stage.

Kovvur: Ratoon of earlier identified high yielding clone of Tella Chakkeri Keli identified at Nutakki village of Guntur district was evaluated during the reporting period. The selected clone registered higher bunch weight (12.95 kg) than check (11.50 kg).

Mohanpur: Evaluation of earlier selected clones of Kanthali, Martaman and Grand Naine was carried out. Kanthali, Martaman and Grand Naine clones registered higher bunch weight (24.30, 19.90 and 24.50 kg/plant), TSS (26.10°B, 24.70°B and 23.60°B) and BC ratio (3.86, 3.17 and 3.89) respectively when compared to respective checks. Kanthali, Martaman and Grand

Naine clones recorded 31.27, 27.56 and 26.29 per cent more yield as compared to respective checks.

Pusa: Evaluation of four promising clones viz., Nepali Chinia, Tepri, Nemopore and Simra were evaluated for yield traits with Karpoorvalli as check. Maximum bunch weight (22.4 kg) and maximum yield (56.0 t/ha) were recorded in the clone Tepri. The same clone recorded maximum number of hands (14.0) and maximum number of fingers (162) when compared to check.

1.2.3.B. Evaluation of new introductions of banana (MLT-II)

The performance of newly introduced clones, the BRS Selection Popoulu (Popoulu) and NRCB selection-10 (NRCB-10) were evaluated against respective check varieties at seven centres located at different agro-climates across the country.

Arabhavi: Evaluation showed that Popoulu recorded higher yield (52.25 t/ha) and better fruit quality over the check variety Nendran (30.99 t/ha) and NRCB-10 recorded higher yield (65.10 t/ha) and superior fruit quality over check variety Budubale (46.20 t/ha). The incidence of *Eumusae* (Sigatoka) leaf spot was less in Popoulu and NRCB-10 was supposed to be suitable for wind prone areas.

Bhubaneswar: Evaluation recorded higher yield in Popoulu (42.46 t/ha) and NRCB Sel-10 (62.00 t/ha) compared with the check variety Nendran (28.42 t/ha) and Budubale (38.42 t/ha).

Coimbatore: Evaluation of clones revealed that the satisfactory yield performance of Popoulu and advantageous dwarf nature of NRCB 10 were observed. Incidence of pseudostem borer in Popoulu, Manjeri Nendran and Nendran, fruit fly incidence in Popoulu and *Fusarium* wilt in Karpuravalli and NRCB 10 were observed (Fig 1).

Jorhat: Evaluation of clones indicated better performance of Popoulu better yield (28.17 t/ha) over check variety Nendran (16.40 t/ha).

Kannara: Among Plantain group, significantly higher bunch weight (17.67 kg), yield (44.18 t/ha) and BC ratio (2.94) were recorded in Popoulu compared to Manjeri Nendran (13.20 kg) and Nendran (10.42 kg). Flowering was earliest in Nendran, followed by Popoulu and Manjeri Nendran but crop duration of Nendran was on par with Popoulu. Need of propping was avoided in Popoulu due to its higher pseudostem girth and hence reduced cost of cultivation. Popoulu showed more tolerance to *Eumusae* leaf spot. The NRCB 10 clone recorded significantly higher bunch weight (21.95 kg/plant), advanced flowering and harvest and shorter height of pseudostem, compared with the check variety Karpooravalli (18.21 kg bunch/plant).

Kovvur: In Ratoon crop-2 (RC-2) among plantain group, Popoulu has recorded higher bunch weight (20.12 kg) and yield (57.06 t/ha) compared to Manjeri Nendran-II (11.08 kg) and check variety Nendran (8.81 kg) whereas, fruit quality was better in Nendran and Manjeri Nendran than Popoulu. Among Pisang Awak group, NRCB-10 recorded significantly higher bunch weight (24.71 kg), productivity (69.23 t/ha) and TSS (25.05°B) over check variety Nukala Bontha (11.67 kg, 32.92 t/ha and 22.13°B respectively).

Mohanpur: The performance evaluation showed that Popoulu recorded higher bunch weight (13.26 kg), productivity (33.00 t/ha) and BC ratio (2.45)

compared with Manjeri Nendran-II and check variety Nendran (11.72 kg, 28.84 t/ha & 2.21 and 11.02 kg, 27.29 t/ha & 2.03 respectively). However, Nendran and Manjeri Nendran recorded superior TSS content and better shelf life of fruit. While among Pisang Awak group, local check Kanthali has recorded maximum bunch weight (18.18 kg), productivity (44.57 t/ha) and BC ratio (3.05) over the clone NRCB Selection-10 (15.13 kg, 37.24 t/ha & 2.84 respectively). While, NRCB-10 recorded minimum crop duration compared to check. Both clones including its checks were susceptible to scarring beetle and sigatoka leaf spot disease (Table 2 & 3).

Table-2: Fruit yield (t/ha) of banana varieties at different centres

Clone /variety	ARB (PD)**	BBI (PD)	COB (PD)	JRH (PD)	KAN (PD)	KVR (PD)	MHR (PD)
V ₁ -Popoulu (AAB)	55.53	42.85	45.00	28.17	41.32	57.06	33.00
V ₂ -Man. Nendran-II	41.43	35.75	28.40	20.78	33.76	31.38	28.84
V ₃ -Check-Nendran	34.66	27.91	36.80	16.40	26.07	24.68	27.29
V ₄ -NRCB Sel.-10 (ABB)	62.77	59.13	43.90	35.56	52.69	69.23	37.24
V ₅ -Check-Centre wise	46.85	38.07	57.10	32.50	43.53	32.92	44.57
CD at 5%	4.71	8.10	8.05	2.27	7.41	11.34	3.38

*ARB-Arabhavi, BBI-Bhubaneswar, COB-Coimbatore, JRH-Jorhat, KAN-Kannara, KVR-Kovvur, MHR-Mohanpur
**PD-Pooled Data of respective centre

Table-3: Bunch weight (kg) of banana varieties at different centres

Clone /variety	ARB (PD)**	BBI (PD)	COB (PD)	JRH (PD)	KAN (PD)	KVR (PD)	MHR (PD)
V ₁ -Popoulu (AAB)	55.53	42.85	45.00	28.17	41.32	57.06	33.00
V ₂ -Man. Nendran-II	41.43	35.75	28.40	20.78	33.76	31.38	28.84
V ₃ -Check-Nendran	34.66	27.91	36.80	16.40	26.07	24.68	27.29
V ₄ -NRCB Sel.-10 (ABB)	62.77	59.13	43.90	35.56	52.69	69.23	37.24
V ₅ -Check-Centre wise	46.85	38.07	57.10	32.50	43.53	32.92	44.57
CD at 5%	4.71	8.10	8.05	2.27	7.41	11.34	3.38

*ARB-Arabhavi, BBI-Bhubaneswar, COB-Coimbatore, JRH-Jorhat, KAN-Kannara, KVR-Kovvur, MHR-Mohanpur
**PD-Pooled Data of respective centre

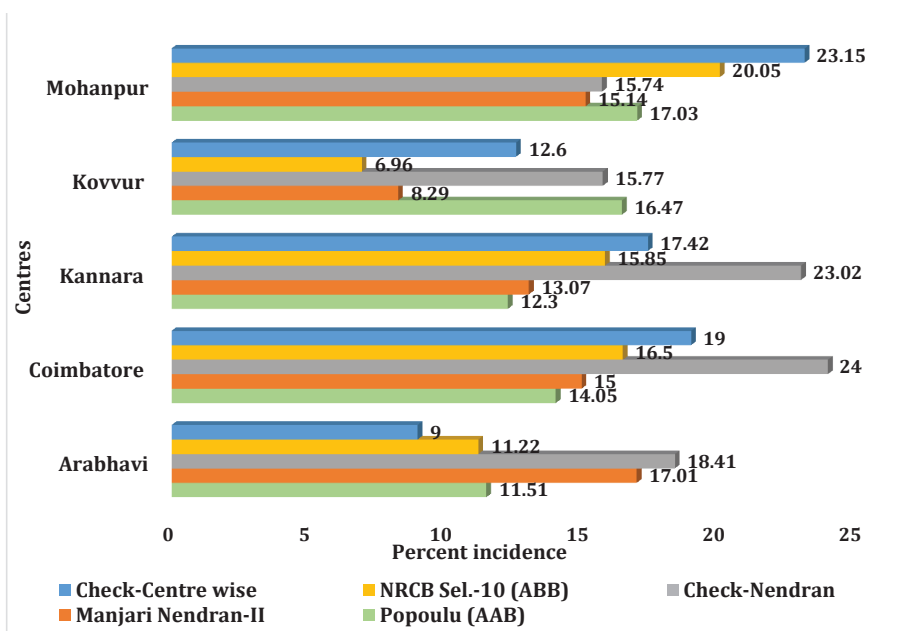


Fig. 1: Reaction of banana varieties to *Eumusae* leaf spot disease at different centres

1.2.4.B. Observational trial on evaluation of banana cultivars in non-traditional banana growing regions.

The trial was laid out in FRBD with three seasons of planting viz., S_1 =Feb-Mar; S_2 =June-July; S_3 =Oct-Nov and five varieties Grand Naine, Poovan, Ney Poovan, Red Banana and Monthan replicated twice in a spacing of 2 x 2 m. Suckers of the varieties were used as the planting material.

Pantnagar: Cultivar Grande Naine significantly recorded higher bunch weight (21.14 kg), yield (52.84 t/ha), finger length (19.00 cm) and BC ratio (2:1) when planted in May month. The maximum duration from shooting to harvest (193 days) was recorded with March planting in cultivar Poovan. The significantly maximum pseudostem girth (58.10 cm) and maximum hands per bunch (12.75) were recorded with May planting in cultivar Poovan, however, maximum pseudostem height (3.15 m), finger weight (170.97 g) and pulp weight (120.43 g) were observed with March planting in cultivar Monthan. Significantly maximum TSS (23.80°B) and number of fingers/bunch (162.50) were recorded in cultivar Ney Poovan planted in May month. The maximum shelf life (8.75 days) was recorded in cultivar Monthan planted in May month, while maximum acidity (0.51%) was found in banana cultivar Ney Poovan planted in March month. The results showed that the best planting season for banana is May and the varieties suitable are Grand Naine for table purpose and Monthan as cooking banana.

Port Blair: Variety Poovan recorded maximum pseudostem girth (53.45 cm) in May planting. Maximum number of leaves per plant (12.25), early shooting (293.75 days) and earliness in shooting to harvest duration (100.25 days) was recorded in the variety Monthan. Maximum number of hands per bunch (11.00), fingers per bunch (129.00) were found in the variety Poovan. With respect to fruit characters like finger weight (166.75g), pulp weight (133.75 g), finger length (23.25 cm), finger diameter (16.08 cm), bunch weight (15.58 kg), yield (38.94 t/ha) and shelf life (9.75 days), maximum values were observed in the variety Monthan in July planting. Maximum TSS (29.25°B) was recorded in the variety Ney Poovan in May planting with minimum acidity (0.06%) in Grand Naine in March planting. The concluded trial showed that July is the best season for planting banana and the suitable varieties for maximum yield are Monthan followed by Poovan.

Udaipur: Plants are in juvenile stage.

1.2.7.B. Evaluation of banana hybrid (MLT-3)

This trial has been laid out to study the performance of Hybrid banana (NCR-17) in seven centres.

Arabhavi: Trial has been initiated.

Bhubaneswar (OUAT): Trial is in establishment stage.

Coimbatore: Trial is in establishment stage.

Jalgaon: Trial is in establishment stage.

Kannara: Vegetative traits such as plant height, pseudostem girth, leaves per plant, leaf area and suckers per plant were significantly higher in Manjeri Nendran. Whereas bunch weight, yield, hands per bunch, finger length and finger diameter were on par between NCR 17 and Manjeri Nendran. NCR 17 recorded higher fingers per hand (12) and fingers per bunch (85) while Manjeri Nendran recorded higher finger weight (204 g), pulp weight (150 g) and pulp: peel (2.76). Among the quality attributes studied, Manjeri Nendran registered higher TSS, shelf life and lower acidity than NCR 17. The PDI for *Eumusae* leaf spot was significantly higher for NCR 17 (21.85) than Manjeri Nendran (16.4). Pseudostem weevil infection was noticed in NCR 17 (17%) whereas no infection was observed in Manjeri Nendran. But Manjeri Nendran recorded 8.33 per cent incidence of corm weevil and no incidence was observed in NCR 17. Nutritional profiling of fruits showed that Manjeri Nendran had a higher carotenoid content both at raw and ripe stage. Being a dessert banana, nutritional profiling of NCR 17 has been compared with Grand Naine and found that NCR 17 recorded higher total sugars and lower total starch at ripening comparable to dessert variety like Grand Naine, while the carotenoid content was very high in NCR17 (1023.6 µg of carotenoid/ 100 g than Grand Naine (µg of carotenoid/ 100 g) at ripe stage.

Mohanpur: Test cultivar NCR 17 and check variety Manjeri Nendran were established and trial is in initial stage.

Pusa: Trial is in establishment stage.

1.2.8.B. Evaluation of banana mutant (MLT-4)

The trial has been initiated to study the performance of BARC mutant TBM-9 and Phule Pride of BRS, Jalgaon for dwarfness and yield contributing parameters using local Cavendish clones as check.

Arabhavi: Plants are in shooting stage. TBM-9 recorded the minimum plant height (1.65 m) followed by Phule Pride (1.79 m) and Grand Naine (2.48 m) proving that the test varieties were shorter than the check.

Bhubaneswar: The crop is in vegetative stage.

Coimbatore: Grand Naine recorded higher yield (26.96 kg/bunch) when compared to TBM 9 (21.13 kg/bunch). However, the pseudostem height of TBM 9 was shorter (1.70 m) as compared to Grand Naine

(2.25 m). Though crop duration was 13 days earlier in TBM 9, it was not statistically different from Grand Naine. The crop after harvest has been allowed for ratooning. Phule Pride was planted during Feb 2021 along with Grand Naine as check and is being evaluated separately. The crop is in shooting phase.

Gandevi: The results on growth, yield and quality parameters recorded lowest pseudostem height (1.72 m) in cv. Phule Pride and minimum days to shooting (256.0 days) and harvesting (346.5 days) were observed in cv. TBM-9. Higher bunch weight (27.94 kg), bunch length (95.95 cm), finger length (25.32 cm) and finger weight (174.7 g) were recorded in cv. Grand Naine. Higher TSS (22.12°B) and maximum organoleptic taste score (8.43) was recorded in cv. TBM-9.

Jalgaon: TBM - 9 recorded minimum pseudo stem height (1.63 m), girth (61.45 cm) and days for maturity from shooting (98.86) when compared to cvs. Phule Pride and Grand Naine. Grand Naine was superior for all yield parameters than Phule Pride and TBM - 9. No damage due high wind velocity, high and low temperature were recorded in TBM - 9, however Grand Naine recorded 3.11 per cent damage.

Jorhat: The crop is in vegetative stage.

Kannara: The mutant variety TBM 9 was significantly shorter in height (1.70 m) than Grand Naine (2.41 m) even though TBM 9 had higher pseudostem girth (58.98 cm) than Grand Naine (52.60 cm). Grand Naine recorded a significantly higher bunch weight (29.87 kg/ plant) and yield (74.70 t/ha) than TBM 9 (24.32 kg bunch weight and 60.80 t/ha yield). Phule Pride was shorter in stature (1.53m) than Grand Naine (2.13 m). Earliness to bunching by 22 days was also recorded in Grand Naine compared to Phule Pride. Bunch weight and yield were the highest in Grand Naine (26.58 kg/plant and 66.46 t/ha respectively) when compared to Phule Pride (15.94 kg/plant and 39.85 t/ha respectively). Reaction to the incidence of Eumusae leaf spot showed that the PDI was higher in Phule Pride (23.75) than Grand Naine (18.82).

Kovvur: The ratoon crop of TBM 9 and Grand Naine and the plant crop of Phule Pride have been completed. TBM-9 plants were nearly 55 cm shorter than Grand Naine. Among the two varieties, pseudostem girth was maximum in Grand Naine (54.7 cm) as compared to TBM 9 (50.4 cm). During the plant crop, shooting and harvesting were nearly 17-18 days earlier in TBM 9 but in ratoon crop no notable differences were recorded with respect to days for shooting, harvesting and bunch maturity. Among the two banana varieties evaluated, maximum finger length was recorded in Grand Naine with the same diameter of TBM 9. Among the two genotypes, highest yield was recorded in

Grand Naine (64.4 t/ha) as compared to TBM 9 (44.0 t/ha). Highest TSS was recorded in banana cv Grand Naine (21.0°B) as compared to TBM 9 (16.0°B).

Mohanpur: The Cavendish clone TBM-9 recorded the minimum plant height of 1.47 m while Phule Pride and Grand Naine were at par with respect to plant height. Earliest flowering in 331.14 days after planting was observed in TBM 9 followed by Phule Pride (345.00 days) and the maximum duration was recorded in Grand Naine check. Grand Naine recorded higher bunch weight (18.60 kg) and yield (57.40 t/ha) followed by TBM-9 (17.90 kg & 55.24 t/ha, respectively) and Phule Pride.

Port Blair: TBM 9 and Phule Pride were received in July and August 2021 respectively and planting was taken up in August, 2021 along with Grand Naine check. The trial is in the early vegetative stage.

3.2.7.B. Alleviation of soil moisture deficit stress in banana

The experiment was laid out with five treatments imposing soil moisture stress at critical phenological stages and biochemical foliar priming with acetyl salicylic acid to alleviate negative effects of soil moisture deficit stress in banana.

Arabhavi: The maximum yield and yield parameters were recorded in irrigated control. The soil moisture stress at 5 MAP increased the duration of flowering by 15.30 days over irrigated control. The yield decreased up to 42.91 per cent over the control. Among stress treatments, foliar priming with Acetyl salicylic acid (0.1mM) + soil moisture stress at flowering recorded maximum bunch weight (76.68 t/ha), TSS (21.55°B) and maximum shelf life (8.84 days). However, same treatment recorded minimum per cent deviation of yield (11.13%) over control. No malformed fruits were observed under soil moisture stress at flowering treatment (Table 4).

Bhubaneswar: The soil moisture stress at 5 MAP increased the duration of flowering by 9.00 days and affected yield parameters. There is a 28.0 percent deviation of yield over control. The soil moisture stress at flowering has affected the yield to the tune of 28.00 percent. The treatment, T₄ (Foliar priming with Acetyl salicylic acid (0.1mM) + soil moisture stress at 5th MAP) yielded 22.94 kg/plant (71.14 t/ha) with maximum TSS (20.32°B) and more shelf life (8.72 days).

Gandevi: The soil moisture stress at 5 MAP increased the duration of flowering by 10.25 days, over irrigated control. Crop is in shooting stage

Jalgaon: The soil moisture stress at 5 MAP increased the duration of flowering by 14.40 days with 46.32 percent deviation of yield over irrigated control.

The treatment T₅ has recorded maximum bunch weight (24.20 kg/plant & 74.68 t/ha), maximum TSS (20.36°B) and better shelf life (7.42 days).

Kovvur: The soil moisture stress at 5 MAP increased

the duration of flowering by 24.02 days with 28.60 percent deviation of yield over irrigated control. The treatment T₅ has recorded maximum bunch weight (20.87 kg/plant & 64.39 t/ha).

Table-4: Effect of soil moisture stress on bunch weight (kg), yield (t/ha) and percent deviation of yield over control of banana at different centres

Treatment	ARB		BBI		JLG		KOV	
	Yield (t/ha)	% deviation of yield over control	Yield (t/ha)	% deviation of yield over control	Yield (t/ha)	% deviation of yield over control	Yield (t/ha)	% deviation of yield over control
T ₁	89.64	-	73.24	-	89.80	-	76.35	-
T ₂	51.17	42.91	57.14	28.00	48.20	46.32	54.51	28.60
T ₃	66.53	25.78	55.24	34.00	68.76	23.43	57.73	24.38
T ₄	61.25	31.67	71.14	15.00	57.34	36.15	60.27	21.06
T ₅	76.68	14.45	69.15	19.00	74.68	16.84	64.39	15.66
CD at 5%	8.28	-	2.16	-	8.06	-	5.19	-

T₁: Irrigated control, T₂: SMS at 5th MAP (Floral primordial initiation stage), T₃: SMS at flowering, T₄: Foliar priming with ASA (0.1mM) + SMS at 5th MAP (Floral primordial initiation stage), T₅: Foliar priming with ASA (0.1mM) + SMS at flowering. ARB-Arabhavi, BBI-Bhubaneswar, JLG-Jalgaon, KVR-Kovvur

4.2.3.B. Assessment of phenology, productivity and incidence of insect pests and diseases in banana grown under varying climatic conditions.

Collection and analysis of the past weather data, mainly temperature (minimum and maximum), rainfall, evapotranspiration and sunshine hours to study the effects of climate change on phenology, pests, diseases and productivity of banana.

Arabhavi: There were no occurrence of extreme weather conditions and no distinct changes observed in phenology of Rajapuri and Grand Naine.

Bhubaneswar: No extreme weather condition was recorded and no distinct changes in the phenology, productivity, fruit quality and incidence if disease and pests were observed of banana cv Champa.

Coimbatore: No extreme weather condition was recorded during the reporting period and the incidence of insect pests and diseases were very low that caused no major damage to crop of the existing trials. The weather impact on the phenology, productivity and fruit quality was negligible.

Gandevi: No extreme weather conditions occurred except for the *Tauktae* cyclone with rain during the month of May, 2021 and the rainfall in September, 2021 was in the normal range. The incidence of insect pests and diseases were normal and the occurrence of new insect pest or diseases were not observed.

Jalgaon: Extreme climatic event were not observed. However, the higher monthly average temperature of 42°C in April and May has adversely affected the growth and yield traits of banana which include scorching of leaves and developing fingers. The

continuous rains from June to September and minimum temperature ranging from 24.3°C to 25.5°C has resulted in increased Infectious chlorosis (CMV disease) incidence in Muktainagar (63.35%), Raver (53.30%) and Yawal (31.05%) of banana plantation in Jalgaon.

Jorhat: No extreme weather conditions occurred except increase in rainfall. Apart from some damage to the field crops, no distinct changes observed on the phenology, productivity and fruit quality.

Kannara: No occurrence of extreme climatic conditions were observed and no distinct changes in phenology of Nendran was recorded. However quantity of rainfall (mm) received and number of rainy days was high during the reporting period when long term average was considered, that resulted in increased Eumuase leaf spot disease. Blast and Pitting disease also appeared during this period as maturity of Nendran banana (August – September) coincided with heavy rainfall. Incidence of new insect pests like flower thrips (*Thrips hawaiiensis*, 5-35%) and Leaf thrips (*Hercinothrips bicinctus*, 5-35%) was noted during the bunch maturation period, which also coincided with heavy rainfall.

Kovvur: No extreme weather condition was recorded and the incidence of insect pests and diseases were very low that caused no major damage to crop of the existing trials. Incidence of rugose spiralling whitefly (RSW) was noticed on all the genotype evaluated.

Mohanpur: The deviations from LTA were estimated positive for weather parameters *viz.*, minimum temperature and average relative humidity by 2.72 and 0.19% per month, respectively during the period

of observations while the maximum and average temperature, rainfall and evaporation recorded negative deviations by 12.65, 8.36, 7.54 and 50.79% per month respectively. Recorded observations on phenology, productivity, fruit quality and incidence of insect pests and diseases of two commercial banana varieties viz., Martaman (Musa AAB) and Grand Nain (Musa AAA) and no distinct changes were observed.

Pusa: No extreme weather parameters, except

excessive rainfall were reported and it had negligible impact of the phenology, productivity and fruit quality.

Vengurle: Extreme climatic event happened during 14-16 May, 2021 due to the Tauktae cyclone that caused about 40 - 60% damage to the banana trials. Incidence of insect pests like spodoptera, skipper butterfly and sigatoka disease were observed that caused no distinct changes in the crop (Table 5 & 6).

Table-5: Long term deviation of weather parameters with the current year at different centre

Weather parameters	ARB	BBI	COB	GND	JRH	KNR	KVR	MHR	Pusa	VNG
Max. Temperature (°C)	-5.25	-0.46	-1.2 (NA)	32.42	0.96	+ 0.30	(-) 1.4	-12.65	-0.52	+1.94
Min. Temperature (°C)	6.27	-11.21	-1.3 (NA)	21.4	- 0.85	- 0.62	1.69	+2.72	-0.23	-1.55
Rainfall (mm)	-262.46	-8.72	+24.2 (Less A)	1879.5	- 598.10	+ 60.00	347.97	+7.54	+1311.3	+0.92
RH (%) (7 am)	-8.51	-2.77	+10.1 (Less A)	-	3.38	+ 1.91	17.38	+0.19 (Avg)	+3.29	+961.2
RH (%) (2pm)	-7.60	-35.40	+9.8 (NA)	-	- 5.42	+ 1.08	27.55	-	+1.57	+5.17
Evaporation (mm)	1.99	0.42	+9.4 (NA)	+3.52	0.01	- 0.92	-	-50.79	-1.30	-

A-Apparent; NA- Not Apparent; ARB-Arabhavi, BBI-Bhubaneswar, COB-Coimbatore, GND: Gandevi, JRH: Jorhat, KNR: Kannara, KVR: Kovvur, MHR: Mohanpur, VNG: Vengurle

Table-6: Extreme variation in weather parameters at different centres for the current year at different centre

Extreme event	Gangian	Vengurle
Excessive rainfall	19 days (September, 2021); 41.50 % in 19 days	No. of rainy days were increase from 102 to 134 days during 2020-21
Cyclone/ Typhoon	2 days (17 th and 18 th May, 2021); 28.8 km/hour	Tauktae cyclone
Drought	Nil	Nil
Others	Nil	Nil

5.2.1.B. Survey on emerging insect pests of banana

Roving survey in banana orchards was done in various parts of the state. Care was taken to record the presence of emerging/new/introduced pests and their associated predators and parasites only.

Roving survey

Gandevi: The status of banana pests under the roving survey indicated that there was no major disparity in incidence pattern of the pests over previous year in banana area of south Gujarat during 2020-21. Major pests were pseudo-stem weevil/borer, corm weevil and thrips complex recorded during survey. Rugose spiralling whitefly (*Aleurodicus rugioperculatus* Martin 2004) was first time reported in banana intercropped with coconut in Jan.-Feb. and then from June onwards in Navsari and Surat districts. The pest was identified by Dr. A.K. Dubey, Scientist-D, ZSI, Port Blair, A & N Islands. Rust and flower thrips were emerging pests in few pockets of Surat and Navsari. Banana cv. Grand Naine has showed susceptibility to major pests. The different predators viz., dragonfly, damselfly and lady bird beetles were reported during early vegetative

stage, while spider and earwigs were observed through later stages of cropping season. There was slight decrease of plant damage intensity due to pseudo-stem weevil on cv. Grand Naine during 2020-21. The maximum incidence was noted in Surat dist. (12.8%), while minimum was in Valsad dist. (6.5%). The plant damage due to corm/rhizome weevil had no change in intensity on cv. Grand Naine. The infestation observed in few pockets was maximum in Anand dist. (3.5%), while minimum was in Vadodara dist. (2.0%). There was decrease in fruit infestation due to rust thrips with minor variation of damage recorded on cv. Grand Naine. The maximum incidence was reported in Surat dist. (19.3%), while minimum in Anand dist. (6.2%). Other districts like Navsari (15.6%), Bharuch (12.7%), Narmada (10.6%), Valsad (7.2%) and Vadodara (7.0%) also showed symptoms during Aug.-Sept. and the symptoms observed on mature fruits.

Jorhat: Regular and major pests of banana viz., banana leaf and fruit scarring beetle, pseudostem borer/weevil and banana aphid were recorded in the surveyed areas with 38-40.50 per cent, 17-22 per cent and 15-18 per cent. incidences respectively on cv. Jahaji, along with Bhimkol, Malbhog, Borjahaji and

chenichampa etc. Pseudo-stem weevil infestation was found mainly on ratoon crops. Aphid infestation was observed at the vegetative stage of the crop. Defoliators like slug caterpillar (*Parasalepida*), *Spodoptera litura* and *Pericallia ricini* were recorded as minor pests mostly during monsoon and post monsoon with a very low incidence. Rugose spiralling whitefly that was recorded as new pest of banana with 5- 6 per cent incidence in previous year was recorded with reduced incidence in the current year in few banana plantations of surveyed area. Banana skipper butterfly was reported for the first time from a banana field of Darrang district with a very low incidence.

Kannara: Regular and major pests of banana viz., pseudostem borer and rhizome weevils were recorded in the surveyed areas with 5-35 per cent and 5-30 per cent incidences respectively on cv. Nendran along with Palayamkodan, Red banana etc. In a unique case, a severe attack of pseudostem borer grubs into the bunch peduncle was recorded in cv. Nendran from Kozhikode district, leading to retarded bunch formation. Defoliators like slug caterpillar (*Miresa decedens*), banana skipper butterfly (*Erionota torus*), *Spodoptera litura* and *Pericallia ricini* were recorded mostly during monsoon and post monsoon with severe defoliation (5-40%), especially in Nendran plots in Kottayam, Wayanad, Kozhikode, Ernakulam, Thrissur, Idukki and Palakkad districts. Seasonal and moderate to heavy incidences of sucking pests like Rugose spiralling whitefly, *Aleurodicus rugioperculatus*, mealy bug (*Ferrisia virgata*), white flies (*Dialeurodicus disperses*), banana spittle bugs (*Phymatostethadeschampsis*), banana flower thrips (*Thrips hawaiiensis*) and Leaf thrips (*Hercinothrips bicinctus* and *Helionoethrips kadaliphilus*) were recorded on leaves and fruits of banana from Wayanad, Idukki, Thrissur, Ernakulam, Pathanamthitta, Kottayam and Kozhikode districts. Red spider mite infestation was observed from Thrissur, Palakkad and Kozhikode districts. As reported in previous year, heavy outbreaks of spotted grasshoppers/ coffee locusts (*Aularches miliaris*) were recorded from Wayanadu, Pathanamthitta, Idukki, Thrissur, Kollam, Kozhikode, Malappuram etc. during the months of March to August, 2021 on banana. Mass migration of adults and mass emergence of nymphs of these large grasshoppers were recorded from Idukki and Wayanad districts in the survey. An invasive pest of banana, Fall Armyworm (*Spodoptera frugiperda*) that had recorded a maximum incidence of 20 per cent in previous year as a new pest, recorded reduced incidence in the current year due to timely awareness campaign and prompt plant protection measures undertaken in collaboration with Agriculture officials. During June-July 2021, outbreaks of leaf beetles were observed infesting wild nutmeg

and banana in Kamakshy Panchayat of Idukki District, Kerala. They were identified as *Sastroides besucheti* Medvedev (Coleoptera: Chrysomelidae: Galerucinae). Few females were seen laying eggs singly on banana leaves and covering it with excreta. Eggs were oval, yellowish orange and measured approximately 1 mm. The present investigations into the outbreaks of leaf beetle, *Sastroides besucheti*, lead to the identification and record of Banana (*Musa* spp.) as a probable alternate host at least in the adult stage.

Ludhiana: No new insect-pest was recorded during reporting period. A new natural enemy predatory spider, *Olios* sp. was observed in banana plantations in Ludhiana.

Mohanpur: During survey banana bag worm infestation was recorded during November, 2020 in banana growing locations of West Bengal. However, the incidence was very less, 2-3 per cent plants were infested by the insects and caused damage by making circular holes. Apart from this, no new pest was recorded. The leaf and fruit scarring beetle infestation were noticed in all banana growing areas with 30-32 per cent fruit damage. Rugose spiralling whitefly infestation was found almost same as previous year and pest was found under control, which may be due to presence of natural enemies. Diversity of various natural enemies of banana pests at Mohanpur centre has also been presented in.

Vengurle: From the roving survey, incidence of the new emerging pest (skipper butterfly-*Erionota tonus*) is found to be spread in the areas where it was not present previously i.e. Kudal, Malvan and Kankavali talukas of Sindhudurg district. From the fixed plot survey incidence of skipper butterfly (*Erionota tonus*) was observed in the banana orchard of Regional Fruit Research Station, Vengurle. The other pests viz., leaf eating caterpillar and rhizome weevil are regular pests of this region and semilooper is found occasionally.

5.2.4.(a).B. Survey of plant parasitic nematodes of banana

Survey was conducted for *Radopholus similis*, *Pratylenchus* sp., *Helicotylenchus multicinctus*, *Meloidogyne* sp. and *Heterodera oryzicola*.

Arabhavi: Among the different plant parasitic nematodes recorded, the burrowing nematode, *Radopholus similis* was predominant followed by root-knot nematode, *Meloidogyne* spp. and spiral nematode, *Helicotylenchus* spp. The *R. similis* population in both soil (250 cc) and roots (10g) was maximum (292 and 177) in Yarazarvi of Belagavi district in TC Grand Naine variety planted in red loamy soil as monocrop and 239 & 131 in Munavalli of Belagavi district on Rajapuri variety where suckers were planted and maintained

as ratoons. The overall frequency of occurrence of *R. similis*, *Meloidogyne* spp. and *Helicotylenchus* spp. was 100 & 100, 98.07 & 98.07, 46.15 & 46.15 per cent in both soil and roots respectively. No new nematode pest was recorded from the survey.

Jorhat: Jorhat district recorded an infestation of *Meloidogyne* spp. from both the cultivars Jahaji and Chenichampa with frequency of 87 and 12% in soil and root. In Golaghat district *Meloidogyne* spp and *Helicotylenchus* sp. were recorded from both Chenichampa and Jahaji cultivars with frequency of occurrence 72% (soil) and 11.6% (root) for *Meloidogyne* spp and *Helicotylenchus* sp with 100 %. Lakhimpur district recorded a frequency of occurrence of 100 per cent for *Helicotylenchus* spp. from cultivar Kachkol. In Morigaon district the occurrence of *Meloidogyne* spp and *Helicotylenchus* sp. were recorded from cv. Jahaji with frequency of occurrence 50.36% (soil) and 12% (root) for *Meloidogyne* spp and 23% for *Helicotylenchus* sp. In Udalguri, *Meloidogyne* spp. was recorded in both the cultivars Bhimkol and Chenichampa whereas *Helicotylenchus* sp was recorded only from Bhimkol. In Darrang district, infestation of *Meloidogyne* spp with 54 (soil) and 6.8 (root) was recorded from cv. Jahaji.

Kannara: In the reporting period severe infections of Root knot nematodes (*Meloidogyne* spp.) and burrowing nematode (*Radopholus similis*) were observed from Wayanadu and Kozhikode districts. High incidences of *Meloidogyne* spp. was observed in banana from the surveyed districts with 30-75% and 20-75 % frequency of occurrence in soil and roots respectively, with root galling and witches broom symptoms in Wayanad, Kozhikode, Idukki, Pathanamthitta and Thrissur districts. Among the root knot nematode complex, *Meloidogyne incognita* was predominant followed by *M.javanica*. Similarly, severe infections of burrowing nematodes (*Radopholus similis*) with 30- 65% and 10-40% frequency of occurrence in soil and roots respectively were recorded. High incidences were recorded from Wayanad, Idukki, Kozhikode and Pathanamthitta districts leading to decay and death of roots, yellowing of leaves and stunted growth. Banana spiral nematode, *Helicotylenchus* spp. was more in high ranges/ hilly terrains (Wayanad and Idukki districts) and lowlands (Kottayam and Ernakulam) with a frequency of occurrence of 10-30%.

Mohanpur: Survey was done in different location of North 24 Parganas and Hoogly districts of West Bengal. The result revealed that no new nematode pest was recorded during 2021. The banana variety Martaman planted in sandy clay loam soil was infested by root knot nematode (*Meloidogyne* sp.). The root knot nematode *Meloidogyne* sp. was mainly observed with 50-90% frequency of occurrence.

5.2.8.B. Biological management of nematodes in tissue culture banana

The experiment was laid out with different bio-agents like *Bacillus pumilus* @ 5 ml/l, *Paecilomyces lilacinus*+ *Pseudomonas fluorescens* each @ 12.5 g/plant along with FYM and neem cake to manage the nematodes in tissue culture banana using eco-friendly, cost effective measures. Cartap hydrochloride 4G @ 10 g/plant was kept as control.

Arabhavi: Among the different treatments, soil drenching of *Bacillus pumilus* @ 5 ml/l in polybags with TC plants 5 days before planting + *B. pumilus* enriched Farm Yard Manure @ 5 kg/plant at the time of planting and 2.5 kg/plant at 6 MAP recorded the lowest nematode population of 168.50 & 127.55 in 250 cc soil and 22.00 & 29.55 in 10 g of roots at vegetative and shooting stage respectively as against maximum in Control. Similarly, same treatment also recorded the lowest root necrosis of 10.65 & 14.50 as against 39.50 and 52.50 in control at vegetative and shooting stage respectively.

Jorhat: Soil drenching of *Bacillus pumilus* @ 5 ml/l in poly bags with TC plants 5 days before planting + *B. pumilus* enriched Farm Yard Manure @ 5 kg/plant at the time of planting and 2.5 kg/plant at 6 MAP recorded the lowest nematode population of 119.25 & 61.85 in 250 cc soil and 25.48 & 31.00 in 10 g of roots at vegetative and shooting stage respectively as against maximum in standard check (144.45 & 66.75 in soil and 29.10 & 35.00 in root respectively)

Kannara: Soil drenching of *Bacillus pumilus* @ 5 ml/l in poly bags with tissue culture plants five days before planting + *B. pumilus* enriched farm yard manure @ 5 kg/plant at the time of planting and 2.5 kg/plant at 6 MAP recorded the lowest nematode population of 85.75 in 250 cc soil and 24.25 in 10 g of roots at vegetative stage respectively as against maximum in standard check (112.00 in soil and 37.75 in root respectively).

5.2.9.B. Management of Rugose spiralling whitefly, *Aleurodicus rugioperculatus* Martin (Hemiptera: Aleyrodidae) in Banana

To develop control measures for the invasive and emerging pest, Rugose Spiralling whitefly in banana, experiment was laid out with five treatments and four replications in randomized block design.

Kannara: Foliar application of Azadirachtin 10000 ppm @ 3ml/l three times at monthly intervals recorded minimum rugose spiralling white fly population (7.56/leaf) and least per cent leaf infestation of 9.38%. This efficacy was closely followed by foliar application of botanical consortium @ 2g/l and botanical pesticide (Aavya) @ 4g/litre (8.81 and 10.88 and leaf infestation of 11.50% and 12.16%

respectively). Population per leaf and per cent leaf damage was significantly higher in untreated control plants (23.16 adults per leaf and 22.5% infestation). Application of Azadirachtin 10000 ppm @ 3ml/l three times at monthly intervals gave 67.36% reduction over control. This was closely followed by T4 and T5 with 61.96% and 53.02% population reduction respectively over control.

Kovvur: Experiment is yet to be initiated as there is no pest infestation because of continuous rains. Will be taken up when the infestation is noticed on the crop.

Periyakulam: Among the various treatments, foliar application of Azadirachtin 10000 ppm @ 3ml/l three times at monthly intervals was found to be superior which recorded minimum rugose spiralling white fly population (8.56/leaf) and per cent leaf infestation (7.74 %) due to rugose spiralling whitefly. This was followed by foliar application of Botanical consortium @ 2 g/l and Botanical pesticide (Aavya) @ 4g/litre and recorded less white fly population in leaf (21.80 population/leaf and 18.43 population/leaf) and leaf infestation (25.96% and 27.99%) respectively as against control (29.51 population/leaf and 53.84% infestation) (Table 7).

Table-7: Effect of botanicals on Rugose Spiralling Whitefly, *Aleurodicus rugioperculatus* Martin (Hemiptera: Aleyrodidae) population in banana across the centres

Treatment	Adults per leaf * (Month after spray) *										Per cent reduction over control	
	Pre-treatment count		First spray		Second spray		Third spray		Mean			
	KNR	PKM	KNR	PKM	KNR	PKM	KNR	PKM	KNR	PKM	KNR	PKM
T ₁	14.75 (3.84)	25.20	7.25 (2.69)	14.15 (4.27)	5.75 (2.39)	8.30 (3.22)	2.50 (1.57)	3.24 (2.13)	7.56 (2.63)	8.56 (3.21)	67.36	70.98
T ₂	14.50 (3.80)	28.26	12.75 (3.57)	18.25 (4.83)	14.75 (3.84)	14.15 (4.38)	10.50 (3.21)	11.18 (3.64)	13.1 (3.62)	14.53 (4.28)	43.35	50.78
T ₃	14.75 (3.84)	24.34	14.75 (3.84)	20.05 (4.90)	12.25 (3.49)	16.45 (4.36)	11.75 (3.42)	12.65 (3.78)	13.38 (3.65)	16.38 (4.35)	42.23	44.49
T ₄	13.25 (3.93)	28.35	9.25 (3.04)	18.62 (4.68)	5.75 (2.39)	9.82 (3.81)	4.75 (2.17)	5.83 (2.74)	8.81 (2.82)	11.42 (3.74)	61.96	61.29
T ₅	15.50 (3.81)	27.65	11.25 (3.11)	9.85 (4.77)	9.75 (3.34)	14.15 (4.13)	9.25 (2.99)	9.47 (3.51)	10.88 (3.36)	14.49 (4.15)	53.02	50.90
T ₆	13.00 (3.60)	28.35	23.00 (4.79)	26.36 (5.62)	24.25 (4.92)	29.60 (5.72)	32.25 (5.67)	32.58 (5.92)	23.16 (4.75)	29.51 (5.75)	-	-
CD at 5%	NS	NS	0.35	0.26	0.36	0.14	0.46	0.22	0.94	0.79	-	-

KNR: Kannara, PKM: Periyakulam.

T₁ - Foliar application of Azadirachtin 10000 ppm @ 3ml/l three times at monthly intervals as and when the infestation is noticed.

T₂ - Foliar application of Pongamia soap IHR @ 10g/l three times at monthly

intervals as and when the infestation noticed. T₃ - Foliar application of Neem oil 2% @ 20ml/l three times at monthly intervals as and when the infestation is noticed. T₄ - Foliar application of Botanical consortium @ 2ml/l with 1st spray when the infestation noticed and 2nd spray two months later. T₅ - Botanical pesticide (Aavya) @ 4g/ litre sprayed in the afternoon, three times at monthly intervals as and when the infestation noticed. T₆ - Untreated control.

6.2.1.B. Survey of new and emerging disease(s) of banana

a) Roving surveys were conducted in banana growing areas at all the centres to monitor major disease(s) scenario in the major banana growing belt and to study the shift (if any) in disease pattern in relation to climate change. In the survey, 50-60 orchards were covered and incidence of disease was recorded to identify the major disease problems. About 20 plants were selected for observation in each orchard.

b) Isolation of causal organism and identification: Majority of the centres took up the survey, isolation and identification of the pathogens responsible for the diseases.

Arabhavi: Survey was conducted in Belagavi, Bagalkot, Vijayapura, Bellary, Koppal, Vijayanagara and Kalaburagi districts of Karnataka in Grand Naine,

Rajapuri, Ney Poovan, Poovan and Sakkarebale cultivars of banana. No new and emerging disease was recorded. Not much or slight deviation in the diseases was observed when compared to the last five years. Among the diseases recorded, the *Eumusae* leaf spot disease was the predominant disease followed by rhizome rot & BBTV diseases. The *Eumusae* leaf spot intensity ranged from 1.0 to 36.0 with an average of 22 PDI. It is highest in Belagavi district in July to November months in Rajapuri and Grand Naine varieties at the shooting to harvesting stage because of monocropping/more ratoon cropping systems and congenial conditions viz., rainfall, temperature and relative humidity prevailing during that period. The bacterial rhizome rot disease ranged from 1.00 to 6.00% with the average incidence of 3.00% at the vegetative stage to shooting stage in Rajapuri and Grand Naine varieties with the maximum in summer

and Kharif seasons. The Fusarium wilt ranged from 5.0 to 66.0 per cent in Ney Poovan variety and the increased incidence is because of the planting of infected suckers, monocropping system and flood irrigation in the command area. The BBTV incidence was found 1.0 to 4.0 % with an average of 1.20 per cent.

Bhubaneswar: The survey was conducted in 4 districts of Odisha *i.e* Jagatsinghpur, Khurdha, Puri and Jajpur. During the survey, Fusarium wilt (66%), Banana bunchy top virus (5%), Anthracnose (5%), Freckle leaf spot (5 PDI), Rhizome rot (5%), Banana streak virus (11%) and *Eumusae* leaf spot disease (39 PDI) were reported as emerging diseases of banana in Odisha. Isolation of causal organism and identification of new disease was done. Samples of diseased plants/plant parts were collected during the surveys. The causal organism(s) were isolated and identified as *Pseudocercospora musae* for *Eumusae* leaf spot, *Fusarium oxysporum* fsp. *cubense* for Fusarium wilt and *Guignardia musae* for Freckle Leaf Spot disease.

Coimbatore: Survey was carried out in Erode district (Anthiyur, Athani, Olagadam) where Sigatoka leaf spot incidence of 35-43 PDI was recorded in Grand Naine, Nendran, Ney poovan and Red banana during July 2021 and September 2021. In Theni, Leaf spot was 26 PDI in Nendran, Ney Poovan and Red banana. Leaf spot severity with 45 PDI was noticed in Grand Naine at Nanjundapuram, Coimbatore. Fusarium wilt (10-12.0%) incidence was observed in Coimbatore, Erode, Theni and Kanyakumari. Wilt incidence with 5-10% incidence was observed in cv Karpooravalli. Grand Naine was infected with Fusarium wilt up with 1% incidence in Pongalur block of Tiruppur. Banana bract mosaic was recorded in Ney poovan, Grand naine and Nendran up to 5-10% incidence in Coimbatore, Erode Theni and Kanyakumari districts. In Red banana and Ney Poovan banana bract mosaic was with 10% incidence in Erode and Coimbatore. BBTV was noticed with less than 1% incidence. Cucumber mosaic virus was noted in Coimbatore with a 3-5% incidence. BSV was observed with less than 2% incidence. Erwinia rot incidence was found with 3% incidence. Fusarium wilt pathogen (to be confirmed) was isolated from cv Grand Naine collected from Pongalur, Tiruppur district.

Gandevi: No new and emerging disease was observed in the banana-growing belt of south Gujarat. There is no shift of minor disease towards major ones. There was a decreasing trend of *Eumusae* leaf spot and rhizome rot as well as no change in the incidence of bunchy top virus disease. The Grand Naine and Robusta variety were found affected by *Eumusae* leaf spot mainly during July to December.

Rhizome rot disease incidence was observed 1-2 months after planting and BBTV (Banana bunchy top virus) showed symptoms during the monsoon period. The incidence of Fusarium wilt disease was first time reported in the Surat district (Kamrej), but the incidence was very low. The incidence of Pitting disease was also found in Valsad (Kaprada) and Navsari district (Gandevi), but the incidence was low. The other fungal and viral diseases of bananas were observed to be negligible.

Jalgaon: Survey was conducted at different locations covering orchards including sucker, tissue plant crop and ratoon crop. *Eumusae* leaf spot was identified as an emerging problem with 19.00 to 22.0 PDI. Rhizome rot a bacterial disease was noticed at 1-2%. The Cucumber Mosaic Virus infection with 0-100% incidence was mostly observed in tissue culture plantations. An average 15% incidence of CMV was noticed in Raver and Bhusawal (14.83%). However, it was 9% in the Burhanpur district of Madhya Pradesh. It was more in tissue cultured plants than the sucker plants. The incidence was more in June-July planting of Grand Naine variety. A slight decreasing trend was observed in *Eumusae* leaf spot, Rhizome rot and Banana bunchy top virus in comparison to the last 5 years.

Jorhat: Survey was conducted in selected banana belts of 8 districts of Assam viz., Goalpara, Barpeta, Kamrup, Kokrajhar, Chirang, Sonitpur, Nagaon and Jorhat covering small and commercial orchards wherein 20-25 plants were selected from each orchard. The survey included different agroclimatic zones viz., Lower Brahmaputra Valley Zone (Goalpara, Kamrup, Kokrajhar, Chirang), Upper Brahmaputra valley zone (Jorhat) and North Bank Plain zone (Sonitpur) and central Brahmaputra Valley zone (Nagaon). Fusarium wilt was most prevalent in cv. Mabhog in Goalpara, Chirang, Barpeta and Kamrup district with 37% incidence. *Eumusae* leaf spot and Bunchy top were prevalent in all the surveyed areas with varied magnitude. Banana streak disease, Cordana leaf spot, and pitting disease were also reported from Goalpara, Jorhat, Sonitpur and Nagaon district.

Kannara: The surveys were conducted in Ernakulam, Idukki, Kozhikode, Malappuram, Palakkad, Pathanamthitta, Thrissur and Waynad districts. The mean per cent disease index (PDI) of *Eumusae* leaf spot observed was 21 which was 1% more than the previous year. The PDI observed was in the range of 12-28 %. Maximum PDI was recorded in the rainy season in the Pananchery of Thrissur district. The mean per cent incidence of Fusarium wilt observed was 37% which was 20% more than the previous year. The maximum incidence recorded was 75%

from Thrissur of Thrissur district. The major factor affecting disease incidence is the variety used for cultivation. The susceptible varieties observed in the survey are Rasthali (AAB), Njalipoovan (AB), Kadali (AA) and Monthan (ABB) and infection was not recorded from the most popular variety Nendran (AAB). The mean per cent incidence of *Deighthoniella* leaf spot observed was 11% which was 1% less than the previous year. The maximum incidence was recorded in Chittar, Pathanamthitta with 22 PDI. The mean per cent incidence of Blast and Pitting disease was 34 which was 14% more than the previous year. It is an emerging banana disease in Kerala. The disease is observed first time in the variety Nendran from Alangad Panchayat of Ernakulam district in August 2019. The pathogen was identified as *Pyricularia angulata* and the sequence is deposited in the NCBI data bank (Accession no: MW269689). Heavy rain during the bunch maturity stage is conducive to the occurrence of the disease. Rhizome rot observed in the current year was 11% incidence and this was one per cent more than the previous year. Maximum incidence was recorded from Kannara, Thrissur district with 26% incidence in the mature Nendran plants. Intermittent rainfall, high temperature, rhizome weevil attack, waterlogging and heavy use of chemical fertilizers are the contributory factors to the disease. Nendran, the most popular variety in Kerala is highly susceptible to rhizome rot disease. The mean incidence of BBTv, BBrMV, CMV and BSMv observed in the survey were 1.2, 3.3, 1.0 and 3.0 per cent respectively. A decrease in the incidence of BBTv, BBrMV, CMV and BSMv was observed in the current year over the previous year. The BSMv infection was noticed only in the variety Mysore Poovan (AAB).

Kovvur: Surveys were conducted in Kovvur, Chagall, Togummi, Chidipi, Ravuripadu, Dommeru, and Kamavarapukota villages in West Godavari and Kadiyapulanka, Ambajipeta, Billakuru, Devipatnam, Rajanagaram villages in East Godavari Districts. Incidence of *Eumusae* leaf spot, rhizome rot, Fusarium wilt, CMV and BBrMV diseases were observed in surveyed gardens. No new disease was observed during the period. However, per cent incidence of rhizome rot, BBrMV and CMV diseases were found increased during the year. Among the diseases, *Eumusae* leaf spot disease incidence was more in all districts in Grand Naine and the average disease incidence recorded was 21.04% followed by bacterial disease, Rhizome rot (7.15%). Rhizome rot incidence was more in Tella Chakkara Keli and Kovvur bontha varieties. Among the viral diseases, BBrMV, BBTv and CMV were observed during the surveys.

Mohanpur: Survey was conducted at 10 different

locations covering 20 orchards including both plant crop and ratoon crop. No visible change in disease severity was recorded during this period. *Eumusae* leaf spot was the main disease of banana and the intensity (PDI) of the disease was unchanged (the average PDI of susceptible varieties was 42 PDI). Incidence of the Fusarium wilt (9.0%) and some other diseases (Bunchy top, Rhizome rot, CMV & Anthracnose) were also unchanged as compared to previous years. *Lasiodiplodia* sp and *Gloeosporium gloeosporioides* were isolated from the infected ripe fruit of Martaman during this period.

Pusa: During the survey, Panama wilt was observed as a major problem for tall bananas i.e. Malbhog (AAB), Alpan (AAB), Champa (AAB), ChiniChampa (AB), Kanthali (AAB), Kothia (ABB) in Zone -I comprising of (Samastipur Muzaffarpur, Vaishali, Hazipur districts). The incidence of the disease (8-32%) was less as compared to the previous year in this zone. However, during the last 5-6 years, Fusarium wilt disease is being observed in some banana plantations of the Koshi belt of Bihar (Purnea, Katihar, Navgachhiya, Madhepura, and Kisanganj) in cultivar Robusta, Basrai, and Grand Naine creating havoc among banana growers of Koshi belt.

Eumusae leaf spot (4-26 PDI) and BBTv (10-16%) were observed as a problem in both zones. In the case of *Eumusae* leaf spot and BBTv, the trend of disease development was less when compared with their incidence in the previous year. It needs to be mentioned that BBTv is a problem of the entire state irrespective of varieties (both tall and dwarf varieties). Dwarf Cavendish varieties were found to be more susceptible than tall ones. Rhizome rot with 2-14% incidence was observed only in Zone I & II on the Cavendish group of bananas at the initial stage of crop growth but the overall scenario showed no change in trend as compared to the previous year i.e. 2020-2021. Anthracnose complex disease was observed in the agro-climatic conditions in Zone-I and Zone II of Bihar with 5-12% and 0-6% incidence respectively in the month of July-August, 2021. The possible reason for the appearance of disease in agro-climatic conditions of Bihar was probably due to high humidity and low temperature as compared to normal environmental conditions. Diseased samples were brought to the laboratory and isolation was made that showed association of three different fungi as pathogens i.e. *Colletotrichum* sp., *Lasiodiplodia* sp., and *Fusarium* sp. Banana Pitting and blast disease of banana were observed for the first time in Ghazipur district of Uttar Pradesh with an incidence of 10-30%. Fusarium wilt disease was found in cv Grand Naine with 10-45% incidence in Ballia district of Uttar Pradesh.

6.2.3.B. Validation of superior treatments for the management of *Fusarium* wilt disease

The experiment was conducted in hot spot (farmer field) and pot culture (Kovvur). Treatments involved were use of disease-free suckers along with neem cake or vermi compost, dipping the suckers in carbendazim, spraying or drenching with carbendazim or a combination of these and biocontrol agents. The trial was in RBD and replicated six times. IMTP ratings were followed for recording observations. Planting time was adjusted in such a way that crops vulnerable stage coincides with vegetative phase. Selected varieties at Kannara, Kovvur were Rasthali and Amritapani respectively.

Kannara: New experiment was laid out in moderately sick plot using TC banana var Rasthali as per the discussion in 8th group discussion. The plants are in shooting stage. Observations were recorded with respect to growth parameters and disease at shooting stage. The plant height recorded was in the range of 2.76 to 2.96 m and there was no significant difference between treatments. The disease incidence recorded was in the range of 36.36 to 64.28 and the maximum incidence was recorded in the treatment with disease free suckers from disease free field + application of Neem cake @ 250 g/plant or vermicompost and the minimum in dipping in carbendazim (0.2%) for 45 min + dipping in carbendazim (0.2%) for 30 min followed by carbendazim drenching 0.2% solution (2nd, 4th and 6th month after planting) and carbendazim injection @ 3 ml of 2% solution (3rd, 5th and 7th month after planting). The external wilt index recorded was in the range of 26.00 to 36.00 and all treatments were on par.

Kovvur: Disease free suckers from disease free field + application of neem cake @ 250 g/plant or vermicompost + Dipping in carbendazim (0.20%) for 30 minutes followed by carbendazim drenching 0.20% solution at 2nd, 4th and 6th month after planting and carbendazim injection @ 3ml of 2.00% solution at 3rd, 5th and 7th month after planting recorded wilt index of 38.89 as against disease free suckers from disease free field + Application of Neem cake @ 250 g/plant or vermicompost (100%). Significant reduction in external wilt index and internal wilt index was also observed in disease free suckers from disease free field + application of neem cake @ 250 g/plant or vermicompost + Dipping in carbendazim (0.20%) for 30 minutes followed by carbendazim drenching 0.20% solution at 2nd, 4th and 6th month after planting and carbendazim injection @ 3ml of 2.00% solution at 3rd, 5th and 7th month after planting (18.06; 33.33) when compared to disease free suckers from disease free field + Application of Neem cake @ 250 g/plant or vermicompost (68.05; 50.89).

6.2.6.B. Diagnosis of banana viruses in germplasm and planting material used in experiments

All genotypes in germplasm and mother plants of planting materials used in experiments should be screened for presence of known viruses to diagnose banana viruses in germplasm and screen the mother plants used in experiments. The indexing was carried out by NRCB, Trichy for Arabhavi and Gandevi centres where as by respective centres in the case of Bhubaneswar, Coimbatore, Jalgaon, Kannara, Kovvur and Pusa.

Arabhavi: Out of 54 germplasm accessions screened, none were infected with BBTv, BBrMV and BSV but eight accessions viz., Mitli, Kadapanilla, Ney poovan, Budubale, Yangambi Selection, BCB-1, BCB-2 and Mysore Mitli were infected with CMV.

Bhubaneswar: Out of 63 germplasm accessions, 20 accessions were screened for viruses. Among these, one accession (Grand Naine) was infected with BBTv and one accession (Balipatana Champa) was infected with BSV. Continuous screening of germplasm accessions (based on symptom and DAC ELISA) showed that one accession Banua (ABB) was free of BBTv, BBrMV, CMV and BSV infection and six accessions viz., Patkapura (AAB), Paunsia Bantal (ABB), Batisha Bantal (ABB), Mendhi Bantal (ABB), Gaja Bantal (ABB) and Chepta Bantal (ABB) were free of BBrMV, CMV and BSV infection for more than three years.

Coimbatore: Out of 206 germplasm accessions, 18 accessions viz., Kothiah, Onkamannan, Kappukadali, Suganthi, Beula, Ney poovan, Grand Naine, Malaiethen, Malbhog, Puttubale, Vannan, Jwaribale, Chennachenkadali, Kathubale, Muthiah, Bhodibale, Karpooravalli, Pacha bonhabathesa were infected with BBrMV; four accessions viz., Motta Poovan, Chenichampa, Onkamannan and Kothiah were infected with BSV. None of the accessions were infected with BBTv and CMV.

Gandevi: Out of 63 germplasm accessions, nine accessions were screened for viruses. All screened accessions were free of BBTv, BBrMV and CMV but two accessions viz, Alpan and Palayankodan were infected with BSV.

Jalgaon: Out of 86 accessions, 34 accessions were screened for viruses. Of this one accession (Grand Naine) was infected with BBTv; two accessions viz, Alpan and Palayankodan were infected with BSV; one accession (Chirapunji) was infected with BBrMV and six accessions viz., Grand Naine, Ladies finger, Sughandhi, Soniyal, Nendran and Arunachal collection were infected with CMV.

Kannara: Out of 220 germplasm accessions screened, two accessions viz., TjauLagda, and Sikuzani were

infected with BBTv; two accessions viz., Rasagalli and Mottapooan were infected with BBrMV; two accessions viz., Alpan and Mottapooan were infected with BSV and one accession Kodapanillakunnan was infected with CMV. Continuous screening of germplasm accessions (based on symptom and DAC ELISA) from 2008-2021 showed that eight germplasm accessions viz., Basrai (AAA), Gros Michel (AAA), Monsmarie (AAA), Paddapacha (AAA), Njalipooan (AB), Valiyakunnan (AB), Sapumal Anamalu (AAB) and Virupakshi (AAB) were free of BBTv, BBrMV and CMV infection. Screening of mother plants of popular banana varieties (TC samples) revealed infection of BBTv (0 – 14.54), BBrMV (0-23.07) and CMV (0 – 9.52).

Kovvur: Out of 112 germplasm accessions screened, four accessions viz., H-531, China, Nepalivannan and BCB-2 were infected with BBrMV whereas BBTv, CMV and BSV infections were not recorded in any accessions.

Pusa: Out of 74 germplasm accessions screened, five accessions viz., Robusta, Grand Naine, Basrai, Kothia and Alpan were infected with BBTv whereas CMV, BSV and BBrMV infection were not recorded in any accessions.

6.2.11.B. Evaluation of bioformulations against Fusarium wilt in banana (Observational trial)

The experiment was laid out at a hotspot (farmer field/ research station) with the following two modules: Module 1 (application of CSSRI bioformulation at monthly interval) and module 2 (using disease free suckers from disease free field, dipping the suckers in carbendazim, application of neem cake or vermicompost followed by carbendazim drenching and carbendazim injection). The two treatments were replicated 13 times in randomized block design. Disease parameters as per IMTP ratings, growth and yield parameters were recorded as per technical programme. Planting time was adjusted in such a way that crop vulnerable stage coincides with vegetative phase. Varieties selected were Neypooan, Rasthali, Karpuravalli, Grand naine, Malbhog,

Rasthali, Amritapani and Martaman at Arabhavi, Bhubaneswar, Coimbatore, Gandevi, Jorhat, Kannara, Kovvur and Mohanpur respectively.

Arabhavi: Application of CSSRI bioformulation at monthly interval recorded less number of diseased plants (18.66), disease severity in external wilt index (12.33) and internal wilt index (22.16) when compared to module 2 (disease free suckers from disease free field, dipping the suckers in carbendazim, application of neem cake or vermicompost followed by carbendazim drenching and carbendazim injection) with values of 29.75, 18.76 & 31.50 respectively.

Coimbatore: A trial was laid out in Paduvampalli block wherein rasthali and Neypooan were raised as Plant crop. There was no wilt incidence in both module 1 and module 2 and in control. Internal symptom assessment and corm lesion index was carried out and there was no lesion index in both control and treated plants. But the yield parameters in module 1 was found to be superior over the module 2.

Jorhat: Trial was initiated during May, 2021. The crop is of 6 months and no symptoms have been observed and the experiment is in progress.

Gandevi: Percent disease incidence and wilt index was low in module 2 (7.69; 30.77) when compared to module 1 (10.26; 43.08) at Gandevi and the experiment is in progress.

Kannara: The CSSRI bio formulation (Module 1) recorded the lowest disease incidence of 2.7 per cent whereas module 2 and negative control showed 38.4 and 41.1 per cent respectively. The external wilt index was in the range of 22.1 to 30.0 and all treatments were on par.

Kovvur: No significant difference was recorded between the treatments.

Mohanpur: There is no significant difference between the two treatments at Mohanpur; however, bunch yield is marginally higher and disease severity is comparatively lower in case of Module 2 (Table 8).

Table-8: Effect of treatments on disease severity of Fusarium wilt in banana at different centres

Treatment	ARB		COB		GND		KVR		MHR		KNR
	ES	IS	ES	IS	ES	IS	ES	IS	ES	IS	ES
T ₁	12.33	22.16	1.8	2.5	43.08	NA	6.41	1.14	3.12	2.80	22.14
T ₂	18.76	31.50	3.0	2.8	30.77	NA	10.25	1.99	3.10	2.75	30.00
CD at 5%	4.29	3.05	-	-	-	-	NS	NS	NS	NS	16.82

NA: Not available due to cyclone. ES: External symptoms: (1-5 scale). IS: Internal symptoms: (1-6 scale), ARB-Arabhavi, COB-Coimbatore, GND-Gandevi, KVR-Kovvur, MHR-Mohanpur, KNR-Kannara

6.2.12.B. Evaluation of BSV free (Episomal BSMYV) tissue culture banana cv. Poovan

Virus free tissue culture banana are to be evaluated for the occurrence of streak disease at all growth stages and confirmed through molecular analysis like RCA and RE analysis (to be done at NRCB). Observation on growth and yield parameters should be recorded at all growth stages. As per 7th GD, new crop is to be planted with suckers of virus free tissue culture banana and local banana cv. Poovan for evaluation.

Arabhavi: No symptoms of occurrence of BSV were noticed in the TC Poovan. Maximum plant height (2.41 m), stem girth (54.97 cm), number of leaves (13.80), leaf area (8.45 m²) and minimum incidence of *Eumusae* (sigatoka) was noticed in TC Poovan compared to local Poovan. TC Poovan also recorded significantly high bunch weight (17.22 kg) compared to local Poovan (14.95 kg).

Bhubaneswar: No symptoms of occurrence of BSV were noticed in the TC Poovan. Maximum plant height (2.68 m), stem girth (58.42 cm), number of leaves (12.32) and leaf area (8.46 m²) was recorded in TC Poovan. Bunch weight also recorded significantly high for TC Poovan (10.52 kg) compared to local Poovan (8.28 kg).

Coimbatore: No symptoms of occurrence of BSV were noticed in the TC Poovan. Bunch weight of TC

Poovan (32.94 kg) was superior over local Poovan (28. kg). Crop is in I ratoon.

Jalgaon: No symptoms of occurrence of BSV were noticed in the macro propagated seedlings of virus free cv. Poovan. Significantly high plant height (3.17 m) and less crop duration (400 days) was recorded in virus free cv. Poovan compared to local poovan. All other parameters of virus free poovan and local poovan were on par.

Kannara: Occurrence of BSV was noticed in 23.08% plants of TC Poovan. The bunch weight was significantly higher for TC Poovan (10.94 kg/plant) compared to local Poovan (9.03 kg). Growth characters like plant height, pseudostem girth and leaves per plant were also significantly higher for TC Poovan than local Poovan. However, expression of Episomal BSV was noticed in sucker crop of tissue culture banana cv Poovan (Fig. 2).

Mohanpur: No symptoms of occurrence of BSV were noticed in the TC Poovan. Bunch weight of TC Poovan (14.90 kg) was superior over local Poovan (13.44 kg).

Tiruchirapalli: The evaluation of TC Poovan is ongoing and the crop is in shooting stage. No symptoms of occurrence of BSV were noticed in the TC Poovan.



Fig.2: Photographs of experiment field view and BSV incidence in tissue culture plants

CITRUS

1.1.1.(a).C. Collection, characterization, conservation, evaluation and utilization of Citrus germplasm

Germplasm collected, maintained, characterized and evaluated at different centres.

Ludhiana: Sixteen varieties of sweet orange were evaluated. The maximum canopy volume was recorded in Early Gold and the minimum canopy volume was recorded in Saugni Blood.

Pasihat: Thirty-three different citrus germplasm has been collected and maintained in the field. Seventeen germplasm has been registered with NBPGR, New Delhi and has IC numbers (IC-0633695 to IC-0633711) and 5 of the citrus germplasm have been characterized. Two elite clones each of Khasi Mandarin and one pummelo has been identified.

Rahuri: Total twenty-one sweet orange germplasm were evaluated. The data revealed that the maximum plant height (2.95 m) and number of fruits per tree (29.00) were recorded by Pineapple. The maximum

canopy volume (5.08 m³) were recorded by Valencia Late.

Sriganganagar: One acid lime germplasm was collected and conserved in the field gene bank. Totally 40 germplasm comprised of sweet orange (9 varieties), mandarin (6 varieties), lime and lemon (13) and rootstock and other species (12) were evaluated. The data revealed that the maximum plant height in sweet orange group was recorded in Pearl (4.36m), Kinnow (4.63 m) in mandarin group, Bhadri lemon (5.15 m) in lime and lemon group and *C. carizo* (5.15 m) in rootstock group. Mosambi (25.20 m³), Daisy (26.84m³), Bhadri lemon (69.18m³) and Sui galgal (51.87m³) recorded the maximum canopy volume in sweet orange, mandarin, lime and lemon and rootstock group respectively.

Tinsukia: Six new germplasm includes pummelo (4), rough lemon (1), and Jaratenga (1) were collected and conserved in the field gene bank. Totally, 154 germplasm have been conserved in the field gene bank of AAU, CRS. Tinsukia. During the period, 38 germplasm have been characterized and evaluated for growth and yield. The analysis of the data revealed that the maximum plant height was recorded by pummelo white (6.48 m), whereas the maximum canopy volume was recorded by Mithachakala (84.51m³). The highest fruit number per tree was recorded by Rangpur lime (500.36 fruits /tree) and the highest fruit weight was recorded by Barapani rough lemon (1080.55 g). The highest yield per tree was obtained in pummelo red (262.6 kg).

Tirupati: A total of 107 citrus germplasm were evaluated. The maximum vegetative growth was observed in Queen Sweet orange 8763 (plant height: 2.93m, canopy volume 22.96 m³) followed by Valencia sweet orange (canopy volume 16.61 m³). Maximum number of fruits were noticed in Valencia sweet orange 8763 (270 fruits/tree) followed by Mediterranean sweet orange (238 fruits/tree). In sour orange group Emekaipuli sour

orange has recorded maximum plant height (4.38 m) and followed by Australian sour orange (3.58m), however, maximum canopy volume was recorded in Australian sour orange (45.53m³). Troyer citrange (canopy volume: 24.54 m³) among trifoliolate hybrids and Unshui Mandarin (canopy volume 22.2 m³) among mandarins are highly vigorous.

1.1.2.C. Evaluation of different cultivars under different agro-climatic conditions

(a) Mandarin

Seven mandarin varieties viz., Mudkhed seedless, Nagpur seedless, Nagpur mandarin, Kinnow mandarin, Coorg mandarin, Khasi mandarin and Darjeeling mandarin were evaluated at Akola, Ludhiana, Sriganganagar, Tinsukia and Nagpur.

Akola: Nagpur mandarin recorded the maximum plant height (3.85 m), canopy volume (55.32 m³) and yield parameter (455.95 fruits/tree & 71.62 kg/tree) as compared to other mandarin varieties evaluated. However, Mudkhed seedless recorded maximum TSS (10.80°B).

Ludhiana: Khasi mandarin recorded maximum canopy volume (33.60 m³) followed by Nagpur Seedless (30.4 m³) whereas, Kinnow mandarin recorded maximum number of fruits per tree (84.40) and fruit weight (177.30 g) with maximum TSS (9.40°B).

Nagpur: Darjeeling mandarin recorded the maximum plant height (4.31m) and canopy volume (51.14 m³).

Sriganganagar: The maximum plant height (4.95 m), canopy volume (57.16m³) and yield parameters (69.93 kg/tree & fruit weight 227.57 g) with maximum TSS (12.07°B) were recorded in Kinnow mandarin.

Tinsukia: Khasi mandarin reported maximum yield (243.66 fruits/tree & 42.66 kg/tree) with less acidic fruits (1.10%). However, Mudkhed seedless fruits recorded maximum juice content (50.62%) (Table 9).

Table-9: Yield and quality performance of mandarin cultivars at different centres

Varieties	Yield (kg/tree)			Fruits/tree			TSS (°B)			
	AKL	SNG	TNK	AKL	LDH	TNK	AKL	LDH	SNG	TNK
Mudkhed seedless	56.85	36.53	34.83	387.02	46.80	206.68	10.80	7.60	8.03	8.55
Nagpur seedless	63.24	42.31	30.65	417.04	57.30	196.54	10.29	7.70	7.97	8.85
Nagpur Mandarin	71.62	30.37	36.41	455.95	53.10	225.24	10.36	8.10	7.40	8.74
Kinnow Mandarin	6.79	69.93	34.72	54.70	84.40	210.32	9.03	9.40	12.07	9.67
Coorg Mandarin	38.76	31.53	28.68	271.90	46.90	205.45	10.25	7.90	8.30	9.88
Khasi Mandarin	40.84	30.37	42.66	320.08	43.90	243.66	10.83	8.00	6.73	10.79
Darjeeling Mandarin	37.67	26.13	38.56	271.65	63.70	231.32	10.90	7.80	7.67	9.73
CD at 5%	7.81	11.64	0.65	35.03	13.00	0.92	NS	0.60	0.79	2.74

AKL-Akola, LDH-Ludhiana, NGP-Nagpur, SNG-Sriganganagar, TNK-Tinsukia

1.1.3.(a).C. Clonal selection in mandarin

Elite mandarin clones were evaluated for vegetative, yield and quality characters at different centres and the details are given below:

Ludhiana Kinnow mandarin clones	Tinsukia Khasi mandarin clones	Chettalli Coorg mandarin clones
Kinnow-1, Kinnow-2, Kinnow-3, Kinnow-4, Kinnow-5, Kinnow-6, Kinnow-7, Kinnow-8, Kinnow-9, Kinnow-10, Kinnow-11	CRS-1, CRS-2, CRS-3, CRS-4, CRS-5, CRS-6, CRS-7, CRS-8	Clone-1, Clone-2, Clone-3, Clone-4, Clone-5, Clone-6, Clone-7, Clone-8, Clone-9, Clone-10, Clone-11, Clone-12, Clone-13, Clone-14, Clone-15, Clone-16, Clone-17, Clone-18, Clone-19, Clone-20

Chettalli: Clone-8 performed to be superior among the others clones with respect to total yield (17.37 kg / tree), average fruit weight (117.77g), number of fruits per tree (147.40) and juicy fruits (43.40%) with TSS 9.03°B compare to check (clone 11).

Ludhiana: Kinnow mandarin clone, Kinnow-1 performed better in terms of yield parameter (351. fruits/tree & 61.1 kg/tree). However, Kinnow-2 recorded minimum number of seeds per fruit (1.71) and yield of 52.6 kg per tree which was at par with Kinnow.

Tinsukia: Maximum fruit weight (141.70 g), yield (82.54 kg/tree & 33.02 t/ha) and TSS (11.60°B) with juicy fruits (60.39%) was recorded in clone CRS-4 when compare to check (CRS 9).

1.1.3.(b).C. Clonal selection in sweet orange

The elite clones of sweet orange were evaluated at New Delhi, Rahuri and Tirupati for growth, yield and quality characters. The different clones evaluated were mentioned below.

New Delhi (Sweet orange cv. Malta clones: 10 nos)	Rahuri (Sweet orange cv. Mosambi: 10 clones)	Tirupati (Sweet orange cv. Sathgudi clones: 6 clones)
MS-1, 2, 4, 7, 8, 9, 10, 15, 17 & 21 along with two local checks Pusa Sharad and Pusa Round.	Sel No. 1, Sel No. 2, Sel No. 3, Sel No. 4, Sel No. 5, Sel No. 6, Sel No. 7, Sel No. 8, Sel No. 9, Sel No. 10 along with local check Phule Mosambi	TS ₁ , TS ₂ , TS ₃ , TS ₄ , TS ₅ , TS ₆ along with local check Sathgudi

New Delhi: Ten clones of cultivar Malta was assessed against two check varieties viz., Pusa Sharad and Pusa Round. Maximum fruits were recorded in clone MS-7 and MS-9 (210 in each). No significant difference reported for quality parameters among the clones.

Rahuri: The growth and yield observations of ten and half years old plants indicated that, significantly higher plant height (3.52 m), canopy volume (16.55 m³), number of fruits per tree (310.85), yield (56.05 kg/tree and 15.52 t/ha), TSS (12°B) and juice content (52.30%) with minimum acidity (0.38%) were recorded in clone no. 7. Whereas, the maximum fruit weight (213.70 g) was recorded in clone no. 6.

Tirupati: Among the six promising clones of sweet orange cv. Sathgudi evaluated along with local check Sathgudi, the clone TS₆ recorded the maximum plant height (2.58 m) and yield (46.44 kg/plant).

1.1.3.(c).C. Clonal selection of acid lime

Survey has been conducted for identification of superior clones of acid lime and the performance of selected clones at different centres has been furnished here under:

New Delhi: The genotype ALC-21 recorded the maximum plant height (4.10 m), however, the

genotype ALC-5 recorded the maximum canopy volume (201.33 m³).

Rahuri: The growth and yield performance of ten and half years old plants indicated that, significantly better plant height (3.31 m), canopy volume (22.95 m³), stem girth (48.45 cm), fruit weight (49.70 g), number of fruits/tree (1385.60) and yield (68.85 kg/tree and 19.06 t/ha) were recorded in clone no. 4. However, there was non-significant difference between the treatments for yield efficiency. Clone no. 3 recorded precocity in fruiting.

Tirupati: The growth, yield and fruit quality of 37 superior acid lime clones and 01 check variety were recorded. During fourth year of bearing, maximum fruit yield was noticed in TAL/94-14 (592 fruits/plant, 25.08 kg/plant, 6.95 t/ha) followed by Selection-16 (510 fruits/plant, 24.33 kg/plant, 6.74 t/ha) with highest percentage increase in yield (35.16% & 31.13% in TAL /94-14 and Selection- 16) compared to check variety Balaji (385 fruits/plant, 18.56 kg/plant, 5.14 t/ha). However, maximum fruit weight was recorded in TAL/95-3 (50.74 g) and thin rind fruits were noticed in KL-12 (1.05 mm). The acid lime clone Selection-32 recorded the maximum juice content (46.67 %). The acid lime clone RHRL 124 recorded the maximum TSS (8.99°B).

1.1.4.(a).C. Evaluation of promising clones of mandarin (MLT- I)

Nine promising clones viz., N-4, N-28, N-34, N-38, N-43, and N-51 selected at ICAR-CCRI, Mandarin-182 selected at Akola, CRS-4 (Khasi mandarin clone) selected at Tinsukia and Clone-11 (Coorg mandarin clone) selected at IIHR-Chettalli were evaluated for growth, yield and quality characters at different centres along with respective local checks.

Akola: Clone N-34 recorded maximum yield parameters (500 fruits/tree & 70.31 kg/tree, 148.02 g fruit weight). Whereas, Mandarin-182 recorded maximum juice percentage (42.96%) with minimum seeds (1.00).

Ludhiana: During the previous year itself, majority of plants were showing declining symptoms. During the year of report, all plants of three clones have died and plants of four clones are in severe decline.

Nagpur: Clone N-34 recorded maximum fruit weight (184.22 g) and clone-11 recorded maximum juice content (44.59%). Whereas, clone N-4 recorded minimum number of seeds per fruit (1.00).

Sriganganagar: Clone N-34 recorded maximum fruit weight (147.58 g) and yield (24.62 kg/tree).

Tinsukia: Maximum number of fruits per tree (206.58), TSS (10.59°B) and lowest acidity (1.20%) were recorded in CRS-4. Similarly, maximum fruit yield was obtained in the clone CRS-4 (22.85 t/ha) which was followed by Mandarin- 182 (17.32 t/ha).

1.1.4.(b).C. Evaluation of promising clones of sweet orange (MLT- I)

A trail has been initiated to evaluate six promising clones viz., M-3, M-8 and M- 4 selected at ICAR-CCRI, Phule Mosambi selected at Rahuri and Kodur Sathgudi selected at Tirupati along with Shamouti orange for growth, yield and quality characters at different centres along with respective local checks.

Ludhiana: Among the different clones of sweet orange evaluated, the maximum fruit weight (175 g), yield (17.2 t/ha), yield efficiency (2.7 kg/m³) and increase in yield of 38.7 per cent over control was recorded in Kodur Sathgudi (Fig. 3-4).

Nagpur: The maximum fruit weight (241.78 g), number of fruits per tree (196) and yield (47.41 kg/tree & 13.13 t/ha) with 20.48 per cent increase in yield over check variety was recorded in Phule mosambi. Whereas, Maximum TSS and juice content was recorded in M-4 (10°B & 43.76%).

Rahuri: Promising variety Phule mosambi recorded maximum yield (39.80 kg/tree & 14.49 t/ha) with 12.85 per cent increase in yield over check. Also recorded significantly the maximum juice (50.25%), TSS (10.80°B), TSS: acid ratio (24.60), ascorbic acid (51.80 mg/100 ml juice), reducing sugars (4.25%), non-reducing sugars (3.10%) and total sugars (7.35 %) with minimum acidity (0.44%). Whereas, the promising clone M-3 recorded the minimum seeds/ fruit (11.66). The pest infestation especially citrus psylla population was recorded minimum (3.70 psylla/leaf) in the check variety Mosambi. Minimum percent greening disease incidence (7.01%) and stem end rot (5.72) and fruit drop due to fruit sucking moth (3.00 fruit drop/plant) was also recorded in the same treatment (Fig. 5-6).

Tirupati: Significantly maximum number of fruits (226 fruits/plant), fruit yield (35.68 kg/plant, 9.88 t/ha) were recorded in Kodur Sathgudi clone followed by Phule Mosambi clone (165 fruits/plant, 23.88 kg/plant, 6.62 t/ha) and M3 (23.86 kg/plant and 6.62 t/ha) clones. Maximum yield efficiency was noticed in Kodur Sathgudi clone (3.29 kg/m³) followed by in Sathgudi clone (Check). There was 49.97 per cent increase in yield in Kodur Sathgudi clone over check variety. For quality parameter, significantly maximum juice content (51.20%) and ascorbic acid content (48.17 mg/100 ml) were recorded in M4 clone and maximum TSS (9.37°B) was recorded in Kodur Sathgudi clone. However, over all acceptability of the fruit was maximum (8) in Sathgudi clone (Check) (Fig. 7). All sweet orange clones were severely affected by citrus greening and dry root rot diseases. Low dry root rot incidence (31.25%) and less greening incidence (45.83%) were noticed in Phule mosambi clone at Tirupati. There was no mortality of plants in Kodur Sathgudi (Table 10).

Table-10: Yield performance of promising clones of sweet orange at different centres

Clones	Yield efficiency (kg/m ³)				Increases yield over check (%)			
	Ludhiana	Nagpur	Rahuri	Tirupati	Ludhiana	Nagpur	Rahuri	Tirupati
Age (years)	8	8	9.5	10	8	8	9.5	10
Phule Mosambi	1.6	2.19	3.79	1.66	- 47.6	20.48	- 1.71	0.41
M-3	1.8	2.35	4.15	3.09	- 46.3	- 10.24	- 8.56	0.30
M-4	1.6	2.08	3.73	1.53	- 22.2	- 20.51	- 12.61	-12.85
M-8	1.6	1.52	3.19	1.37	- 40.7	- 40.48	- 4.82	-10.42

Clones	Yield efficiency (kg/m ³)				Increases yield over check (%)			
	Ludhiana	Nagpur	Rahuri	Tirupati	Ludhiana	Nagpur	Rahuri	Tirupati
Age (years)	8	8	9.5	10	8	8	9.5	10
Kodur Sathgudi	2.7	1.58	3.92	3.29	38.7	- 32.25	- 11.05	49.97
Shamouti orange	-	0.42	3.45	3.19	-	-74.16	-	- 0.76
Local checks *	2.3	1.83	3.53	2.40	-	-	-	-
CD at 5%	0.4	-	NS	0.80	-	-	-	-

Local checks: *Mosambi at Nagpur, Ludhiana & Rahuri * Sathgudi at Tirupati

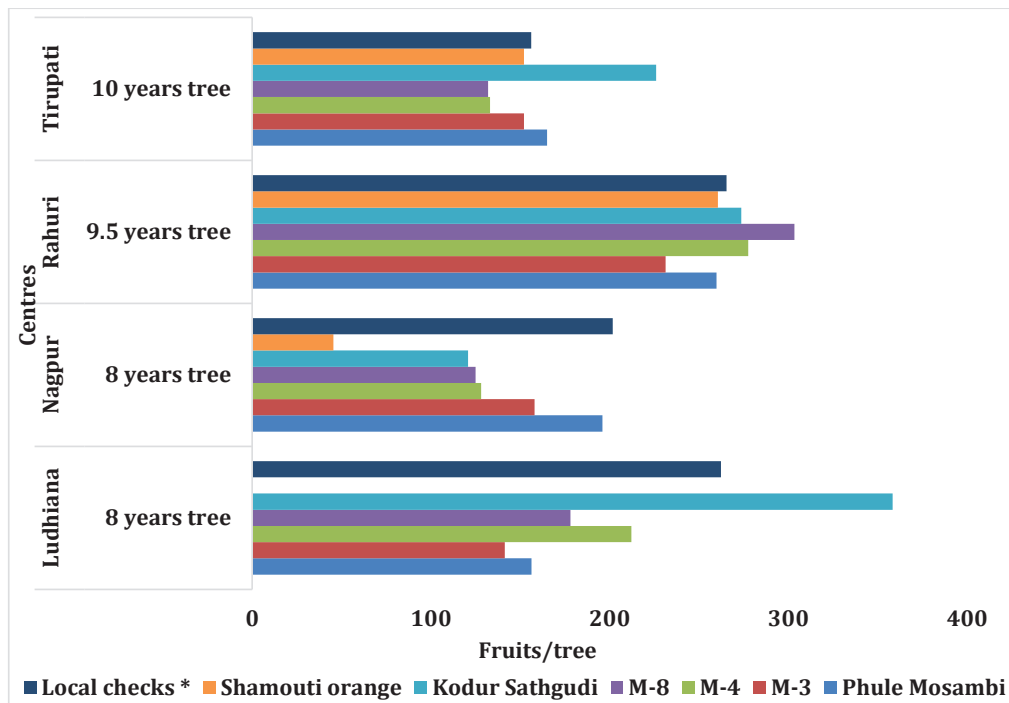


Fig. 3 : Yield performance (fruits/tree) of promising clones of sweet orange at different centres

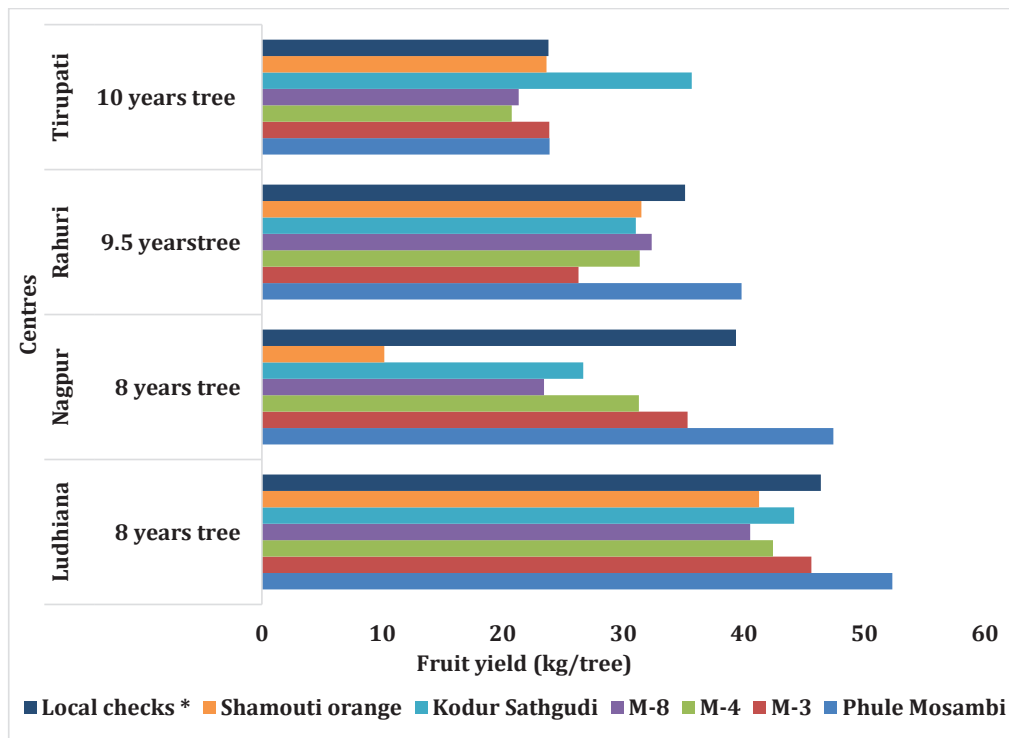


Fig. 4: Yield (kg/tree) performance of promising clones of sweet orange at different centres

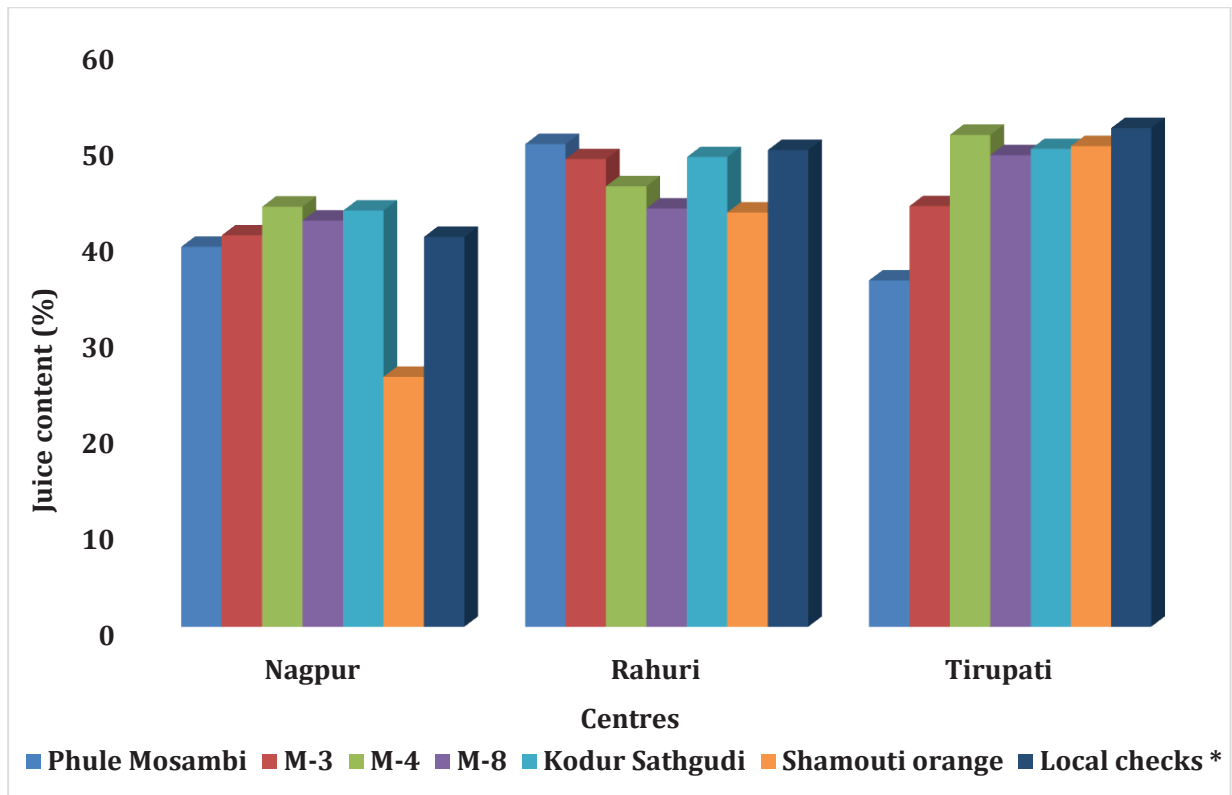


Fig. 5: Quality performance (juice content) of promising clones of sweet orange at different centres

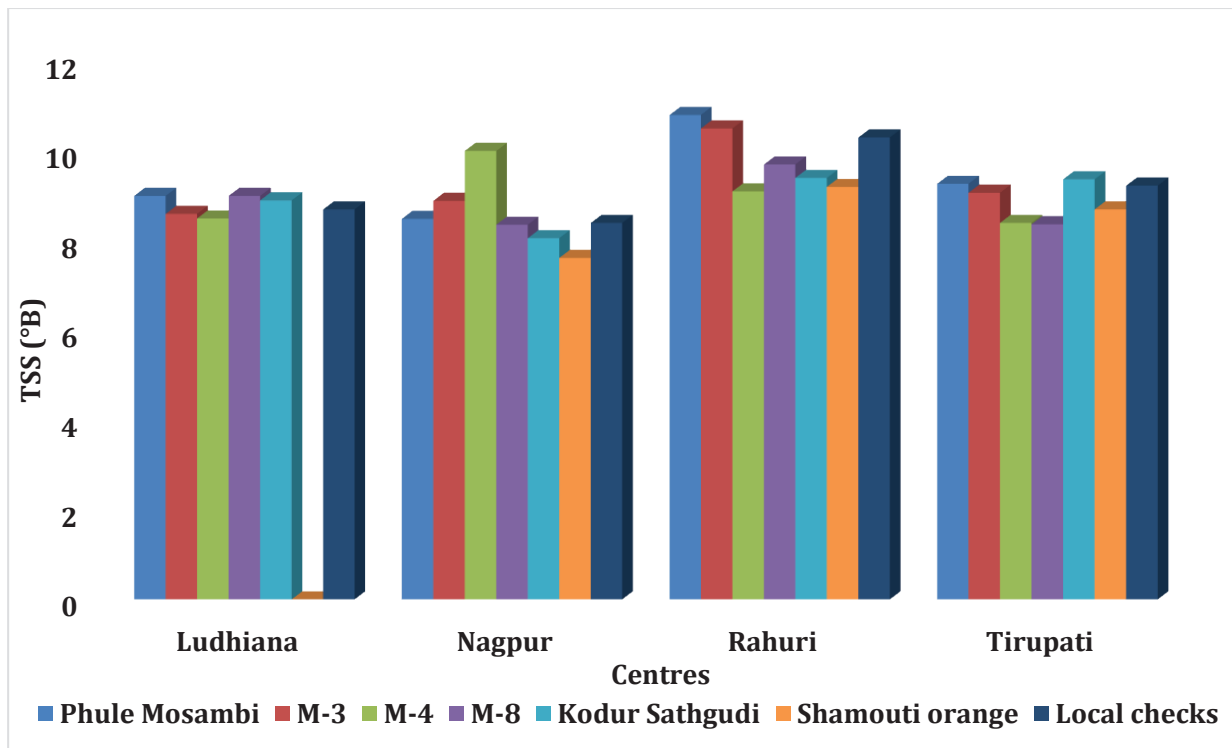


Fig. 6: Quality performance (TSS) of promising clones of sweet orange at different centres

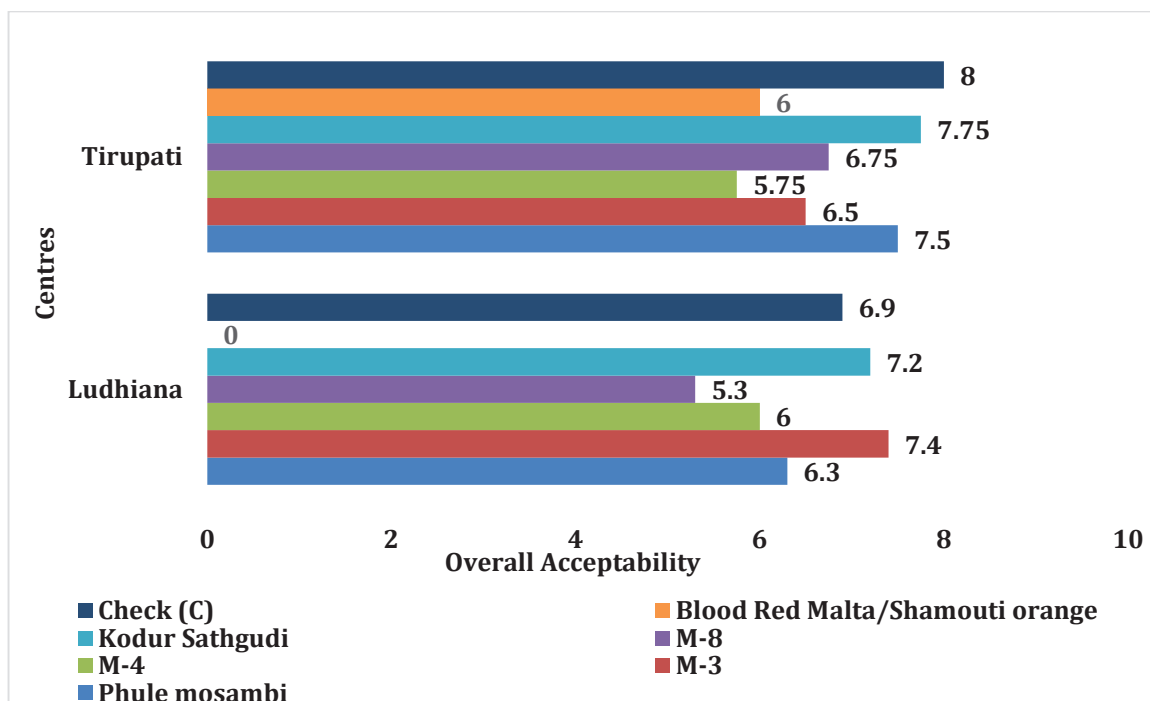


Fig. 7: Sensory evaluation of promising clones of sweet orange at different centres

1.1.4.(c).C. Evaluation of promising clones of acid lime (MLT- I)

This trial was initiated to evaluate eight promising clones viz., TAL-94/13 and TAL-94/14 from Tirupati, Phule-Sharbatati from Rahuri, Akola lime (PDKV lime) from Akola, NRCC Nimboo- 2, NRCC Nimboo - 3, NRCC Nimboo- 4 and KL-12 from CCRI, Nagpur along with local check variety for growth and yield characters.

Akola: Among all the promising acid lime clones evaluated, maximum fruits per tree (718.67) and yield (26.73 kg/ tree) were recorded in Akola lime (PDKV lime). Whereas, NRCC Niboo-3 reported maximum juice content (47.60%).

Nagpur: Among all the clones evaluated, maximum fruit weight (52.52 gm) was recorded in Phule Sharbatati. Whereas, maximum number of fruits per tree was recorded in PDKV lime (446.67fruits/tree).

Periyakulam: The clone NRCC Nimboo-3 recorded consistent yield performance with 412 fruits per tree compared with local check (PKM-1)

Rahuri: The clone NRCC Nimboo-3 recorded the maximum plant height (3.27 m), canopy volume (24.73 m³), (68.37 kg/tree and 18.93 t/ha), juice (52.90%), TSS (7.98°B), acidity (6.95%), ascorbic acid (38.40 mg/100 ml juice) with minimum seeds per fruit (7.20).

Tirupati: Maximum fruits per tree (428.33) and yield (20.20 kg/plant and 5.60 t/ha) was recorded in TAL-94/14 followed by NRCC, Nimboo-4 (422 fruits/plant and 19.90 kg/plant and 5.51 t/ha). The fruit quality parameters viz., maximum juice percentage was recorded in Balaji (49.71%) followed by Akola lime (45.66 %) (Table 11).

Table-11: Yield performance of acid lime clones at different centre

Clones	Canopy volume (m ³)					Fruits/tree				
	Akola	Nagpur	PKM	Rahuri	Tirupati	Akola	Nagpur	PKM	Rahuri	Tirupati
TAL-94/13	160.83	394.00	200.46	1321.10	406.33	6.23	17.10	7.80	62.49	17.29
TAL-94/14	403.50	-	128.12	1269.30	428.33	14.69	-	4.80	58.64	20.20
Phule Sharbatati	461.33	406.67	138.54	1349.35	395.67	16.28	21.36	5.60	65.34	18.68
Akola lime (PDKV lime)	718.67	446.67	186.50	1267.65	390.33	26.73	20.56	6.58	53.83	18.08
NRCC, Nimboo-2	520.50	443.33	210.20	1330.95	298.33	17.47	22.99	9.06	60.02	14.13
NRCC, Nimboo-3	635.50	424.33	412.24	1428.40	388.67	20.79	22.11	19.24	68.37	18.20

Clones	Canopy volume (m ³)					Fruits/tree				
	Akola	Nagpur	PKM	Rahuri	Tirupati	Akola	Nagpur	PKM	Rahuri	Tirupati
NRCC, Nimboo-4	497.00	367.33	238.60	1305.80	422.00	16.24	17.65	10.30	55.20	19.90
KL-12	204.67	416.67	113.526	1240.50	343.33	7.12	20.07	4.56	61.81	15.28
K. lime local	279.67	418.33	-	-	-	10.79	21.02	-	-	-
PKM-1	-	-	396.60	-	-	-	-	19.08	-	-
Sai Sharbati	-	-	-	1353.90	-	-	-	-	63.86	-
Balaji	-	-	-	-	396.00	-	-	-	-	18.66
CD at 5%	87.06	NS	42.18	NS	18.71	3.00	NS	3.42	8.65	1.03

PKM: Periyakulam

1.1.4.(d).C. Evaluation of promising clones of pummelo (MLT- I)

The trial was initiated with nine promising clones of pummelo viz., PTF-1, PTF-2, PTF-3, PTF-4, NRCC Pummelo-1, NRCC Pummelo-2, NRCC Pummelo-3, NRCC Pummelo-4, and NRCC Pummelo-5 with local check for growth, yield and quality characters at different centres.

Ludhiana: Among the different clones of pummelo, the maximum yield (116.4 kg/tree & 12.8 t/ha) was recorded in clone PTF-4. Whereas, maximum TSS (9.3°) was recorded in NRCC P-2.

Nagpur: Maximum fruit weight (1494.00 g) and yield (197.34 kg/tree & 54.66 t/ha) was recorded in NRCC-P-5. The maximum TSS was recorded in PTF-4

(12.40°B) whereas, PTF-1 recorded highest vitamin C (49.87 mg/100g).

Tinsukia: Significantly the maximum number of fruits per tree (134.0) was recorded by NRCC Pummelo-4. Whereas, the maximum fruit yield of 310.5 kg per tree and 86.80 t/ha was recorded in NRCC Pummelo-3. Maximum TSS (8.8°B) was recorded in PTF-4 (Table 12).

Tirupati: Among nine pummelo clones, NRCC Pummelo -5 has recorded significantly maximum number of fruits and yield (118 fruits/tree, 120.75 kg/tree, 33.45 t/ha) with TSS (12.5°B). Whereas, maximum juice content was recorded in NRCC Pummelo-1 (37.73%)

Table-12: yield performance of promising clones of pummelo at different centres

Clone	Yield (kg/tree)				Yield (t/ha)				TSS (°B)			
	LDH	Nagpur	TNK	TPT	LDH	Nagpur	TNK	TPT	LDH	Nagpur	TNK	TPT
PTF- 1	78.8	151.6	38.50	29.1	8.7	42.02	10.78	8.08	8.0	8.27	6.9	11.5
PTF- 2	48.4	176.6	58.69	27.1	5.3	48.92	16.41	7.53	8.4	6.35	7.9	11.5
PTF- 3	38.1	39.90	26.87	-	4.2	11.05	7.50	-	8.3	11.0	8.2	-
PTF- 4	116.4	43.09	33.24	-	12.8	11.94	9.30	-	8.3	12.4	8.8	-
NRCC P -1	27.0	84.05	133.1	29.5	3.0	23.28	37.27	8.19	8.7	8.08	7.6	8.80
NRCC P -2	102.2	81.68	245.6	85.5	11.2	22.63	68.77	23.7	9.3	8.64	7.8	12.0
NRCC P -3	109.6	104.7	310.5	93.2	12.1	29.03	86.80	25.8	7.3	8.61	7.5	11.6
NRCC P -4	64.3	92.89	260.4	41.03	7.1	25.73	72.91	11.3	7.4	10.49	7.9	10.3
NRCC P -5	90.6	197.3	120.5	120.7	10.0	54.66	33.74	33.4	8.4	8.32	8.0	12.5
Local Check*	94.0	-	93.16	68.71	10.3	-	26.07	19.0	9.1	-	7.6	9.82
CD at 5%	29.54	86.22	2.89	11.15	3.25	-	-	3.09	0.6	1.85	0.75	0.21

LDH-Ludhiana, TNK-Tinsukia, TPT- Tirupati *local check: White pummelo at Ludhiana, Pummelo Red: at Tirupati, Rabab Tanga at Tinsukia, No Local check at Nagpur

1.1.4.(e).C. Evaluation of promising clones of grapefruit (MLT-I)

A trial has been initiated with seven promising clones of Grapefruit viz., Flame grapefruit, NRCC-6 grapefruit, Star Ruby, Red Blush, Imperial, Foster and

Marsh Seedless with local check for growth, yield and quality characters at different centres.

Chettali: The significantly maximum fruit yield (54.94 kg/tree) and quality attributes of maximum juice content (44.48%) with minimum acidity

(0.28%) were recorded in Star Ruby. The maximum TSS (7.07°B) was recorded in Red Blush, whereas, minimum number of seeds (0) was recorded in Flame grapefruit.

Ludhiana: Different grapefruits did not differ significantly for plant height but significantly differed for canopy volume and stem girth. The maximum canopy volume (5.86 m³) and stem girth (31.12 cm) were recorded in the clone NRCC grapefruit-6 and variety Flame grapefruit, respectively. These two genotypes also showed statistical parity with each other for these growth attributes. NRCC grapefruit-6 and Foster showed precocious bearing by producing few fruits.

Rahuri: The maximum plant height (2.06 m) and canopy volume (5.07 m³) were recorded in Imperial grapefruit.

Nagpur: All the genotypes produced fruits this year and fruit yield ranged from 3.19 kg (Star Ruby) to 5.87 kg (Red Blush grapefruit). The number of fruits per plant varied from 11.67 (NRCC Grapefruit-6) to 17.33 (Flame grapefruit). The fruit weight ranged from 208.00 g (Star Ruby) to 470.67 g (NRCC grapefruit-6). The maximum TSS (8.6°B) was recorded in NRCC grapefruit-6 while the minimum number of seeds per fruit (0.50) were observed in Star Ruby grapefruit. The maximum fruit juice (38.12%) and minimum acidity (0.90%) were recorded in Flame grapefruit (Table 13).

Tinsukia: The maximum canopy volume (3.06 m³) and stem girth (4.76 cm) were recorded in Star Ruby. But, the Local check (Dhulijan) was statistically on par with Star Ruby (2.67 m³ & 4.22 cm)

Table-13: Yield performance of promising clones of grapefruit

Clone	Fruits/tree		Yield (kg/tree)		Fruit weight (g)		Juice (%)		TSS (°B)		Acidity (%)	
	CHL	NGP	CHL	NGP	CHL	NGP	CHL	NGP	CHL	NGP	CHL	NGP
Flame grapefruit	34.00	17.33	10.81	5.51	340.67	319.33	43.07	38.12	6.80	8.13	1.10	0.90
NRCC grapefruit-6	51.67	11.67	20.93	5.51	405.33	470.67	36.67	37.79	6.67	8.60	0.80	1.15
Star ruby	109.00	15.33	54.94	3.19	558.67	208.00	44.48	25.24	6.80	7.37	0.28	1.57
Red blush	54.00	16.00	19.28	5.87	380.00	370.00	41.23	29.43	7.07	8.03	0.88	1.66
Imperial	22.33	14.33	9.89	4.33	443.33	306.67	36.76	23.39	5.87	8.03	1.10	1.84
Foster	17.67	13.33	7.26	3.83	444.67	285.67	36.61	23.25	6.80	8.60	0.60	1.59
Marsh seedless	60.67	15.00	25.84	4.24	457.33	284.00	39.21	30.18	6.00	7.52	0.28	1.63
Local Check*	-	-	-	-	-	-	-	-	-	-	-	-
CD at 5%	31.78	NS	13.94	2.04	65.85	77.01	4.93	6.05	0.81	0.95	0.39	0.24

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1.1.5.(a).C. Evaluation of promising clones of mandarin (MLT II)

Evaluation of the promising clone PDKV mandarin-5 of PDKV, Akola vis-a-vis Nagpur mandarin was initiated at Akola, Ludhiana, Sriganaganagar, Tinsukia and Nagpur.

Akola: PDKV mandarin recorded maximum canopy volume (3.60 m³). Plants are in vegetative stage.

Ludhiana: Kinnow mandarin recorded significantly maximum canopy volume (4.62 m³).

Nagpur: No significant difference was noticed for growth parameters among the varieties.

Sriganaganagar: No significant difference was seen for growth parameters among the varieties.

Tinsukia: No significant difference was seen for growth parameters among the varieties.

1.1.6.C. Evaluation of promising clones of acid lime (MLT II)

A trial to evaluate the superior clones of acid lime viz., PDKV Bahar, PDKV Chakradhar, NRCC Acid lime-7,

NRCC Acid lime-8, Pusa Udit, Pusa Abhinav, SGNR-AL-1, Patlur Sel-1 and Local Check at Akola, Nagpur, Rahuri, Tirupati, Periyakulam, Sriganaganagar and Arabhavi (Vijayapura) has been initiated.

Akola: PDKV Chakradhar recorded maximum plant height (1.65 m) and canopy volume (0.60 m³).

Rahuri: Acid lime clone, NRCC AL-8 recorded significantly the maximum plant height (1.48 m) and canopy volume (1.52 m³).

Nagpur: Maximum plant height was recorded in SGNR- AL -1 (2.07 m), however, maximum canopy volume (4.67 m³) and plant spread was recorded in NRCC-AL-7 (2.09 m).

Periyakulam: The trial is in vegetative stage.

Sriganaganagar: Maximum plant height (2.70 m) was recorded in NRCC AL - 8. Whereas, canopy volume (3.28 m³) was recorded in Local Check.

Tirupati: Maximum canopy volume (5.93 m³) was recorded in NRCC AL-7.

1.1.7.C. Rootstock breeding in Citrus

Controlled hybridizations of Rough lemon and Rangpur lime with trifoliolate orange were attempted to produce rootstocks hybrids. The seeds were extracted from the crossed mature fruits and sown in pro-trays, filled with sterilized potting mixture (cocopeat 3 parts: vermiculite 1 part: garden soil 1 part: vermicompost 1 part) and placed under shade net-house or in growth chamber. The shade net house grown seeds were shifted to polyhouse in November end.

Ludhiana: Total of 434 and 258 flowers of Rough lemon and Rangpur lime were emasculated and pollinated with Rubidoux trifoliolate (an accession of *Poncirus trifoliata*) pollen. A total of 37 and 42 fruits were obtained from crossed flowers of Rough lemon × *P. trifoliata* and Rangpur lime × *P. trifoliata* crosses, respectively. 19 and 103 trifoliolate hybrids have been obtained in Rough lemon × *P. trifoliata* and Rangpur lime × *P. trifoliata* crosses, respectively.

1.1.9.C. Evaluation of promising clones of sweet orange (MLT-III)

The trial was laid out in row trial having 10 plants/row with three varieties/clones. Experimental material were bud grafts on rough lemon. Trial was planted at 5 x 5 m spacing. Trial is in progress.

Pasighat: The trial has been laid out and planted in September-2019. The growth performance data revealed that, Cutter Valencia clone recorded the maximum plant height (1.98 m), canopy volume (2.13 m³) and stem girth (16.42 cm).

Rahuri: The trial was planted in the field in November-2019. The growth performance data revealed that, Mosambi clone recorded the maximum canopy volume (1.20 m³). Whereas, there was non-significant difference between the treatments for plant height and stem girth.

Tinsukia: The trial was planted in the field in 2020. The growth performance data revealed that, Cutter Valencia clone recorded the maximum plant height (1.08 m), canopy volume (0.87 m³) and stem girth (3.25 cm).

Tirupati: Procured the planting material of Cutter Valencia from CCRI, Nagpur and planting was done in August, 2019. Mosambi bud grafts were planted in August, 2020. All clones have been well established. The growth performance data revealed that, Sathgudi clone recorded the maximum plant height (1.42 m), canopy volume (1.21 m³) and stem girth (17.04 cm).

1.1.11.C. Evaluation of promising clones of pummelo (MLT-V)

To assess the performance of new varieties for its

characters (yield and quality) compared to released variety of the region.

Results: Trial is in initial stage at Akola, Rahuri, Ranchi, Sriganaganagar, Tinsukia and Tirupati

2.1.5.C. Evaluation of promising rootstocks in Citrus

To evaluate the influence of Citrus rootstocks on different mandarin varieties, a trial has been laid out at Chettalli, Ludhiana, Sriganaganagar, Nagpur, Rahuri, Tirupati, and Tinsukia.

(a) Mandarin

Ludhiana: For Kinnow mandarin, NRCC-2 rootstock recorded maximum canopy volume (19.9 m³). Whereas, maximum number of fruits per tree (450.1) and yield (79.8 kg/tree) was recorded in Rough lemon.

Sriganaganagar: For Kinnow mandarin, Jattikhatti recorded maximum plant height (4.16 m) and NRCC rootstock-2 recorded maximum canopy volume (35.4 m³).

Tinsukia: Rootstocks did not significantly influence the plant growth of Khasi mandarin.

(b) Sweet orange

To evaluate the influence of Citrus rootstocks on different sweet orange varieties, a trial has been laid out at Rahuri, Tirupati and Nagpur.

Nagpur: CRH-12 and NRCC rootstock-4 recorded the maximum number of fruits for Nagpur mandarin (103.65 and 102.97). The maximum yield was recorded in NRCC rootstock-2 and 4 (20.52 and 20.39 kg/tree).

Rahuri: The maximum plant height of Phule Mosambi was recorded in Rangpur lime and NRCC rootstock – 6 (2.8 m in each) and the maximum canopy volume (11.3 m³) and fruit yield (42.79 kg) was recorded in Rangpur lime rootstock.

Tirupati: The maximum plant height (2.26 m) and canopy volume (8.53 m³) of Sathgudi was recorded in NRCC rootstock-6. Whereas, Alemow recorded the highest fruit yield (32.06 kg/tree).

3.1.1.(D).C. Nutrient management under high density planting in Citrus

The trial was laid out to the study the effect of different spacing (6 x 6 m, 6 x 5 m, 6 x 4 m) and three levels of nutrients viz., RDF as 75% inorganic source + 25% organic source (FYM), 50% inorganic source + 50% organic source (Vermicompost or Green manure) and 100% inorganic source only (as check) on growth, yield and fruit quality.

(a) Mandarin

Akola: The interaction effect of spacing and nutrition as well as nutrition level or spacing did not affect growth parameters significantly. However, maximum number fruits per tree (319.4) and yield (44.1 kg/tree) were recorded when plants were spaced at 6 x 6 m supplied with 50% N (Inorganic source) + 50% N (Organic source - Vermicompost) + P (100% through inorganic) & K (100% supplied through Vermicompost) and which was on par with when plants were spaced at 6 x 6 m supplied with 75 per cent N (Inorganic source) + 25 per cent N (Organic source- FYM) + P (100% through inorganic source) & K (100% K supplied through FYM).

Ludhiana: Maximum fruit weight (208.1 g) and yield (141.09 kg/tree) were recorded when plants were spaced at 6 x 6 m supplied with 75 per cent N (Inorganic source) + 25 per cent N (Organic source- FYM) + P (100% through inorganic source) & K (100% K supplied through FYM). However, maximum yield was recorded when plants were spaced at 6 x 4 m supplied with 75 per cent N (Inorganic source) + 25 per cent N (Organic source- FYM) + P (100% through inorganic source) & K (100% K supplied through FYM).

Tinsukia: Reduced spacing (500 plants/ha) supplied with 75% inorganic source of N, 25% organic source of N and 100 % P and K recorded maximum canopy volume (24.81m³), number of fruits per tree (294), TSS (9 °B) as well as maximum organic carbon and improved soil nutrient status (N= 312 kg/ha, P₂O₅ = 23.97 kg/ha, K₂O = 173.6 kg/ha). maximum yield (18.02 t/ha) was recorded in treatment S₃L₁ which was statistically at par with S₂L₁ (17.67 t/ha). However, there were evidences of building up of soil fertility level in the nutrient levels containing both organic and inorganic sources of nutrients. No significant difference was observed in different micro nutrient levels of soil as well as leaf nutrient content.

(b) Sweet orange

Rahuri: The interaction effect of spacing and nutrient level on growth and yield was found significant. The maximum canopy volume (22.79 m³), number of fruits (372.48 fruits/tree) and yield (69.39 kg/tree) were recorded when plants were spaced at 6 x 6 m and supplied with 50% N (Inorganic source) + 50% N (Organic source - Vermicompost) + 100% P & K (100% Inorganic - P & K supplied through Vermicompost). The significantly minimum acidity contents (0.48%), less rind (25.12%) less rag (17.55%) and maximum sugars (4.80, 1.75 and 6.55% reducing, non-reducing and total sugars respectively) were recorded in the same treatment. However, the maximum yield (24.99 t/ha) was recorded when plants were spaced at 6 x

4 m and supplied with 50% N (Inorganic source) + 50% N (Organic source - Vermicompost) + 100% P & K (100% Inorganic - P & K supplied through Vermicompost). The interaction effects were found non-significant for juice content, TSS and ascorbic acid contents.

Tirupati: Maximum number of fruits (250 fruits/plant) were recorded when plants were spaced at 6 x 4 m (416 plants/ha) and supplied with 50% N (Inorganic source) + 50% N (Organic source - Vermicompost) + P (100% through inorganic) & K (100% supplied through vermicompost). However, significantly maximum fruit yield (16.25 t/ha) was recorded when plants were spaced at 6 x 4 m (416 plants/ha) and supplied with 50% N (urea) along with 50% N (organic source: vermicompost) + P (100% through inorganic) & K (100% supplied through vermicompost).

(c) Acid lime

Periyakulam: The maximum plant height (6.75 m) was recorded under 6 x 4 m spacing with 100% inorganic only. However, maximum, number of fruits per tree (1030.52) and yield (50.41 kg/plant) were recorded under 6 x 5 m spacing with 75% N as inorganic source + 25% N as organic source through FYM + P (100% through inorganic) & K (100% supplied through FYM).

Rahuri: The interaction effect due to different spacings and nutrient levels were found significant. The maximum plant height (3.79 m), canopy volume (40.15m³), number of fruits (1618.09 fruits/tree) and yield (78.08 kg/tree) were recorded in the treatment T₂ (S₁ L₂) i.e. 6 x 6 m spacing with 50 % N (Inorganic source) + 50% N (Organic source-Vermicompost) + 100% P & K (100% Inorganic - P & K supplied through Vermicompost), whereas, the maximum yield (25.5 t/ha) was recorded in the treatment T₈ (S₃ L₂) i. e. 6 x 4 m spacing with 50% N (Inorganic source) + 50% N (Organic source-Vermicompost) + 100% P & K (100% Inorganic - P & K supplied through Vermicompost).

Tirupati: Among interaction effects, significantly maximum fruit yield (1189 fruits/ plant, 55.34 kg/plant and 18.43 t/ha) was recorded in S₂L₁, when plants were spaced at 6 x 5 m (333 plants/ha) and supplied with 75 per cent RDF (600:450:600 g N:P₂O₅:K₂O+ 80 kg FYM+ 8 kg neem cake/plant /year) which is at par with S₃L₁ (18.15 t/ha), when plants were spaced at 6 x 4 m (416 plants/ha) and 75 per cent RDF (600:450:600 g N:P₂O₅:K₂O K₂O/ plant/year 80 kg FYM+ 8 kg neem cake /plant /year).

3.1.1.(E).C. Residual and cumulative effect of nutrients in Citrus

The experiment has been laid out with a total of 9

treatment combinations ($A_1B_1, A_1B_2, A_1B_3, A_2B_1, A_2B_2, A_2B_3, A_3B_1, A_3B_2, A_3B_3$) comprising of three levels of age wise nutrient: i.e. i) Application of 1/10 of RDF for 10 years (A_1), ii) Application of 1/8 of RDF for 8 years (A_2) and iii) Application of 1/6 of RDF for 6 year (A_3) and three age wise dose of nutrients viz. 100% RDF after 10 years (B_1), 80% of RDF after 8 years (B_2) and 60% RDF after 6 years (B_3) in factorial randomized block design with three replications having 4 plants in each treatment. The spacing followed is 6x6m except at Tinsukia (5x5m). The irrigation method followed was drip irrigation except at Tinsukia (rainfed) and Rahuri (basin with double ring method). Recommended dose (100%) of fertilizers was used by the respective centres. For main plot treatments (A), cumulative increase in RDF was followed as per the treatment types.

(a) Mandarin

Akola: Maximum plant height (5.25 m), fruit yield (75.02 Kg/tree & 19.25 t/ha) was recorded in application of 1/8thRDF for 6 years. However, the interaction of the two factors (A×B) significantly did not influence the yield.

Ludhiana: The maximum fruit yield (148.88 kg/tree, 41.24 t/ha) was observed in application of 1/6 RDF for 6 years followed by application of 100% RDF after 10 years.

Nagpur: The interaction effect of different treatments had no significant influences on yield parameters.

Sriganganagar: Maximum fruit yield (88.28 kg/tree) were recorded in treatment T_8 : A_3B_2 (Application of 1/6 of RDF for 6 year and 80% of RDF after 8 years) and which is at par with T_9 as A_3B_3 i.e., application of 1/6 of RDF up to six years followed by addition of 60% of RDF up to next six years (83.83 kg/tree).

(b) Sweet orange

Rahuri: The age wise nutrient levels (factor A) or interaction of the two factors (A×B) significantly influenced growth and yield attributes Among the interactive treatments, the maximum plant height (3.82 m), canopy volume (25.42 m³), fruits per tree (415) and yield (73.35 kg/tree & 20.32 t/ha) were recorded in plants were supplied with 1/10 of RDF for 10 years followed by application of 100% RDF after 10 years

Tirupati: The interaction effect of different treatments had no significant influences on growth parameters. Maximum fruit yield (8.01 t/ha) was recorded in plants were supplied with 1/6 of RDF for 6 year followed by 60% RDF after 6 years.

(c) Acid lime

Periyakulam: Among the interaction effect of different treatments, maximum number of fruits per tree (810.4) and yield (40.50 kg/tree & 11.20 t/ha) were recorded in plants supplied with 1/6 of RDF for 6 year followed by 80% RDF after 8 years).

Rahuri: Among the interaction effect of different treatments, maximum number of fruits per tree (1598.33) and yield (76.67 kg/tree & 21.24 t/ha) were recorded in plants supplied with 1/10 of RDF for 1 to 10 years followed by application of 80% RDF after 6 years.

Tirupati: The interaction effect of different treatments had no significant influence on growth and yield parameters.

3.1.1.(F).C. Standardization of stage-wise requirement of nutrients in Citrus

A trial was laid out on bearing trees using RBD with four treatments replicated five times. The dose of nutrients at different stages was varied to increase nutrient use efficiency compared to the existing practice.

The treatment details of stage-wise requirement of nutrients in Citrus

Treatment	Percent RDF supplied through soil application																	
	Stage-I (Jan-Feb.)			Stage-II (Mar-April)			Stage-III (May-June)			Stage-IV (July-Aug.)			Stage-V (Sept-Oct.)			Stage-VI (Nov-Dec)		
	N	P ₂ O ₅	K ₂ O	N	P ₂ O ₅	K ₂ O	N	P ₂ O ₅	K ₂ O	N	P ₂ O ₅	K ₂ O	N	P ₂ O ₅	K ₂ O	N	P ₂ O ₅	K ₂ O
T_1	0	0	0	40	50	0	40	50	0	20	0	50	0	0	25	0	0	25
T_2	0	0	0	30	40	10	30	35	10	20	25	30	10	0	25	10	0	25
T_3	0	0	0	30	40	0	30	35	0	40	25	30	0	0	35	0	0	35
T_4	Control: 1200:400:400 N: P: K g/plant (Akola); Split as per package of practices of the particular region																	

(c) Acid lime

Periyakulam: Maximum canopy volume (36.12 m³), number of fruits per tree (736.1), yield (36.14 kg/tree, 10.02 t/ha) and juice content (48.00%) were recorded in treatment involving 0:0:0, 30:40:10, 30:35:10, 20:25:30, 10:0:25 and 10:0:25 percent RDF

of N:P₂O₅: K₂O for stage – I to stage – VI, respectively.

3.1.3.C. Organic production of Citrus

The trial was laid out in RBD with four replications and five treatment combinations involving various organic sources of nutrients and bio-control

agents (*Trichoderma harzianum* and *Pseudomonas fluorescens*) also with inorganic inputs as check.

(a) Mandarin

Akola: Application of 75 per cent vermicompost (on N equivalent basis of RDF) + *Trichoderma harzianum* (30-40 ml / plant) + Azadirachtin (1% at 3-4 ml/l as spray) + *Pseudomonas fluorescens* (30-40 ml / plant) recorded maximum plant height (5.64 m), canopy volume (102.3 m³), number of fruits (854.50) and yield (132.13 kg/tree).

Sriganganagar: Application of 75 per cent vermicompost (on N equivalent basis of RDF) +

Trichoderma harzianum(30-40ml/plant)+Azadirachtin (1% at 3-4 ml/l as spray) + *Pseudomonas fluorescens* (30-40 ml / plant) recorded maximum plant height (4.76 m), canopy volume (49.66 m³), number of fruits (464.3) and fruit yield (84.33 kg/tree).

Tinsukia: Application of 75 per cent vermicompost (on N equivalent basis of RDF) + *Trichoderma harzianum* (30-40 ml/plant) + Azadirachtin (1% at 3-4 ml/l as spray) + *Pseudomonas fluorescens* (30-40 ml/plant) recorded maximum plant height (4.64 m), canopy volume (33.32 m³), number of fruits (497.8) and fruit yield (61.83 kg/tree) (Table 14).

Table-14: Effect of organic manures and bio agents on growth and yield

Treatment	Fruits/tree			Fruit weight (g)			Yield (kg/tree)			Yield (t/ha)		
	AKL	SRG	TNK	AKL	SRG	TNK	AKL	SRG	TNK	AKL	SRG	TNK
T ₁	696.2	202.0	318.8	154.4	169.8	103.5	102.1	34.2	33.0	25.4	9.5	13.2
T ₂	779.5	268.0	364.3	157.3	171.4	113.4	116.5	45.99	41.32	29.05	12.7	16.53
T ₃	811.2	385.0	361.6	160.3	171.5	117.5	123.6	65.99	42.50	30.81	18.3	17.00
T ₄	854.5	464.3	497.8	162.7	181.7	124.2	132.1	84.33	61.83	32.94	23.4	24.73
T ₅	645.0	441.3	322.8	156.1	177.5	103.9	95.69	78.42	33.53	23.86	21.7	13.41
CD at 5%	79.65	48.44	16.60	NS	10.15	3.4	11.40	9.21	10.3	2.95	2.55	3.2

T₁: Control (800:300:600 g NPK + 20 Kg FYM + 15 kg neem cake/plant/year + Inorganic plant protection; T₂: 100% Vermicompost (On N-equivalent basis of RDF); T₃: 75% Vermicompost (On N-equivalent basis of RDF) + *Trichoderma harzianum* (30-40 ml/plant) + Azadirachtin (1% at 3 - 4 ml / l as spray); T₄: 75% Vermicompost (On N-equivalent basis of RDF) + *Trichoderma harzianum* (30-40 ml / plant) + *Pseudomonas fluorescens* (30-40 ml / plant) + Azadirachtin (1% at 3 - 4 ml / l as spray); T₅: 50% Vermicompost (On N-equivalent basis of RDF) + *Trichoderma harzianum* (30-40 ml / plant) + *Pseudomonas fluorescens* (30-40 ml/plant) + *Azotobacter chroococcum* (30-40 ml/plant) + Azadirachtin (1% at 3 - 4 ml/l as spray).
*AKL: Akola, TNK:Tinsukia; SRG: Sriganganagar

(b) Sweet orange

Tirupati: Application of 75 per cent Vermicompost (On N-equivalent basis of RDF) + *Trichoderma harzianum* (30 - 40 ml / plant) + Azadirachtin (1% at 3 - 4 ml / litre as spray) recorded maximum number of fruits (118.91 fruits/tree) and yield (18.36 kg/ tree and 4.84 t/ha) which is at par with control.

3.1.3.(C).C. Standardization of stage-wise water requirement in Citrus

The trial was laid out in RBD replicated four times with five treatment levels, involving reduction of irrigation levels at different stages for economizing water needs in citrus.

(a) Mandarin

Tinsukia: Maximum canopy volume (25.18 m³), fruit weight (115.26 g), number of fruits per tree (173) and yield (19.94 kg/tree and 7.98 t/ha) were recorded in treatment involving application of irrigation water at 80:80:80:80:80:80 ER (%) from Stage-I (January-February) to stage-VI (November-December). There was non-significant difference between the treatments for plant height, stem girth,

juice, TSS, acidity, ascorbic acid, shelf life of fruits, pH, organic carbon, soil available P₂O₅, soil available K₂O, leaf nutrient contents and pest and disease incidence.

4.1.3.C. Assessment of phenology, productivity and incidence of insect pest and diseases in citrus grown under varying climatic conditions

Analysis of the past weather data viz., temperature (minimum and maximum), rainfall, evapo-transpiration, sunshine hours and analysis of the data on phenology and productivity in relation to observed trends in weather patterns recorded at different centres are presented hereunder. Impact on insect pest and disease incidence has been furnished.

A. Impact of climate on crop phenology and productivity

(a) Mandarin

Akola: Compared to monthly decennial averages reduction in monthly maximum temperature recorded during the months of February to July months of 2021. But, increase in minimum temperature levels

was noticed in almost all moths (except June – July 2021). Number of days to flowering was increased to 10 – 15 days when compared to decennial actual number of days (30 days) to flower and accordingly it took more number of days to attain fruit maturity. 10 to 15 days delayed flowering was observed during the months of January and July 2021. Continuous rains from July to October. caused fruit drop up to 70 % during September- November.

Ludhiana (Abohar): Comparison of the average temperature of different months of the year 2021 to decennial average revealed that except February, March, August, November and December, 2021, the temperatures in all other months were lower than that of decennial averages. Interestingly, the maximum temperature of July month was higher than the decennial average but its average minimum temperature was also lower than the decennial average. It may be due to the fact that this month also received good rains which lowered the minimum temperature value. The upper temperature limit of January to April is critical for the onset of seasonal vegetative flush, flower initiation, flowering duration and fruit set. The daily maximum and average temperatures of February (23.1 and 15.4°C) and March months (27.3 and 20°C) in 2021 were higher than that of the corresponding decennial maximum and average temperatures of these months. This rise of temperature probably caused induction of peak of the flowering in a short interval and flowering in 2021 was 30-50% less than that of 2020. In the recent years, the January month is considered to be the representative winter month under north Indian conditions. This month was cooler in 2021. The temperature of this month (maximum, minimum and average) in the year 2021 was significantly lower than the decennial averages of this month. The average annual rainfall of this place is 284 mm. In the year 2021, total rainfall of 243 mm was recorded which was lower than the annual range of 284 mm. Except four months (February, Aug, November and December), rains occurred in all the months, but its intensity was low. The maximum daily rainfall (3.0 mm) was recorded in July month. Barring April, July and October 2021, rainfall average in all other months was lower than the decennial averages. The patterns of average monthly maximum and minimum humidity were compared against the decennial averages to infer the percent positive or negative deviation. Except May, 2021, the percent maximum relative humidity was lower in all other months. In this month, 5.6 and 83.0% increase over decennial values was recorded for maximum and minimum relative humidity.

Bud sprouting for spring flush in Abohar conditions starts on 15th to 20th of February. In the year 2021,

the bud swelling was observed on 10th of February, which was early by a week. The flowering occurred in March month and was of optimum duration in 2021. But, its intensity was less due to high temperature of February March and heavy yields in the preceding year (2020). The overall flowering in 2021 was 30-50 % less than that of 2020. The fruit maturity was advance by one week. Due to the high yields of 2020, the average flowering intensity in 2021 was 30-50% less than that of 2020 and as a consequence, fruit yield was almost half of 2020.

(b) Sweet orange

Rahuri: When compared to decennial maximum (32.5°C) and minimum (18.5°C) there is a reduction in current years maximum temperature (31.6°C) and increment in daily minimum temperature (20.6°C). Similar trend was noticed with a total rainfall of 968 mm in 54 rainy day. Maximum and minimum relative humidity levels was also recorded high. Emergence of new flush and flowering delayed by 10 days compared to last year.

Tirupati: Among the different vegetative flushes during spring new flush was noticed during 4th week of December 2020 and continued up to second week January 2021. During the months of June, July and August 2021 the summer flushes were noticed. The intermittent rains during the last week of August (9 days, 208.6 mm) and September (10 days, 203.0 mm) new vegetative flush was noticed. 50 per cent flowering for *Ambe* bahar crop in sweet orange during second week of January, 2021 was noticed and extended up to first week of February, 2021 and the fruits attained full maturity during last week of July and harvesting was continued upto First week of November. Post set and pre mature fruit dropping were noticed due to continuous rains. Even though during March 2021 higher temperature (36°C) has recorded as compared to decennial maximum average temperatures (34.28°C), a reduction in temperature from April to August 2021 was noticed. Likewise, reduction in the average minimum temperature from March to July 2021 and thereafter slight incremental in minimum temperature was noticed coupled with higher rainfall when compared to decennial monthly averages.

The upper temperature limit during April is critical for fruit set and during May and June for fruit development of *Ambia* bahar crop and also there was decrease in average maximum temperature compared to decennial average. The average minimum temperature was also low compared to decennial average during May and June. Due to intermittent rains post set drop was noticed in citrus orchards. A large variation has been observed in the quantity of rains received during different months,

but, overall, the total rainfall pattern is erratic. The decennial average annual rainfall is 1049.98 mm distributed in 55 rainy days. Total rainfall of 1695.9 mm (83 rainy days) was recorded during 2021. Highest rain fall of 637.0 mm was recorded during November with 23 rainy days. The same trend was observed in the previous years except during the year 2020 where the maximum rainfall was received in the month of July (435.2mm) past years showed that maximum rain fall was recorded during November month. Due to intermittent and continuous heavy rains from June to December the generative phase is converted in to vegetative during which ultimately may affect the yields in the coming years.

A relative increase in the maximum relative humidity has been observed in most of the months during the year under report. The yearly maximum relative humidity was observed November month. Compared to decennial mean minimum relative humidity was recorded during the month of March.

(c) Acid lime

Rahuri: Emergence of new flush compared to last year was two weeks, one week and three weeks earlier in *Ambia*, *Mrig* and *Hasta* bahar respectively in acid lime.

Tirupati: The intermittent rains during the last week of August (9 days, 208.6 mm) and September (10 days, 203.0 mm) new vegetative flush was noticed in October. *Ambia* flowering was initiated during last week of January extended up to last week of March, summer flowering was in July and autumn flowering recorded in 1st week of November. *Hasta* Bahar fruiting was good (30-40%) and the fruits were harvested during May with good quality. No much difference was observed in case of days to maturity of fruits in *Ambia* and *Mrig* bahar crop and it took 145 to 150 days to mature.

Periyakulam: Emergence of new flush season was observed during the month of June, July and August in 2021. Flowering time was observed during January, June and July of 2021. Days to flowering was 23 days and days to maturity was 144 and 158 days in January and July 2021 in acid lime var PKM1 minimum temperatures 21.04 and 22.87°C in January and February 2021. Increase in maximum and of 35.32 and 36.35°C in the month of March & April 2021, and minimum of 21.93°C was recorded in December 2021. Maximum temperature 36.23°C was recorded in March 2022 and minimum of 23.09°C was recorded in December 2021. During the year 2021, rainfall was recorded higher during October 2021 (159.4 mm (Actual) & 150.26 mm (normal)) followed by the month of April 2021 received 79.80 mm (normal) and 74.0 mm (normal) in August 2021.

B. Impact on pest incidence

(a) Mandarin

Ludhiana (Abohar): The citrus psyllid is the main insect pest of Kinnow mandarin in the region. But, its incidence was lower in 2021 than 2020. The adult population of citrus psyllid was noted in all months; it ranged from 5.9 adults/10 leaves (March) to 20.0 adults/ 10 leaves (May). The nymph population remained high in the months of March (35.2), August (25.2) and September (28.0). This year aphid infestation was mainly recorded in February month. The leaf miner comes second in the list of economic importance for Kinnow mandarin. But, magnitude of incidence was higher than that of citrus psyllid, it was present in most of the months, with highest incidence (55.7%) in May month. The thrips were observed from May to December with maximum incidence in May month (3.09/leaf). A sporadic incidence of lemon buter fly and grey weevil in in August month and fruit fly in October month has also been recorded. Thus, the drier weather in 2021 favoured more incidence of leaf miner and thrips over citrus psylla. But, the maximum incidence of most of the insect peaked during May month, which may be due to fact that average temperature of this month was about 26°C, which might be favouring the insects.

Sriganganagar: Citrus psylla, Leaf minor and thrips was the major enemy in mostly months of the year except January, November and December months. Citrus psylla caused maximum damage in the months of April followed by July to September months. Leaf minor was most active in March to April and July to August months. Thrips caused maximum damage in the month of April-May months. Lemon butter fly caused maximum damage in the month of April. Fruit sucking moth again caused serious damage in the Months of October and November.

(b) Sweet orange

Rahuri: Leaf miner and fruit sucking moth incidence was observed decreasing in the surveyed orchards in the current year as compared to past incidence.

Tirupati: Moderate to high (20-50%) citrus green mite incidence during January to March, Very severe fruit sucking moth damage (30-45 %) during August and November, low to moderate (6-14%) leaf minor incidence from January to February, low to moderate thrips damage from March to May, low to moderate (4-7%) fruit damage with rust mite was recorded during the months under report. Due to excess rainfall.

(c) Acid lime

Rahuri: In *Mrig bahar* infestation of bark eating

caterpillar and mites was observed to be in increasing trend in surveyed orchards. Incidence of *Phytophthora* foot rot and bacterial canker was increased due to continuous rains. Thrips and aphid infestation was decreased as compare to past incidence.

Tirupati: Acid lime pest calendar revealed that 5-8 per cent (low to moderate) rust mite incidence during February- April, moderate to high (20-35 %) mite damage on foliage during February to June, low incidence (5- 7%) of citrus butterfly during July-August, low to moderate (8-15 %) incidence of leaf minor damage during June to August, low to moderate (4-10 %) incidence of leaf thrips damage during February to May and low incidence (6-8%) of scales was recorded.

Periyakulam: The pest disease calendar for 2021 in citrus was developed and major pests incidence recorded through fixed plot survey. Incidence of leaf miner, citrus butterfly, Psylla population and citrus rust mite damage on fruits were recorded. Maximum citrus rust mite infestation (25-50%) was observed in the month of march.

C. Impact on disease incidence

(a) Mandarin

Akola: November month recorded to be congenial environment for twig blight (33.22%) and gummosis (11.87%). Continuous rains from July to October caused fruit drop up to 70 per cent during September-November. Severity of gummosis was recorded more in Nagpur mandarin during the month of November and recorded as 11.87 per cent and due to continuous rains caused fruit drop up to 60 per cent during September- November 2021.

Sriganganagar: Among the diseases, incidence of Citrus canker recorded maximum in August month. *Phytophthora* root rot recorded maximum in the month of June-July and Twig blight recorded highest in the month of May to July with 10-35 per cent damage.

(b) Sweet orange

Rahuri: Slight increasing trend of *Phytophthora* foot rot and greening disease was observed in surveyed area of Western Maharashtra.

Tirupati: Canker, twig blight and greasy spot incidence was maximum during December, 2020 to January-February, 21.

(c) Acid lime

Rahuri: Slight increase in incidence of *Phytophthora* foot rot was observed in *Hasta* bahar and constant pressure of Tristeza virus infection was observed throughout the year.

Tirupati: Acid lime bacterial canker and greasy spot

disease incidence were severe during November-December.

Periyakulam: The disease calendar for 2021 was developed using the fortnightly disease incidence recorded through fixed plot survey. The diseases recorded were twig blight, bacterial canker, gummosis and citrus greening. The diseases like greening and gummosis were present in all the observed plants, but the expression of the diseases varied across the months. The expression of greening was high during October to November. In the gummosis affected plants oozing of gum was recorded in February to July. Twig blight infestation was maximum in January-September 2021 and February-March 2022.

5.1.1.C. Survey for new and emerging insect pests and their natural enemies in Citrus

Roving survey was carried out to identify new emerging insect pests and their natural enemies. This was done once in each flushing/fruiting stage in about 10% orchards (at least 25-50 orchards) in the specified region.

Ludhiana: Incidence of a non-insect pest, like snail, *Lymnaea* sp. (Family: Lymnaeidae) infested leaves of Kinnow mandarin plants (25.8% leaf infestation) in District Hoshiarpur. The centre has reported three new natural enemies. Spider, *Eriovixia laglaizei* (Simon) and *Telamonia dimidiata* (Simon) were observed on Kinnow plants at Hoshiarpur and PAU, Ludhiana during April 2021. Syrphid fly, *Eristalinus* sp. was observed on flowers of citrus plants at PAU, Ludhiana.

Periyakulam: No new insect-pests have been reported.

Rahuri: No new insect-pests have been reported.

Tinsukia: No new insect-pests have been reported.

Tirupati: No new insect-pests have been reported.

5.1.3.(VI).C. Efficacy of different repellents against fruit sucking moths

Treatments were imposed at colour breaking stage twice at 10 days interval. The observations on fruit drop due to fruit sucking moth (%) were recorded at 10, 20 and 30 days after 2nd spray.

Ludhiana: The petroleum spray oil at 2 per cent recorded minimum fruit drop due to fruit sucking moth damage (21.8%) and the same treatment recorded maximum yield (16.9 t/ha) and BC ratio (10.7).

Rahuri: The neem oil (1%) recorded minimum fruit drop (5.83%) with maximum fruit yield (14.2 t/ha) and BC ratio (2.20) at 30 days after treatment.

Tinsukia: The petroleum spray oil at 2 per cent

recorded minimum fruit drop due to fruit sucking moth damage (12.86 %) at 30 days after treatment and the same treatment recorded maximum fruit yield (19.5 t/ha) and BC ratio (2.03).

Tirupati: The neem oil (1%) recorded minimum fruit drop (12.99 %) with maximum fruit yield (19.52 t/ha) and BC ratio (2.03) at 30 days after treatment (Table 15).

Table-15: Efficacy of different repellents against fruit sucking moths at different centres

Treatment	Fruit drop due to fruit sucking moth (%)											
	10 DAT*				20 DAT				30 DAT			
	LDH	RHR	TNK	TPT	LDH	RHR	TNK	TPT	LDH	RHR	TNK	TPT
T ₁ : Neem oil 1%	20.3 (26.8)	5.83 (13.87)	22.9 (28.6)	13.15 (21.25)	22.1 (28.0)	7.58 (15.9)	18.30 (25.33)	14.02 (21.97)	26.2 (30.8)	9.00 (17.30)	14.50 (22.34)	12.99 (21.11)
T ₂ : Azadirachtin 1% @ 3ml/l	27.2 (31.4)	10.75 (19.14)	36.8 (37.35)	14.20 (22.12)	30.1 (33.3)	11.17 (19.5)	28.00 (31.95)	15.89 (23.47)	34.2 (35.8)	12.67 (20.84)	14.90 (22.71)	14.05 (22.00)
T ₃ : Petroleum spray oil 2%	16.8 (24.2)	7.17 (15.45)	16.8 (24.20)	13.54 (21.57)	18.2 (25.3)	8.75 (17.1)	12.8 (20.96)	13.99 (21.94)	21.8 (27.8)	10.25 (18.66)	12.86 (21.00)	11.94 (20.20)
T ₄ : Citronella oil 2%	32.1 (34.5)	11.42 (19.74)	33.7 (35.49)	15.10 (22.85)	35.8 (36.8)	12.50 (20.6)	20.30 (26.78)	17.94 (25.03)	39.3 (38.8)	13.67 (21.69)	17.49 (24.70)	18.01 (25.10)
T ₅ : Soapnut extract 2%	27.5 (31.6)	11.83 (20.07)	29.1 (32.6)	20.01 (26.56)	29.2 (32.7)	13.00 (21.1)	18.20 (25.23)	19.02 (25.84)	33.9 (35.6)	14.17 (22.11)	16.67 (23.97)	22.59 (28.36)
T ₆ : Mustard oil 2%	31.6 (34.2)	11.33 (19.65)	21.71 (27.75)	21.99 (27.95)	38.5 (38.4)	12.25 (20.5)	17.00 (24.34)	24.05 (29.35)	39.8 (39.1)	12.83 (20.99)	14.33 (22.24)	27.01 (31.29)
T ₇ : Jatropha oil 2%	29.3 (32.8)	12.00 (20.25)	20.8 (27.13)	18.23 (25.25)	32.2 (34.6)	13.33 (21.4)	16.61 (24.04)	17.02 (24.35)	38.8 (38.5)	14.83 (22.62)	14.90 (22.71)	15.02 (22.79)
T ₈ : Pongamia oil 2%	29.6 (33.0)	12.42 (20.62)	33.2 (35.2)	22.15 (28.06)	34.3 (35.9)	14.00 (21.9)	21.97 (27.94)	22.01 (27.96)	35.5 (36.8)	15.00 (22.72)	17.00 (24.34)	25.94 (30.60)
T ₉ : Control	40.4 (39.5)	17.08 (24.36)	37.21 (37.57)	37.99 (38.03)	45.3 (42.3)	18.17 (25.2)	40.91 (39.74)	41.64 (40.17)	48.8 (44.3)	19.42 (26.14)	38.50 (38.35)	42.97 (40.94)
T ₁₀ : Botanical pesticide	32.2 (34.6)	12.58 (20.74)	39.3 (38.8)	-	36.1 (36.9)	14.25 (22.1)	33.04 (35.08)	-	37.3 (37.6)	15.17 (22.87)	31.50 (34.14)	-
CD at 5%	4.48	2.43	2.14	1.00	3.98	2.62	2.10	1.135	3.31	2.38	2.20	0.80

*DAT-Days after treatment; Figures in parentheses are arc sin transformed values; LDH-Ludhiana, RHR-Rahuri, TNK-Tinsukia, TPT-Tirupati

5.1.5.C. Testing of crop phenology based citrus insect pest management for *Ambia* crop

The experiment was laid out in Kinnow mandarin, acid lime - PKM-1, sweet orange - Phule mosambi, Khasi mandarin, sweet orange – Sathgudi at Ludhiana, Periyakulam, Rahuri, Tinsukia and Tirupati, respectively comprising two modules viz, T₁: Crop phenology-based insect pest management modules and T₂: university recommendation followed at respective places with 40 trees/treatments in T-test design. The observations on insect pest incidence before treatment and 15 days after each subsequent sprays were recorded at different crop phenological stages.

Ludhiana: Minimum population of citrus aphids

(11.3 population/twig) and leaf mite (11.7 mites/twig) were recorded in crop phenology-based module. Similarly, minimum fruit drop due to fruit sucking moths (12.7%) and fruit flies (6.5%) were recorded in the same treatment. The maximum yield (17.5 t/ha) and benefit cost ratio (4.25:1) were recorded in the phenology-based insect pest management module. However, psylla population (13.8 nymphs/twig) were minimum in farmers Practice.

Periyakulam: The lowest pest population of aphids (11.72 nymphs/twig) was recorded at crop phenology-based module. Similarly, the maximum yield (12.14 t/ha) and BC ratio (2.86) were recorded in the phenology-based insect pest management module.

Rahuri: Significantly minimum population of aphids (8.23 nymphs/twig), psylla (7.43 nymphs/twig) and leaf mites (8.43 mites/twig) were recorded at crop phenology-based insect pest management module. Similarly, minimum fruit drop due to fruit sucking moth (8.88 %) and fruit fly (7.33%) with higher yield (12.44 t/ha) and BC ratio (1.71) were observed in the same treatment.

Tinsukia: Minimum population of aphids (21.25 nymphs/twig), psylla (13.40 nymphs/twig) and leaf mites (5.34 mites/twig) were recorded at crop phenology-based insect pest management module. Similarly, minimum fruit drop due to fruit sucking moth and fruit fly were recorded to be 10.30 per cent and 4.20 per cent, respectively in the same treatment with maximum yield (10.56 t/ha) and BC ratio (2.80) as against farmers practice.

Tirupati: The population of aphids (3.90 nymphs/twig) psylla (3.67 nymphs/twig) and leaf mites (4.99 mites/twig) were significantly low in crop phenology-based module in comparison to farmers practice. Similarly, maximum yield (23.45 t/ha) and BC ratio (2.19) were recorded in the same treatment as against farmers practice.

5.1.6.C. Slow-release pheromone formulation for the management of fruit fly in Citrus

Two types of pheromone-based treatments *viz.*, slow-release pheromone formulation and conventional lure (control) were tested for the management of adult fruit fly in existing orchard of Citrus (Akola: PC Phero-sensor Catch-A- Fly Fruit Fly Trap; Ludhiana: PAU Fruit Fly Trap; Tinsukia: Barrix Fruit Fly Trap; Tirupati: IIHR-Fruit Fly Trap). Citrus orchards of 1 ha were selected separately for each treatment keeping at least 200 m isolation distance. Total 20 number of traps (one trap as one replication) in each treatment were installed under orchard of commercial variety

with recommended package of practices for the region. There was more than 200 m isolation distance kept between two treatments. The observation on adult male catches count was done at each standard meteorological week. The replacement of pheromone formulation lure was done after one month when the effectiveness of lure comes down.

Akola: Fruit fly traps were installed on 6th August 2021 and weekly observation of adult fruit fly catches was recorded. In end of September 2021, an average of 160.89 and 204.91 adult fruit flies were trapped in T₁ (Slow release pheromone formulation trap) and T₂ (Conventional trap) respectively (Fig. 9).

Ludhiana: Conventional lure (PAU Fruit Fly Trap) was more effective (36.7 fruit flies) than slow-release pheromone formulation (27.6 no.). The per cent fruit infestation was also low in conventional PAU Fruit Fly Trap (24.7%) as compared to 39.6 per in slow release trap. The slow release units trapped the fruit flies for 3 weeks more as compared to conventional trap. The PAU Fruit Fly traps as well as slow release traps were replaced after 1 month (Fig. 10).

Tinsukia: Conventional lure (control) was recorded to be more effective than slow-release pheromone formulation. Replacement of pheromone formulation was not required during the month of September as it was found to be effective till the December. However, the shelf-life of the slow-release pheromone formulation could not be determined as the trap was installed during first week of September which covered only one month of the reporting period (Fig. 8).

Tirupati: Conventional trap recorded higher number of fruit flies than slow-release pheromone formulation as evident from more number of trap catch *i.e.*, 58.67 fruit flies as compared to 36.10 per cent fruit flies in slow release trap, in Citrus. The lure was replaced after 1 month in IIHR fruit fly trap (Fig. 11).

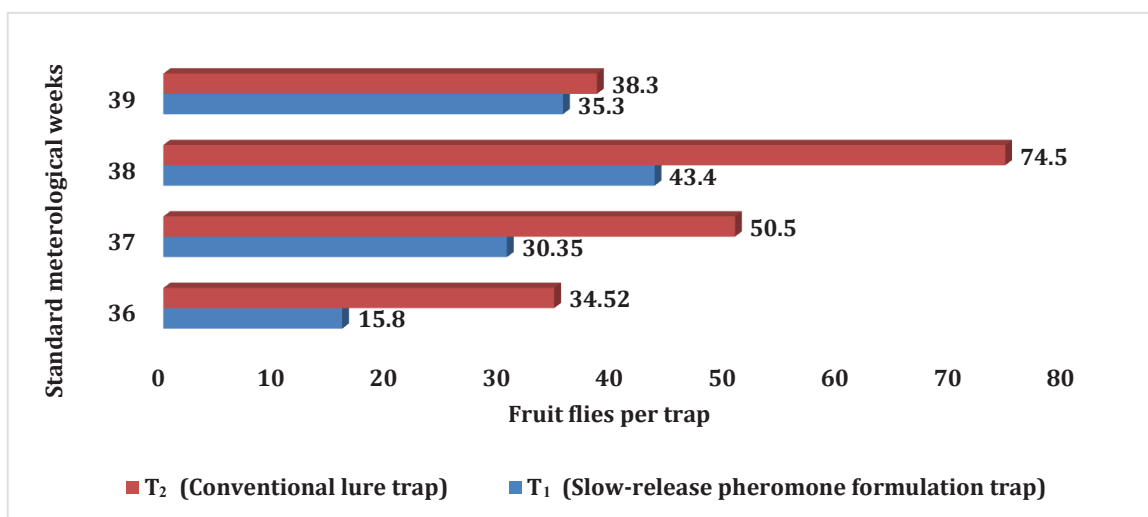


Fig. 8: Weekly population of fruit fly trap catches in Khasi mandarin orchard during standard meteorological weeks at Tinsukia

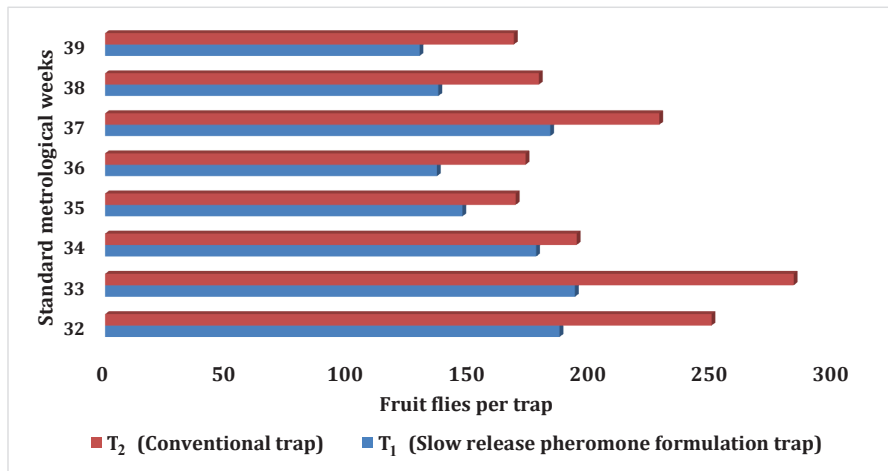


Fig. 9: Weekly population of fruit fly trap catches in Nagpur mandarin orchard during standard metrological weeks at Akola

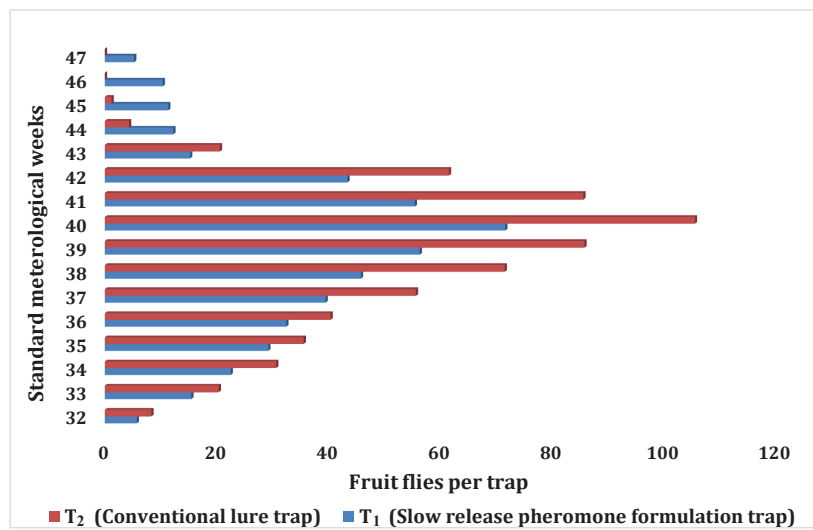


Fig. 10: Weekly population of fruit fly trap catches in Kinnow mandarin orchard during standard metrological weeks at Ludhiana

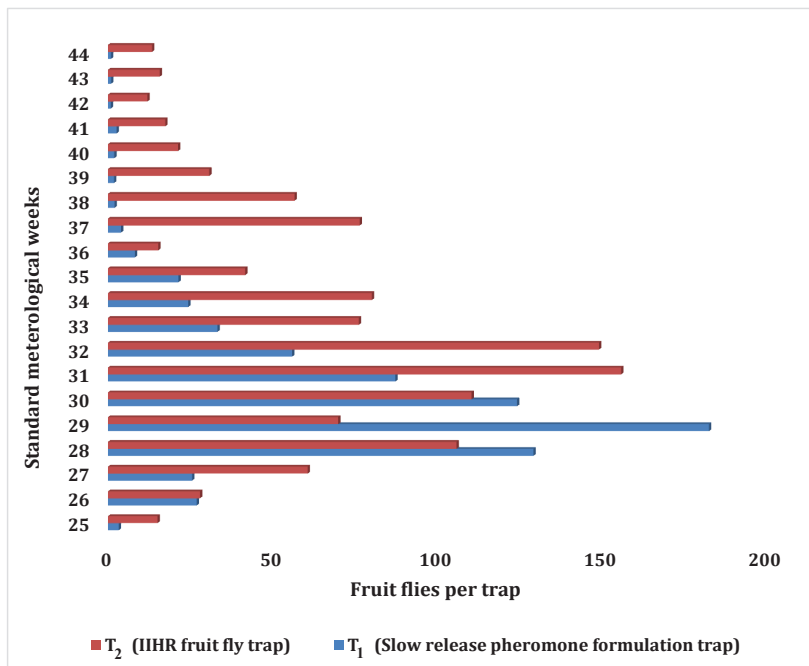


Fig. 11: Weekly population of fruit fly trap catches in Sathgudi sweet orange orchard during standard metrological weeks at Tirupati

6.1.1.C. New and emerging diseases of Citrus

Roving survey was conducted at different centres to identify new, emerging and major diseases and to detect any new emerging pathogen. Accordingly, 79 Nagpur mandarin, 32 acid lime and 21 sweet orange (cv. Mosambi) orchards of different age groups from Vidarbha region of Maharashtra, 49 Kinnow mandarin orchards of different age groups of Punjab, 32 Khasi mandarin from Tinsukia, 12 sweet orange (cv. Mosambi) orchards and 34 acid lime orchards from Rahuri region of Maharashtra, 52 sweet orange and 14 acid lime orchards from Tirupati and 31 orchards from Periyakulam centre were surveyed during roving survey for the year 2021.

(a) Mandarin

Akola: Fungal diseases like twig blight, *Phytophthora* root rot/gummosis, brown rot, greasy spot, fruit drop due to stem end rot and greening are the most important diseases recorded during the reporting period. Significance fruit drop incidence due to stem end rot was noticed in the range of 2.60 - 30.50 per cent. Brown rot disease (11.60 - 38.60%) pressure mainly recorded in Amravati and Nagpur district. Greasy spot was observed in Akola, Washim and Amravati district pockets to the tune of 5.19 - 19.11 per cent. The next widest spread disease was greening (2.30 - 20.22 per cent).

Ludhiana: The most widespread and serious disease prevalent in Punjab was *Phytophthora* foot rot/gummosis (7.33 - 19.40 per cent). Other commonly occurring diseases were citrus greening (2.33 - 14.25%), citrus ring spot (1.0 - 9.76%) and bacterial canker (2.33 - 15.28%).

Tinsukia: Three major fungal diseases of Khasi mandarin viz., twig blight (8.33 - 28.33%), gummosis/foot rot (3.33 - 15.00%), fruit drop due to pre-harvest stem end rot (1.66 - 33.33%) and minor fungal diseases like scab (6.66 - 18.33%) and sooty mould (3.33 - 15.00%) were recorded during the survey. Among virus and virus like diseases, Citrus greening disease (CGD) and Citrus tristeza virus were detected in most of the orchards up to incidence level of 36.66 and 38.33 per cent respectively.

(b) Sweet orange

Akola: Roving survey was carried out at four districts of Vidarbha regions to identify the various diseases of sweet orange (cv. Mosambi). Increase trend of brown rot (20.00 - 42.10%), greening

(2.40 - 12.40%) and twig blight (4.13 - 22.66%) was recorded in Vidarbha region. *Phytophthora* foot rot/Gummosis (1.0 - 6.10%) occurred in sweet orange orchards of all age groups in all the districts. No new diseases were recorded in sweet orange.

Rahuri: Major diseases observed in Western Maharashtra were greening, twig blight, and *Phytophthora* foot rot/gummosis. Slight increasing trend of greening (13.28 - 37.78%), *Phytophthora* foot rot and gummosis incidence (9.57 - 22.59%) and twig blight incidence (9.55 - 17.58%) was noticed, whereas tristeza disease appeared with mild pressure (0.61 - 1.11%).

Tirupati: Major diseases observed in Andhra Pradesh were citrus greening (2.40 - 56.80 %), dry root rot (0.80 - 35.20%), gummosis (1.60 - 68.80%) and Citrus yellow mosaic (1.60 - 75.20 %). Moderate pressure of greasy spot ranged between 1.92 to 28.16 per cent, stem end rot up to 28.80 per cent and twig blight up to 26.40 per cent.

(c) Acid lime

Akola: Prevalence of bacterial canker, twig blight, sooty mould, witches broom and *Phytophthora* foot rot/gummosis were recorded in the surveyed areas. Bacterial canker and twig blight were predominant in all age group of surveyed orchards. Disease pressure of bacterial canker (10.08 - 40.76%), twig blight (6.78 - 20.34 %) and *Phytophthora* foot rot/gummosis (1.00 - 6.90%) was observed in Vidarbha region. No new disease was recorded in surveyed orchards.

Periyakulam: The diseases viz., twig blight, bacterial canker, stem end rot, gummosis and greening were recorded in the roving survey conducted in six districts of Tamil Nadu. Average incidence of twig blight, bacterial canker, stem end rot, gummosis and greening was 22.27, 27.61, 6.73, 10.01 and 24.45 per cent respectively.

Rahuri: Bacterial canker was observed with the highest per cent incidence of 45.94 per cent followed by twig blight (22.08%). However, tristeza disease pressure appeared with 0.12 - 0.52 per cent.

Tirupati: Bacterial canker (7.52 - 15.36%) and greasy spot (4.00 - 8.80%) were recorded in all locations in Andhra Pradesh. Low to moderate incidence of dry root rot (1.60 - 5.60 %), twig blight (0.80 - 21.60 %), greening (1.60 - 15.20%), Lingitudinal bark and wood splitting disease (0.80 - 8.80%), Diplodia gummosis (0.80 - 7.20 %) and Ganoderma (1.60 - 7.20%) were recorded during the reporting period.

6.1.2.(c).C. Screening of promising root stocks against root rot

Seeds of different rootstocks were sown in sterilized soil/sand mixture in pots. Three-month-old seedlings were transplanted in poly bags filled with sterilized soil/sand mixture and allowed to grow in cage house. Cultures of *Phytophthora* isolated from root adhering soil were multiplied on large scale. The multiplied culture of *Phytophthora* was collected in sterilized water and inoculations were carried out.

Phytophthora root rot

Akola: The minimum per cent root rot incidence (4.44) was observed in Alemow (*C. macrophylla*) while maximum root rot incidence (28.89%) was noticed in susceptible check rough lemon. Significantly minimum per cent of leaf fall was recorded in Alemow (3.38%). Population density of *Phytophthora* found non-significant.

Ludhiana: Significantly minimum disease incidence, leaf fall and feeder root rating (13.75%, 13.96% and 1.33, respectively) were observed in Rangpur lime Abohar followed by NRCC-4 (16.67%, 14.11 % and 1.33, respectively), NRCC-1 (16.90%, 14.33%, 1.46, respectively) and Sour orange Tirupati (17.66%, 19.76% and 1.67, respectively). Whereas, rough lemon (Abohar) recorded significantly minimum disease incidence (15.79%) and leaf fall (16.90%) but feeder roots rating was severe (2.60).

Rahuri: The disease incidence and feeder root rating recorded was non-significant. Leaf fall per cent was significantly minimum in Rangpur lime Rahuri (Marmalade orange), NRCC-1, NRCC-5, NRCC-6, NRCC-3 and NRCC-2 (11.84, 12.79, 12.89, 13.15, 13.90 and 13.96, respectively). Lowest population density of 2.1 propagule/cc soil was observed in Rangpur lime Rahuri.

Fusarium, Rhizoctonia

Tirupati: Disease incidence was significantly minimum in case of NRCC-6 (0.00), Tirupati sour orange (0.00%), Rangpur lime (0.00%) and NRCC-3 (3.33%) when compared to other root stocks and susceptible check Jambheri (26.67%).

6.1.8.C. Evaluation of native bio-agents against *Phytophthora* root rot/dry root rot of Citrus

Different bio-agents were collected, isolated and screened against *Phytophthora/Fusarium solani* by dual culture technique in vitro at different centres to identify the effective bio-agents.

Akola: The effect of various bio-agent formulations on the incidence of root rot and leaf fall caused by *Phytophthora nicotianae* varied significantly. Consortia 1 was the most effective of the bio-agents tested, with the least root rot incidence (6.67%) and the least leaf fall (4.28%) of rough lemon seedlings compared to the control, which had 33.33 per cent and 16.13 per cent root rot incidence and leaf fall respectively (Fig. 12).

Ludhiana: Five isolates of *Trichoderma* were recovered which on evaluation against *Phytophthora nicotianae* under *in vitro* conditions by dual culture technique, showed percent growth inhibition of 52.22 to 71.89 per cent. Among these isolates, FRF₁ (recovered from Fruit Research Farm) showed maximum per cent growth inhibition of 71.89 followed by FRF₃ where per cent growth inhibition of *Phytophthora nicotianae* was recorded to be 66.67 per cent. The effect of various bio-agent formulation, Consortia 1 was the most effective with the least root rot incidence (11.11%) and leaf fall (7.41%) of rough lemon seedlings compared to control exhibiting root rot incidence of 37.04 per cent and leaf fall 20.50 per cent.

Periyakulam: The effect of various bio-agent formulations on the incidence of root rot and intensity of leaf roll caused by *Fusarium solani* in rough lemon seedlings were evaluated. Consortia 1 was recorded to be the most effective one with the root rot incidence of 16.31 per cent and leaf fall of 15.63 per cent. In untreated control, root rot incidence was 47.73 percent and leaf roll intensity was 36.25 per cent respectively.

Tirupati: The effect of various bio-agent formulations on the incidence of root rot and intensity of leaf roll caused by *Fusarium solani* in rough lemon seedlings were evaluated. Consortia 1 and 2 were recorded to be most effective. The root rot incidence of 16.67 and 20.00 per cent were observed in Consortia 1 and 2, respectively. Significantly the lowest leaf roll intensity of 14.93 per cent reported with Consortia 2 followed by Consortia 1 which was 15.64 per cent. Both Consortia were on par with each other. Whereas untreated control recorded 53.33 per cent and 37.50 per cent root rot incidence and leaf roll intensity respectively (Fig. 13).

Tinsukia: Five isolates of *Trichoderma* spp isolates were recovered, which on evaluation against *Phytophthora* under *in vitro* conditions by dual culture technique, showed per cent growth inhibition of 63.36 to 78.04. Among these isolates, TKaP1 showed maximum per cent growth inhibition of 78.04.

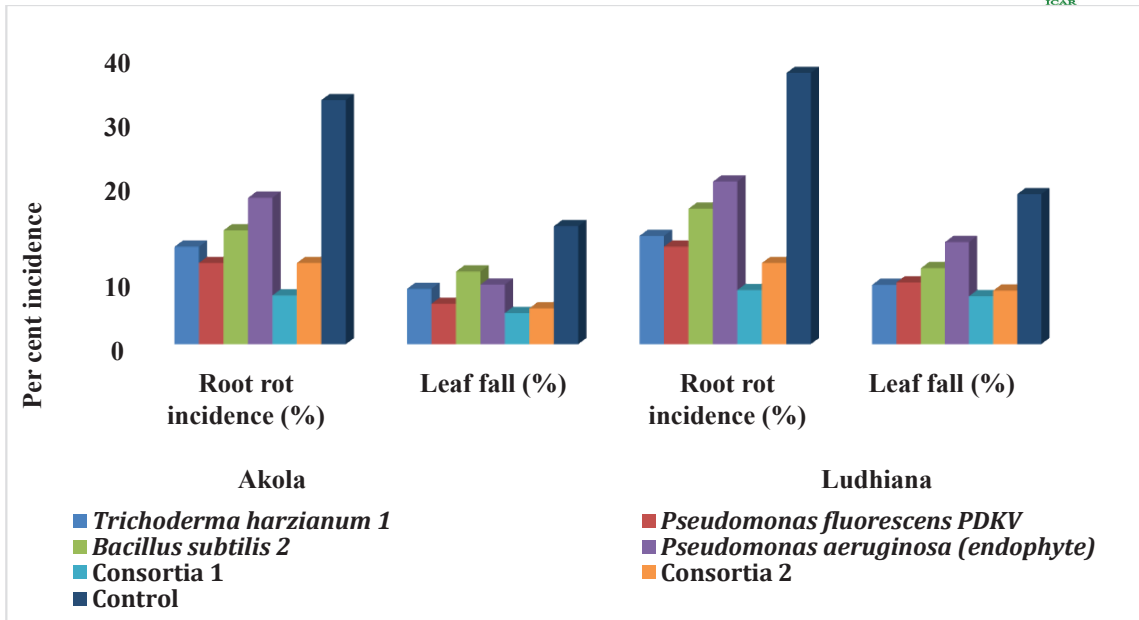


Fig. 12: Efficacy of effective bio-control against *Phytophthora nicotianae* (In pot culture)

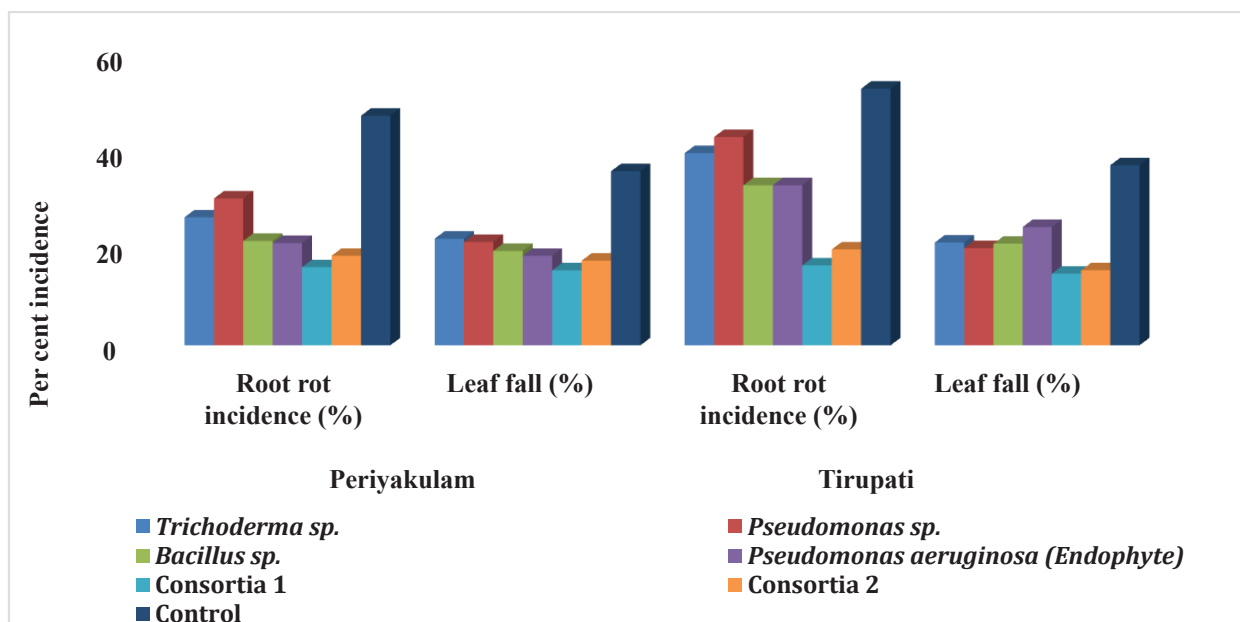


Fig. 13: Efficacy of effective bio-control agents *Fusarium solani*

6.1.11.C. Integrated management of citrus greening disease

The trial has been laid out in RBD having seven treatments and three replications. The treatments included application of tetracycline in combination with nutrients. Symptoms of citrus greening as given in fig. 14-15.

Akola: Application of 50 per cent more than recommended dose of phosphorus + Tetracycline hydrochloride 600 ppm + ZnSO₄ + FeSO₄ (200 gm each) recorded minimum disease severity (22.85%) with maximum fruit yield (51.66 kg/tree) as compared to control.

Ludhiana: Application of 50 per cent more than recommended dose of phosphorus + Tetracycline hydrochloride 600 ppm + ZnSO₄ + FeSO₄ (200 gm each) was most effective in reducing the disease severity (22.83%) and maximum fruit yield (56.0 kg/tree) as compared to control.

Periyakulam: Application of 50 per cent more than recommended dose of phosphorus + Tetracycline hydrochloride 600 ppm + ZnSO₄ + FeSO₄ (200 gm each) has recorded lowest disease severity (23.96) with maximum fruit yield (29.52 kg/tree) and recorded significantly superior over control.

Rahuri: Application of 50 per cent more than recommended dose of phosphorus + Tetracycline hydrochloride 600 ppm + $ZnSO_4 + FeSO_4$ (200 g each) was most effective in reducing the disease severity of 20.84 per cent and maximum fruit yield (44.61 kg/tree) as compared to other treatments.

Tinsukia: Application of 50 per cent more than recommended dose of Phosphorus (RDP) + Tetracycline hydrochloride 600ppm + $ZnSO_4 + FeSO_4$ (200g each) was better in terms of per cent reducing the disease severity (5.41) and maximum fruit yield (45.64 kg/tree) as compared to control.

Tirupati: Application of 50 per cent more than recommended dose of Phosphorus (RDP) +

Tetracycline hydrochloride 600ppm + $ZnSO_4 + FeSO_4$ (200g each) was better in terms of per cent reducing the disease severity (34.17) and maximum fruit yield (25.35 kg/tree) as compared to control.

Two sprays of Tetracycline hydrochloride at 6 g/10 lit of water at an interval of 45 days in the month of October to December and soil application of 50 per cent more than recommended dose of phosphorus (along with recommended dose of nitrogen and potash) and followed by $ZnSO_4$ (200 gm/plant) and $FeSO_4$ (200 gm/plant) after 15 days, is recommended for effective management of greening disease of Citrus at all the centres.



Fig.14: Citrus greening symptoms on leaves

Fig. 15: Abortive seeds in citrus fruit

GRAPES

1.4.7.Gr. Evaluation of coloured table varieties

Vineyard with six coloured table grape varieties viz., Red Globe, Fantasy Seedless, Crimson Seedless, Manjari Shyama (A-18/3), Nana Purple and Sharad Seedless grafted on Dogridge rootstock was raised in Randomized Block Design.

Arabhavi: Maximum yield was obtained in Crimson Seedless (12.3 kg/vine) and Red Globe (12.2 kg/vine), but lower fruitfulness was observed in Fantasy Seedless. Bunch weight (493 g), 100 berries weight (463 g) and berry diameter (24.1 mm) was found highest in Red Globe. Total soluble sugar was more than 18°B in all the varieties. Manjari Shyama recorded with maximum bunches per vine (29.0) and was at par with Red Globe (26.3) and Sharad Seedless (25.5). Early veraison and uniform colour development was achieved in Nanasaheb Purple Seedless (91.0 days), Fantasy Seedless (92.5 days) and Sharad Seedless (94.0 days). Fantasy Seedless (135 days), Sharad Seedless (135 days), Manjari Shyama (136 days) and Nanasaheb Purple Seedless (138 days) were early to harvest as compared to the Red Globe (139 days) and Crimson Seedless (142

days). Maximum Shelf life was reported in Red Globe (16.21 days for 5% physiological loss in weight). Overall, Crimson Seedless and Red Globe were found superior at Arabhavi centre.

Mandsaur: Vines were at establishment stage and yet to achieve fruitfulness.

Pune (NRCG): Manjari Shyama was recorded with maximum yield (6.58 kg/vine), number of fruitful canes (21.6 canes/vine) and number of bunches (34.6 bunches/vine). However maximum bunch weight (655 g), 100 berries weight (689 g) and berry diameter (23.8 mm) was reported in Red Globe. Early veraison was obtained in Fantasy Seedless (81.0 days), Crimson Seedless (84.0 days) and Manjari Shyama (86.5 days); while uniformity for development of colour achieved early in Fantasy Seedless and Manjari Shyama in 106 days after fruit pruning. Similarly, these two varieties were early to harvest (Manjari Shyama: 123 days and Fantasy Seedless: 123 days); while Crimson Seedless (139 days) and Red Globe (141 days) were comparatively late to harvest. Shelf life was recorded maximum in Red Globe (21.0 days), Nanasaheb Purples Seedless (20.5 days) and Crimson Seedless (19.5 days) at 5% physiological loss in weight. At Pune (NRCG), Manjari

Shyama and Red Globe were performed better with respect to yield and quality traits.

Rahuri: Vines were at establishment stage and yet to achieve fruitfulness.

Rajendranagar: Due to unavailability of labours on time, the foundation pruning was delayed till May end (27.05.2020). Further the fruit bud differentiation stage (30-60 days after pruning) was coincided with the continuous heavy rains from June to October 2020 resulted in no fruitfulness and severe incidence of anthracnose and downy mildew. Thus, delayed in fruit pruning (3.11.2020) and no fruitfulness was recorded.

Theni: Fantasy Seedless was reported with maximum yield (8.74 kg/vine); while bunch weight (393 g), 100 berries weight (483 g) and berry diameter (19.6 mm) was found maximum in Red Globe. Fruitful canes (18.5 canes/vine) and number of bunches (37.4 bunches/vine) was maximum in Manjari Shyama. Sharad Seedless (115 days), Manjari Shyama (118 days) and Nanasahab Purple Seedless (122 days) were early to harvest; while Crimson Seedless (147 days) and Red Globe (140 days) were late (Fig. 16-17).

Overall Crimson Seedless found superior followed by Manjari Shyama and Red Globe based on yield, bunch weight and quality parameters during the reporting period (Fig. 18).

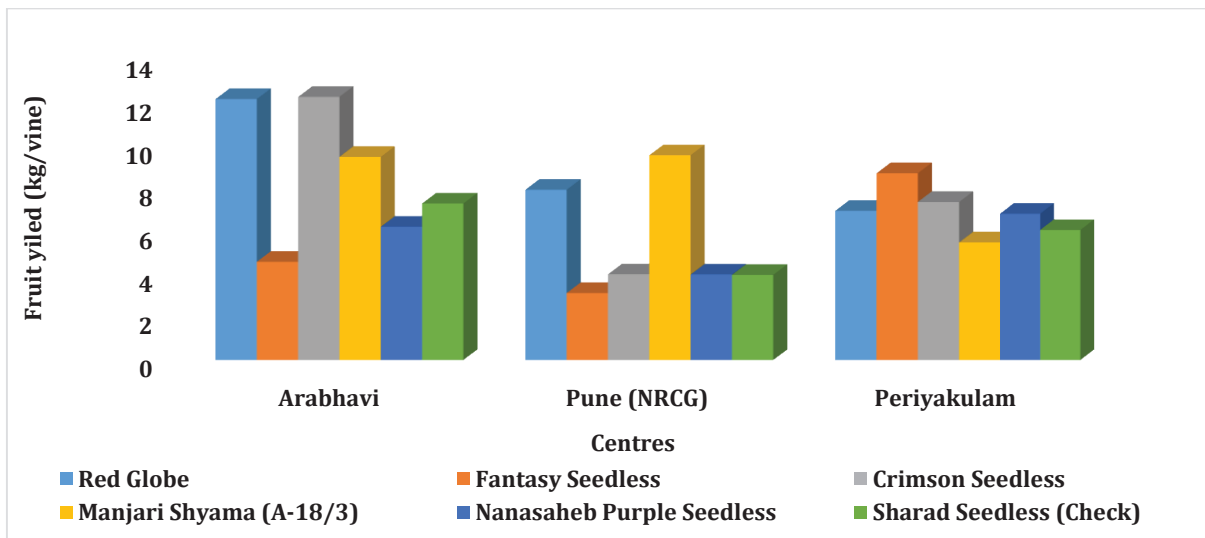


Fig. 16: Evaluation of table grape varieties for fruit yield at different centres

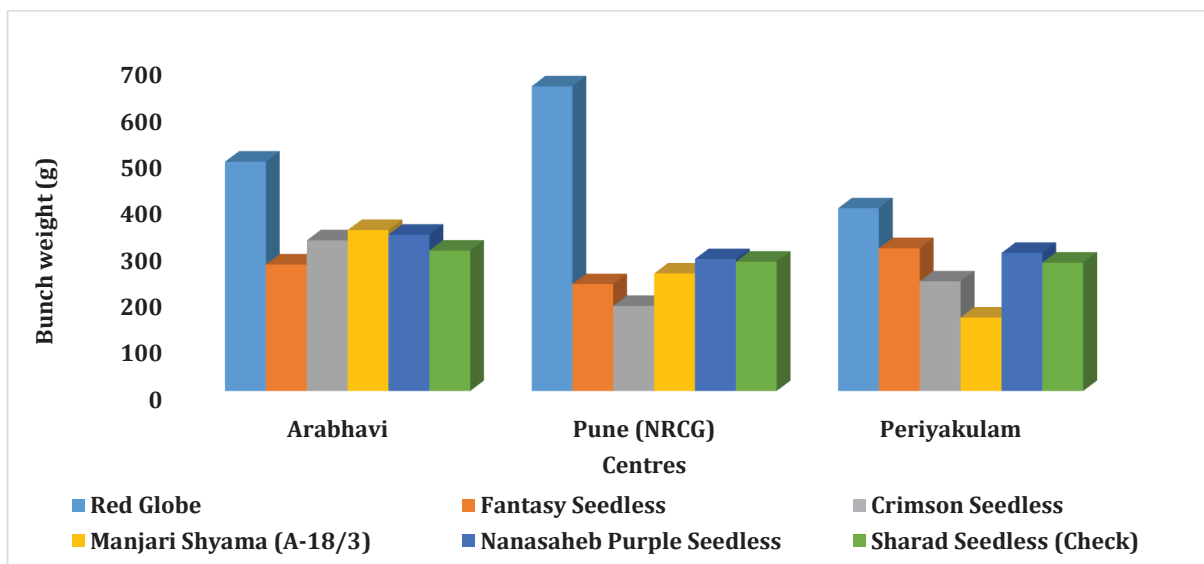


Fig. 17: Evaluation of table grape varieties for bunch weight (g) at different centres


Red Globe

Fantasy Seedless

Crimson Seedless

Manjari Shyama (A-18/3)

Nanasaheb Purple Seedless

Sharad Seedless (Check)
Fig. 18: Evaluation of coloured table varieties

1.4.8.Gr. Evaluation of raisin varieties

Vineyard with four raisin grape varieties viz., Merbein Seedless, 2A Clone, Kishmis Rozavis White and Thompson Seedless grafted on Dogridge rootstock was raised in Randomized Block Design.

Arabhavi (Vijayapura): Among different raisin varieties, Thompson Seedless has recorded significantly highest fresh fruit yield (16.84 kg/vine) which was at par with Manjari Kishmish (16.55 kg/vine), whereas minimum yield was recorded in Merbein Seedless (12.78 kg/vine). Significantly minimum number of raisins per 100 g (279) and highest raisin recovery was observed in Merbein Seedless (26.61%) which was at par with Manjari Kishmish (26.56%) and 2 A- Clone (26.18%), whereas Thomson Seedless (25.48%) recorded the lowest raisin recovery. Bunch weight (313 g), bunches per vines (54.2) and days to veraison (94.4) was noticed maximum in Thompson Seedless and was at par with Manjari Kishmish and 2A Clone. Significantly highest TSS (24.2°B) and less acidity (0.42%) was recorded in Thompson seedless. The days to achieve 24 °B and harvest was observed minimum in Manjari Kishmish with 136 and 131 days, respectively; and was at par with 2A Clone.

Periyakulam (Theni): Among the four raisin varieties evaluated, the highest number of productive canes (28.3), number of bunches per vine (30.9) and fruit yield (5.86 kg/vine) was recorded in Thompson Seedless but the highest berry diameter (8.03 mm) was registered in Manjari Kishmish. Variety 2A Clone had highest bunch weight (301 g). Whereas, Merbein Seedless recorded the maximum values for TSS (24.0°B) and raisin recovery of 24.6 per cent with the lowest acidity (0.39%) and moisture content (15.0 %). Merbein Seedless achieved 24°B (136 days) and veraison (105 days) significantly earlier. In the sensory evaluation maximum score was obtained by Merbein Seedless in respect to texture, sweetness, flavor, mouth feel, test and overall acceptability.

Pune (NRCG): Maximum number of fruitful canes was recorded in Manjari Kishmish (20.9) and was found at par with Thompson Seedless (20.6) and 2A-Clone (19.6). Yield has shown the widest range of variation from 2.87-4.09 kg/vine. Thompson Seedless took maximum days for veraison (99.2). Manjari Kishmish was found superior with respect to yield per vine (4.09 kg), number of bunches (20.4) and raisin recovery (31.1%). However, bunch weight

(189 g) and berry diameter (15.0 mm) was recorded maximum in Merbein Seedless. During the flowering season, incidence of downy mildew lead to loss of bunches in all the four varieties. In the sensory evaluation of raisins, the overall acceptability was found maximum for Merbein Seedless followed by Manjari Kishmish and 2A-Clone. Considering the yield, number of bunches, raisin recovery and sensory parameters; Manjari Kishmish was found better for raisin purpose as compared to other three varieties including check Thompson Seedless.

1.4.9.Gr. Evaluation of juice varieties

Vineyard with six juice grape varieties viz., Medika, Gulabi x Bangalore Purple, H 516, Concord, Arka Shyam and Bangalore Blue were grafted on Dogridge rootstock in Randomized Block Design.

Arabhavi: Among different Juice varieties evaluated Manjari Medika recorded significantly highest yield (14.8 kg/vine) followed by ARI 516 (12.5 kg/vine) whereas lowest yield is registered in Arka Shyam (5.72 kg/vine). Manjari Medika also recorded significantly highest Juice recovery (70.9%) which is on par with ARI 516 (69.1%) and Gulabi x Bangalore Purple (68.8%) whereas lowest Juice recovery is registered in Bangalore blue (60.1%). ARI 516 registered highest TSS (21.3°B) and highest values for sensory parameters (7.79).

Periyakulam: The highest yield was recorded with respect to fruit yield (13.79 kg/vine) and bunch weight (376.5 g) whereas the highest number of bunches per vine (57.4), TSS (22.84°B), juice recovery (61.7%) and the lowest acidity (0.50%) were recorded in ARI 516. The lowest bunch weight (105 g) and fruit yield (4.05 kg/vine) were registered in Concord. The flavour of the Manjari Medika and Arka Shyam was neutral and characteristic sweet flavour was sensed in ARI 516 whereas foxy flavour was noted in all other varieties.

Pune (ARI): Excess rains during the month of September and October, water was stagnated in the field for 2-3 days caused heavy incidence of mildews

and root rotting which affected performance of the plants. In spite of that, ARI 516 (7.34 kg/vine) followed by Manjari Medika (4.62 kg/vine) performed significantly better than the control Bangalore blue (1.24 kg/vine) whereas significantly lowest yield was recorded in Arka shyam (1.16 kg/vine). ARI 516 recorded highest bunches/vine (56.71) whereas Gulabi x Bangalore purple recorded average 10.2 bunches per plant. Bunch weight was highest in Manjari Medika (368 g) whereas lowest was recorded in Bangalore blue (77.4 g). Juice recovered in all the varieties was flavoured except Manjari Medika which is having neutral flavour. The variety ARI 516 recorded highest overall acceptability score followed by Manjari Medika (Fig. 19).

Pune (NRCC): Among the varieties tested, maximum yield (12.15 kg/vine) was obtained in Concord followed by ARI 516 (9.96 kg/vine) and Manjari Medika (9.41 kg/vine). ARI 516 was earliest to attain the veraison stage (91.2 days). ARI 516 had maximum number of bunches (62.9), while bunch weight was found maximum in Manjari Medika (176 g). Maximum juice recovery was recorded in Gulabi x Bangalore Purple (70.1%) at par with Manjari Medika (68.2%) and ARI-516 (67.9 %). Also the better juice colour intensity was recorded in ARI-516 (5.43 %) followed by Manjari Medika (5.31%). Considering the colour, flavour, consistency, mouth feel and taste maximum overall acceptability was achieved for ARI 516 followed by Manjari Medika during the sensory evaluation of juice, Hence, ARI-516 and Manjari Medika were found superior over other varieties under evaluation.

Rajendranagar: The trial was vitiated on account of no fruiting due to intermittent heavy rainfall followed by water logging conditions at fruit bud differentiation and during forward pruning period.

Mandsaur: Plants are still in the establishment stage.

Rahuri: Plants are still in the establishment stage.



Fig. 19: Field view of ARI 516 grapevine and bunches

2.4.1. Gr. Evaluation of commercial grape varieties on different rootstocks

The trial was laid to study the compatibility and yield potential of commercial scion varieties (Thompson Seedless for Hyderabad, Rahuri & Mandasaur and Flame Seedless for Ludhiana) on three rootstocks (1103 P, SO4, 110R and Dogridge).

Among seven centres, fruiting was achieved at the three centres (second fruiting season at Arabhavi, while first year fruiting at Ludhiana and Pune) during the period of reporting.

Arabhavi: Maximum yield was obtained in Thompson Seedless when grafted on Dogridge rootstock (13.2 kg/vine, 31.7 t/ha) followed by 110R and 1103P. Similarly, 100 berries weight (222 g), bunches per vine (43.5), mature canes (43.8 canes/vine) and fruitful canes (37.5 canes/vine) were also found maximum in Dogridge grafted Thompson Seedless. Bunch weight was reported maximum in 110R grafted vines followed by in Dogridge.

Ludhiana: Flame Seedless were grafted on four rootstocks. Hundred berries weight were found maximum when vines were grafted on Dogridge. Total soluble solids were ranged from 17.2 °B in own root vines to 17.7 °B in 1103P, SO4 and Dogridge grafted vines. Non-significant differences were reported for total soluble solids and acidity.

Pune (NRCG): At the centre, maximum yield was reported in 1103P grafted Thompson Seedless (14.2 kg/vine) at par with Dogridge (14.0 kg/vine). Number of bunches per vines were also observed maximum in 1103P grafted vines. Bunch weight (329 g) and 100 berries weight (264 g) was found maximum in Dogridge grafted vines.

5.4.2. Gr. Status of new emerging insect pests of grapes and their natural enemies

The vineyards were surveyed to record the incidence of new emerging pests and their natural enemies.

Ludhiana: In Ludhiana (Punjab), several regular insect pests infesting grapevine was observed in 2020-21. The infestation of mealybugs sp. Viz., *Nipaecoccus viridis*, *Maconellicoccus hirsutus* and *Paracoccus marginatus* was decreased by 2 per cent whereas, the incidence of Black thrips *Rhipiphorothrips cruentatus*, Six-spotted beetle *Scelodonta strigicollis*, Grey weevil *Myllocerus undecimpustulatus*, Tortrix berry borer *Lobesia* sp. and Hawk moth *Theretra alecto* was decreased by 1 per cent as compare to previous year. However, the incidence of Chafer beetle, *Holotrichia consanguinea* was increased by 1 % over previous year.

Mandasaur: The infestation of thrips *R. cruentatus* was highest and was found to be a major pest

infesting grape vineyards which increased by 20 per cent during 2020-21 at Mandasaur centre. However, the per cent infested vineyards with mealy bug, flea beetle and stem borer remained the same as past average reported.

Periyakulam: At Periyakulam, the infestation of flea beetle *Scelodonta strigicollis*, thrips *Rhipiphorothrips cruentatus*, mealy bugs *F. virgata* and *M. hirsutus* and mite *Tetranychus aurtic* were found to be decreased as compared to the past incidence. The mealybug *Maconellicoccus hirsutus* infestation was higher (10.58-15.68 %) in most of the vineyards surveyed. The mealybug infestation starts from January and the infestation level was reached maximum during the month of May. This was followed by thrips infestation (10.45-15.68 %) in the fruits. Moderate level of flea beetle infestation (12.55-14.35 %) was observed in 50 per cent of the orchards surveyed at Periyakulam centre.

Pune (ICAR-NRCG): The roving survey of grape vineyards was carried out by different centres during 2020-21. The ICAR-NRCG, Pune centre reported 46 per cent stem borer *Dervishiya cadambae* infestation in the surveyed vineyards during 2020-21. As compare to the past average the stem borer incidence was increased by 22.60 per cent at Pune centre.

Rahuri: The thrips *R. cruentatus* remained to be a major pest at Rahuri centre with hundred per cent infestation in the surveyed orchards followed by the infestation of flea beetle *S. strigicollis* (70% of the vineyards surveyed) and Spodoptera (23.33% of the vineyard surveyed), the incidence of which was increased by 43.33 and 23.33 per cent, respectively as compared to the past incidence. However, the incidence of mealy bug *M. hirsutus*, stem borer *C. scabrator* and mite *T. urticae* was decreased by 3.34, 10.00 and 3.34 per cent, respectively.

6.4.1. Gr. Survey of grape growing areas for important diseases to develop digital disease map

Roving survey was conducted periodically by the identified centres and incidence of important diseases viz., powdery mildew, downy mildew and anthracnose at different crop growth stages was recorded. The GPS data was collected and attempts were made to prepare digital map.

Ludhiana: Nine vineyards were visited after pruning and percent disease index (PDI) of different diseases were recorded. PDI of anthracnose disease was recorded in the range of 3.00-16.67 and 8.00-27.33 at 91-135 days and 136-180 days after pruning, respectively. PDI of powdery mildew was recorded in the range of 0-2 and 0-5.50 at 61-90 days and 91-135 days after pruning, respectively. PDI of downy

mildew was recorded in the range of 0-8.00 and 6.00-17.67 at 91-135 days and 136-180 days after pruning, respectively.

Mandsaur: The survey was under taken after foundation pruning and fruit pruning. In the surveyed vineyards, 0.0- 50.00 per cent anthracnose was reported in rainy season. While after fruit pruning powdery mildew, downy mildew and anthracnose incidences recorded in field were ranged between 0.0-15.0, 0.0-17.0 and 0.0-10.0 per cent respectively.

Periyakulam: Twenty vineyards were surveyed during the reporting period. During the reporting period between 70th to 120th days, powdery mildew incidence was registered predominantly on the leaves and bunches. PDI of downy mildew incidence was recorded in the range of 6.48 -18.59, 3.62-48.11, 3.15 - 19.36 and 10.21-15.49 during 0-30, 31-60, 61-90 and 91-140 days after forward pruning, respectively. Whereas, the PDI of powdery mildew incidence was observed in the range of 1.25 - 5.13, 3.26- 24.33, 0 - 31.45 and 15.22 - 35.16 during 0-30, 31-60, 61-90 and 91-140 days after forward pruning, respectively.

Pune (ICAR-NRCG): Surveys were conducted after foundation pruning at Nashik (8 vineyards), Sangli (7 vineyards), Osmanabad (4 vineyards) and Pune (4 vineyards) for anthracnose, downy mildew, powdery mildew and bacterial leaf blight. The range of per cent disease index (PDI) for anthracnose was 2.25-6.04, 2.28-5.46, 0.00-5.32 and 2.03-4.20 at Nashik, Sangli, Osmanabad and Pune, respectively. The incidence of downy mildew, powdery mildew and bacterial leaf spot was comparatively low at all the vineyard surveyed.

In contrast to disease incidence recorded after foundation pruning, the incidence of downy mildew and powdery mildew was recorded in most of the vineyard surveyed after fruit pruning (Ahmednagar: 10 vineyards, Nashik: 6 vineyards, Sangli: 9 vineyards and Solapur: 14 vineyards). The incidence of downy mildew ranged between 0.00-8.20 PDI, 0.00-8.20 PDI, 0.00-7.41 PDI and 0.00-6.48 PDI at Ahmednagar, Nashik, Sangli and Solapur, respectively. The incidence of powdery mildew was observed between the range of 0.00-6.23 PDI, 0.00-5.63 PDI, 0.00-8.30 PDI and 0.00-11.25 PDI at Ahmednagar, Nashik, Sangli and Solapur, respectively.

Rahuri: During the reporting period, sixteen vineyards were surveyed periodically at different growth stages. The incidence of anthracnose was recorded in the range of 0.0-3.87 PDI and 0.0-5.12 PDI at 61-90 and 91-135 days after fruit pruning. PDI of downy mildew incidence was recorded in the range of 0.00-20.54, 0.00-21.6 and 0.00-17.3 PDI during 31-60 days, 61-90 days and 91-135 days

after fruit pruning, respectively. PDI of powdery mildew was recorded in the range of 0.00-3.21, 0.00-3.25, 0.00-21.0 and 0.00-23.1 PDI during 1-30, 31-60, 61-90 and 91-135 days after fruit pruning respectively. Whereas, surveys carried out after foundation pruning 2021, has recorded the PDI of anthracnose in the range of 0.00-0.84, 0.00-3.12, 3.25-18.3 and 3.90-46.2 PDI at 1-30, 31-60, 61-90 days and 91-135 days. PDI of downy mildew was observed in the range of 0.00-5.11, 0.00-6.25, 1.25-20.4 and 3.26-35.2 PDI at 1-30, 31-60, 61-90 days and 91-135, respectively. PDI of powdery mildew was observed in the range of 0.00-0.95, 0.00-16.1, 0.00-18.1 and 0.11-25.2 PDI at 1-30, 31-60, 61-90 days and 91-135 after pruning, respectively.

Rajendranagar: During reporting period, eight vineyards were visited periodically and recorded the intensity of different diseases after foundation and fruit pruning during 2021. The disease incidence downy mildew was recorded in the range of 0.00-38.2 after foundation pruning and from 0.00-12.8 after fruit pruning. The disease incidence of powdery mildew was recorded in the range of 0.00-8.17 after foundation pruning and from 0.00-10.8 after fruit pruning. Whereas, anthracnose disease incidence was recorded in the range of 0.00-26.3 after foundation pruning and no incidence was recorded after fruit pruning. The PDI of rust disease on leaves was recorded in the range of 0.00- 5.22 PDI after foundation pruning only.

Vijayapura: Fifty-six vineyards were visited after backward pruning and forward pruning during 2021. PDI of anthracnose disease was recorded in the range of 0.00-5.00, 0.00-15.0, 0.00-15.0 and 0.00-15.0 PDI during 0-30 days, 31-60 days, 61-90 days and 91-140 after backward pruning, respectively. PDI of downy mildew disease on leaves was recorded in the range of 0.00-5.00, 0.00-7.50 PDI during 61-90 days and 91-140 days after backward pruning, respectively. PDI on leaves of *Bacterial leaf spot* in the range of 0.00-8.00, 0.00-16.0, 0.00-16.0 and 0.00-16.5 PDI during 0-30 days, 31-60 days, 61-90 days and 91-140 days after backward pruning respectively. The PDI of anthracnose disease was recorded in the range of 5.00-70.0, 0.00-20.0, 0.00-10.0 and 0.00-8.00 PDI during 0-30 days, 31-60 days, 61-90 days and 91-140 after forward pruning, respectively. PDI of downy mildew disease on leaves was recorded in the range of 0.00-55.0, 0.00-20.0 and 0.00 to 5.00 PDI during 0-30, 31-60 and 61-90 days and 61-90 days after forward pruning, respectively. PDI of powdery mildew disease on leaves in the range of 0.00-15.0, 0.00-25.0 and 0.00-35.0 PDI during 31-60 days, 61-90 days and 91-140 days after forward pruning, respectively.

6.4.3.Gr. Bio intensive disease management in grapes

Vineyard less than 10 years old was selected as experimental material and six different treatments were imposed for disease management in grapes.

Arabhavi: The experiment was implemented at HREC, Vijayapura (Tidagundi) during 2021 as per the technical programme. During the study period the disease incidence were recording at fortnightly interval. The spraying of bio inoculums, sample collection, residue analysis at ICAR-NRC for Grapes and data analysis is under progress.

Mandsaur: At Mandsaur centre, treatment T₄ and T₅ were found effective comparatively in controlling downy mildew. With respect to powdery mildew T₄, T₃ and T₁ were most effective. While T₄ and T₅ were found most promising for anthracnose control.

Periyakulam: The fruit pruning was carried out on 25.08.2021. Before imposing the treatments, Percent Disease Index (PDI) of downy mildew was observed on leaves ranged from 7.90 to 9.46 per cent. The results of this experiment revealed that 6th spray after observation on downy mildew incidence was observed in the soil drenching of *Trichoderma asperelloides* with foliar spray of *T. asperelloides* / Azoxystrobin 11% + Tebuconazole 18.3 % w/w @ 0.75 ml/l (T₃) recorded the lowest PDI of 4.89 followed by soil drenching of *Trichoderma asperelloides* @0.5 g/l with the foliar spray of *T. asperelloides* @ 2ml/l (T₁) recorded of 6.16 PDI and when compared to the control (Fig. 20).

In the case of powdery mildew disease, the incidence on leaves ranged from 7.65 to 12.58 per cent. Observation of powdery mildew disease incidence after 6th spray revealed that soil drenching of *Trichoderma asperelloides* with foliar spray of

T. asperelloides / Azoxystrobin 11 % + Tebuconazole 18.3 % w/w @ 0.75 ml/L (T₃) were recorded the lowest PDI of 9.86 followed by soil drenching of *Trichoderma asperelloides* @ 0.5 g/l with the foliar spray of *T. asperelloides* @ 2ml/l registered the highest PDI score of 10.95 when compared to the control.

Rajendranagar: The treatments were applied as per the protocol from 9-7-2021 during vegetative growth after foundation pruning and continued till 11-1-2021 at weekly intervals. The disease incidence was recorded at fortnightly interval. The actual rainfall during June, July August and September was much higher than the normal rainfall. The weather was highly favorable for diseases. When compared to control the disease incidence was less severe in all treatments. Initially treatments T₃ and T₄ recorded less disease severity when compared to T₁, T₂ and T₅. However, after 110 days of pruning anthracnose and downy mildew became severe in all treatments. There was slight incidence of powdery mildew at later stages. Therefore, irrespective of treatments premature leaf fall was observed.

After fruit pruning the treatments were applied from 18th October 2021 till date at weekly intervals. The observations are in progress. Except in control diseases incidence was not observed in other treatments till 51 days after pruning. After which moderate incidence downy mildew was observed both on leaves and fruits in control, T₁, T₂ and T₅ treatments. Hence need based chemical spray had to be given to all treatments in order to control the disease severity. The sprays have again been stopped from 20-12-2021 since the downy mildew is now in control and the treatments are imposed as per the protocol.

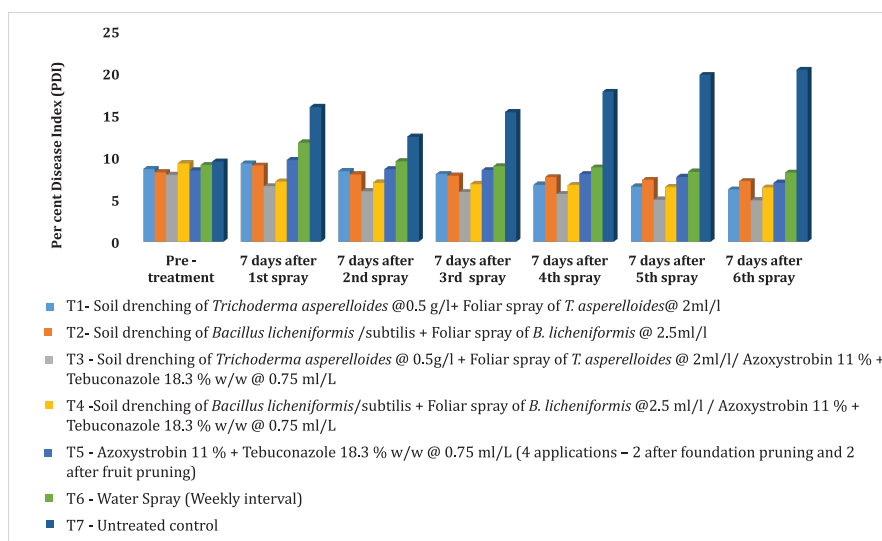


Fig. 20: Effect of bio intensive diseases management practices on downy mildew disease incidence on grapes leaves (var. Muscat Hamburg) at Periyakulam centre

GUAVA

1.2.1.G. Augmentation and evaluation of germplasm in guava

Collection of different genetic resources of guava from various locations in the country and document the details as per the descriptor besides conserving diversity. Based on the characterisation, it is also planned for selection of the promising genotypes based on yield, quality, pest and disease tolerance/resistance.

Bengaluru: During the reporting period, maintaining genetic repository with total collection of 69 genotypes for evaluation of desirable traits like red flesh, soft seeded, more pulp recovery, high yielding, lycopene content and tolerance to TMB.

Lucknow: During the reporting period, Lucknow centre collected 2 accessions with total conservation of 162 genotypes in the field gene bank for evaluation with genetic traits *viz.*, flesh colour, soft seeded and TSS content.

Ludhiana: During reporting period, two new accessions were collected and totally 47 accessions were conserved in genetic repository. Evaluated one promising genotype for the character of skin colour, flesh content and TSS.

Pantnagar: During the reporting period, 13 accessions were conserved and 2 accessions were evaluated. The evaluation results revealed that the highest fruit yield (64.12 kg/tree) and fruit weight (198.10 g) recorded in the genotypes KG guava and Kayam Ganj respectively. The highest ascorbic acid content (148.03 mg/100 pulp) and seed hardness (14.52 kg) registered in the var. KG guava. The maximum 100 seed weight (1.23 g) reported in the variety Kisar Safeda. During this year three new collection *viz.*, PGSS 1 (Red flesh with soft seeded) and PGSS 2 & PGSS 3 (White flesh with soft seeded) genotypes were included in the gene bank.

Rewa: During reporting period, two new accessions were collected and added to the existing 79 accessions in the guava repository and so far, 20 accessions were evaluated for yield and quality. During the year the centre got IC

Sangareddy: One new accession was included to the germplasm collection, thus making the total collection to 25, which were evaluated during reporting period.

Udaipur: Three new accession included with total of 82 genotypes under conservation.

1.2.4.G. Testing the performance of promising hybrid/selection of guava

Guava varieties released by different institutes/universities were tested by the coordinating centres for their performance. The varieties included are Arka Amulya, Arka Mridula, CISH-G-1, CISH-G-3 (Lalit), CISH-G-4 (Shweta).

Sabour: Variety CISH-G-1 exhibited the highest fruit yield (13.54 kg/tree) and number of fruits per tree (120.40) while, the maximum fruit weight (127.20 g) was recorded under check variety Allahabad Safeda. With respect to quality parameters, the higher producing variety CISH-G-1 recorded with the lowest TSS (i.e. 8.40°B) and medium acidity (0.34%) as compared to variety Shweta where significantly maximum TSS (i.e. 10.24°B) with fairly low acidity (0.32%) was observed. Though maximum acidity i.e. 0.42% was observed under variety Lalit.

1.2.5.G. Testing the performance of new promising hybrids/selections of guava

A trial has been laid out with 10 varieties *viz.*, MPUAT S-1 (PH SG-10-1), MPUAT S-2 (PH SG-10-2), Arka Kiran (PH SG-10-3), SRD H-1 (PH SG-10-4), SRD H-4 (PH SG-10-5), CISH G-35 (PH SG-10-6), (PH SG-10-8), RCGH-7 (PH SG-10-9), RCGH-1 (PH SG-10-10), RCGH-11 (PH SG-10-11) and RCGH-4 (PH SG-10-12) released by different institutes/universities along with Allahabad Safeda as standard check (Fig. 21).

Neri: Trial has been initiated, plants are in vegetative stage.

Ranchi: Trial has been initiated, plants are in vegetative stage.

Raipur: Trial is in initial stage and centre is in process of procuring planting materials.

Sabour: No significant difference was recorded in the yield apart from fruit weight (124.60 g) over check (104.80 g).



Fig. 21: Performance of new promising hybrids selections of guava

1.2.6.G. Evaluation of new hybrids of guava (MLT-4)

New trial has been laid out using 5 hybrids (Arka Rashmi, CISH-GS14, CISH-GS15, IIHR 13-14 and Allahabad Safeda) for testing their performance at Anantharajupet, Neri, Rahuri, Rewa, Periyakulam and Udaipur centres (Fig. 22).

Anantharajupet: Performance of different guava hybrids revealed that no significant difference was recorded among the hybrids.

Neri: No significant difference was recorded among the hybrids.

Periyakulam: Performance of different guava hybrids revealed that maximum plant height (2.88

m), pulp weight (177.22 g), fruits per tree (21.44) and fruit weight (178.70 g) was recorded in Allahabad Safeda.

Rahuri: Performance of different guava hybrids revealed that maximum fruit weight (168.25 g) was recorded in Allahabad Safeda and maximum TSS (12.50°B) in Arka Rashmi. However, no significant difference was recorded for other parameters.

Rewa: The results revealed that maximum fruit yield (8.10 kg/tree) and TSS (11.29°B) was recorded in Allahabad Safeda. However, no significant difference was recorded for other parameters.

Udaipur: No significant difference was recorded among the hybrids.



Arka Rashmi

Lalit

IIHR 13-14

Allahabad Safeda

Fig. 22: New hybrids of guava (MLT-4)

1.2.7.G. Testing the performance of promising hybrids of guava (MLT-5)

Anantharajupet: Trial is in initial stage, and centre in the process of procuring the planting material

Lucknow: Trial is in initial stage, and centre in the process of procuring the planting material

Sabour: The plantation has completed. Plant growth is satisfactory.

Sangareddy: Trial is in initial stage, and centre in the process of procuring the planting material

Udaipur: The trial has been initiated

3.2.2.G. Irrigation trial in guava (drip)

A trail has been laid out in RBD with three replications, having five treatments (70% ER, 80% ER, 90% ER, and 100% ER and local control as calendar schedule).

Rewa: Among five treatments, irrigation with 90% ER exhibited maximum yield (21.02 kg/tree), fruits per tree (120). Whereas, maximum fruit weight (260.85

g) and TSS (11.23°B) was recorded in 80% ER. However, other parameters recorded no significant difference between the treatments (Table 16).

Udaipur: Among the five treatments, drip irrigation at 80% ER has recorded maximum yield (27.42 kg/tree & 45.71 t/ha). However, for other yield parameters no significant difference was recorded among the treatments.

Table-16: Effect of irrigation treatments on fruit yield, number of fruits and fruit weight of guava

Treatments	Yield (kg/tree)		Fruits/tree		Fruits weight (g)	
	REW	UDP	REW	UDP	REW	UDP
70% ER	15.02	12.77	62.00	62.88	242.32	203.11
80% ER	14.31	27.42	52.00	105.13	275.25	260.85
90% ER	21.02	23.40	120.00	95.70	175.19	244.50
100% ER	17.87	20.73	75.00	88.04	238.25	235.44
Local control (Calendar schedule)	12.34	17.53	56.00	81.50	220.32	215.04
CD at 5%	0.12	2.85	5.44	11.84	0.78	28.59

Rewa: REW and Udaipur: UDP

3.2.3.G. Development of organic source of nutrient package and practice for guava

The trial was laid out to develop organic package for guava with seven treatments in RBD replicated three times.

Ludhiana: No significant difference was recorded for yield parameters.

Rahuri: Application of vermicompost (30 kg/plant) + *Azospirillum* culture @ 250 g/tree + PSB @ 250 g/tree + vermiwash recorded maximum fruits per plant (646.51). However, no significant difference was recorded for other growth and yield parameters among the treatments.

Sabour: Maximum number of fruits per tree (291.00) was recorded in the treatment with vermicompost (30 kg/plant) + *Azospirillum* culture+ PSB (@ 250 g/tree). However, no significant difference was recorded for other growth and yield parameters among the treatments.

Sangareddy: Application of Vermicompost (30 kg/plant) + *Azotobactor*+ PSB (@ 250 g/ tree) recorded maximum fruit weight (184.00 g). However, the growth and other yield parameters were non-significant (Table 17).

Vengurle: Plants pruned during the month of April, 2021 and are in vegetative phase.

Table-17: Effect of organic source of nutrients on number of fruits per plant and yield of guava at different centres

Treatments	Fruits/plant				Yield (kg/tree)			
	LDH	RHR	SBR	SNG	LDH	RHR	SBR	SNG
T ₁	278.0	551.77	216.33	338.3	54.60	87.10	42.70	40.26
T ₂	322.3	592.72	180.67	325.5	65.62	93.29	36.22	43.29
T ₃	299.0	613.06	161.67	332	54.84	91.92	30.46	49.92
T ₄	351.0	588.99	291.00	360	61.78	93.27	52.37	47.33
T ₅	309.3	619.24	266.00	355	54.13	92.71	53.35	51.47
T ₆	345.0	646.51	179.33	318.3	69.21	102.18	32.52	43.28
T ₇	308.0	622.11	202.33	292.6	57.35	100.83	40.08	39.23
CD at 5%	18.6	24.34	18.55	6.90	5.9	3.32	4.79	2.06

LDH: Ludhiana, RHR: Rahuri, SBR: Sabour, SNG: Sangareddy & VNG: Vengurle

#T₁: FYM (30 kg/plant), T₂: FYM (30 kg/plant) + *Azospirillum* culture+ PSB (@ 250, T₃: Vermicompost (30 kg/plant) g/tree), T₄: Vermicompost (30 kg/plant) + *Azospirillum* culture+ PSB (@ 250 g/tree), T₅: Vermicompost (30 kg/plant) + *Azotobactor*+ PSB (@ 250 g/ tree), T₆: Vermicompost (30 kg/plant) + *Azospirillum* culture @ 250 g/tree + PSB @ 250 g/tree + vermiwash, T₇: Vermicompost (30 kg/ plant) + *Azotobactor* + PSB @ 250g/tree) + vermiwash (dilution with water @ 1:1)

3.2.4.G. Enhancing the input use efficiency in guava under HDP

The experiment was laid out with various treatment combinations comprises of the raised bed cultivation, drip irrigation (80% ER), fertigation (75% RDF), mulching, micronutrient spray with $ZnSO_4$ & H_3BO_3 . The Fe @ 0.5 & Mn @ 0.4 was also added as micronutrients at Periyakulam, Rewa, Sabour and Sangareddy.

Lucknow: No significant difference was recorded among the treatments.

Mohanpur: During the reporting period no significant difference was recorded among the treatments.

Neri: The trial has been initiated in 2019 and the plants are in vegetative phase. Maximum plant height (4.33 m) and canopy volume (8.26 m³) was recorded in treatment with raised bed cultivation +drip irrigation (80% ER at all stages) + Fertigation (75% RDF) + Mulching with 100-micron UV stabilize black polythene + Micro nutrients spray ($ZnSO_4$ & Boric acid @ 0.2 %).

Pantnagar: No significant difference was recorded among the treatments.

Periyakulam: Significantly maximum number of fruits per tree (290.53), fruit weight (185.25 g) were recorded with the treatment of T₁ [Raised bed cultivation + Drip irrigation + Fertigation (75% RDF) + Mulching with 100-micron UV stabilize black polythene + Micro nutrients spray ($ZnSO_4$ & Boric acid @ 0.02%)], when compared to control (229.55 & 128.88 g respectively).

Rewa: Raised bed cultivation + Drip irrigation (80% ER at all stages) + Fertigation (75% RDF) + Mulching with 100-micron UV stabilize black polythene recorded maximum number of fruits per tree (150). Whereas, maximum fruit weight (200.00 g), TSS (11.36 °B) and shelf life (5.65 days) was recorded in the treatment of with raised bed cultivation Drip irrigation (80% ER at all stages) + Fertigation (75% RDF) + Mulching with 100-micron UV stabilize black polythene + Micro nutrients spray ($ZnSO_4$ & Boric acid @ 0.2 %) when compared to control (165.00 g, 9.73 °B and 2.71 days respectively).

Sabour: No significant difference was recorded among the treatments.

Sangareddy: The treatment, Raised bed cultivation Drip irrigation (80% ER at all stages) + Fertigation (75% RDF) + Mulching with 100 micron UV stabilize black polythene + Micro nutrients spray ($ZnSO_4$ & Boric acid @ 0.2 %) recorded higher fruit yield (38.05 kg/tree) fruits per tree (226.7), fruit weight (177.20 g), TSS (11.21 °B)

and ascorbic acid (170.50 mg/100 g), when compared to control (15.60 kg/tree, 119.25 fruits per tree, 115.75 g 10.18 °B and 138.50 mg/100 g respectively).

Udaipur: Significantly higher fruit yield (22.12 kg/tree), fruits per tree (98.10) and BC ratio (3.23) were registered with the treatment of T₁ [Raised bed cultivation + Drip irrigation + Fertigation (75% RDF) + Mulching with 100-micron UV stabilize black polythene + Micro nutrients spray ($ZnSO_4$ & Boric acid @ 0.02%)], when compared to control (9.47 kg/tree, 51.80 fruits per tree and BC ratio (1.95) respectively).

3.2.5.G: Evaluation of Arka Microbial Consortium (AMC) for guava

The trial was taken to study the effect of AMC on guava, the trial has been laid out in RBD replicated seven times with four plants per replication. Region specific variety was used.

Pantnagar: Significantly higher TSS (13.69 °B), ascorbic acid (256.43 mg/100 g) and B:C ratio (2.90) were recorded with the treatment with 75% RDF + AMC soil application (12.5 kg/ha) twice a year along FYM] as compared to control (11.08 °B, ascorbic acid 202.29 mg/100 g and 1.50 respectively). However, other yield parameters were found non-significant among the treatments.

Rahuri: No significant difference was recorded among the treatments.

Rewa: Significantly higher fruit yield (56.40 kg/tree), fruits per tree (235.00), and TSS (13.24 °B) were recorded with the treatment T₃ [75% RDF + AMC soil application (12.5 kg/ha) twice a year along FYM] as compared to control (30.60 kg/tree, 180.00 fruits per tree & 12.34 °B respectively).

Sabour: No significant difference was recorded among the treatments.

Sangareddy: Application of 5% RDF + AMC soil application (12.5 kg/ha) twice a year along FYM recorded significantly higher fruits yield (15.98 kg/tree) and fruits per tree (124.20) as compared to control (12.25 fruits/tree & 66.40 fruits per tree respectively)

Udaipur: Application of 75% RDF + AMC soil application (12.5 kg/ha) twice a year along FYM recorded significantly higher fruit yield (45.39 kg/tree and 12.62 t/ha), fruits per tree (241.20) with higher BC ratio (2.19) as compared to control (30.43 kg/tree & 8.46 t/ha, 182.00 fruits per tree and BC ratio 1.62) (Table 18).

Table-18: Effect of different treatments on fruit yield (kg/tree) of guava at various centres

Treatments #	Pantnagar	Rahuri	Rewa	Sabour	Sangareddy	Udaipur
T ₁	29.3	44.71	44.65	12.80	11.64	33.33
T ₂	33.9	50.53	36.08	13.19	13.34	38.00
T ₃	38.0	48.68	56.40	14.66	15.98	45.39
T ₄	26.9	42.51	30.60	12.25	8.85	30.43
CD at 5%	7.17	3.77	6.70	1.45	2.18	3.21

T₁: 100% Recommended Dose of Fertilizers (RDF) as soil application, T₂: 75% RDF + AMC soil application (4 times @ 5g/l) through biofertiligation, T₃: 75% RDF + AMC soil application (12.5 kg/ha) twice a year along FYM, T₄: 75% RDF

5.2.2.G. Survey for new and emerging insect pests and their natural enemies in guava

Observation were recorded from ten guava trees randomly and maintained without applying any pesticides. Incidence of new and emerging pests was recorded.

Lucknow: Incidence of thrips was observed as increasing trend in various orchards of the state during the reporting period, incidence was 4.3 percent. The occurrence semilooper *Hyposidra talaca* was also observed on the foliage and young fruits, the incidence were 35.3 percent.

Ludhiana: Snail, *Lymnaea* sp. (Family Lymnaeidae) was reported as new pest on guava

Mohanpur: Guava fruit borer (*Conogethes punctiferalis*), fruit fly (*Bactrocera dorsalis*, *B. zonata*), shoot borer (*Microcolona technographa*) were recorded as predominant pests.

Pantnagar: Larvae of *Helicoverpa armigera* Hübner was observed for the first time on guava fruits, the incidence of thrips was observed as increasing trend in various orchards of the state during the year 2021. Similarly, the occurrence of mealy bug, *Rastrococcus* sp. was found causing serious damage (35.75%) to the guava fruits and affecting yield.

Sangareddy: The dynamics of pest population in guava post monsoon period of 2020-21 revealed that spiralling whitefly and fruit flies recorded more incidence, whereas, fruit borer has recorded less incidence.

5.2.4.a.G Biological control of tea mosquito bug *Helopeltis antonii* Signoret by *Beauveria bassiana* on guava

The trails have been initiated as per the envisaged programme. Initial observations like number of tea mosquito bug (TMB) affected fruits/healthy fruits were calculated. Spraying of different concentrations of *Beauveria bassiana* WP at 10 days intervals (T₁ to T₃) and chemical sprays (T₄) at 15 days interval is in progress.

Bengaluru: Among the three different doses of bio-control agent *B. bassiana* tested minimum TMB damage (%) was recorded in *B. bassiana* @ 12 g/lit (14.04 %), whereas the chemical insecticide lamda-

cyhalothrin @ 0.05% recorded 10.46% and in control TMB damage recorded 56.95%. The TMB population ranged from 1.15 to 2.72 in different treatments as against 4.00 in control, minimum TMB population among the three different doses of bio-control agent *B. bassiana* in T₃ (*B. bassiana* W/P-12g/l) recorded (1.58). However chemical insecticide Lambda-cyhalothrin 0.05% recorded (1.15) TMB population. Similar trend has been observed for number of TMB damaged fruits (47.06), weight of healthy (23.01) and damaged fruits (3.76) and BC ratio (2.15) in T₃ (*B. bassiana* W/P-12g/l) as over control (19.28 kg/tree, 140.89, 8.30, 10.98 & 1.13 respectively)

Lembucherra: Among the three different doses of bio-control agent *B. bassiana* tested no significant difference was observed. Minimum TMB damage (%) was recorded in *B. bassiana* W/P-12g/l (15.91%), which was closely followed by *B. bassiana* W/P-10g/l, which recorded 16.16 % as against 20.83 % in standard check (Lambda -cyhalothrin - 0.05%) and 27.50% in control. Whereas, maximum yield (22.49 kg/tree), weight of healthy (15.74 kg/tree) and BC ratio (1.76) in treatment *B. bassiana* W/P-10g/l over the standard check (Lambda-cyhalothrin - 0.05%) 18.13 kg tree yield, 24.00, 15.55 kg/tree & 1.21 respectively.

Periyakulam: Among the treatments no significant difference was recorded for TMB damage. TMB population ranged from 2.15 to 4.72 in different treatments as against 6.45 in control. Similar among the three bioagents *B. bassiana* W/P-5g/l recorded minimum number of fruits damaged (171.84) and maximum weight of healthy fruits (33.84), minimum damaged fruits (19.16).

Tinsukia: Among the treatments, minimum TMB damage (%) was recorded in *B. bassiana* @ 12 g/lit (24.85 %), whereas the chemical insecticide lamda-cyhalothrin @ 0.05% recorded 36.80 % and in control TMB damage recorded 40.91%. TMB population ranged from 3.75 to 5.47 in different treatments as against 7.20 in control. Similarly, minimum number of TMB damaged fruits (15.60), weight of healthy fruits (17.50 kg/tree) and BC ratio (2.60) in treatment *B. bassiana* W/P-12 g/l over the standard check (Lambda -cyhalothrin - 0.05%) 25.80, 14.25 kg/tree & 1.78 respectively (Table 19-20).

Table-19: Yield and fruit damage by tea mosquito bug at different centres

Treatments #	Yield (kg/tree)				Fruits damaged by tea mosquito bug (Number)			
	BLR	LEM	PKM	TNK	BLR	LEM	PKM	TNK
T ₁	24.65	18.77	57.28	13.80	96.87	163.42	166.77	31.30
T ₂	27.75	22.49	51.81	15.40	95.06	213.94	171.84	22.30
T ₃	26.77	20.14	53.9	17.50	47.06	213.56	176.27	15.60
T ₄	33.91	18.13	61.13	14.25	45.63	184.57	160.43	25.80
T ₅	19.28	13.42	41.4	10.10	140.89	246.29	230.47	35.34
CD at 5%	3.70	0.98	10.43	2.31	3.52	8.86	1.30	3.31

#T₁: B. bassiana W/P-5g/l, T₂: B. bassiana W/P-10g/l, T₃: B. bassiana W/P-12g/l, T₄: Lambda -cyhalothrin - 0.05%, T₅: Unsprayed (control); BLR-Bengaluru, LEM-Lembucherra, PKM-Periyakulam, TNK-Tinsukia
 Values in the parenthesis are arcsin transferred values for damage (%) and square root transformed for population.

Table-20: Weight of healthy and damaged fruits at different centres

Treatments #	Weight of healthy fruits (kg/tree)				Weight of damaged fruits (kg/tree)			
	BLR	LEM	PKM	TNK	BLR	LEM	PKM	TNK
T ₁	16.91	16.63	33.84	13.80	7.74	2.14	19.16	2.60
T ₂	20.15	20.28	29.36	15.40	7.60	2.21	19.47	2.02
T ₃	23.01	18.21	29.45	17.50	3.76	1.93	20.76	1.30
T ₄	30.36	15.55	36.85	14.25	3.55	2.58	21.69	2.15
T ₅	8.30	10.21	20.10	10.10	10.98	3.21	23.80	2.95
CD at 5%	3.25	1.71	1.73	2.31	2.98	2.14	2.50	1.02

#T₁: B. bassiana W/P-5g/l, T₂: B. bassiana W/P-10g/l, T₃: B. bassiana W/P-12g/l, T₄: Lambda -cyhalothrin - 0.05%, T₅: Unsprayed (control); BLR-Bengaluru, LEM-Lembucherra, PKM-Periyakulam, TNK-Tinsukia
 Values in the parenthesis are arcsin transferred values for damage (%) and square root transformed for population.

5.2.5.G. Slow-release pheromone formulation for the management of fruit fly in guava

Ananthrajupeta: The results revealed that, slow release pheromone formulation trapped 390.6 fruit flies per trap whereas conventional fruit fly trap trapped 303.05 at weekly intervals. The percent fruit damage due to fruit fly incidence after harvest is 7 and 19 in slow release pheromone formulation and conventional fruit fly trap treatments respectively.

Lucknow: Fruit flies trapped were found significantly different between the T1 and T2 ($t = -3.88$; $df = 129$; $p < 0.001$). Highest number of fruit flies were trapped in slow-release pheromone formulation (55.2 fruit flies /trap/week) compared to the Conventional lure (22.1 fruit flies /trap/week).

Ludhiana: Conventional lure (PAU Fruit Fly Trap) was found to be more effective than Slow-release pheromone formulation as evident from a greater number of trap catches with 47.3 fruit flies as compared to 26.4 per cent fruit flies in slow release trap, in guava. The per cent fruit infestation was also low in conventional PAU Fruit Fly Trap (22.3%) as compared to 35.7 per fruit infestation in slow release trap. The slow release trap trapped the fruit flies for 3 weeks more as compared to Conventional trap.

Mohanpur: The results revealed significant differences between the treatments. Maximum number of adult flies was trapped by conventional bottle trap (519.7 fruit flies /trap/week) using methyl eugenol. However, in case of conventional

lure refilling was done (ignored while doing the analysis) and in case of slow-release pheromone trap the fruit fly adults were found almost consistent to slightly lower at 7th and 8th week of installation and then reduced its efficiency.

Pantnagar: Maximum numbers of fruit flies were captured in the treatment with slow-release pheromone trap (72.25 fruit flies /trap/week) as compared to the treatment with conventional bottle trap (44.05 fruit flies /trap/week) on 28 SMW. The shelf-life of the slow-release pheromone formulation was observed as 3 months.

Periyakulam: Peak catches of fruit fly was observed on 34 and 35 SMW (82 and 64 flies/trap/week). Thereafter the catches were declined and zero on 38 SMW. Whereas the maximum catches of fruit fly in methyl eugenol trap was on 32 SMW and thereafter gradually decline and no catches on 38 SMW. Comparing the two traps, slow-release pheromone trap attracted more flies than methyl eugenol trap (conventional bottle trap) and the difference over ME trap was 48.53%. The effectiveness of the slow release pheromone is more than 30 days

Udaipur: Maximum fruit fly catch (256.95/trap) was recorded in T₁ (Slow release pheromone formulation trap) during 32th SMW (6Aug.-12Aug., 2021) which was significantly superior to T₂ (Conventional lure i.e. Methyl Eugenol trap) (i.e. 227.10/trap). The shelf life of T₁ (Slow release pheromone formulation trap) was about 10 weeks (Table 21).

Table-21: Per cent fruit damage due to fruit fly and shelf-life of the slow-release pheromone at different centres

Centres	Per cent average fruit damage in		Shelf-life of the slow-release pheromone formulation (in months)
	T ₁ (Slow release pheromone formulation trap)	T ₂ (Conventional lure trap)	
Mohanpur	NR*	NR	2
Pantnagar	NR	NR	3
Anantharajupet	7	19	3
Udaipur	14	22	2.5
Ludhiana	35.7	22.3	1
Lucknow	NR	NR	3
Periyakulam	NR	NR	>1
*Not recorded (NR)			

6.2.2.G. Survey on disease dynamics in guava

A roving survey for occurrence of different diseases in guava at different centres was conducted and visual estimation of the disease incidence was noted for each disease at pre-monsoon, monsoon and post monsoon period.

Jorhat: During pre-monsoon, monsoon and post monsoon period major disease were Sooty mould (11, 19 & 14.5 %), Canker (11, 16 & 8.7 %) and Algal rust (15.720, 20 & 8.5 %) respectively.

Ludhiana: During monsoon period highest incidence of anthracnose (22.45%) was observed whereas, low incidence of wilt (3.75- 8%) was observed during pre-monsoon and post-monsoon periods.

Rewa: During pre-monsoon, monsoon and post monsoon period, higher incidence of anthracnose (8.3, 10.2 & 16.4% respectively) was recorded. Apart from that monsoon also recorded canker at 12.8% with low incidence of wilt (0.8 %).

Rahuri: During pre-monsoon and monsoon period incidence of canker (8.12, 55.68 & 39.75%), anthracnose (6.58 to 24.35 & 13.55 %), Dieback (3.58-5.38 & 6.25%) and Wilt (1.68, 2.25 & 0.51%) respectively was reported.

Mohanpur: During pre-monsoon, monsoon and post monsoon canker (5.25, 17.50 & 3.25 %), anthracnose (4.50, 16.00 & 5.75 %) and Algal rust (3.5, 10.5 & 2.0 % respectively) incidence was reported.

Sabour: During monsoon period 14.7 per cent of anthracnose incidence, 4.7 per cent of canker, stylar end rot (10%), Algal rust (5.1%) and wilt (5.9%) was reported.

Sangareddy: During pre-monsoon, monsoon and post-monsoon period anthracnose was reported (9.2, 10.2 & 18.4%). Sooty mould (17.3 %) Anthracnose (14.5 %) and wilt (6.0%) was also recorded during post monsoon.

JACKFRUIT

1.5.1.J. Collection, characterization, conservation, evaluation and utilization of germplasm

The jackfruit growing areas of the region were surveyed and the variability with respect to growth, flowering, fruiting and quality of the germplasm

collected at different centres was documented and characterized as per the descriptor developed by Bioversity International (IPGRI). One set of germplasm should be deposited at Bengaluru (ICAR-IIHR) to maintain in NAGS for jackfruit.

Jorhat: Exploration was carried out in major jackfruit growing areas in Central Brahmaputra Valley Zone (Marigaon), Lower Brahmaputra Valley Zone (Kamrup & Nalbari), North Bank Plains (Darrang & Udalguri) and UBZ (Jorhat & Golaghat). A total of 6 accessions were characterized and evaluated during the reporting period. Among them AAULBVZ-2 has recorded maximum number of fruits (270.33) and fruit weight (10.20 kg).

Kannara: Exploration for collection of new accession carried out at Idukki, Palakkad, Thrissur and Ernakulam districts of Kerala resulted in identification of nine accessions including all purpose types. Out of nine accessions, maximum fruit weight (15.44 kg) was recorded in KJ 48/21, collected from Thodupuzha, Idukki district and a small sized fruit of KJ51/21 (8.00 kg) was collected from Moovattupuzha, Ernakulam district. The chips recovery percentage was maximum in KJ 48/21(44.00).

Kovvur: Explorations were carried out in tribal zone of East Godavari district, high altitude of north coastal and Devarapalli Mandal of West Godavari district. Eight genotypes (in-situ) were identified from Devarapalli village, West Godavari district of Andhra Pradesh which are having unique characteristics viz., cluster bearing habit, small fruits with round shape and flakes with high TSS content. Plants in the field gene bank are in bearing stage. Twenty-nine accessions were planted from 2000 to 2015. Gumless jack has recorded highest number of fruits (84.0) and yield per plant (654.5 kg).

Lembucherra: During the reporting period, explorations were carried out in major jackfruit growing areas (Cocotilla, Salbagan, Gandhigram, Barkathal and Bamutia in West Tripura). Two new accession (TJS-22 & TJS-23) were collected and evaluated.

Mohanpur: During the reporting period, explorations were carried out in different parts of Nadia, Murshidabad and Hooghly district of West Bengal. A total of sixty accessions were identified, collected and conserved from different parts of West Bengal and adjoining states. Characterization and evaluation of forty one accessions are in progress and passport data has been submitted for IC numbers. Among them BCJ-24 and BCJ-26 has recorded maximum number of fruits (76 & 86). BCJ-27 is suitable for dessert purpose having fruit weight of more or less 2 kg with spherical shape. Big sized fruit were recorded in BCJ-22 (15.0kg) & BCJ-30 (15.3kg). Whereas, BCJ-6, 8, 9, 10, 19, 20, 31, 35 produced fruits year-round (Table 22).

Periyakulam: Explorations carried out in Maruthanathi dam site area, Ayyampalayam, Chitraevu of Dindugul districts adjoining to Western Ghats resulted in collection of two new accessions. Out of total 41 accessions conserved in field gene bank, one accession was evaluated during the reporting period and all are of table purpose type. Twenty three accessions were characterized, among which 14 accessions are in bearing stage and 9 accessions are in pre-bearing stage. The accession AH-2 has recorded maximum number of fruits (40) followed by AH 18 (26).

Table-22: Variation in fruit characteristics (quantitative) of jackfruit at different centres

Quantitative parameters	Lower (Min.)	Higher (Max.)
Fruit weight(kg)	2.0(BCJ-27).	23.10 (AH 15).
Flake/fruit ratio	0.20(BCJ-15)	0.80(AH 2).
Flake thickness (mm)	0.20 (Khajawa).	3.20 (KJ 51/21)
Flakes/ kg fruit	8.50(BCJ-30).	44.00(Khajawa)
Total soluble solids(□B)	14.80 (AH 7).	34.20 (M. Varikka)
Fruit rind thickness (cm)	0.56(BCJ-21).	1.46 (AH 10).
Flake length(cm)	3.2(Khajawa).	10.20 (AH 5).
Flake width(cm)	2.20 (AH 4).	4.9 (BCJ-2)

Note: Kannara-KJ-51/21, Kovvur- Khajawa & M. Varikka, Mohanpur-BCJ-2, BCJ-15, BCJ-21, BCJ-27 & BCJ-30, Periyakulam – AH-2, AH-4, AH-5 & AH-7.

1.5.2.J. Varietal trial in jackfruit

To evaluate promising jackfruit varieties suitable for the identified region, the trial was initiated in RBD replicated four times.

Jorhat: Among the evaluated varieties, Muttom Varikka has recorded the maximum fruit weight (7.77 kg), fruits per tree (33) and yield (25.6 t/ha) (Fig. 23).

Kovvur: Among the evaluated varieties, maximum fruits per tree (49.0) and yield (45 t/ha) were recorded in Palur-1. Whereas, Singapore jackfruit has recorded maximum fruit weight (10.2 kg).

Kannara: Among the evaluated varieties, Muttom Varikka has recorded maximum fruits per tree (130) with yield of 187.7 t/ha (Table 23).

Mohanpur: Among the evaluated varieties, maximum number of fruits per tree (20.2) was recorded in Palur-1 and maximum yield (12.8 t/ha) was recorded in Muttom Varikka which was at par with Palur-1 (12.32).

Periyakulam: Variety Palur-1 has recorded maximum number of fruits per tree (21.4) and yield (55.8 t/ha).

Table-23: Yield of jackfruit varieties at different centres

Varieties	Yield (t/ha)				
	JRH	KNR	KOV	MHR	PKM
Muttam Varikka	25.6	187.7	11.0	12.88	18.90
Gum less jack	10.0	6.6	12.5	6.85	-
Palur-1	15.4	19.0	45.0	12.32	55.82
Pechiperai-1	17.5	88.1	16.5	11.83	12.10
Singapore jack	12.1	105.5	35.2	10.14	14.76
Velipala	14.3	18.8	3.9	9.51	4.10
Burliar-1	10.0	27.5	7.2	10.92	3.30
CD at 5%	2.45	22.6	7.3	2.55	-

JRH: Jorhat, KNR: Kannara, KOV: Kovvur, MHR: Mohanpur, PKM: Periyakulam

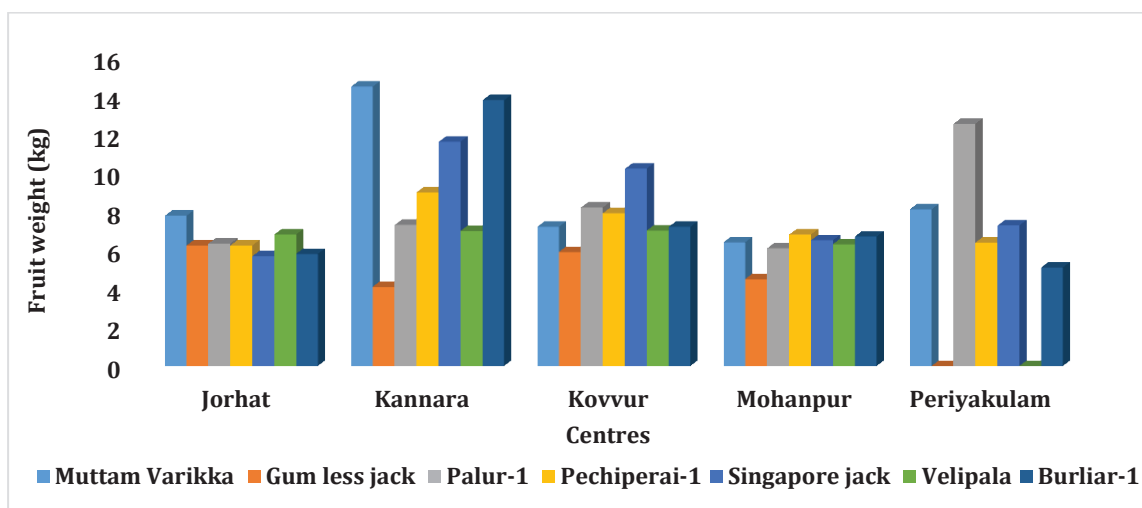


Fig. 23: Fruit weight (g) of jackfruit varieties at different centres

5.5.1.J. Survey for new and emerging insect pests of jackfruit

Roving survey and fixed plot surveys were conducted to identify the insect pests and their natural enemies associated with jackfruit.

Roving survey

Jorhat: Surveys were conducted in different areas of Jorhat, Sibsagar, Morigaon, Udalguri and Darrang districts of Assam. No new insect pests were recorded during reporting period. Fruit and shoot borer (*Glyphodes caesalis*) and aphid were recorded with an increased incidence (28 & 4%) along with Mealy bug, whitefly and Bark borer infestation was also recorded with a low incidence in jackfruit (Table 24).

Kannara: High incidences of xylophagous and phytophagous cerambycid beetles viz., *Glenea multiguttata* and *Macrochenus isabellinus* were reported from Thrissur, Wayanadu, Ernakulam, Idukki, Palakkad and Kottayam districts. Infestation of *Olenecamptus bilobus*, a defoliator was observed across the surveyed areas during the pre-monsoon and monsoon period. They preferred young shoots and made shot holes in the leaves and recorded 10-60% incidence. Sporadic and heavy incidences of Jackfruit spittle bug (*Cosmoscarta relata*) were recorded from various orchards from Wayanadu and Idukki districts of Kerala during March-May.

Kovvur: Surveys were conducted in East Godavari and West Godavari Districts of Andhra Pradesh. Infestation of fruit borer, mealy bug and *Olenecamptus bilobus* was observed in jackfruit. Among them, fruit borer was found to be the major pest of jackfruit (0.5-25.0%).

Lembucherra: During the reporting period, infestations of mealy bug (20%), shoot & fruit borer (10%) and fruit fly (30%) were recorded.

Mohanpur: No new insect pests observed during the reporting period. However, fruit borer (*Glyphodes caesalis*) damage was observed increasing in all the jackfruit growing areas (20-34.66%). The other insects reported are Aphid, Bark eating caterpillar, mealy bug as of minor importance. Incidence of eriophyid mite *Tegolophus indica* which reported as new was recorded 1 to 2 per cent infestation throughout the year. Stem borer (*Batocera rufomaculata*) was recorded very high (5.62%) in jackfruit.

Periyakulam: During reporting period, survey was conducted in various parts of Tamil Nadu. Incidence of shoot and fruit borer was maximum in Manjalar (9.36%) followed by Panruti (6.82%). Stem borer incidence was recorded maximum in Periyakulam, and Panruti (6.20%). Mealybug infestation was maximum in Vriddhachalam (8.58%) followed by Manjalar (8.52%). Aphids infestation (6.35% and 5.25%) recorded maximum in Periyakulam and Manjalar. Natural enemies viz., spiders, coccinellid grub and green lacewings egg gloom were also recorded in surveyed areas.

Table-24: Status of different insect pests of jackfruit at different centres

Centres	Name of the Pest	Past incidence (%)	Current incidence (%)	Remarks
Jorhat	Fruit & shoot borer (<i>Glyphodes caesalis</i>)	28	28 – 38	Pest incidence slightly increased
	Mealy bug	15	5 - 10.0	Pest incidence decreased
	Aphid (<i>Toxoptera aurantii</i>)	4	5.0 - 10.0	Pest incidence increased and found at budding at stage
	Bark eating caterpillar (<i>Indarbela tetraonis</i>)	Trace	Trace	Pest infestation insignificant
	Mealy bug	Trace	Trace	Pest infestation insignificant
	Rugose spiralling white fly	Trace	Trace	Pest infestation insignificant
Kovvur	Fruit borer	12.05	0.50 - 25.0	Pest infestation slightly increased
	<i>Olenecamptus bilobus</i>	15.20	0.00 - 26.50	Pest infestation remained same
	Mealy bug	1.67	2.63 - 3.33	Pest infestation remained same
Lembucherra	Mealy bug	-	20	Colonize between bark & trunk, young shoot & panicles. Nymph ascent on trees cause flower drop. Excrete honey dew; sooty mould.
	Fruit fly <i>Bactrocera umbrasia</i>	-	30	Large numbers of flies are present on fruit sucking sap.
	Shoot & fruit borer <i>Diaphania caesalis</i>	-	10	Lay eggs on tender shoots & bud on hatching bore into shoot, bud & fruit
	Bark borer <i>Inderbela tetraonis</i>	-	30	Bore holes on bark & feed on cambium layer; Gummy exudation.
	Termite	-	20	Mounding at base; making muddy tunnel on tree & feeding on cellulose matter.
	Fire ant (Red) <i>Solenopsis invicta</i>	-	10	Feed on anything in their path; young trees, seedling, bud, fruit; often kill young plant
Periyakulam	Shoot and fruit borer (%)	6.57	6.82	Pest incidence slightly increased
	Stem borer (%)	5.12	5.20	Pest incidence slightly decreased
	Mealy bug (%)	5.28	6.32	Pest incidence increased
	Aphid infestation	5.98	4.64	Pest incidence decreased
	Rugose spiralling whitefly (%)	-	4.38	Noticed during current year
Kannara	Shoot and fruit borer (<i>Margaronia caesalis</i>)	0.75 %	0.5 - 1.0 %	Pest population insignificant and remained same
	<i>Batocera rufomaculata</i>	12.5 %	10.0-15.0 %	The pest incidence remained same
	<i>Olenecamptus bilobus</i>	35.0 %	10.0-60.0 %	Pest incidence same
	<i>Glenea multiguttata</i>	12.5 %	5.0-30.0 %	Pest incidence increased
	<i>Oberea artocarp</i>	12.5 %	5.0-10.0 %	Pest incidence decreased
	<i>Epepeotes uncinatus</i>	15.0 %	5.0-25.0 %	Pest incidence increased
	<i>Macrochenus isabellinus</i>	22.5 %	10.0-35.0%	Pest incidence remained same
	Leaf caterpillar (<i>Margaronia bivitalis</i>)	15.0%	10.0 - 20.0 %	Pest incidence remained same
	Mealy bug	10%	10-25.0%	Pest incidence increased
Jack fruit aphid (<i>Greenidia artocarpii</i>)	7.5%	5.0 -10.0%	Pest incidence remained same	
Mohanpur	Bark eating caterpillar (<i>Indarbela tetraonis</i>)	3.32%	2.96-3.34 %	Regular/Minor
	Aphid (<i>Toxoptera aurantii</i>)	3.84%	3.82-4.0%	Regular/Minor
	Fruit & shoot borer (<i>Glyphodes caesalis</i>)	20.2%	20-34.66%	Regular/ Major
	Stem borer (<i>Batocera rufomaculata</i>)	2.62%	5.62%	Regular/ Major
	Mealy bug	2.28%	2.75-5.22%	Regular/Minor
	Eriophyid mite (<i>Tegolophus indica</i>)	1-2% (New)	1.2.5%	Regular/Minor

6.5.1.J. Survey on disease dynamics in jackfruit

Surveys were conducted in a systematic manner in jackfruit growing areas and the incidence of major disease(s) and new or emerging diseases has been reported.

Jorhat: Survey was conducted in different locations representing different agroclimatic zones of Assam viz. Goalpara, Kamrup (Lower Brahmaputra valley zone) Jorhat, (Upper Brahmaputra valley zone), Sonitpur (North bank plain zone) district of Assam. Leaf spot (caused by *Colletotrichum* spp., *Phyllosticta* spp), Fruit rot (*Rhizopus* spp) and Red rust/algal rust (*Cephaleuros* spp) were the most predominant diseases recorded at various magnitude. Fruit rot (*Botrydiplodia* spp) was also recorded in mature fruits during storage. No new disease was recorded during the reporting period.

Kannara: During reporting period, survey was conducted in Thrissur and Ernakulam Districts. No new diseases were recorded. Ganoderma wilt was observed in one young jackfruit plant at BRS, Kannara (Plate 3). Seedling blight caused by *Colletotrichum* sp and *Rhizctonia* sp were observed as an emerging disease with an incidence of 1-10

per cent. *Colletotrichum* leaf spot, *Rhizopus* fruit rot, *Botrydiplodia* fruit rot, *Sclerotium* fruit rot, Red rust and Pink disease were also recorded.

Kovvur: Survey was conducted in East Godavari and West Godavari Districts of Andhra Pradesh during the reporting period. No new disease was recorded. *Rhizopus* fruit rot, Leaf spot (caused by *Colletotrichum* sp) and foot rot/ collar rot are the major diseases were recorded. Jack foot rot/ collar rot was observed only at Venkataramannagudem of West Godavari District as an emerging disease (Table 25).

Mohanpur: Survey was conducted in Nadia district of West Bengal. Inflorescence rot/ Young fruit rot (*Rhizopus* spp), Post-harvest rot (*Botrydiplodia* spp) and *Phyllosticta* and *Colletotrichum* leaf spot were recorded as major regular diseases. Collar rot complex caused by *Phytophthora* was also recorded.

Periyakulam: During the reporting period, survey was conducted in existing orchards of Theni, Dindigul, Tenkasi and Tirunelveli districts. No new and emerging diseases were recorded. Leaf spot, fruit rot and Algal red rust were recorded as major jackfruit diseases in Tamil Nadu.

Table-25: Status of diseases of jackfruit at different centres

Centres (District surveyed)	Name of the disease with causal organism	Average past incidence (%)	Average current status (%)	Remarks
Jorhat (Goalpara, Jorhat, Kamrup Rural, Sonitpur district)	Leaf spot (<i>Colletotrichum</i> sp)	23 (PDS)	28 (PDS)	Increased
	Leaf spot (<i>Phyllosticta</i> sp)	9.8	11	Increased
	Algal rust (<i>Cephaleuros</i> sp.)	10.5	11	No change
	Fruit rot (<i>Rhizopus</i> sp.)	20 (PDI)	22 (PDI)	Increased
	Fruit rot (<i>Botrydiplodia</i> sp)	-	3 (PDI)	-
Kannara (Thrissur and Ernakulam District)	Seedling blight (<i>Colletotrichum</i> sp. and <i>Rhizoctonia</i> sp.)	1-5	1-8	Increased
	Algal rust (<i>Cephaleuros</i> sp.)	16	22	Increased
	Pink disease (<i>Corticium salmonicolor</i>)	8	8	No change
	Fruit rot (<i>Rhizopus</i> sp.)	20	20	No change
	Fruit rot (<i>Botrydiplodia</i> sp)	5	8	Increased
	Fruit rot (<i>Sclerotium rolfsi</i>)	-	2	Increased
Kovur (West Godavari)	Fruit rot (<i>Rhizopus artocarp</i>)	19.13	16.25	Decreased
	Leaf spot (<i>Colletotrichum gleosporoides</i>)	8.55	4.72	Increased
	Foot rot/ collar rot (<i>Phytophthora</i> sp.)	2.00	1.87	-
Mohanpur (Nadia District)	Inflorescence Rot/ Young fruit rot (<i>Rhizopus</i> spp.)	03.4 – 05.2	5.8-8.5	Increased
	Leaf spot (<i>Phyllosticta</i> sp., <i>Colletotrichum</i> sp)	10.7-17.5	12.46-15.98	No much change
	Post-harvest fruit rot/ Storage rot (<i>Botrydiplodia</i> spp.)	06.8 - 18.4	5.0-17.6	No much change
	Foot rot/collar rot (Wilt complex)	03.2 - 06.8	2.7-4.8	Decreased
Periyakulam (Theni, Tirunelveli, Tenkasi District)	Leaf spot (<i>Colletotrichum gloeosporioides</i>)	22.48%	21.82%	Decreased
	Fruit rot (<i>Rhizopus</i> sp.)	10.29%	11.83%	Increased
	Red rust (<i>Cephaleurus</i> sp)	9.18%	9.34%	Increased

6.5.2.J. Etiology of foot rot/collar rot disease of jackfruit

Isolation and characterization of pathogen from wilt infected jackfruit plants were carried out and pathogenicity was tested on jackfruit plants.

Kovvur: During reporting period, Foot rot/collar rot disease (16.67%) was recorded at Venkataramannagudem of West Godavari District. Associated pathogens were isolated and identified as *Phytophthora* sp. and *Fusarium* sp. based on microscopic studies. Pathogenicity studies with *Phytophthora* sp. produced wilting symptoms and death of the seedlings after two weeks in nursery seedlings. Pathogen was reisolated from the dead seedlings proving Koch postulates. However, number of attempts were made during the last three to four

years, *Fusarium* sp. was not producing any disease symptoms in the inoculated seedlings (Fig 24)

Mohanpur: Two different pathogens were isolated from infected roots of foot rot/ collar rot affected jackfruit plants. *Fusarium* sp. and *Phytophthora* sp. were identified through microscopic studies. *Phytophthora* sp. after inoculation as soil drenching with minor root injury showed wilt symptom, however, pathogenicity of *Fusarium* sp is yet to be confirmed. Leaves of inoculated seedlings lost turgidity, became dull in colour and quickly drooped. All the leaves dry up starting from the top and remain hanging around the plant. Time required to develop visible symptoms ranged from 3-4 weeks in potted seedlings.



Foot rot affected jackfruit plant



Partial wilting symptom in foot rot affected jackfruit plant



Rotting of roots in foot rot affected jackfruit plant



Microscopic view of *Phytophthora* sp. from jackfruit

Fig. 24: Foot rot/collar rot disease of jackfruit

LITCHI

1.3.2.L. Creating variability in litchi fruits

For strengthening the genetic base of litchi, the half-sib seedling population of potential and leading varieties of the region were raised and evaluated as per the litchi descriptor.

Gangian: Seedlings population of Dehradun variety have been planted. The average plant height and stem girth were measured at 0.43 m and 0.81 cm respectively.

Medziphema: Seedlings of the Shahi have been planted. The average plant height was measured as 0.74 m and stem girth was 1.22.

Mohanpur: Seedlings of Bombai have been planted. The plant height ranged from 0.20 m to 1.60 m and stem girth ranged from 0.20 cm to 1.20 cm.

Muzaffarpur: Due to the heavy flood at the centre none of the seedlings survived. However, 250 seedlings of the cultivar Shahi were raised and maintained in the nursery and will be planted in the field in June-July, 2022.

Pantnagar: A total of 400 seedlings of Rose Scented were planted in November 2021.

Ranchi: Seedlings of Bedana have been planted. The plant height ranged from 0.60 m to 1.3 m and stem girth ranged from 0.17 cm to 0.28 cm.

Sabour: Seedlings of Mandraji were planted. The plant height ranged from 0.40 m to 0.90 m and stem girth ranged from 0.45 cm to 0.78 cm.

2.3.4.L. High-density planting in litchi

The growth and yield performance of Purbi (Sabour) Bombai (Mohanpur), Rose Scented (Pantnagar) and Dehradun (Neri) was assessed under high density planting at different spacing (2m, 3m, 4m, 5m and 6m) in square system.

Gangian: Plantation of litchi cv. Calcuttia has been established and plants are in the vegetative phase.

Mohanpur: The fruit yield was observed highest (5.98 t/ha) in planting density 3x3 m followed by planting densities of 5x5 m (4.09 t/ha) and 4x4 m

(4.08 t/ha). Higher fruit weight (18.8 g), fruit size (3.76, 3.14 cm) and fruit qualities (Pulp weight: 11.97 g, TSS: 18.40 °B, total sugar: 15.05 %, reducing sugar: 11.20 % and acidity 0.35 %) were observed in plants with spacing of 6x6 m.

Neri: Plantation of litchi cv. Dehradun has been established and plants are in the vegetative phase.

Pantnagar: Plantation of litchi cv. Rose Scented has been established and plants are in the vegetative phase.

Sabour: Plantation of litchi cv. Purbi has been established and plants are in the vegetative phase.

2.3.5.L. Development of plant canopy architecture in litchi

The effect of plant architecture on yield and quality of litchi fruits was evaluated under different branching combinations comprising 2, 3 and 4 primary branches each retaining 2, 3 and 4 secondary branches.

Gangian: Treatments have been imposed and plants are in the vegetative phase.

Mohanpur: Plants are in the vegetative growth phase. Scattered flowering was observed in a few plants in 2021 but the fruit set was not observed.

Muzaffarpur: The plantation has been established and the secondary branches have been trained on the primary branches.

Neri: Plant height (1.26 m), TCA (9.22 cm²) and stem girth (10.76 cm) were measured maximum in T₇. Canopy volume (5.11 m³) was found higher in T₆.

Pantnagar: According to the data obtained in the year 2021, maximum plant height (2.80 m), stem girth (32.10 cm), TCA (82.10 cm²) and canopy volume (17.52 m³) were found with treatment T₉. Maximum light interception in the middle of the canopy (6,152.33 Lux) was found in treatment T₁ (Table 26).

Ranchi: The trial has been badly affected at Ranchi centre during the year 2021 due to the cyclone Yaas.

Sabour: The vegetative parameters have been recorded.

Table-26: Effect of various treatments on canopy volume (m³) and light interception (lux) of litchi at different centres

Treatments	Canopy volume (m ³)			Light interception (lux)		
	Gangian	Neri	Pantnagar	Gangian	Mohanpur	Pantnagar
T ₁ (P ₂ S ₂)	0.15	2.98	9.72	31660.00	6760.00	6,152.33
T ₂ (P ₂ S ₃)	0.29	2.45	9.74	25553.50	6791.00	6,035.33
T ₃ (P ₂ S ₄)	0.25	2.66	10.94	31203.50	6784.00	5,428.33
T ₄ (P ₃ S ₂)	0.15	2.94	12.48	30341.00	6628.00	5,682.33
T ₅ (P ₃ S ₃)	0.15	2.91	11.88	25671.00	6634.00	4,665.67

Treatments	Canopy volume (m ³)			Light interception (lux)		
	Gangian	Neri	Pantnagar	Gangian	Mohanpur	Pantnagar
T ₆ (P ₃ S ₄)	0.16	5.11	13.91	25739.75	6920.00	3,728.67
T ₇ (P ₄ S ₂)	0.24	4.84	15.56	31258.00	6852.00	4,527.67
T ₈ (P ₄ S ₃)	0.15	1.82	16.03	3459.75	6701.00	3,507.33
T ₉ (P ₄ S ₄)	0.10	1.67	17.51	33972.75	6720.00	3,232.67
T ₁₀ (control)	0.11	0.81	14.21	30310.75	6733.00	4,093.67
CD at 5%	0.06	NS	1.983	-	-	327.516

P₂ - 2 primary branches; P₃ - 3 primary branches; P₄ - 4 primary branches;
 S₂ - 2 secondary branches; S₃ - 3 secondary branches; S₄ - 4 secondary branches

2.3.6.L. Rejuvenation of senile litchi orchards (MLT)

Old plants were headed back at 1.5 m above ground during August – September. From the new emerging shoots, only 6, 9 and 12 numbers of effective shoots were retained at a 2 m radius inside the canopy, and the rest were removed. There were four treatments including control replicated thrice with 2 plants per replication.

Gangian: The trial has been initiated in cv. Dehradun. However, the plants are under the non-bearing stage.

Mohanpur: The trial has been initiated in cv. Bombai. However, the plants are under the non-bearing stage.

Neri: Litchi plants maintained with six effective shoots at 2 m radius inside the canopy produced good quality litchi fruits with maximum fruit weight (24.8 g), fruit size (36.55 & 33.61 mm) and TSS (19.60 °B). Acidity was observed minimum (0.41%) in the said treatment. All rejuvenated treatments produced a higher yield than the control plant (12.50 kg/plant) (Table 27).

Pantnagar: The plants are under non-bearing stage.

Ranchi: The plants are under non-bearing stage.

Sabour: The plants are under non-bearing stage.

Table-27: Fruit quality and yield under different rejuvenation treatments in Litchi cv. Dehradun at Neri

Treatments	T ₁ (6 shoots)	T ₂ (9 shoots)	T ₃ (12 shoots)	T ₄ (Control)
Flushing behaviour	1 st flush in May-June 2 nd flush in Sept-Oct	1 st flush in May-June 2 nd flush in Sept-Oct	1 st flush in May-June 2 nd flush in Sept-Oct	1 st flush in May-June 2 nd flush in Sept-Oct
Fruit weight (g)	24.82	22.85	21.37	20.24
Fruit size (L) mm	36.55	35.57	35.41	35.03
Fruit size (B) mm	33.61	32.31	31.78	29.78
TSS (°B)	19.60	18.90	18.00	16.80
Acidity (%)	0.41	0.47	0.54	0.72
Fruit yield (kg)	18.50	22.50	24.50	12.50
Date of first flowering	1 st week of April	1 st week of April	1 st week of April	1 st week of April
Date of first fruiting	3 rd week of April	3 rd week of April	3 rd week of April	3 rd week of April

2.3.7.L. Evaluation of hedge row system of planting in litchi for higher productivity

This experiment was started in 2020 to analyze the effect of the hedge row planting system on the yield and quality of litchi at different centres.

Gangian: The growth parameters were recorded and did not differ significantly.

Mohanpur: Plants were planted at the centre on 23.09.2021 and are in good health.

Pantnagar: The experiment has been started in September 2020, but all plants got damaged by the flood during the year 2021 in month October, again the replanting has been done in November

2021 in a new field at Horticulture Research Centre, Patherchatta.

Raipur: Plants are in the vegetative phase.

Ranchi: Planting was done in August 2020 and the initial plant height and TCSA were measured and found non-significant

Sabour: The trial is not started.

3.3.3.L. Irrigational scheduling in litchi

The trial consisting of irrigation at 50% ER, 75% ER, 100% ER and control (calendar schedule) was laid out to determine the optimum irrigation requirement in litchi. Spacing of 8×8 m (Muzaffarpur), 5×5 m (Ranchi) and 10×10 m (Mohanpur and Pantnagar)

were followed as per the standard practice of the region.

Mohanpur: Treatments were not applied due to the COVID-19 pandemic.

Muzaffarpur: Treatments were not applied due to the COVID-19 pandemic.

Pantnagar: The highest TSS (18.95°B), lowest acidity (0.41%) and highest ascorbic acid (24.69 mg/100 ml) were found under treatment T₃ (75% ER + Plastic mulch) while the lowest TSS (18.20°B) and highest acidity (0.63%) and lowest ascorbic acid (21.76 mg/100 ml) were observed under treatment T₁ (control). On the other hand, minimum fruit drop (58.00%), maximum number of fruits per

tree (1420.00) and maximum yield (31.72 kg/tree and 12.83 t/ha) were recorded under treatment T₄ (100%ER + Plastic Mulch). In terms of individual fruit weight, the maximum fruit weight (24.31 g) was noted under T₃ (75% ER with Plastic Mulching). Based on the above findings, it can be concluded that the treatment T₄ (100%ER + Plastic Mulch) exhibited the best response in terms of the number of total fruits and yield as the treatment (T₄) received the highest moisture regime (Table 28).

Ranchi: The crop was damaged due to litchi sting bug during the lockdown period.

Sabour: The plants are still in the pre-bearing phase.

Table-28: Effect of drip irrigation and mulching on yield of Litchi cv. Rose Scented at Pantnagar

Treatments	Fruit drop (%)	Fruit weight (g)	Fruits/tree	Yield (kg/tree)	Yield (t/ha)
T ₁ (Control)	69.75	21.38	851.75	17.47	6.96
T ₂ (50% ER with Plastic Mulching)	70.50	23.75	787.50	17.65	7.06
T ₃ (75% ER with Plastic Mulching)	66.75	24.31	1301.25	30.81	12.38
T ₄ (100% ER with Plastic Mulching)	58.00	22.84	1420.00	31.72	12.83
T ₅ (50% ER)	72.50	21.80	693.75	13.69	5.48
T ₆ (75% ER)	70.50	22.10	1203.75	25.82	10.33
T ₇ 100% ER)	67.25	22.83	1217.50	26.97	10.79
CD at 5%	4.36	1.23	45.75	1.23	0.56

*ER- Evaporation Replenishment

4.3.3.L. Improving bearing potential of litchi through girdling of branches

The trial was laid out in Factorial RBD with two girdling treatments comprising 25, 50 and 75 per cent of the primary branches (PB); and three girdling levels at 2, 4 and 6 mm wide along with control. There were three replications with three plants per replication unit. Treatments were imposed from August to September 5 to 6 months before the anticipated flowering.

Chettalli: The treatments were imposed as per the technical program in February 2021 and cultural and plant protection practices were followed as per the package of practices. The flowering was observed during mid-September, while the fruit set was noticed during 1st week of October. The results showed that 2 mm girdling of 25 % branches took a minimum number of days for wound healing (129.67 days), while 6 mm girdling of branches took a maximum period for healing (150.11 days). The maximum flowering was observed in trees girdled with 2 mm 50 per cent branches (41.33 %) followed by 4 mm girdling of 25 % branches (36.33 %). The maximum fruit set (27.0 %), fruit weight (17.91 g) and fruit yield (14.30 kg per tree) were observed in trees girdled with 2 mm of 50 per cent shoots and minimum yield was noticed in trees that were girdled with 2 mm of 50 % shoots (9.93 kg/tree). There were no differences

observed in fruit colour. The maximum pulp recovery (52.30 %) and TSS to acid ratio (31.15) were recorded in trees girdled with 2 mm 50 per cent branches and a minimum was noticed in control.

Gangian: The highest yield (88.33 kg/tree) was recorded in T₄. However, maximum fruit weight (22.36 g) was recorded in 2 mm girdling in 25 per cent of primary branches.

Medziphema: Experimental results revealed that litchi tree branches girdled with 4 mm and 50% branches had significantly influenced on yield per tree, fruit weight however trees girdled with 4 mm 75% primary branches gave comparatively good quality fruits in respect to pulp recovery and TSS: acid ratio which was recorded highest during estimation of fruits. The results obtained for most of the other recorded parameters did not differ statistically and were found at par with among the treatments.

Neri: The yield (25.88 kg/tree) and fruit weight (30.60 g) were recorded highest in 4 mm girdling performed in 25% of primary branches. Pulp recovery percentage (71.25 %) and TSS: acid ratio (44.40) was observed maximum in 6 mm girdling performed in 25% of primary branches.

Raipur: Highest yield (55.29 kg/tree), fruit weight (25.17 g) and maximum fruit set (80.97) were observed

in T_4 , pulp recovery (88 %) and TSS: acid ratio (31.93) were found maximum in T_2 and T_6 respectively (Table 29-31).

Table-29: Effect of girdling on yield (kg/plant) in litchi

Treatments	Chettalli	Gangian	Medziphema	NERI	Raipur
$G_1L_1 (T_1)$ 25%	10.43	7.53	13.54	20.37	51.14
$G_1L_2 (T_2)$ 25%	12.27	29.17	18.15	25.88	54.45
$G_1L_3 (T_3)$ 25%	12.77	40.00	17.68	22.25	51.34
$G_2L_1 (T_4)$ 50%	14.30	88.33	16.73	18.29	55.29
$G_2L_2 (T_5)$ 50%	11.43	37.50	16.20	21.25	54.03
$G_2L_3 (T_6)$ 50%	10.87	24.17	14.49	22.27	51.57
Control (T_7)	9.93	38.33	10.43	20.36	38.57
CD at 5%	1.15	5.01	4.81	2.51	1.99

Table-30: Effect of girdling on flowering per cent and fruit set in litchi

Treatments	Flowering intensity (%)			Fruit set (%)			
	Chettalli	Gangian	Medziphema	Chettalli	Gangian	Medziphema	Raipur
$G_1L_1 (T_1)$ 25%	27.33	13.05	78.56	12.67	22.17	73.44	34.74
$G_1L_2 (T_2)$ 25%	36.33	33.65	89.22	19.67	36.14	74.56	35.44
$G_1L_3 (T_3)$ 25%	32.67	50.67	100.00	23.00	19.17	71.14	35.66
$G_2L_1 (T_4)$ 50%	41.33	78.00	81.88	27.00	58.27	55.23	80.97
$G_2L_2 (T_5)$ 50%	24.00	46.20	100.00	21.67	37.72	60.38	37.64
$G_2L_3 (T_6)$ 50%	21.33	26.67	90.94	12.67	11.19	66.70	80.35
Control (T_7)	18.33	48.97	59.31	14.33	50.06	51.03	32.80
CD at 5%	3.27	7.06	14.16	2.63	6.98	5.85	0.78

Table-31: Effect of girdling on initial fruit drop and pulp recovery percentage in litchi

Treatments	Fruit drop (%)				Pulp recovery (%)			
	Chettalli	Gangian	Medziphema	Raipur	Chettalli	Gangian	NERI	Raipur
$G_1L_1 (T_1)$ 25%	68.33	38.45	23.91	81.15	47.67	69.29	66.50	82.86
$G_1L_2 (T_2)$ 25%	69.00	22.56	22.50	81.59	51.00	70.17	69.26	88.00
$G_1L_3 (T_3)$ 25%	72.00	42.60	30.16	80.83	44.77	63.61	71.25	82.77
$G_2L_1 (T_4)$ 50%	76.27	18.33	30.42	80.67	52.30	68.80	65.63	83.84
$G_2L_2 (T_5)$ 50%	66.33	21.22	33.10	82.44	44.23	68.32	64.90	85.04
$G_2L_3 (T_6)$ 50%	74.33	31.75	34.38	80.38	51.53	66.02	67.19	84.23
Control (T_7)	72.00	28.35	32.64	85.95	47.37	68.46	66.33	81.10
CD at 5%	3.32	6.78	5.92	0.98	2.847	10.51	4.17	1.99

4.3.6.L. Bagging of litchi bunches for quality fruits

To study the effect of bagging on fruit quality in litchi, fruit bunches were bagged at 15, 25 and 30 days after fruit set, using polypropylene pink and white bags.

Medziphema: Bagging of fruit bunches with PPP bags at 25 DAFS enhanced fruit yield per tree and individual fruit weight which is on par with PPP 15 DAFS. It was also recorded that fruits bagged with PPP at 15 and 25 DAFS had significantly reduced the sunburn, cracking and borer infestation incidence over control (Table 32).

Neri: Results revealed that fruit bunches bagged with pink polypropylene bag 25 days after fruit set (T_5) resulted in best quality fruits having the highest fruit yield (65.50 kg), maximum TSS (17.40°B) and lower acidity (0.43%), maximum fruit size (42 mm) along with pinkish-red to red color fruits. The fruits were also free from sunburn, fruit cracking and borer infestation.

Raipur: Maximum fruit weight (21.90 g) and TSS (21.10°B) were observed in bunches bagged with white polypropylene bag 30 days after fruit set (Table 33).

Table-32: Effect of bunch bagging on fruit yield and quality of litchi at Medziphema Centre

Treatments	Fruit weight (g)	Fruit colour	TSS (°B)	Acidity (%)	Sun burn (%)	Cracking (%)	Borer Infestation (%)	Yield (kg/ tree)
T ₁ (PPW + 15 DAFS)	13.22	Purple red	19.20	0.26	0.36	2.94	0.35	12.56
T ₂ (PPW + 25 DAFS)	14.54	Purple red	20.10	0.29	2.40	2.95	0.71	14.23
T ₃ (PPW + 30 DAFS)	14.55	Moderate purple red	20.90	0.35	2.49	4.33	1.44	14.45
T ₄ (PPP + 15 DAFS)	16.80	Deep purple red	16.20	0.26	0.00	1.02	0.20	17.30
T ₅ (PPP + 25 DAFS)	16.92	Deep purple red	16.97	0.31	0.12	2.16	0.96	17.65
T ₆ (PPP + 30 DAFS)	15.37	Deep purple red	16.40	0.19	1.50	2.87	1.31	14.80
T ₇ (Control)	8.86	Moderate purple red	14.95	0.53	16.08	10.98	39.06	10.10
CD at 5%	2.71	-	3.75	0.06	0.06	0.10	0.11	0.86

Table-33: Effect of bagging of litchi bunches for quality fruits at Ambikapur

Treatments	Fruit weight (g)	TSS (°B)	Fruit cracking (%)	Sun burn (%)	Borer infestation (%)	Fruit color (visually)
T ₁ (PPW + 15 DAFS)	21.15	19.50	4.55	0.36	0.00	Pinkish red
T ₂ (PPW + 25 DAFS)	21.28	20.27	2.60	8.05	0.00	Pinkish red
T ₃ (PPW + 30 DAFS)	21.90	21.10	1.63	8.10	0.00	Bright red
T ₄ (PPP + 15 DAFS)	20.50	19.17	3.56	2.14	0.00	Bright dark red
T ₅ (PPP + 25 DAFS)	20.88	19.77	3.05	3.79	0.00	Bright dark red
T ₆ (PPP + 30 DAFS)	21.53	20.33	0.69	3.65	0.00	Bright dark red
T ₇ (Control)	20.67	18.40	17.93	15.41	0.00	Dull red
CD at 5%	3.60	1.40	1.69	1.74	-	-

5.3.1.L. Survey for new and emerging pests and their natural enemies in litchi

Regular and systematic surveys were carried out in the various litchi orchards to study the diversity and incidence of insect pests with their natural enemies in litchi during the year 2021. A diverse insect pest fauna was observed during the year 2021 at various stages in litchi. Diversified fauna of spiders, coccinellid beetles, predatory bugs and lacewing bugs etc. were observed on the litchi at different centres during the year 2021.

Gangian: Fruit borer, *Anarsia* sp. (Lepidoptera: Gelechiidae) reported as new insect pest on litchi fruits at Gangian.

Mohanpur: No new insect was observed. Grey weevil, *Myloceros undecimpustulatus* and litchi bug, *Tessarotoma javanica* were observed as emerging pests.

Muzaffarpur: Experiment kept in abeyance.

Pantnagar: Higher incidence (72.25%) of litchi fruit borer was recorded at Pantnagar during the current year. Grey weevil, *Myloceros undecimpustulatus* and litchi bug, *Tessarotoma javanica* were observed as emerging pests.

MANGO

1.1.1.M. Augmentation and evaluation of germplasm in mango

Promising germplasm of mango collected from different states of India and abroad conserved at various participating centres are periodically evaluated

for morphological, physiological and biochemical characteristics and promising genotypes were selected based on yield, quality, pest and disease tolerance for utilization.

During the report period, a total of 11 accessions were collected, characterized 114 accessions, 26 accessions have been added to field gene bank, evaluated 206 accessions for various horticultural traits and 24 genotypes are being used in the breeding mango programme at 5 different centres across India.

1.1.9.M. MLT of mango hybrids

Multi-location trial of mango hybrids was laid out with 11 hybrids and two local commercial cultivars as two local checks. The hybrids included were H-949 (Amrapali x Vanraj), H-1084 (Amrapali x Janardan Pasand), H-1739 (Neelum x Tommy Atkins) from Lucknow; Pusa Pratibha (Amrapali x Sensation), Pusa Shreshta (Amrapali x Sensation), Pusa Pitambar (Amrapali x Lal Sundari) from IARI, New Delhi; Arka Udaya (Amrapali x Arka Anmol) from IIHR, Bengaluru; Suvarna (Alphonso x Neelum), Hybrid-314 (Alphonso x Neelum), Hybrid-360 (Neelum x Alphonso) from Vengurle and GMH-1 (Sonapari) from Paria.

Malda: Plants are at vegetative stage.

Mohanpur: Mango hybrid variety H-1739 recorded the highest plant height 4.2 m when compared to other mango hybrids. The hybrid H-1084 registered the maximum fruit weight (335.50 g) followed by H-949 (320.00 g) and remaining hybrids will be expected to flowering and fruit set during 2021-22. The quality parameters were

examined and concluded that the hybrid H-949 observed that the highest TSS content (16.33 °B)

Neri: Plants are at vegetative stage.

Pantnagar: The highest fruit yield (21.52 kg/tree) and (8.61 t/ha) recorded in mango hybrid H-1084 followed by H-1-6 which recorded (20.55 kg/tree) and yield (8.22 t/ha). The maximum number of fruits per tree was observed in H-1-1 (92.00) with fruit length of 12.69 cm. The TSS content of the hybrids recorded with range between 15.33 °B to 19.67°B. However, hybrid H-311 registered the highest TSS content (19.67°B) followed by H-1-1 (19.53°B) (Table 34).

Paria: Plants are at vegetative stage.

Periyakulam: Among the hybrids evaluated, H-12 (Arka Udaya) observed the highest fruit yield (7.34 kg/tree) followed by H-2-6 (6.92 kg/tree). Similarly, the number of fruits/tree also maximum in H-12 (27.38). At Sabour, the maximum yield/tree (6.91 kg/tree) registered

in H-2-6 followed by H-1-1 and H-1084. Whereas, H-2-6 observed the maximum number of fruits/tree (19.33), H-360 recorded the highest fruit weight (414.67 g), H-1-6 registered maximum value of fruit length (13.86 cm) and TSS content also recorded with range between 17.27 °B to 20.83 °B (H-311))

Ranchi: Plants are at vegetative stage.

Sangareddy: Plants are at vegetative stage.

Vengurle: Four hybrids exhibited flowering and fruit set during the year. Among the hybrids, H-360 reported the highest fruit yield/tree (12.15kg/ha). However, the numbers of fruit/tree recorded the maximum value (18.75) in H-1-6. Among the 11 hybrids evaluated at Mohanpur, two hybrids were exhibited yield i.e., the hybrid H-949 recorded 338.3 g and H-1084 (342.05 g). The fruit length and width observed maximum value in H-949 (11.83 cm and 6.96 cm respectively). The TSS content also reported the highest value of 7.25 °B in the same hybrid (H-949).

Table-34: Yield characters of mango hybrids planted at different centres

Mango hybrids	Yield (kg/tree)				Yield (t/ha)			Yield efficiency (kg/m ³)		
	PNT	PKM	SBR	VNG	PNT	PKM	SBR	PNT	PKM	SBR
V1 (H- 949)	15.81	-	2.38	-	6.32	-	0.95	1.03	-	0.16
V2 (H-1084)	21.52	1.85	5.15	-	8.61	0.74	2.06	1.53	-	0.56
V3 (H-1739)	17.60	-	1.59	1.82	7.04	-	0.63	0.63	-	0.44
V4 (H- 1 -1)	16.72	1.52	5.71	-	6.69	0.60	2.28	0.38	-	0.80
V5 (H- 1 - 6)	20.55	3.17	3.81	3.87	8.22	1.26	1.54	1.12	-	0.25
V6 (H- 2 - 6)	19.62	6.92	6.91	-	7.85	3.16	2.76	0.97	1.48	0.80
V7 (H-12)	5.47	7.34	0.32	-	2.19	2.93	0.13	0.77	1.31	0.05
V8 (H-311)	7.18	1.46	2.74	2.87	2.87	0.58	1.10	0.68	-	0.10
V9 (H-314)	7.11	1.59	3.20	-	2.85	0.63	1.28	0.46	-	0.19
V10 (H-360)	10.51	6.43	2.62	12.15	4.20	2.97	1.05	0.93	1.52	0.10
V11 (GMH - 1)	11.69	-	2.65	-	4.68	-	1.06	0.48	-	0.24
V12 (Local check)	7.89	7.52	1.71	-	3.16	9.92	0.68	0.17	0.95	0.24
V13 (Local Check)	12.29	9.80	4.27	-	4.91	12.28	1.71	0.23	0.68	0.32
CD at 5%	3.41	5.13	0.73	-	1.37	2.36	0.29	0.18	0.26	0.03

PNT: Pantnagar, PKM: Periyakulam SBR: Sabour & VNG: Vengurle

1.1.13.M. Improvement of mango through half-sibs

To select promising seedlings from the progenies of improved hybrids based on their initial performance, about 500 seedling progenies have been raised at various centres.

Gangian: Five hundred half sib seedlings of Dashehari are planted in field during the reporting period and growth of all seedling is satisfactory.

Mohanpur: Five hundred half sib seedlings of Amrapali variety are planted and are in vegetative phase.

New Delhi: Five hundred half sib seedlings of Amrapali variety are established in field of which 34 are in flowering stage and shown precocity in bearing.

Paria: Five hundred half sib seedlings of Sonpari are planted in field. Majority seedlings are in vegetative stage however, 41 half sib seedlings produced fruits during the year 2021. No special character is notice during the fruiting season.

Sangareddy: One hundred and fifty half sib seedlings of KMH-1 are raised planted in field and all are in vegetative phase.

Vengurle: Three hundred and thirty-four half sib seedling of Ratna variety are planted in the field and all are in vegetative phase.

1.1.14.M. Scion breeding in mango

Cross combination of Amrapali with Vanraj were attempted to develop F₁ progenies.

Bengaluru: No new crosses were made during the reporting period. However, previously raised progenies are being maintained for further evaluation

New Delhi: Amrapali x Vanraj cross was attempted employing 169 flowers and 27 panicles. Only 4 fruits have been recovered. The crossing and subsequent management of crossed fruit suffered due to successive lockdown imposed during corona pandemic.

1.1.15.M. Root stock breeding in mango

Cross combination of Olour with Terpentine and Terpentine with Vellaikolumban were attempted to increase the variability in rootstocks.

Bengaluru: A total of 617 hermaphrodite flowers of Vellaikolumban were crossed with Terpentine and raised 3 F1 progenies. Besides, the previously raised progenies are being maintained for further evaluation.

New Delhi: A total of 617 hermaphrodite flowers of Vellaikolumban were crossed with Terpentine and raised 3 F1 progenies. Besides, the previously raised progenies are being maintained for further evaluation.

1.1.16.M. Multi location testing of mango hybrids

Local mango seedling Jammu Mango (Selection-5) has been planted along with the check variety Mallika for evaluation under subtropical climate of Himachal Pradesh.

Lembucherra: Planting will be done during rainy season 2022

Mohanpur: Planting will be done during rainy season 2022

Neri: The experiment has been laid out during February, 2021.

Pantnagar: The experiment has been laid out during February, 2021.

Sabour: Planting will be done during rainy season 2022

2.1.2.a.M. Evaluation of different rootstocks of mango for problematic soils

To recommend region specific suitable rootstock for the problematic soils, an experiment was initiated with the promising commercial variety of the region on five rootstocks combinations viz., 13-1, Kurukkan, Bappakai, Terpentine and open pollinated own seedling rootstock as check.

Anantharajupet: Recorded maximum plant height (1.78m) was recorded in treatment R1 (13-1) whereas lowest plant height (0.74 m) was recorded in treatment R₅ (Baneshan seedlings).

Imphal: The trial was not conducted due to non-available of rootstocks.

Paria: The plants were in juvenile stage.

Periyakulam: The treatment R1 (13-1) rootstock exhibited the maximum plant height (1.52m), rootstock girth (6.51 cm) and scion girth (2.42 cm) followed by Terpentine recorded the plant height (1.26 m), rootstock girth (5.87 cm) and scion girth (1.92 cm).

Sangareddy: The site with problematic soil in Telangana has been identified and the respective scion will be grafted on rootstocks, for plantation during the year 2022.

Udaipur: The scions of Amrapali were grafted on different rootstocks during year 2019. Some of the rootstocks were grafted again in the month of September, 2021 due to damage of grafts by the monkey herds.

3.1.2.M. Nutritional survey in mango

Leaf samples of three months old leaves (at 3rd and 4th position from top shoot) are collected during October every year and are analysed for Nitrogen, Phosphorous, Potash, Zinc, Iron, Manganese and Copper nutrient. The soil samples at 3 depths (50 cm, 50-100 cm and 100-150 cm) were also collected and analysed for the same major and micro nutrients status.

Anantharajupet: The yield potential of high yielding orchards was 7.9 t/ha when compared to 1.80 t/ha in low yielding orchards cv Banganpalli. Further, high yielding orchards have highest soil N (366.90 kg/ha) and K₂O (377 Kg/ha) Compared to low yielding orchards.

Bhubaneshwar: The yield potential of high yielding orchards was 8.80 t/ha when compared to 3.30 t/ha in low yielding orchards.

Imphal: The yield potential of high yielding orchards was 12.25t/ha when compared to 8.70 t/ha in low yielding orchards. Further, high yielding orchards have highest soil N (351.82kg/ha) and K(280.41kg/ha) and other micro nutrient Fe(109.45 ppm), Mn(38.84 ppm), Zn(0.79 ppm) and Cu(4.34 ppm) Compared to low yielding orchards.

Lembucherra: The yield potential of high yielding orchards was 8.90 t/ha when compared to 3.05 t/ha in low yielding orchards. Further, high yielding orchards have highest soil N (298.96 kg/ha) and K₂O(213.89 kg/ha) Compared to low yielding orchards.

Mohanpur: The yield potential of high yielding orchards was 21.84 t/ha when compared to 6.22 t/ha in low yielding orchards.

Paria: The yield potential of high yielding orchards was 2.29 t/ha when compared to 2.13 t/ha in low yielding orchards.

Periyakulam: The yield potential of high yielding orchards was 7.36 t/ha when compared to 4.02 t/ha in low yielding orchards. Further, high yielding orchards have highest leaf N (2.74%) and K (1.18%) and other micro nutrient Fe (90.22ppm), Mn (72.98ppm), Zn (39.02ppm) and Cu (5.88ppm) Compared to low yielding orchards.

Rewa: The yield potential of high yielding orchards was 6.07 t/ha when compared to 2.41 t/ha in low yielding orchards. Further, high yielding orchards have highest leaf N (2.17%) and K (52.59%) Compared to low yielding orchards.

Sabour: The yield potential of high yielding orchards was 9 t/ha when compared to 3.5 t/ha in low yielding orchards.

Sangareddy: The Mean yield of high yielding orchard of cv Banganpalli was recorded 9.67 t/ha when compared with low yielding orchard of 2.72 t/ha. Further, high yielding orchards have highest leaf N (1.74%) and K (0.94%) and other micro nutrient Fe(105.32 ppm), Zn(40.42 ppm) and Cu(64.62 ppm) Compared to low yielding orchards.

Vengurle: High yielding orchard of cv Alphonso recorded 3.5 t/ha yield compared to low yielding orchard of 2 t/ha. In general, the soil PH 5.37 was the major constraint in low yielding orchard. Further, high yielding orchards have highest soil N(474.04 kg/ha) and soil K₂O (343.21kg/ha) when compared to low yielding orchards

3.1.3.M. Fertigation scheduling for quality fruit production of mango

The experiment was laid out with cv. Kesar in Paria, cv. Langra in Rewa & Sabour, cv. Banganpalli in Sangareddy and cv. Alphonso in Vengurle in RBD comprising five treatments and five replications with various treatments and yield and yield parameters were recorded.

Paria: No significant difference was noticed among different fertigation treatments in respect of yield and quality parameters. Flowering and fruit set was influenced severely due to the off-seasonal rain during flowering period. During fruit maturation stage, major yield loss was occurred due to Tauktae cyclone in May, 2021.

Rewa: Application of N: P₂O₅: K₂O in the ratio of 25:50:15, 20: 25: 15 and 30:0:45 at after harvest, during fruit set and at marble size stage respectively recorded highest yield (55.68 kg/tree) and maximum TSS (21.80 °B) in Langra.

Sabour: Application of N: P₂O₅: K₂O in the ratio of 20:30:10, 20: 20: 10 and 10:0:30 at after harvest, during fruit set and at marble size stage respectively gave maximum yield (178.15 kg/tree) in Langra, while application of recommended dose of N: P₂O₅: K₂O recorded highest TSS (21.76°B).

Sangareddy: Application of N: P₂O₅: K₂O in the ratio of 40:60:20, 40: 40: 20 and 20:0:60 at after harvest, during fruit set and at marble size stage respectively on Banganpalli had given significantly higher yield (41.92 kg/tree) and maximum TSS was recorded in treatment T₃ (20.82°B).

Vengurle: Application of N: P₂O₅: K₂O in the ratio of 25:50:15, 20: 25: 15 and 30:0:45 at after harvest, during fruit set and at marble size stage respectively on cv. Alphonso had given significantly higher yield (23.18 kg/tree) while treatment T₁ and T₄ recorded 20.0°B TSS. At Vengurle centre due to Tauktae cyclone during 15-16 May, 2021 more than 10 per cent fruit drop was noticed.

3.1.5.M. Fertilizer scheduling for high density planting in mango

The experiment was laid out in RBD with two varieties and different levels of nutrients of the recommended dose of fertilizers viz., 120:75:100 g N:P₂O₅:K₂O per tree per year. Drip irrigation was installed on 100% pan evaporation and scheduled with 70% pan evaporation scheduling, which was split into 6 doses and applied at weekly intervals at four different stages of plant growth.

Lucknow: Application of 100% of RDF through fertigation recorded maximum yield (21.31 kg/tree & 8.52 t/ha), fruit weight (310.90 g) and TSS (21.03°B) with minimum acidity content (0.19%). However, the number of fruits per tree observed with the highest value in application of 90% of RDF through fertigation in Dashehari.

Mohanpur: Maximum yield (9.57 kg/tree) and fruit weight (442.00 g) were recorded in the var. Himsagar with the application of 100% of RDF through fertigation. Whereas, the highest yield (8.16 kg/tree) registered in the treatment F₂ (90% RDF through fertigation) with respect to var. Amrapalli.

Neri: The plants are in vegetative stage.

Paria: The highest fruit yield (3.12 kg/tree & 1.25 t/ha), fruit weight (377.37 g) and fruits per tree (8.42 number) were recorded in the treatment F₁ (100% of RDF through fertigation).

Periyakulam: Application of 90% of RDF through fertigation recorded maximum yield (4.61 & 3.15 kg/

tree and 1.66 & 1.26 t/ha), fruit weight (182.00 and 381.43 g), fruits/tree (12.17 and 13.50 number) and TSS content (20.10 and 21.52 °B in the var. Alphonso and Imam Pasand respectively.

Rewa: The plants are in vegetative stage.

Sabour: Maximum fruit yield (1.75 kg/tree, 0.70 t/ha), fruit weight (436.67 g) and fruits/tree (4.00 number) were recorded in the var. Langra with the application of 100% of RDF through fertigation. Whereas, in the var. Zardalu the treatment F₄ (70% of RDF through fertigation) recorded the maximum yield (0.84 kg/tree & 0.08 t/ha) and fruit weight (281.00 g).

Sangareddy: Application of 70% of RDF through fertigation) recorded the highest value in yield (27.30 & 30.80 kg/tree and 10.80 & 12.30 t/ha), fruit weight (174.50 and 350.60 g) and fruits/tree (150.00 and 85.00 number) in Dashehri and Banganapalli varieties respectively (Table 35).

Udaipur: Application of 90% of RDF through fertigation recorded maximum yield (8.77 kg/tree and 3.51 t/ha), fruit weight (246.00 g) and fruits per tree (35.70 number).

Vengurle: The plants are in vegetative stage.

Table-35: Effect of fertigation on yield (t/ha) of mango at different centres

Treatments	LKO	PRI	PKM		SBR		SNG		UDP
F ₁	8.52	1.25	1.54	1.12	0.70	0.08	7.70	8.90	2.84
F ₂	8.14	1.04	1.66	1.26	0.48	0.05	8.40	7.80	3.51
F ₃	6.80	0.62	1.22	0.72	0.51	0.07	8.00	9.00	2.96
F ₄	5.95	0.53	0.86	0.60	0.56	0.08	10.80	12.30	2.50
F ₅	4.69	0.52	1.08	0.54	0.37	0.06	8.80	8.20	2.06
CD at 5%	1.98	0.12	0.16	0.48	0.11	0.02	-	-	0.17

LKO-Lucknow: Dashehari, MHR-Mohanpur: Himsagar & Amrapali, PRI-Paria: Sonpari, PKM-Periyakulam: Alphonso & Imam Pasand, SBR- Sabour: Langra & Zardalu, SNG-Sangareddy : Dashehari& Banganapalli, UDP-Udaipur: Mallika

3.1.6.M. Effect of micronutrients on yield and quality of mango

The trial was conducted to see the effect of different micronutrients on yield and quality of mango at different centres viz., at Pantnagar on 25 years old Dashehari, at Paria on 25 years old Kesar, at Udaipur on 20 years old Dashehari, at Sabour on 33 years old Langra, at Periyakulam on 20 years old Imam Pasand, at Bhubaneswar (CHES) on 13 years old Amrapali, at Lucknow on 18 years old Dashehari, at Sangareddy on 17 years old Banganapalli, at Mohanpur on 14 years old Himsagar, at Rewa on 19 years old Dashehari, at Vengurle on 34 years old Alphonso and at Anantharajupet on Baneshan.

Anantharajupet: The fruit yield on per hectare basis (7.34 t/ha) with the treatment of T₈ (RDF + Mango special (IIHR) @ 5g/l (2 sprays at 2 months before flowering & fruits of 2-4 cm diameter stage) at Anantharajupet.

Bhubaneswar: The fruit yield on per hectare basis (17.20 t/ha) was found higher with the treatment of T₇ [RDF + 100 g zinc sulphate + 50 g copper sulphate + 50 g borax (Soil application) in basin after harvest + Foliar spray of 0.2% Zinc sulphate + 0.1% Copper sulphate + 0.1% Boric acid (2 sprays at just before flowering and marble stage)] at Bhubaneswar.

Lucknow: The fruit yield on per hectare basis (15.20 t/ha) as well as the flowering intensity (58.45 %) were found significantly higher with the treatment of T₇ RDF + 100 g zinc sulphate + 50 g copper sulphate + 50 g borax (soil application) in basin after harvest + foliar spray of 0.2% zinc sulphate + 0.1% copper sulphate + 0.1% boric acid (2 sprays at just before flowering and marble stage) at Lucknow.

Mohanpur: The fruit yield on per hectare basis (25.83 t/ha) was found significantly higher with the treatment of T₅ (RDF + Foliar spray of 0.2% ZnSO₄ + CuSO₄ (0.1%) + H₃BO₃ (0.1%) [2 sprays at just before flowering and marble stage]) at Mohanpur.

Sabour: The fruit yield on per hectare basis (15.49 t/ha) as well as the flowering intensity (68.67 %), were found significantly higher with the treatment of T₇ [RDF + 100 g zinc sulphate + 50 g copper sulphate + 50 g borax (soil application) in basin after harvest + foliar spray of 0.2% zinc sulphate + 0.1% copper sulphate + 0.1% boric acid (2 sprays at just before flowering and marble stage)] at Sabour.

Sangareddy: The fruit yield on per hectare basis (14.52 t/ha) was found higher with the treatment of T₇ [RDF + 100 g zinc sulphate + 50 g copper sulphate + 50 g borax (soil application) in basin after harvest + foliar spray of 0.2% zinc sulphate + 0.1% copper

sulphate + 0.1% boric acid (2 sprays at just before flowering and marble stage)]. However, the flowering intensity (60.83 %) was observed higher with T₆ at Sangareddy.

Rewa: The fruit yield on per hectare basis (7.13 t/ha) was found higher (but non significant) with the treatment of T₅ (RDF + Foliar spray of 0.2% ZnSO₄ + CuSO₄ (0.1%) + H₃BO₃ (0.1%) [2 sprays at just before flowering and marble stage]) at Rewa (Table 36).

Table-36: Effect of micronutrients on yield (t/ha) in different cultivars of mango at various centres (2021).

Treatments #	ANP (Baneshan)	BBI (Amrapali)	LKO (Dashehari)	MHR (Himsagar)	REW (Dashehari)	SBR (Langra)	SNG (Banganpalli)
T ₁	4.89	7.7	9.84	25.26	4.19	9.20	10.14
T ₂	5.01	13.0	11.14	22.53	5.95	11.16	10.88
T ₃	5.18	9.9	12.59	21.86	6.41	13.56	10.91
T ₄	6.05	8.9	12.93	22.83	6.28	13.66	10.69
T ₅	6.56	15.4	13.20	25.83	7.13	12.63	13.00
T ₆	6.74	10.8	14.09	24.03	6.30	13.73	13.10
T ₇	6.83	17.2	15.20	25.00	6.30	15.49	14.52
T ₈	7.34	13.3	11.42	24.30	6.13	13.40	14.18
CD at 5%	1.22	0.26	1.71	2.46	-	3.54	0.36

ANP: Anantharajupet, BBI: Bhubaneswar, LKO: Lucknow, MHR: Mohanpur, REW: Rewa, SBR: Sabour & SNG: Sangareddy
 #Treatment details: T₁ - Control as per RDF (Region specific) in basin after harvest; T₂ - RDF + 200 g ZnSO₄+ 100 g Borax (Soil application) in basin after harvest; T₃ - RDF + 200 g ZnSO₄+ 100 g CuSO₄+ 100 g H₃BO₃ (Soil application) in basin after harvest; T₄ - RDF + Foliar spray of 0.2% ZnSO₄ + H₃BO₃ (0.1%) [2 sprays at just before flowering and marble stage]; T₅ - RDF + Foliar spray of 0.2% ZnSO₄+ CuSO₄ (0.1%) + H₃BO₃ (0.1%) [2 sprays at just before flowering and marble stage]; T₆ - RDF + 100 g ZnSO₄+ 50 g CuSO₄+ 50 g H₃BO₃ (soil application) in basin after harvest + Foliar spray of 0.2 % ZnSO₄+ 0.1% H₃BO₃ (2 sprays at just before flowering and marble stage); T₇ - RDF + 100 g ZnSO₄+ 50 g CuSO₄+ 50 g H₃BO₃ (Soil application) in basin after harvest + Foliar spray of 0.2% ZnSO₄+ 0.1% CuSO₄+ 0.1% H₃BO₃ (2 sprays at just before flowering and marble stage); T₈ - RDF + Mango special (IIHR) (2 months before flowering & fruits of 2-4 cm diameter stage) at 5 g/l

4.1.4.M. Assessing the effect of climatic variability on mango flowering and yield.

To understand extent of variation in flowering and

yield with respect climate, the mango crop phenology was studied at various locations and the observations of the phenological traits is presented below for the following varieties:

Centre	Varieties
Anantharajupet	Benishan (Banganapalli), Bangalora (Totapuri), Neelum, Pulihora
Bengaluru	Alphonso, Amrapali, Banganapalli, Totapuri
Bhubaneswar	Amrapali, Arka Neelachal Kesari, Dusheheri
Lucknow	Dashehari, Mallika
Mohanpur	Bombai, Fazli, Himsagar, Langra
Paria	Alphonso, Amrapali, Dashehari, Kesar, Sonpari
Periyakulam	Bangalora (Totapuri), Banganapalli, Imam Pasand, Neelum
Raipur (Ambikapur)	Amrapali, Chhattisgarh Nandiraj, Dashehari, Langra, Mallika
Rewa	Langra, Mallika, Sunderja, Totapuri
Sabour	Bombai, Langra, Totapuri, Zardalu
Sangareddy	Banganapalli, Mallika, Suvarnarekha, Totapuri
Udaipur	Amrapali, Dashehari, Kesar, Langra, Mallika
Vengurle	Alphonso, Kesar, Pairs, Ratna, Totapuri (Bangalora)

Anantharajupet: Among all the varieties evaluated for climatic variability Benishan (Banganapalli), recorded the lowest number of days (18.62 days) for 50% flowering. The lowest sex ratio was recorded in Neelum (4.08), while the highest number of fruits set per panicle (8.04 fruits) was recorded in the Neelum variety. Analysis of yield data revealed that the highest fruit weight (285.14 g) was recorded in Bangalora (Totapuri), cultivar, but the highest fruit/

tree (267.54) was recorded in Neelum while the lowest yield was recorded in Benishan (5.63 t/ha). However, Benishan recorded the highest TSS content (18.6 °B) when compared to the other cultivar.

Bengaluru: The first appearance of flower bud ranged from the third week of November (Alphonso) to the end of January (Totapuri) under Bengaluru conditions. The duration of flowering varied from 35 days in Totapuri to 55 days in Amrapali. Days to

50 per cent flowering were lowest in Totapuri and highest in Amrapali. The least sex ratio of male/hermaphrodite flowers was recorded in Amrapali (2.47) whereas Alphonso showed a maximum sex ratio of 6.06. The highest fruit set at the marble stage and the maximum number of fruits per panicle at harvest were recorded in Amrapali while these were comparatively lower for Banganapalli and Alphonso. Totapuri gave maximum fruit yield followed by Banganapalli during the current year. Comparatively less and delayed flowering except for Alphonso but higher fruit yield due to better fruit set and retention was observed for all varieties during the year under report which had slightly less rainfall but more rainy days and cooler nights than their respective averages. Wide variations in the time of peak flowering from November first week to December last have been observed in the varieties during different years at the location previously, but during the current year, it was much delayed from the end of November to the end of January. Despite less flowering in all varieties except Alphonso, higher yield despite less flowering due to better fruit set and retention.

Bhubaneswar: The days taken for 50 per cent flowering were lowest (13.50 days) in Arka Neelachal Kesari followed by Amrapalli (15.45 days) and Dashehari (18.11 days) at Bhubaneswar. The flowering intensity was highest in Amrapalli (69.50 %) followed by Arka Neelachal Kesari (60.00 %) and Dusheheri (32.50 %). Maximum flowering duration (45 days) was observed in Amrapalli and minimum duration of flowering (36 days) was recorded for "Dashehari". Number of male flowers per panicle was lowest in "Dashehari" (512.00) and was highest (855.0) in Amrapalli. Similarly, no of perfect flowers per panicle was observed maximum (135.50) in Amrapalli and the lowest number of perfect flowers per panicle (103.5) was recorded in Dasheheri.

Lucknow: Maximum flowering intensity (43.68%) was recorded in Dashehari and 51.76% in Mallika mango. Fruit yield (33.15 kg/tree) was harvested in Dashehari and 45.27 kg/tree was in Mallika mango at Lucknow centre.

Mohanpur: At Mohanpur, it was observed that cv. Himsagar took maximum of days (14.85 days) from first flowering to 50 per cent flowering but it was a minimum (11.05 days) in cv. Bombai. The flowering percentage was observed maximum in cv. Himsagar (51.3%) and it was found minimum in cv. Fazli (33.3 %) in 2021. The maximum number of fruits was noted in cv. Himsagar (138.55) in 2021 and minimum was recorded in cv. Fazli (46.36). The highest fruit yield was recorded in Himsagar (31.3 kg/plant) while it was found lowest in cv. Langra (20.7 kg/plant)

Paria: During the year 2021 at Paria, only Kesar,

Amrapali and Sonpari produced flowering and fruits. It was observed that Kesar produced vegetative flush on many shoots but not yield much. The trees of Alphonso and Dashehari neither initiated flowers nor produced vegetative flush. This was the second consecutive year in which the trees of Dashehari didn't produced flowers. The regular bearing variety Kesar and Sonpari produced very less flowering (42.00% and 34.75%, respectively) and many mature shoots produced vegetative flush. The average number of fruits set per panicle at marble stage was higher in cv. Amrapali (5.33) as compared with Kesar (4.73) and Sonpari (3.27). From flowering to harvest, Kesar, Amrapali and Sonpari took 113.81, 139.56 and 117.33 days, respectively. The duration of flowering as well as days taken for 50 % flowering was more or less similar in Kesar, Amrapali and Sonpari. Male to female sex ratio in different varieties was Kesar (22.17), Amrapali (16.32) and Sonpari (17.80). Major impact of adverse weather was on flowering intensity which was very less in Kesar (42 %) and Sonpari (34 %). Off-season rains during December, 2020 and January, 2021 affected adversely the flowering of varieties. Tauktae cyclone on 16th May, 2021 many mature and near-mature fruits dropped and resulted in reduced yield of Kesar, Amrapali and Sonpari (40-50%). Due to the fallen fruits during cyclonic rain, fruit flies were populated manifold in the fallen fruits and the infestation increased tremendously and the fruits that survived the cyclonic wind, were also infested by fruit fly and resulted in decay of fruits after harvesting.

Periyakulam: Variety Neelum, recorded the highest number of fruits (641.51) but the yield per tree recorded with the highest value in variety Bangalora (239.64 kg/tree). In the quality parameters, highest TSS (22.45°B) and lowest acidity content of (0.20 %) is recorded in the variety Imam Pasand. Bangalora recorded the low TSS content of 16.48°B. Mango flowering was slightly affected by unexpected rainfall. Late flowering and fruit drop were observed in Neelum.

Raipur: At Ambikapur (Raipur), the data on phenology and yield of mango varieties, Amrapali, Chhattisgarh Nandiraj, Dashehari, Langra and Malika were collected and it showed that the Dashehari recorded a higher yield of 110 kg/tree (11 t/ha) and Amrapali 45 kg/tree (4.5 t/ha). The number of fruits/tree were 569 and 14 respectively. However, the fruit weight was higher in Amrapali (311 g) and least in Dashehari (164 g). It was interesting to see higher fruit set at marble stage/panicle is higher in Chhattisgarh Nandiraj (18.64%) and least in Dashehari (1.30%). The Duration of flowering from December to March early being Dashehari and late being Mallika. The fruit drop was in range of 76-96%

in the varieties under study with higher in Langra (96.61%). Harvesting of all the varieties was in June and the TSS ranged 17-19 °B and ascorbic acid from 29-45 mg/100 g.

Rewa: Maximum yield was recorded in Totapari (71.30 kg/tree) followed by Mallika (61.20 kg/tree) at Rewa. The Maximum TSS was recorded in Langra (20.810°B) and minimum in Totapari (17.26°B).

Sabour: The maximum flowering intensity (68.75%) was observed in cv. Bombai with minimum fruit drop percentage (93.34%) in Totapuri. The cultivars Zardalu and Bombai (Bombay) was harvested earlier. The more numbers of fruits per tree (570) were recorded in Zardalu, and more fruit yield per tree (150.44 kg) and per ha (15.04 t) was produced by the cv. Langra. The maximum TSS content and minimum acidity of 20.95 °B and 0.295 per cent was recorded in Langra and Bombai respectively. The maximum flowering intensity (68.75%) was observed in cv. Bombai with minimum fruit drop percentage (93.34 %) in cv. Totapuri.

Sangareddy: The flower initiation during 2020-21 was two days earlier in Banganapalli (18-12-2020) when compared to Suvarnarekha (22-12-2020). The early fruit set (01-03-2021) in cv. Banganapalli was recorded when compared to Suvarnarekha (12-03-21). Maximum yield of 92.80 kg per tree was obtained in mango cv. Mallika which is due to maximum fruit weight of 390.00 g when compared to Suvaranarekha.

(310.80 g). Mango cv. Mallika is giving consistently higher yield during the past two years.

Udaipur: During the year 2020-21 early panicle emergence was recorded in variety Amrapali (29/11/2020) while, late panicle emergence during January, 2021 was observed in Langra (19/01/2021) and as well as in Dashehari (10/01/2021) with the highest flowering intensity of 68%. Variety Mallika and Dashehari took maximum of 35 days each to attained 50% flowering. While, variety Langra took minimum of 28 days to 50% flowering. Dashehari proved best as compared to other varieties with highest number of fruits per tree (518.7) and yield per tree (113.08 kg) but, variety Mallika recorded with the highest average fruit weight (285.0 g) and Amrapali with maximum yield/ha (30.80 t/ha) was recorded. Hopper population during flowering was observed maximum in Kesar whereas, malformation was observed maximum in Amrapali. In case of powdery mildew low to moderate infection was observed in all five varieties.

Vengurle: An extreme event of weather was observed from 14-16th May, 2020-21 (Touktae disaster cyclone) and a fruit drop to the extent of 30% was observed due to the cyclone at the farm. Totapuri variety did not flower and thus not fruited in 2020-21. The minimum temperature (17.66°C) was observed in January 2021 and had caused late flowering in mango. And also, mango flowering was delayed due to extended rains (Table 37).

Table-37 : Days to 50% flowering, flowering duration and flowering intensity of varieties at different centres

Varieties	Centres	Days to 50% flowering (days)	Duration of flowering (days)	Flowering intensity (%)
Alphonso	Bengaluru	23	48	37.00
	Vengurle	7	90	40.00
Amrapali	Ambikapur (Raipur)	30	46	
	Bengaluru	24	55	14.00
	Bhubaneswar	15	45	69.50
	Paria	14	29	63.50
	Udaipur	33	63	64.00
Arka Neelachal Kesari	Bhubaneswar	14	38	60.00
Banganapalli	Anantharajupet	19	43	-
	Bengaluru	18	38	15.00
	Periyakulam	26	34	-
	Sangareddy	38	59	-
Bombai	Mohanpur	11	-	-
	Sabour	12	69	-
Chhattisgarh Nandiraj	Ambikapur (Raipur)	22	-	-
Dashehari	Ambikapur (Raipur)	17	47	-
	Lucknow	5	27	43.68
	Udaipur	35	51	68.00
	Bhubaneswar	18	36	32.50
Fazli	Mohanpur	12	-	-

Varieties	Centres	Days to 50% flowering (days)	Duration of flowering (days)	Flowering intensity (%)
Himsagar	Mohanpur	15	-	-
Imam Pasand	Periyakulam	30	38	-
Kesar	Paria	15	31	42.00
	Udaipur	34	55	54.00
	Vengurle	19	92	30.00
Langra	Ambikapur (Raipur)	16	26	-
	Mohanpur	11	-	-
	Rewa	20	-	-
	Sabour	6	-	65.00
	Udaipur	28	53	59.00
Malika	Ambikapur (Raipur)	17	38	-
	Lucknow	5	36	51.76
	Rewa	20	-	60.00
	Sangareddy	12	62	-
	Udaipur	35	56	-
Neelum	Anantharajupet	21	32	-
	Periyakulam	36	45	-
Pairi	Vengurle	7	84	36.00
Pulihora	Anantharajupet	23	34	-
Ratna	Vengurle	16	82	24.00
Sonpari	Paria	15	33	34.75
Sunderja	Rewa	19	-	-
Suvarnarekha	Sangareddy	36	68	-
Totapuri	Anantharajupet	25	37	-
	Bengaluru	16	35	-
	Periyakulam	32	33	-
	Rewa	19	-	-
	Sabour	13	-	26.25
	Sangareddy	20	70	-
Zardalu	Sabour	11	-	38.75

5.1.5.M. Survey and surveillance for new and emerging pests of mango

Regular and systematic surveys were also carried out in the various mango orchard of the respective regions/centres to identify insect pests and their natural enemies in mango during the year 2021

Ludhiana: *Anarsia* sp., *Autoba silicula* (Swinhoe), *Etanna* nr. *Breviuscula* (Walker), Lycaenid butterfly, *Rapala manea* (Hewitson), *Comibaena* sp. reported as new insects by Ludhiana. *Diachasmimorpha longicaudata* (Ashmead) (Hymenoptera: Braconidae), parasitoids of fruit flies, *Bactrocera dorsalis* and were observed in large number parasitizing maggots of fruit flies at FRS Gangian, district Hoshiarpur. Syrphid flies viz. *Episyrphus balteatus* DeGeer, *Episyrphus viridaureus* (Wiedemann), *Ischiodon scutellaris* (Fabricius) and *Melanostoma* sp. (Diptera: Syrphidae) were observed in large number on mango inflorescence. Orange blackish wasp parasitoids, *Metaphycus* nr. *indicus* Shafee, Alam & Agarwal (Hymenoptera: Encyrtidae) were reared

from scale insect, *Pulvinaria polygonata* from mango leaves. Parasitoid, *Coccophagus ceroplastae* Howard (Aphelinidae) and *Metaphycus* sp. were reared from mango scale, *Pulvinaria polygonata* during April 2021. Coccinellid beetles like *Harmonia dimidiata*, *Coccinella septempunctata*, *Chielomenes sexmaculatus* were observed as predators on nymphs and adults of mango hoppers. Coccinellid predator, *Rodolia fumida* was observed in large numbers on mealy bug, *Drosicha mangiferae* on mango. Mango black predatory beetle, *Chilocorus nigrita* (Fabricius) was observed feeding on scale, *Aulacapsis tubercularis*. Blue bottle flies, *Chrysomya megacephala* (Fabricius) (Diptera: Family Calliphoridae) were observed on inflorescence in large number as a pollinator of mango. Spider, *Thomisus lobosus*, *Neoscona* Sp. was observed on mango during the year 2021.

Mohanpur: No new insect reported during 2020-21. The hoppers and mango red banded caterpillar or fruit borer, *Deanolis sublimbalis* are the most destructive pest observed in surveyed locations. Thrips infestation

observed higher from flowering to marble stages and become a threat to fruit quality. The mango fruit fly incidence was also recorded higher in all the mango growing parts.

Pantnagar: A diversify insect pest fauna was observed during the year 2021 on various stages in mango. Higher incidence (42.50 hoppers/ panicle) of mango hoppers was recorded during the year 2021. Although no new insect was observed during the year 2021.

Mango mealy bug, Rastrococcus iceryoides, white mango scale insect, *Aulacaspis* sp. (Hemiptera: Diaspididae), Fruit borer and thrips were recorded as emerging pests on mango fruits during the year 2021. A diversify fauna of spiders, coccinellid beetles, predatory bugs, Lacewing bugs and different parasitoids were observed in mango

Paria: No new pest was recorded during the year 2021. Hopper and thrips incidence was recorded higher on both vegetative and reproductive stage of the plants and maximum activity was noticed during new flush and flowering cum fruit setting stages of the plant at different surveyed areas. Effect of two days Taukte cyclone (17 & 18/05/2021) was also noticed in pest infestation/incidence. Due to cyclone with heavy rains at maturity stage 35 to 40 per cent fruits were dropped and ultimately infestation of fruit fly was also recorded higher (5-30%) as compared to past incidence (5-20%). Due to heavy rains, new flush was also noticed at maturity stage. So, hopper population was also increased.

Periyakulam: Outbreak of the mango shoot looper, *Perixera illepidaria* (Lepidoptera: Geometridae) recorded at Periyakulam.

Sangareddy: The pest fauna observed during 2020-21 were viz., hoppers, fruit flies, mealy bug, stem borer, thrips and webber. There was a heavy infestation of leaf webber and fruit fly during this year.

Vengurle: Incidence of nine different pests has been recorded at Vengurle centre, out of which 3 pests are major viz. mango hopper, thrips and fruit fly. Leaf twisting weevil (*Apoderus transquwbaricus*) has been reported as new insect pest by Vengurle. Fruit borer, *Citripestis eutrapphera* and *Deanolis albizonalis* were recorded as emerging pest with increasing trend for 5-6 years.

5.1.6.M. Management of mango hoppers and thrips on mango by oil-based formulation of *Metarhizium anisopliae*

Sprays have been given as per treatment details at panicle initiation time. Pest population (hopper, thrips) was counted a day before spray and 3rd and 9th day after each spray for randomly selected plants. The treatment details are as follows. T₁: *M. anisopliae* (oil-based formulation) @ 0.25ml/l, T₂: *M. anisopliae* (oil-based formulation

@0.5ml/l, T₃: *M. anisopliae* (oil-based formulation @ 1ml/l, T₄: Standard check –Imidachloprid @0.3ml/l and T₅: Unsprayed (control).

Bengaluru: Among the different treatments of biocontrol agent comprising recommended dose of *M. anisopliae* @ 0.5 ml/l was significantly more effective than T₁ (half dose) and on par with double dose (T₃). It has resulted in more than 80% reduction in hopper and thrips population after five sprays. The efficacy was on par with standard check (insecticides) in case of hoppers and slightly lesser against thrips.

Mohanpur: Oil based formulation of *Metarhizium anisopliae* was applied against mango hopper and thrips at different doses. Three sprays were done and the result revealed that among the different doses T₃ and T₂ were found superior to control mango hopper at 3 days after 1st spray (12.87&14.07 numbers of hoppers per panicle) and statistically on par, but after 9 days of 1st, 2nd and 3rd spray the treatment T₃ i.e. *M. anisopliae* (oil-based formulation @ 1ml/l) was observed most effective treatment by lowering hopper population (5.47, 1.87&0.99 hopper/panicle) Both the doses T₃ and T₂ were observed very effective to control thrips at 9th days after application. The fruit damage due to thrips was observed 1-25% for all treatments except T₄ at peanut stage and the damage was recorded same at marble stage, however, in control or no treated fruits showed 25-50% thrips damage at marble stage. Highest yield was recorded in T₄ (95.89 kg/tree) followed by T₃ (91.47 kg/tree) and T₂ (85.06 kg/tree).

Pantnagar: After the 5th spray of 9th day, treatment T₃ (3.65 hoppers/ panicle) were found to be superior as compared to others and followed by T₂ (6.35 hoppers/ panicle) in reducing the hopper population. The highest yield was also recorded in the treatment T₄ (79.67 kg / tree) followed by treatment T₃ (47.04 kg /tree).

Paria: Lowest hopper population (2.30 hopper/panicle) was recorded in the treatment T₃ [foliar application of *M. anisopliae* oil-based formulation, 1x10⁹ cfu/ml @ 1 ml/l) followed by T₂ [2.55] (oil-based formulation of *M. anisopliae* @ 0.5 ml/l). Both treatments were found statically at par with each other for reducing the hopper population after three days of spray. After nine days of spray, T₃ (2.07 hopper/panicle) was found statistically at par with standard check (1.78). Standard check (1.64 & 1.78) also proved to be most effective against mango hopper and significantly superior over rest doses of *M. anisopliae* after three and nine days of last spray, respectively.

On the other hand, minimum thrips population was recorded in T₃ (2.55 & 2.43 thrips/panicle/tap) among the different oil-based doses of *M. anisopliae* and on par with standard check (1.66 & 1.73 thrips/panicle/tap) in term of efficacy after three and nine days of last spray, respectively. After three days of last spray T₂ (2.98) was

on par with T_3 (2.55) but after nine days it was at par with T_3 (2.43). Minimum thrips damage on fruits at pea stage was recorded in standard check (8.25%) followed by T_3 (11.62) which was at par with T_2 (12.91). whereas, at marble stage minimum three damage was recorded in T_3 (13.30) which was statistically at par with standard check (10.72).

Periyakulam: Application of oil-based *M. anisopliae* @ 0.5 ml/l significantly reduced the hoppers population in mango crop when compared to other treatments. The trend was similar right from the first spray to fifth spray. Though the application of chemical insecticide imidachloprid @0.3ml/l stood first in reducing hopper population, the bioefficacy of *M.anisopliae* @ 0.5 ml/l was on par with imidachloprid spray. After the first spray, the hopper population ranged from 3.83 to 21.20 in different treatment including control on 9th day after spray. After 5th spray, among the different doses of biocontrol agent *M. anisopliae* @ 0.5 ml/l found to be effective against hoppers, which recorded 3.43 no/panicle and was on par with imidachloprid (3.54 numbers/panicle). Maximum of 69.72 kg/plant was recorded in T_4 followed T_1 (66.81 kg/plant).

Sangareddy: Among the different entomopathogen treatments, T_2 (*M. anisopliae*) 0.5ml/l was found most effective for management of mango hopper (5.25 hopper count after last spray), however it was on par with treatment T_3 (*M. anisopliae*) (oil based formulation) @1 ml/l. For management of thrips, the treatment T_3 (*M. anisopliae*) (oil based formulation) @1 ml/l was found most effective (3.50 thrips count after last spray) which was significantly superior to all other treatments. Minimum thrips damage on fruits at pea stage was recorded in standard check (7.00%) followed by T_3 (9.75). whereas, at marble stage minimum thrips damage was recorded in standard check (11.50). Maximum thrips damage was found in control (16.50 & 23.50%) during both the stages, respectively.

Vengurle: Among the different entomopathogen treatments, T_3 [*M. anisopliae* (oil-based formulation) @ 1ml /l] was found most effective for management of mango hopper (2.90 hopper count after last spray), however it was at par with treatment T_2 [*M. anisopliae* (oil-based formulation) @ 0.5ml /l]. For management of thrips, the treatment T_3 [*M. anisopliae* (oil-based formulation) @ 1ml /l] was found most effective (4.17 thrips count after last spray) which was significantly superior to all other treatments. Among the different entomopathogen treatments, the maximum yield (26.75 kg/plant) was recorded in treatment T_3 [*M. anisopliae* (oil-based formulation) @ 1ml/l] which was significantly superior to all other treatments.

5.1.7.M. Module based pest management in mango

The mango trees were selected randomly at the time of initiation of flowering. Ten panicles were labelled

randomly for recording the observation of foliage pests (hopper, thrips, mealy bug and midge). At the time of harvesting the per cent infested fruits due to fruit fly and fruit borer were counted. Regarding stem borer, the infested tree was examined as and available and the treatment were applied. The per cent recovery was recorded.

Pantnagar: Module II was found effective in reducing the pest population.

Paria: Both modules were tested under high pest density and remained significantly superior over untreated control at different post spray intervals against major sucking pest of mango viz., hopper and thrips.

Vengurle: For management of all the three pests viz., hopper, thrips and fruit fly, both the module was equally effective.

5.1.8.M. Evaluation of different botanical formulations for management of sucking pest complex in mango

Mango trees were selected at the time of panicle initiation and sprays were given as per treatment details. Ten panicles were labelled and sucking pest population (hopper, thrips, mealy bug and scale) was counted a day before spray and 7 days after each spray.

Bengaluru: On the basis of per cent reduction in pest population, neem soap @ 10g/l (T_3) was found most effective for management of mango hopper and thrips with 92.73 and 85.54 per cent reduction, respectively.

Lucknow: Maximum per cent reduction in hopper population was recorded in treatment T_2 (Botanical formulation “AAVYA” @ 4 g/l of water), however, the hopper population data were non significant. Regarding thrips, the maximum per cent reduction was recorded in treatment T_5 (T_1 followed by T_3 followed by T_4 followed by T_2), but, the thrips count data was non-significant.

Ludhiana: Treatment T_1 (Azadirachtin 10,000 ppm @ 3 ml/l of water) was found to be the most effective for management of mango hopper with the maximum per cent reduction (89.86%) in hopper population.

Mohanpur: Treatment T_1 (Azadirachtin 10,000 ppm @ 3 ml/l of water) was found the most effective for management of mango hopper as well as thrips with the maximum per cent reduction in hopper (84.09%) and thrips (55.71%). Also, significantly maximum yield (106.53kg/tree) was recorded in treatment T_1 (Azadirachtin 10,000 ppm @ 3 ml/l of water)

Pantnagar: Treatment T_5 (T_1 followed by T_3 followed by T_4 followed by T_2), was found the most effective for management of mango hopper with 90.04 per cent reduction in hopper count. Also for, management of mango mealy bug, the treatment T_5 (T_1 followed by T_3 followed by T_4 followed by T_2) was found the most effective with 87.87 per cent reduction in mealy bug

count. Significantly maximum yield (82.94kg/tree) was also recorded in the same treatment.

Paria: Treatment T₁ (Azadirachtin 10,000 ppm @ 3 ml/l of water) was found the most effective for management of mango hopper as well as thrips with the maximum per cent reduction of 48.98 and 54.05 per cent, respectively. The significantly maximum yield (39.18 kg/tree) was recorded in treatment T₁ (Azadirachtin 10,000 ppm @ 3 ml/l of water)

Rahuri: Treatment T₅ (T₁ followed by T₃ followed by T₄ followed by T₂) was found the most effective for management of mango hopper and thrips with the maximum per cent reduction in hopper (92.56%) and thrips (91.31%). The maximum yield (36.24kg/tree) was recorded in treatment T₅ (T₁ followed by T₃ followed by T₄ followed by T₂).

Sangareddy: Treatment T₅ (T₁ followed by T₃ followed by T₄ followed by T₂) was found the most effective for management of mango hopper, however, it was at par with all other treatments except control. The maximum per cent reduction (68.91%) in mango hopper population was recorded in treatment T₅ (T₁ followed by T₃ followed by T₄ followed by T₂). For management of mango thrips, treatment T₃ (Neem soap (IIHR product) @ 10g/l of water) was found the most effective, but it was at par with all other treatment except untreated control. The maximum per cent reduction (75.16%) in thrips count was observed in treatment T₃ (Neem soap (IIHR product) @ 10 g/l of water). Significantly maximum yield (24.32kg/tree) was recorded in treatment T₅ (T₁ followed by T₃ followed by T₄ followed by T₂)

Vengurle: For management of mango hopper and thrips, the treatment T₁ (Azadirachtin 10,000 ppm @ 3 ml/l of water) was found most effective with 92.01 and 88.51 per cent reduction in hopper and thrips count, respectively. Also, significantly maximum yield (20.75 kg/tree) was recorded in treatment T₁ (Azadirachtin 10,000 ppm @ 3 ml/l of water)

5.1.9.M. Management of mango stem borer (*Batocera rufomaculata*) using 'Arka Borer Control'

Experiment was laid out with three (3) treatments (T₁- ABC product, T₂- Standard check i.e. recommended/ existing pattern of the region and T₃- Untreated control) and seven (7) replications in > 20 years old trees at all the centres.

Anantharajupet: The trial was initiated in the month of January-2021 due to delay in availability of the material. COC+ monocrotophos was applied as treatment T₂. Before initiation of experiment 42.85, 42.85 and 71.25 trees infested with stem borer in T₁, T₂ and T₃, respectively. Moreover, after six months of application non-significant results were found. The product was found persisted on tree trunk in rains.

Bhubaneswar: Experiment was laid out in Amrapali variety with 10m x 10m spacing. Cotton dipped in DDVP 76%EC and plugged in infested hole was the standard check (T₂). Significantly minimum per cent stem borer infestation and number of live borer hole was observed in T₁ (ABC) (0 % and 0.01) as against T₂ (4.76% and 0.34) and T₃ (23.81% and 0.27), respectively after six month application. ABC product was washed out heavily (95%) due to heavy rains.

Gangian: The trial was commenced in second fortnight of August. Six months after application non-significant results were obtained. However, minimum stem borer infestation (0.1%) and number of live borer hole per stem (1.3) was observed in T₁. Swabbing of cotton dipped in kerosene and killing grubs with iron wire was the standard practice followed in T₂. The ABC product was found remained intact.

Imphal: Experiment was started in September, 2020. Six months after application significantly minimum per cent stem borer infestation and number of live borer hole was observed in T₁ (ABC) (38.09 % and 2.0) which was at par with standard check (T₂ - Emamectin benzoate was used at 5g/litre of water) (42.86% and 1.86). The product was applied after rainy season, so remained intact.

Lembucherra: As the product ABC was received on July 2020, the trial had been started in 1st week of August, 2020. Six months after application significantly minimum per cent stem borer infestation and number of live borer hole was observed in T₁ (ABC) (1.15 % and 0) which was at par with standard check (T₂ - Cotton soaked in kerosene and plugged in the holes) (4.72% and 0.03). The product is heavily washed off.

Ludhiana: The trial was commenced in second fortnight of August. Six months after application non-significant results were obtained Swabbing of cotton dipped in kerosene and killing grubs with iron wire was the standard practice followed in T₂. The ABC product was found remained intact.

Lucknow: No any natural infestation of stem borer was observed in experimental field; hence the trail was not reach up to any conclusion.

Medziphema: Experiment was laid out in Amrapali variety with 5m x 5m spacing and was commenced in September, 2020 due to late arrival of ABC product. No any natural infestation of stem borer was observed in experimental field; hence the trail was not reach up to any conclusion.

Mohanpur: Experiment was commenced in July, 2020. Swabbing of bark with chlorpyrifos @5ml/l of water was used as standard check. No any natural infestation of stem borer was observed in experimental field; hence the trail was not reach up to any conclusion. ABC product was applied after rainy season, so found remained intact.

Neri: Experiment was laid out in first week of August, 2020. Before imposition of treatment non-significant results were found in all the treatments. Six months after application significantly minimum per cent stem borer infestation and number of live borer hole was observed in T_2 (standard check - Methyl Parathion 50EC @ 0.2%) (30.0 % and 6.0). The ABC product is washed off up to 60%.

Pantnagar: Experiment was commenced during July, 2020 in Dasherri variety with 10m x 10m spacing. Six months after application significantly minimum per cent stem borer infestation (14.2 %) and number of live borer hole (1.4) was observed in T_2 (standard check - Methyl Parathion 50EC @ 0.2%). ABC product was found persisted on the stem.

Paria: Experiment was laid out during June 2020. No any natural infestation of mango stem borer was observed in treated orchard. Moreover, due to heavy rains ABC product was heavily washed out and colour changes from dark red-brown to pale brown.

Periyakulam: The experiment was initiated during first week of September, 2020 in Sendhura variety (7m x 7m spacing). Six months after application, significantly minimum per cent stem borer infestation (7.93 %) and number of live borer hole (2.28) was observed in T_2 (Hooked out the grub from hole and applied monocrotophos 36WSC 10 to 20 ml/hole) which was found at par with T_1 (8.19% and 2.87). ABC product was found persisted on the stem.

Rahuri: Experiment was commenced during first week of August, 2020. Treatment T_1 (ABC) was significantly superior for prevention mango stem borer with 3.68 per cent stem borer infestation and 0.94 live borer holes/stem after six months of application. Bordeaux paste + chloropyriphos 20 EC applied as standard check. The ABC product was partially faded up.

Rewa: The experiment was commenced during July, 2020 in Langara variety. Six months after application non-significant results were obtained. Bordeaux paste + chloropyriphos 20 EC was the standard practice followed in T_2 . Persistency of the product was also noted and found that it was partially fed up due to rains (Table 38).

Sabour: Experiment was started during July, 2020. Cleaning the bore hole followed by plugging the hole with cotton dipped in kerosene oil and then sealing it with mud is the common practice followed as standard check in T_2 . Six months after application, T_1 (ABC) was found significantly most effective for management of mango stem borer with 3.77% stem borer infestation and 1.45 number of live borer holes/stem. The ABC product was slightly persisted (Table 39).

Sangareddy: Experiment was laid out in variety Banganpalli with spacing of 10m x 10m. Arka Borer Control product was applied in August, 2020. Six months after application, T_1 (ABC) was found significantly most effective for management of mango stem borer with 4.08% stem borer infestation and 1.9 number of live borer holes/stem. The ABC product was heavily washed out due to heavy rains.

Udaipur: The trial was commenced on variety Dashehari during August, 2020. Before imposition of experiment no any infestation of stem borer was recorded. Six months after application significantly minimum per cent stem borer infestation and number of live borer hole was observed in T_1 (ABC) (5.45 % and 0.60). The product was partially faded up.

Vengurle: The trial was commenced during August, 2020. Six months after application non-significant results were obtained. Swabbing of chlorpyriphos 20 EC @ 5ml/l at 3 months interval was the standard practice followed in T_2 . The ABC product was found partially faded up.

Table-38: Effect of Arka Borer Control on per cent stem borer infestation

Centres	T_1			T_2			T_3			CD
	ATA	3MAP	6MAP	ATA	3MAP	6MAP	ATA	3MAP	6MAP	
ANP	42.85	42.85	57.14	42.85	57.14	57.14	71.25	85.71	85.71	NS
BBI	19.05	4.76	0	23.81	9.52	4.76	19.05	19.05	23.81	0.19
GNG	1.4	0	0.1	2.1	1.5	1.6	3.5	9.1	9.3	NS
IMP	89.29	61.91	38.09	82.14	52.38	42.86	89.29	100.0	100.0	10.45
LEM	16.52	3.48	1.15	14.28	8.24	4.72	14.99	15.27	15.28	4.01
LKO	0	0	0	0	0	0	0	0	0	-
MDI	0	0	0	0	0	0	0	0	0	-
MHR	0	0	0	0	0	0	0	0.1	0	NS
NER	78	20	40	87	25	30	72	40	50	0.25
PNT	18.0	22.0	22.0	14.2	14.2	14.2	22.0	28.0	28.0	5.51
PRI	0	0	0	0	0	0	0	0	4.76	NS
PKM	3.56	2.76	2.05	2.68	2.08	1.91	4.12	4.72	4.61	1.48

Centres	T ₁			T ₂			T ₃			CD
	ATA	3MAP	6MAP	ATA	3MAP	6MAP	ATA	3MAP	6MAP	
RHR	0	0	3.46	0	11.93	16.99	0	18.09	37.38	2.58
REW	0	2.03	3.06	0	4.07	5.09	0	7.13	8.14	NS
SBR	10.0	5.7	4.08	10.95	6.67	5.1	14.28	20.48	24.49	0.40
SNG	0	9.52	19.05	0	33.33	52.38	0	47.62	76.19	2.12
UDP	0	0	5.45	0	2.44	8.69	0	5.21	14.86	0.73
VNG	0	0	7.14	0	3.57	10.71	0	7.10	25.0	NS
LDN	1.2	0	1.1	1.8	1.3	1.5	3.1	8.5	8.6	NS

ANP: Anantharajupet, BBI: Bhubaneswar, GNG: Gangian, IMP: Imphal, LEM: Lembucherra, LKO: Lucknow, MLD: Malda, MDI: Medzhiphema, MHR: Mohanpur, VNG: Vengurle, NER: Neri, PNT: Pantnagar, PRI:Paria, PKM: Periyakulam, RHR: Rahuri, REW : Rewa, SBR: Sabour, SNG: Sangareddy, UDP: Udaipur, LDN Ludhiana; *ATA: At the time of application, 3MAP: 3 Months after application and 6MAP: 6 Months after application*Refer methodology for treatment details

Table-39: Effect of Arka Borer control on number of live borer holes/stem

Centres	T ₁			T ₂			T ₃			CD
	ATA	3MAP	6MAP	ATA	3MAP	6MAP	ATA	3MAP	6MAP	
ANP	3.0	2.43	2.26	3.5	2.93	3.21	4.5	4.71	5.0	NS
BBI	0.45	0.05	0.01	0.30	0.15	0.34	0.27	0.26	0.27	0.06
GNG	4.9	1.3	1.3	7.2	2.5	2.6	5.8	11.2	11.5	NS
IMP	7.57	4.43	2.0	7.29	4.57	1.86	7.71	11.0	13.86	0.93
LEM	0.57	0	0	0.32	0.09	0.03	0.34	0.41	0.40	0.12
LKO	0	0	0	0	0	0	0	0	0	-
MDI	0	0	0	0	0	0	0	0	0	0
MHR	0	0.34	0	0	0	0	0	1.0	0	0
NER	45.70	5.0	10.0	43.52	3.0	6.0	47.20	7.0	11.0	0.12
PNT	1.8	2.0	2.0	1.4	1.4	1.4	2.2	2.8	2.8	0.31
PRI	0	0	0	0	0	0	0	0	0.10	NS
PKM	6.0	4.2	2.87	5.4	3.4	2.28	5.0	5.4	5.0	0.92
RHR	0	0.00	0.40	0	0.57	1.27	0	1.14	2.73	0.28
REW	0	2.0	3.0	0	3.5	4.0	0	6.0	8.0	NS
SBR	4.3	3.1	1.9	5.3	3.3	2.4	7.2	8.1	9.8	0.46
SNG	-	1.62	2.09	-	2.09	2.52	-	1.94	2.84	0.03
UDP	0	0	0.60	0	0.45	0.81	0	1.11	1.33	0.09
VNG	0	0	0.86	0	0.43	1.0	0	1.0	2.29	NS
LDN	5.3	1.1	1.2	6.2	2.3	2.5	5.3	9.3	9.7	NS

ANP: Anantharajupet, BBI: Bhubaneswar, GNG: Gangian, IMP: Imphal, LEM: Lembucherra, LKO: Lucknow, MLD: Malda, MDI: Medzhiphema, MHR: Mohanpur, VNG: Vengurle, NER: Neri, PNT: Pantnagar, PRI:Paria, PKM: Periyakulam, RHR: Rahuri, REW : Rewa, SBR: Sabour, SNG: Sangareddy, UDP: Udaipur, LDN Ludhiana; *ATA: At the time of application, 3MAP: 3 Months after application and 6MAP: 6 Months after application*Refer methodology for treatment details

5.1.10.M. Slow release pheromone formulation for the management of fruit fly in mango

Mango orchard of 1 ha was selected separately for each treatment keeping at least 200 m isolation distance. Twenty traps of each treatment (20 replication) was installed in separate plots. Fruit flies trapped in trap was counted at weekly interval.

Ananthrajupet: Treatment T₁ (Slow release pheromone formulation) was found most effective for attracting fruit flies which was significantly superior to T₂ (Conventional lure). Also, the per cent fruit damage due to fruit fly was less in T₁ (Slow release pheromone formulation).

Ludhiana: Treatment T₂ (Conventional lure) was

found most effective for attracting fruit flies which was significantly superior to T₁ (Slow release pheromone formulation). Also, the per cent fruit damage was less in T₂ (Conventional lure).

Pantnagar: Treatment T₁ (Slow release pheromone formulation) was found most effective for attracting fruit flies which was significantly superior to T₂ (Conventional lure).

Paria: Treatment T₂ (Conventional lure) was found most effective for attracting fruit flies which was significantly superior to T₁ (Slow release pheromone formulation).

Periyakulam: Treatment T₁ (Slow release pheromone formulation) was found most effective for attracting

fruit flies which was significantly superior to T_2 (Conventional lure).

Sangareddy: Treatment T_1 (Slow release pheromone formulation) was found most effective for attracting fruit flies which was significantly superior to T_2 (Conventional lure).

Udaipur: Treatment T_1 (Slow release pheromone formulation) was found most effective for attracting

fruit flies which was significantly superior to T_2 (Conventional lure). Also, the per cent fruit damage due to fruit fly was less in T_1 (Slow release pheromone formulation).

Vengurle: Treatment T_2 (Conventional lure) was found most effective for attracting fruit flies which was significantly superior to T_1 (Slow release pheromone formulation) (Fig. 23).

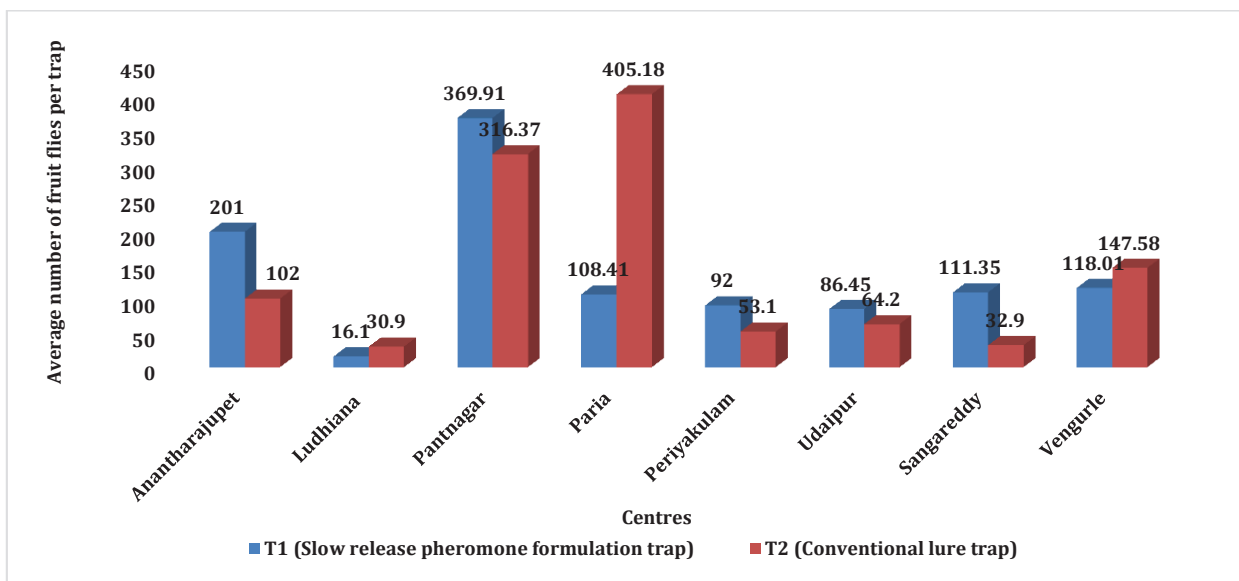


Fig. 23: Effect of different treatments on fruit fly catch at different centres

6.1.5.M. New and emerging diseases of mango

Incidences and severity of different diseases of mango was recorded under natural climatic conditions in a roving survey for major mango growing areas.

Anantharajupet: Among the major diseases, incidence of blossom blight (32-53%), sooty mould (19-32%), powdery mildew (23.0-44.3%), leaf anthracnose (10.0-12.5%) was recorded high during flowering and fruiting season. Whereas, high PDI of powdery mildew (21.7), fruit anthracnose (17 PDI) and incidence of black tip (10%) was observed during fruit maturity season.

Lucknow: Among the major diseases, incidence of blossom blight (78.0%) and sooty mould (21.2%) was recorded high; and incidence of powdery mildew was low (24.0%) during flowering and fruiting season. Incidence of shoulder browning (82.5%) was recorded very high, and leaf anthracnose ranged between 31.4-39.2%) during the year. Incidence of stem end rot (4.1%) and fruit anthracnose (4.0%) was recorded during fruit ripening, which was slightly less than previous years.

Mohanpur: Incidence of floral malformation (2.5%), powdery mildew (10.0%) and blossom blight (10.5%) was recorded during flowering, which was slightly higher than previous years. Leaf anthracnose

incidence ranged between 5.5-9.75% throughout the year.

Paria: Among the major diseases, severity of powdery mildew (8.2%), anthracnose (9.5%), black banded (3.5%) and sooty mould (15.5%) were recorded high or at par with previous years. Anthracnose severity was found increased (9.8-11.4%) than last three years average.

Rahuri: Incidence of floral malformation (8.66%), powdery mildew (17.48%) and blossom blight (4.55%) was recorded during flowering, which was slightly higher than previous years. Leaf anthracnose incidence ranged between 6.6-18.2% throughout the year. Incidence of stem end rot (5.2%) and fruit anthracnose (2.1%) was recorded during fruit ripening, which was slightly higher than previous years.

Sangareddy: Among the major diseases, incidence of sooty mould (17.25%), powdery mildew (19.5%) and blossom blight (6.5%) was recorded during flowering, which was slightly higher than previous years. Leaf anthracnose incidence ranged between 6.6-18.2% throughout the year. Incidence of stem end rot was recorded 6.5% during fruit ripening, which was slightly lesser than previous years.

Sabour: Severe incidence of blossom blight (22.3%) and low of powdery mildew (9.7%) was recorded

during flowering period. Leaf anthracnose incidence ranged between 15-22% throughout the year. Incidence of shoulder browning (15.53%) was recorded during fruiting season.

Vengurle: Incidence of sooty mould (25.67%), powdery mildew (16.79%) and blossom blight (26.17%) was recorded during flowering period, which was higher than previous years. Leaf anthracnose incidence ranged between 22.8-46.8% throughout the year. Incidence of stem end rot was recorded 7.2 % during fruit ripening, which was higher than previous years.

6.1.11.M. Integrated management of post-harvest diseases (anthracnose, shoulder browning, stem end rot and Aspergillus rot) of mango fruits

Anantharajupet: Shoulder browning incidence was not observed in any treatment. Aspergillus rot was observed 10 days after harvest. Anthracnose and stem end rot were the major postharvest diseases. T₄ {difenoconazole 25 EC @ 0.5 ml/l + hot water treatment (52 ± 1 °C for 10 minutes)} was superior both in reducing the incidence and severity of all the diseases.

Bengaluru: Stem end rot, Aspergillus rot and shoulder browning did not differ significantly. T₄ was the best for the management of anthracnose on mango cv. Banganapalli.

Lucknow: Severe incidence of stem end rot, anthracnose and shoulder browning was recorded on mango cv. Mallika. T₄ was the best treatment

in reducing the incidence and severity of all the diseases. Incidence of postharvest Aspergillus rot was not seen. The B:C ratio of best treatment was 9.0: 1.0 (Fig. 24).

Paria: T₄ was found most effective for management of postharvest anthracnose and stem end rot with lowest incidence and severity of the diseases on mango cv. Kesar. No incidence of Aspergillus rot and shoulder browning diseases occurred.

Rahuri: No incidence of shoulder browning disease occurred. T₄ was found most effective in managing anthracnose, Aspergillus rot and stem end rot till 10 days after harvest. The B:C ratio of best treatment was 2.41: 1.0.

Sabour: T₄ was the best treatment resulting significant reduction in the incidence and severity of shoulder browning and anthracnose diseases in mango cv. Langra.

Sangareddy: T₄ has given better performance in reducing the postharvest losses by anthracnose, stem end rot and Aspergillus rot. No incidence of shoulder browning disease occurred in any treatment. The B:C ratio of best treatment was 10:1.0.

Vengurle: The treatment T₄ was the most effective for the management of stem end rot up to 15 days after harvest on mango cv. Alphonso. Whereas, the results of anthracnose and Aspergillus rot was non-significant. The B:C ratio of best treatment was 1.68 :1.0 (Fig. 25).



Fig. 24: Effect of treatments at ICAR-CISH Lucknow

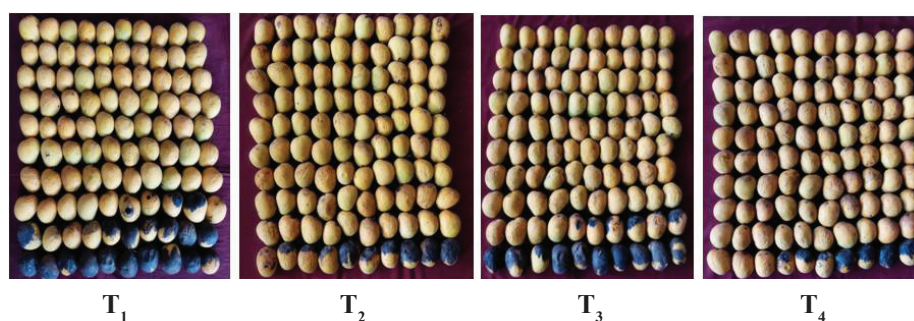


Fig.25: Effect of treatments at Vengurle

PAPAYA

1.3.4.P. Multilocation testing of new papaya selection (MLT-I)

Anantharajupet: Maximum fruit weight (1.09 kg), yield (37.67 kg/plant & 85.39 t/ha) and pulp thickness (3.10 cm) with minimum PRSV infection was recorded in Pune selection-1 and it was at par with national check (Red Lady) and local check (CO 8). However, maximum number of fruits per plant (31.54 & 32.44) and TSS (12.12 & 12.01°B) was

recorded in check varieties (Red Lady & CO 8). The data on sensory evaluation revealed that overall-acceptability, texture, taste, flavour was found higher with cv. Red Lady followed by cv. Pune selection-1.

Ranchi: Plants are in juvenile stage.

Coimbatore: The second trial has been initiated at Coimbatore during second fortnight of November, 2020. The observations revealed that Pune Selection 3 performed better for yield (1.20 kg/fruit & 27.41 kg/plant, 61.72 t/ha) and pulp thickness (2.72

cm). Sensory evaluation revealed that overall acceptability, texture, taste and flavour were found higher in Red Lady and TNAU Papaya CO 8 followed by Pune Selection 3 (Table 40).

Gandevi: Plants are in juvenile stage.

Udaipur: Plants are in juvenile stage.

Table-40: Sensory evaluation of papaya selections at different centres

Sensory parameters	Varieties	Anantharajupet	Coimbatore
Pulp Colour	Pune Selection-1	8.0	7.2
	Pune Selection-3	7.0	7.5
	National Check (Red Lady)	9.0	8.6
	Local Check (Pusa Nanha / TNAU Papaya CO 8)	8.0	8.7
Flavour	Pune Selection-1	7.0	6.3
	Pune Selection-3	7.0	6.5
	National Check (Red Lady)	9.0	8.2
	Local Check (Pusa Nanha / TNAU Papaya CO 8)	7.0	8.5
Texture	Pune Selection-1	8.0	6.8
	Pune Selection-3	7.0	7.0
	National Check (Red Lady)	9.0	8.5
	Local Check (Pusa Nanha / TNAU Papaya CO 8)	8.0	8.0
Taste	Pune Selection-1	8.5	7.0
	Pune Selection-3	7.0	7.5
	National Check (Red Lady)	9.0	8.5
	Local Check (Pusa Nanha / TNAU Papaya CO 8)	8.0	8.5
Overall acceptability	Pune Selection-1	8.5	6.8
	Pune Selection-3	7.0	7.0
	National Check (Red Lady)	9.0	8.5
	Local Check (Pusa Nanha / TNAU Papaya CO 8)	8.0	8.5

Note: 9 point Hedonic scale: Like extremely-9; Like very much-8; Like moderately-7; Like slightly-6; Neither like nor dislike-5; Dislike slightly-4; Dislike moderately-3; Dislike verymuch-2; Dislike extremely-1

2.3.1.P. Validation of protocol for extending papaya seed viability in storage

The papaya seeds of variety Arka Prabhath collected at ICAR-IIHR, Bengaluru (during December 2018, having initial germination of 86 %) were subjected to germination test during March 2020 (V set, 13 months of storage), June, (VI set, 16 months of storage), September, 2019 (VII set, 19 months of storage) and December 2020 (VIII set, 22 months of storage) at Anantharajupet, Bengaluru, Coimbatore, Gandevi and Pune. Germination test was conducted using quality germination towels by incubating seeds at alternating temperature of 20-22°C for 16 hours and 30-32°C for 8 hours.

Anantharajupet: The germination per cent 20 days after incubation and seedling vigour index for all the four sets of seeds incubated for germination exhibited significant differences among the modules. Seed germination and vigour index were significantly higher in Module I (seed stored in airtight poly lined aluminium pouches at 15°C) and II (seed stored in airtight poly lined aluminium pouches at room temperature) than the Module III (local practice-butter paper cover) from 4th set (15th December 2019) after 9 months of storage onwards. Module I recorded

the highest germination percentage and seedling vigour index compared to other two modules. Highest germination of 72.00, 68.35, 57.42, 60.16 and 62.06 per cent was recorded in Module I as against lowest germination of 33.54, 9.53, 9.14, 6.38 and 0.0 per cent respectively after 12, 15, 18 and 21 and 24 months of storage. The seedling vigour index also followed the same trend of germination (Fig 28).

Bengaluru: The germination per cent 20 days after incubation and seedling vigour index for all the four sets of seeds incubated for germination exhibited significant differences among the modules. Seed germination and vigour index were significantly higher in Module I and II than the Module III (local practice-butter paper) from 4th set (December 2019, after 9 months of storage) onwards. Module I recorded the highest germination percentage and seedling vigour index compared to Module II from 15 months of storage. The highest germination of 82.00, 76.57, 80.29, 70.00, 78.57 and 72.00 per cent was recorded in Module I as against lowest germination of 60.57, 25.14, 23.43, 6.57, 0.0 and 0.00 per cent respectively after 9, 12, 15, 18, 21 and 24 months of storage. The seedling vigour index also followed the same trend of germination.

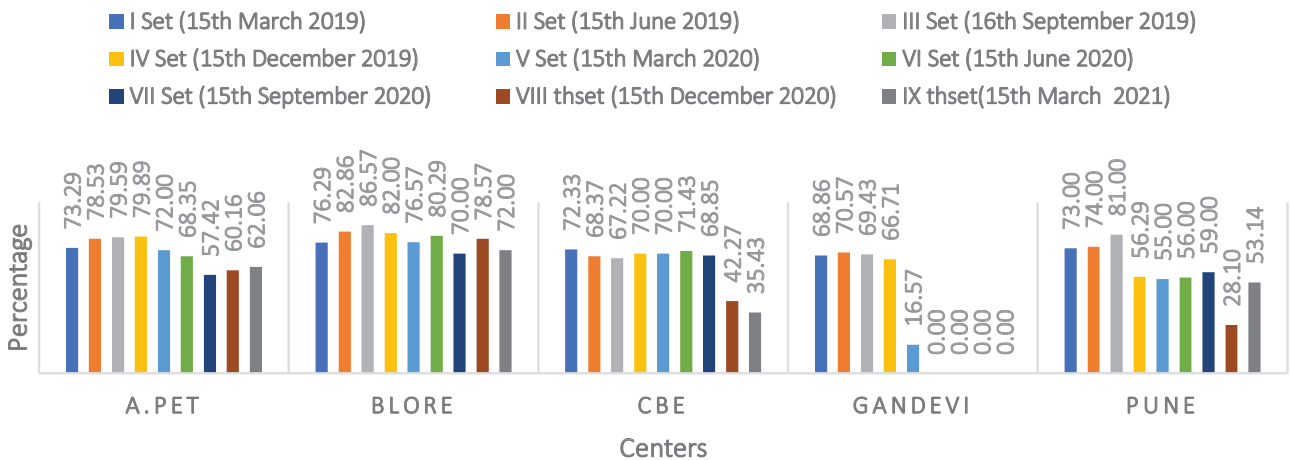
Coimbatore: Significant differences were found for germination percentage (20 days after incubation) and seedling vigour index for all the four sets of seeds incubated for germination from 9 months of storage onwards. The module I recorded the highest germination percentage (70.00, 70.00, 71.43, 68.85, 42.27 and 35.43 respectively after 9,12,15,18,21 and 24 months of storage). The vigour index also followed the same trend.

Gandevi: The germination per cent 20 days after incubation and seedling vigour index for all the four sets of seeds incubated for germination exhibited significant differences among the modules which was more pronounced from 9 months of storage. Seed germination and vigour index were significantly maximum in Module II than the Module I and III. The Module-II recorded highest germination percentage (69.27, 69.14, 70.29, 71.43,

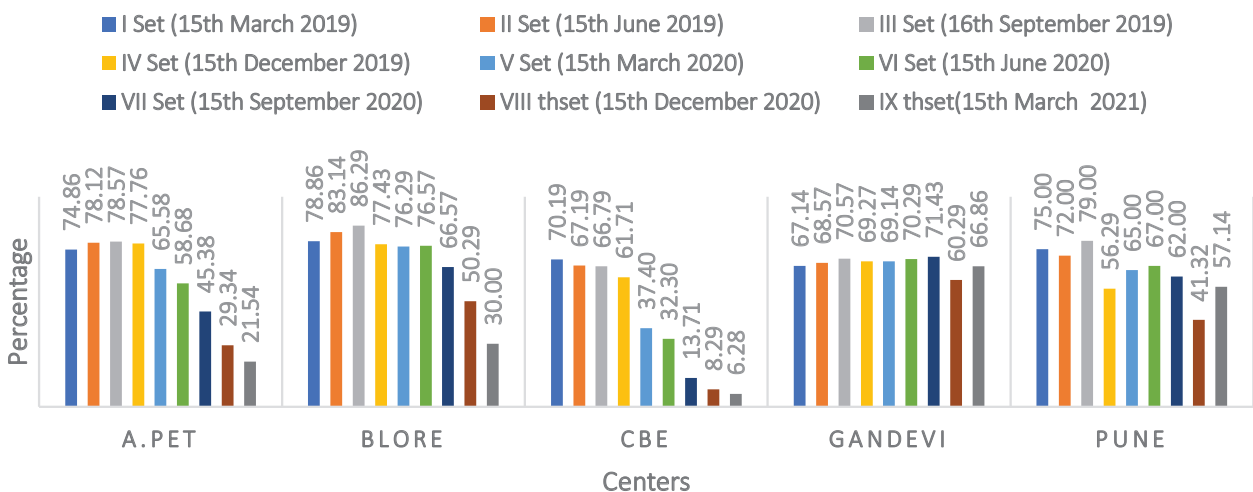
60.29 and 66.86 respectively during 9,12,15,18,21 and 24 months of storage) and seedling vigour index (1162,1162,1158,1166, 800.40 and 879) as compared to Module-I and Module-III, where Module III failed to germinate (Fig. 26 & 27).

Pune: The germination per cent 20 days after incubation and seedling vigour index for all the four sets of seeds incubated for germination exhibited significant differences among the modules from 9th month of storage onwards. Seed germination and vigour index were significantly maximum in Module II than the Module I. Highest germination percentage of 56.29, 65.43, 67.43, 62.00, 41.32 and 57.14 was recorded in Module II (respectively during 9,12,15,18,21 and 24 months of storage) as against Module 1 and local practice.

Module 1



Module 2



Module 3

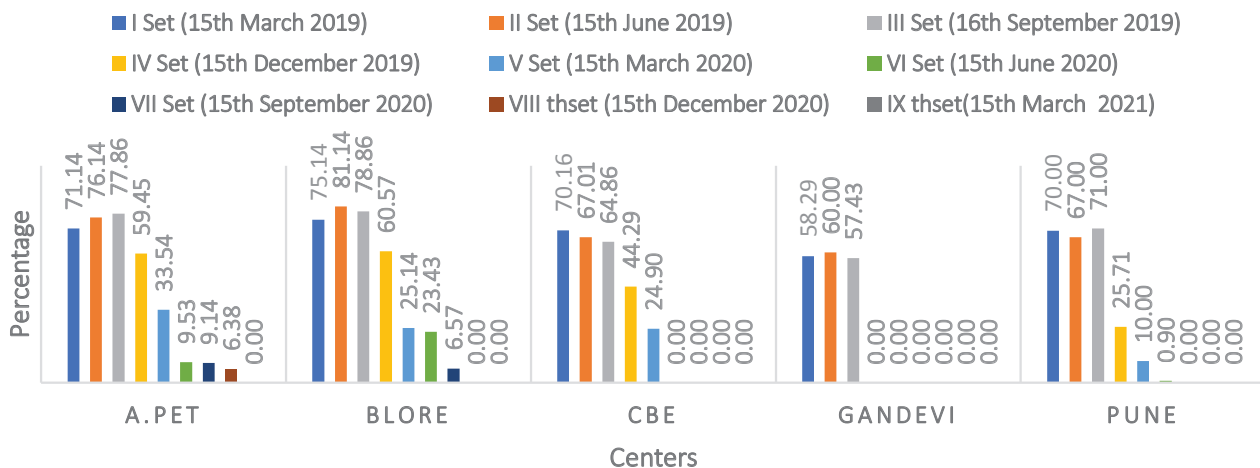
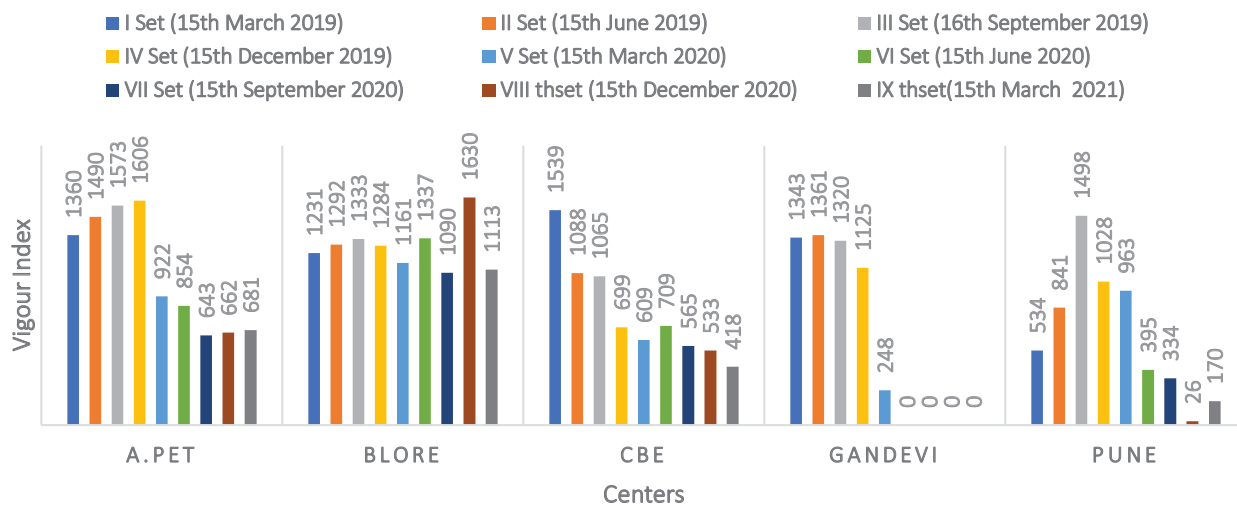
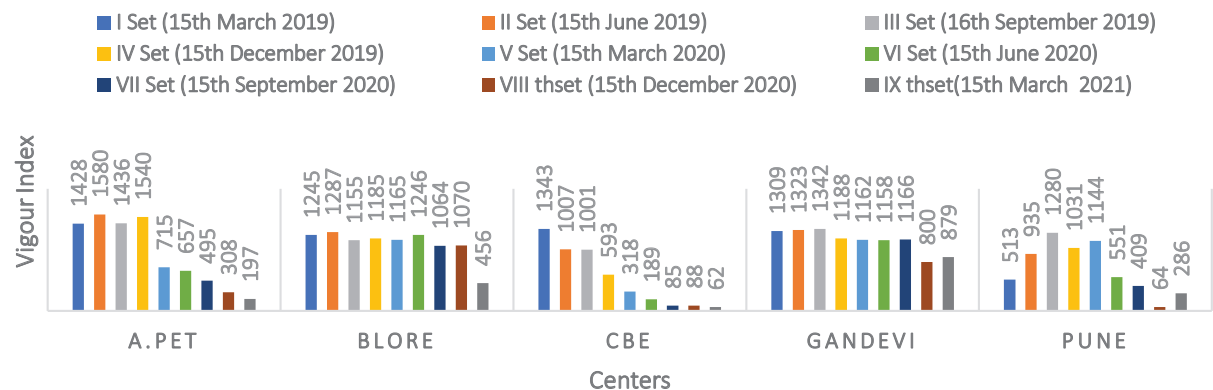


Fig.26: Comparison of seed germination (after 20 days of sowing) among different modules of seed storage in Pa-paya cv. Arka Prabhath.

Module 1



Module 2



Module 3

- I Set (15th March 2019)
- II Set (15th June 2019)
- III Set (16th September 2019)
- IV Set (15th December 2019)
- V Set (15th March 2020)
- VI Set (15th June 2020)
- VII Set (15th September 2020)
- VIII thset (15th December 2020)
- IX thset(15th March 2021)

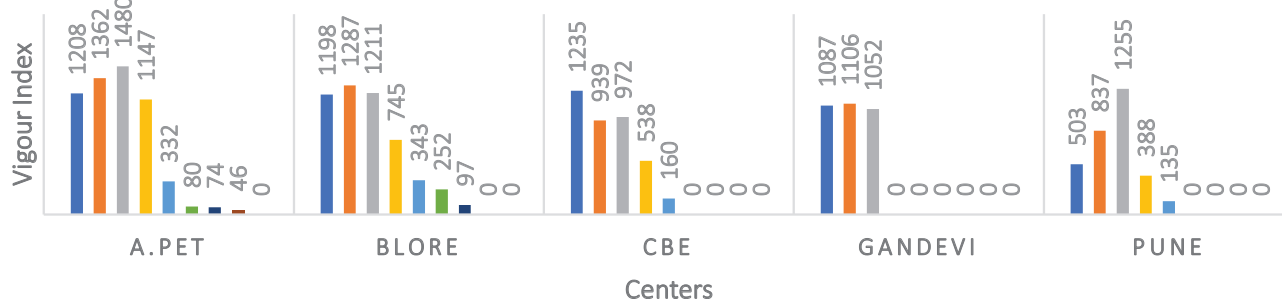


Fig. 27: Comparison of seedling vigour index among different modules of seed storage in Papaya cv. Arka Prabhath

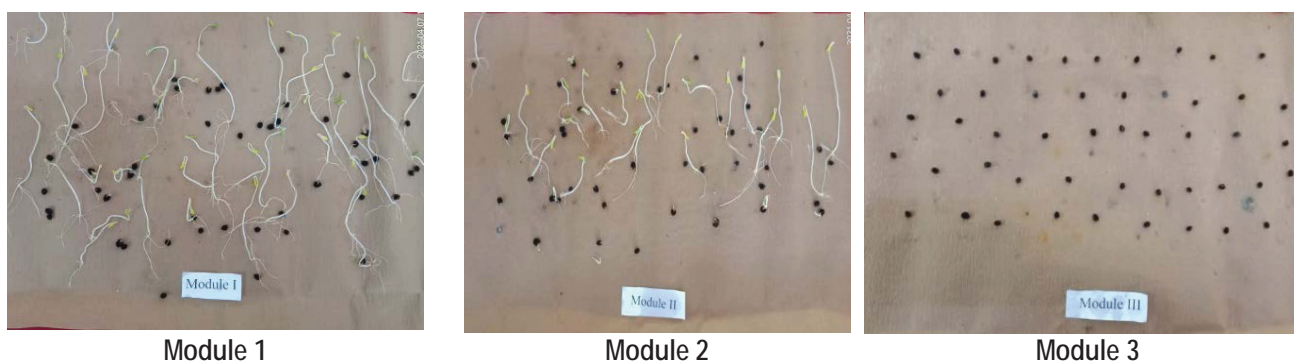


Fig. 28: Comparison of three modules at 24 months of storage

3.3.4.P. Evaluation of Arka Microbial Consortium (AMC) for growth and yield of papaya

This study was conducted in the existing papaya orchard with two months old plants. AMC was applied twice *viz.*, during onset of South West/ North East monsoon and 6 months after first application. AMC was applied by two methods *viz.*, soil application (after enriching with FYM) and bio fertigation. Application of microbial consortium was done two – three weeks after application of chemical fertilizers.

Anantharajupet: New trial was initiated during January, 2021. The yield parameters *viz.*, number of fruits (33.00), fruit weight (1.00 kg), yield (30.00 kg/plant) and estimated yield (101.83 t/ha) and benefit ratio of 3.38 were recorded maximum in treatment supplemented with 75 per cent Recommended Dose of Fertilizers + AMC application at 12.5 kg/ha twice a year through biofertigation (Table 41).

Coimbatore: New trial as per revised technical programme was initiated during August, 2020. The

results indicated that the treatment involving 75 per cent Recommended Dose of Fertilizers + AMC application at 12.5 kg/ha twice a year through biofertigation recorded superiority for fruit weight (1.11 kg), number of fruits (31.27) and fruit yield (34.74 kg) with highest cost benefit ratio of 2.81.

Gandevi: New trial as per revised technical programme was initiated during May, 2021. The plants are in flowering phase and the treatment T₃ (75% RDF along with AM fungi (50 g/plant) + PSB (25 g/plant) + *Azospirillum* (50 g/plant) + *Trichoderma harzianum* (50 g/plant)) performed better for growth characters.

Ranchi: The new trial was taken up during September, 2021 and the crop is in vegetative phase.

Pune: The trial has been implemented in the already existing papaya plantation established during August, 2019 and the treatments were not found to significantly influence the growth and yield of papaya.

Table-41: Effect of Arka Microbial Consortium (AMC) on yield and its attributes in papaya

Treatments	Fruits/plant			Fruit weight (kg)			Yield (kg/plant)		
	ANP	COB	Pune	ANP	CBE	Pune	ANP	CBE	Pune
T ₁	32.01	30.10	31.83	0.91	1.06	0.760	29.12	31.90	29.12
T ₂	32.99	29.35	40.42	0.98	1.07	0.889	32.33	31.47	32.33
T ₃	30.85	27.17	28.79	0.89	0.96	0.852	27.45	26.03	27.45
T ₄	33.00	31.27	33.00	1.00	1.11	0.834	33.00	34.74	33.00
T ₅	31.06	30.75	34.63	0.99	1.09	0.860	30.94	33.35	30.94
CD at 5%	1.07	2.58	NS	0.05	0.10	NS	2.77	3.50	2.77

ANP -Anantharajupet (Red Lady); COB -Coimbatore (TNAU Papaya CO 8); Pune (IARI RS) (Pune Selection 3)

Treatment details: T₁ : 100% Recommended Dose of Fertilizers; T₂ : 75% of RDF along with AM fungi (50g/plant) + PSB (25g/plant) + Azospirillum (50g/plant) + Trichoderma harzianum (50g/plant); T₃ : 75% Recommended Dose of Fertilizers; T₄ : 75% Recommended Dose of Fertilizers + AMC application @ 12.5 kg/ha twice a year through biofertiligation; T₅ : 75% Recommended Dose of Fertilizers +AMC application @ 12.5 kg/ha twice a year along FYM

4.3.1.P. Assessment of phenology, productivity and incidence of insect pests and diseases in papaya grown under varying climatic conditions

Analysis of the past weather data and its effect on phenology and productivity which includes vegetative and reproductive growth parameters, yields along with the incidence of pests and diseases of papaya were monitored.

Coimbatore: The papaya yield per plant and quality of papaya was reduced with the occurrence of papaya ring spot virus that was to the range of 35-40 per cent in the existing trials.

Pune: Among dioecious papaya ringspot virus (PRSV) tolerant lines of papaya, plants in all lines showed 100% PRSV infection except a few plants in PS-2-1 and PS-5-1. The highest TSS was recorded in PS-2-1 (100 °B) and the lowest in PS-2 (7.50 °B). The maximum fruit yield was recorded in PS-1 (42 kg/plant) and the lowest in PS-2 (26 kg/plant) among dioecious lines. Among gynodioecious lines, fruit yield varied from 25 kg/plant (PS-5-1) to 31 kg/plant (PS-2-1). Plant from Red Lady produced only negligible fruits (2.41 kg/plant). Average fruit weight of gynodioecious lines (PS-2-1 PS-3-1 PS-5-1 Red Lady) ranged from 1228 g to 1474 g which was more than that of dioecious lines (PS-1PS-2PS-3) in the range of 973 g to 1025 g.

Pusa: Excessive rainfall was reported at Pusa during the reporting period. The days to flowering and days to fruit maturity from fruit set in Red Lady were 84 and 107 days respectively. And the yield was 32 kg/plant.

4.3.3.P. Grafting in papaya

Anantharajupet: The trial has been initiated during 2021 and the scion block has been established with papaya variety Red lady.

Coimbatore: The grafts of CO 8 on CO 8 rootstock produced earlier were planted in field during May

2021 along with seedlings to study the comparative performance of grafts with seedlings. The initial observations revealed that the grafts recorded lesser number of days for first flowering (59.75 days) when compared to seedlings (126.7 days). First flowering height and plant height at first flowering in grafts were minimum (51.8 cm and 62.40 cm respectively) as compared to seedlings (87.80 cm and 111.98 cm respectively). The number of leaves and leaf area at first flowering were higher in grafted plants (22.80 and 1733.41 cm²) than seedlings (19.85 and 1650.20 cm²) respectively. The higher stem girth was registered in grafted plants (21.60 cm) when compared to seedlings (20.29 cm). A new scion block of TNAU Papaya CO 8 has been established in an insect proof net house during December 2021.

Gandevi: The trial has been initiated during 2021 and the scion block has been established with papaya varieties viz., Arka Prabhath and Red Lady respectively.

Pusa: The trial has been initiated during 2021 and the scion block has been established with papaya varieties viz., Arka Prabhath and Red Lady respectively.

6.3.1.P. New and emerging disease(s) of papaya

An intensive survey was conducted in different districts by all the centres to record papaya diseases.

Anantharajupet: During the reporting period survey was conducted in Obanapalli, Balireddipalli, Bayanapalli villages of Kodur division in Kadapa District and observed severe deformity due to Leaf curl and moderate (10%) incidence of Papaya ringspot virus. PRSV incidence (90%) was recorded as the crop was at the harvesting stage. Fruit rot was recorded up to 12-16%. Pathogens associated were isolated and identified as Colletotrichum sp and Fusarium sp. The disease is predisposed due to fruit fly damage.

Coimbatore: Incidence of papaya ringspot virus, Phytophthora rot and *Cercospora* leaf spot and bacterial crown rot was recorded in Coimbatore, Dindigul and Erode districts. In all the places irrespective of variety, PRSV incidence was observed and the disease incidence ranged from 20 to 90 per cent. Papaya leaf curl incidence of less than 3 per cent was observed in Coimbatore. *Cercospora* leaf spot intensity ranged up to 5 PDI. Phytophthora rot (5%), Bacterial crown rot (5%) and Black leaf spot up to 5 per cent were recorded in Co 8.

Gandevi: No new and emerging disease was observed from papaya growing area of South Gujarat. There is no change in status of existing papaya diseases. Papaya Ring Spot Virus (PRSV) is a major viral disease in papaya growing belt and the maximum disease infection was observed during March to May on Red Lady and there was no major change in disease pattern and seasonal variability. The incidence of fruit rot and collar rot was low in

severity and occurred infrequently. There was no major change in incidence of diseases in current year as compared to last 5 years average incidence.

Pusa: Survey was conducted in major papaya growing districts of Bihar viz, Samastipur, Muzaffarpur, Vaishali, Siwan, Saran, and Katihar during the reporting period. The incidence of various fungal diseases viz., collar rot, fruit rot, and root rot were recorded at various locations. Highest incidence was observed in the case of root rot (20-50%) while fruit rot and collar rot showed 8-10 per cent and 2-6 per cent incidence respectively in the area under survey. The black leaf spot disease was observed for the second time in the agro-ecological condition of Bihar because of frequent rain and high humidity in the month of August and September 2021. PRSV incidence was recorded between 60 to 90 per cent, while leaf curl showed less than 3% incidence only (Table 42).

Table-42: Scenario of various fungal and viral diseases of papaya at different location / states

Name of centres	Anantharajupet	Coimbatore	Gandevi	Pusa
Area surveyed	Five different mandals of Kadapa district	Different papaya orchards of Tamil nadu	Navsari, Surat, Bharuch and Narmada	Samastipur, Muzaffarpur, Begusarai Vaishali, Siwan, Saran, Katihar
Collar rot	17-23 (10-15)	0-5 (5-10)	3-5 (5-8)	2-6 (2-5)
Fruit rot	12-16 (9)	-	3-5 (3-9)	8-10 (2-10)
Root rot	-	-	-	20-50 (15-80)
<i>Cercospora</i> leaf spot (PDI)	6 (4)	5 (5-10)	-	-
Bacterial crown rot (PDI)	4-6 (1)	5 (5-10)		
Black leaf spot (PDI)	7 (3)			4 (6)
Powdery mildew	6-8 (2)			
PRSV	90 (49-65)	20-90 (70-90)	75-95 (83-92)	60-90 (80-100)
Leaf curl	9-11 (4-6)	<3 (5)		<3 (2)

SAPOTA

1.4.4.S. Widening the genetic base in sapota

In order to widen the genetic base of sapota, selfing the flowers of important commercial varieties (Cricket Ball for Arabhavi, Kalipatti for Gandevi, Pala for Kovvur and PKM-1 for Periyakulam) was undertaken. The seedlings of these half-sibs were planted for further evaluation to select superior types.

Arabhavi: Half sibs were raised and planted during June to October, 2014 for further evaluation to select

superior types. The plants are in vegetative stage.

Gandevi: Half sibs were raised and planted during June to October, 2014 for further evaluation to select superior types. The plants are in vegetative stage.

Kovvur: Half sibs were raised and planted during June to October, 2014 for further evaluation to select superior types. The plants are in vegetative stage.

Periyakulam: Half sibs were raised and planted during June to October, 2014 for further evaluation to select superior types. The plants are in vegetative stage (Table 43).

Table-43: Plant morphological characters of sapota half sibs

Parameters	Periyakulam (PKM-1)	Arabhavi (Cricket Ball)	Kovvur (Pala)	Gandevi (Kalipatti)
Plant height (m)	1.21 - 3.52	0.77 - 2.51	2.11 - 5.34	1.50 - 5.10
Stem girth (cm)	9.26 - 29.70	3.0 - 6.0	24.0 - 48.0	10.0 - 45.0
Canopy volume (m ³)	4.68 - 75.63	0.112 - 4.05	5.41 - 42.29	3.36 - 31.67

1.4.5.S. Evaluation of new hybrids of sapota

The hybrid progenies of sapota were evaluated in different regions by using new hybrids (DHS 2/1, IIHS-63, PKM-5 and Cricket Ball as check) with 7 m x 7 m spacing. The trial was carried out using RBD with 3 replications.

Arabhavi: The plants are in vegetative stage. No significant difference was recorded for growth parameters.

Kovvur: The plants are in vegetative stage. No significant difference was recorded for growth parameters.

Gandevi: The plants are in vegetative stage. No significant difference was recorded for growth parameters.

Periyakulam: The plants are in vegetative stage. No significant difference was recorded for growth parameters.

2.4.3.S. Canopy management under high density planting in sapota

The trial was initiated with four spacing viz., 10 x 10 m, 8 x 8 m, 8 x 6 m and 6 x 6 m (S_1 , S_2 , S_3 and S_4). Three pruning times and stages were planned for regulating the canopy and its effects on yield.

Arabhavi: The variety DHS-2 has been used for the trial. No significant difference was recorded for yield parameters among the treatments.

Gandevi: The variety used for the trial is Kalipatti. Trees are in pre bearing stage. Maximum fruit per tree (326.50) was recorded in treatment T_6 (8 X 8m) with 2.0 m gap.

Kovvur: The variety used for the trial is Kalipatti. No significant difference was recorded for yield parameters among the treatments.

Periyakulam: The variety PKM-1 spaced at (10 X10m) with 1.0 m gap recorded maximum yield of 1098 fruits per tree (Table 44).

Table-44: Effect of canopy management under high density planting on yield parameters of sapota at different centres

Treatments	Fruits/tree				Fruit yield (t/ha)			
	ARB	GND	KVR	PKM	ARB	GND	KVR	PKM
T_1 (10 X10m) 1.0 m	764.8	125.6	365.0	1098.5	6.6	0.7	1.8	8.9
T_2 (10 X10m) 1.5m	776.7	157.1	471.7	999.4	6.7	0.9	2.4	8.4
T_3 (10 X10m) 2.0 m	783.0	231.4	343.1	965.4	6.4	1.4	1.7	8.0
T_4 (8 X 8m) 1.0 m	803.3	258.5	362.0	887.3	10.2	2.5	2.8	11.5
T_5 (8 X 8m) 1.5 m	733.7	244.2	405.4	865.2	9.4	2.3	3.2	10.8
T_6 (8 X 8m) 2.0 m	737.0	326.5	368.3	875.5	9.3	3.2	2.9	11.5
T_7 (8 X 6 m) 1.0 m	688.3	268.3	335.0	890.6	11.6	3.0	3.5	15.5
T_8 (8 X 6 m) 1.5 m	691.7	260.8	387.8	802.9	10.7	2.9	4.0	13.8
T_9 (8 X 6 m) 2.0 m	714.3	274.6	351.1	756.4	11.6	3.1	3.7	12.5
T_{10} (6 X 6 m) 1.0 m	614.3	273.3	456.7	796.4	12.2	4.3	6.3	17.0
T_{11} (6 X 6 m) 1.5 m	581.3	300.7	386.7	726.0	12.1	4.4	5.4	15.8
T_{12} (6 X 6 m) 2.0 m	552.0	264.9	301.1	684.3	11.2	4.2	4.2	14.7
CD at 5%	69.39	24.69	59.3	2.087	0.8	0.4	0.9	2.0

ARB: Arabhavi (DHS-2), GND: Gandevi (Kalipatti), KVR: Kovvur (Kalipatti), PKM: Periyakulam (PKM-1)

Spacing levels: S_1 : 10 x 10 m, S_2 : 8 x 8 m, S_3 : 8 x 6 m, S_4 : 6 x 6 m; Pruning time (Space between the plants with in a row) and final canopy gap achieved between plants with in a row: P_1 : 1.0m, P_2 : 1.5m and P_3 : 2.0m

2.4.4.S. Rejuvenation of sapota at normal spacing

In order to improve the productivity of old and senile orchards, rejuvenation trial involving various pruning treatments were attempted.

Arabhavi: No significant difference was recorded among the various pruning treatment. However, center opening along with cutting of cross branches trees have recorded maximum yield (65.00 kg/tree with 889.00 fruits/tree) on 43 years old sapota cv. Cricket ball over control (42.80 kg yield /tree with 628.80 fruits/tree).

Kovvur: At Kovvur center experiment started from

2021-22 on 26 years old sapota cv. Kalipatti tree at 10 x 10 m spacing.

Gandevi: Topping terminal growth of 1.0m has recorded maximum light penetration beneath the canopy (1030 lux), yield/tree (151.40 kg/tree with 2187 fruits/tree) on 38 years old sapota cv. Kalipatti (10 x 10 m spacing) over control (103.00 kg yield/tree with 1589 fruits/tree).

Periyakulam: Center opening along with cutting of cross branches at 8x8 m spacing has recorded maximum yield (3398 fruits/tree & 279.0 kg/ tree) on 39 years old sapota cv. PKM-1 over control (2569 fruits/tree & 208.10 kg/tree) (Table 45).

Table-45: Effect of rejuvenation on yield of sapota at different centres

Treatments	Light penetration (Lux)			Fruits/tree			Yield (kg/tree)			Fruit weight (g)		
	ARB	GND	PKM	ARB	GND	PKM	ARB	GND	PKM	ARB	GND	PKM
T	-	769	825	857.6	1807	2530	61.51	150.1	203.3	73.08	83.00	80.20
T ¹	-	1030	943	851.6	2040	2501	60.56	170.0	194.5	72.48	83.00	77.50
T ²	-	967	1052	896.0	1812	3355	67.09	138.3	274.9	76.20	76.00	82.15
T ³	-	541	961	690.6	1555	2553	48.65	115.0	203.6	72.30	74.00	79.60
CD at 5%	-	107.08	109.02	27.62	127.6	76.87	2.34	11.84	10.26	1.41	3.12	2.280

Arabhavi (Cricket Ball), Gandevi (Kalipatti), Periyakulam (PKM-1); *T₁: Topping Terminal Growth of 0.5 m; T₂: Topping Terminal Growth of 1.0 m; T₃: Center opening along with cutting of cross branches; T₄: Control;
 1. Re-pruning@ Gandevi in month of June- 2021 (Gandevi) 2. Pruning@ Kovvur in month of July- 2021 (Kovvur)

3.4.3.S. Studies on residual and cumulative effect of nutrients in sapota cv. Kalipatti

The experiment was laid out with total nine treatment combinations (A₁B₁, A₁B₂, A₁B₃, A₂B₁, A₂B₂, A₂B₃, A₃B₁, A₃B₂, A₃B₃) comprising of three levels of age wise nutrient viz., (i) application of 1/12th RDF for 12 years (A₁), (ii) application of 1/10th RDF for 10 years (A₂) and (iii) application of 1/8th RDF for 8 years (A₃) as well as three age wise doses of nutrients viz., 100% RDF after 12 years (B₁), 80% RDF after 10 years (B₂) and 60% RDF after 8 years (B₃) in factorial randomized block design with three replications having 4 plants in each treatments.

Arabhavi: The experiment was initiated in 2008 with

cv. Kalipatti. No significant difference was recorded among the treatments for yield parameters.

Gandevi: The experiment was initiated in 2011 with cv. Kalipatti. Maximum fruit weight (90.87 g) was recorded with application of 1/8 of RDF for 1 to 8 years followed by 100% RDF application.

Kovvur: The trees under experiment are 8 years old and non-significant results were observed at early fruit bearing stage in cv. Kalipatti.

Periyakulam: The experiment was initiated in 2006 with cv. PKM-1. Maximum yield (107.0 kg/tree) and number of fruits (1237) were recorded with application of 1/8 of RDF for 1 to 8 years followed by 100% RDF application (Table 46).

Table-46: Effect of residual and cumulative doses of nutrient on yield parameters of sapota

Treatment	Fruits/ tree				Yield (kg/tree)			
	ARB	GND	KVR	PKM	ARB	GND	KVR	PKM
T ₁ : A ₁ B ₁	905.0	404	267.2	1179	65.55	30.23	16.22	92.76
T ₂ : A ₁ B ₂	897.0	408	287.5	987.7	63.53	30.54	17.97	77.87
T ₃ : A ₁ B ₃	920.0	425	297.5	859.5	67.17	31.30	19.37	69.45
T ₄ : A ₂ B ₁	922.0	392	395.8	1166	67.17	28.91	23.75	88.34
T ₅ : A ₂ B ₂	921.7	389	369.2	1032	71.70	26.53	21.62	82.90
T ₆ : A ₂ B ₃	948.0	422	377.3	923.6	71.73	30.25	24.25	74.32
T ₇ : A ₃ B ₁	957.0	394	306.3	1237	78.67	30.47	18.68	107.7
T ₈ : A ₃ B ₂	930.0	424	347.3	1013	73.73	30.62	21.15	81.87
T ₉ : A ₃ B ₃	877.0	388	401.0	935.7	63.47	29.62	25.16	72.75
CD at 5%	NS	NS	70.56	39.02	5.68	1.3	4.00	5.26

ARB: Arabhavi (Kalipatti – 10x10 m), GND: Gandevi (Kalipatti – 10x10 m), KVR: Kovvur (Kalipatti – 10x10 m) and PKM: Periyakulam (PKM1- 8x8 m)

4.4.1.S. Assessment of phenology, productivity and incidence of insect pests and diseases in sapota grown under varying climatic conditions

Analysis of the past weather data and the phenology and productivity in relation to the observed trends in weather patterns were studied at various locations.

Arabhavi: The least incidence was noticed in May 2021 (4.66). The incidence of bud borer was

maximum (6.61 %) during July, 2021. The least incidence of 4.20 % was observed in Feb 2021. The Chiku moth incidence was maximum (6.8 %) in June 2021. The occurrence of mid rib folder was also noticed which was maximum (4.90%) during Aug, 2021. The leaf miner incidence was maximum in April (2.5 %) in April 2021. The fruit fly incidence was maximum (20.50 nos.) during July 2021.

Gandevi: The highest new flush emergence (57.77) in February 2021 and flowering (51.11%) was found in April, 2021. There was no flowering during August month. Whereas, the highest TSS (21.80 °B) was recorded from December 2020 to January 2021. During the observation period, the sapota trees go through a flowering and fruiting period. There were no extreme weather conditions except *Tauktae* cyclone with rain in May 2021 and constant rainfall in September 2021 that occurred during the flowering and fruiting stages of the tree. During flowering, bud borer and Chiku moth incidence showed an increasing trend from March to June 2021 (>10%), as well as Chiku moth, also caused more damage from December 2020 to June, 2021 (>10%). Similarly, midrib folder incidence was found moderate between December, 2020 and March to June 2021 (<10%). The seed borer fruit damage was found high during the period of Feb.-May 2021 at the advanced fruiting stage. Among diseases, leaf spot incidence was found low on sapota. No new insect pest or diseases and outbreaks were reported on the sapota crop.

Kovvur: New flushes were observed continuously from Nov 2020 to March 2021 and then followed by in June 2021 and Sept 2021. The highest peak was in Feb 2021. The flowering intensity also was in similar trend but was higher in the month of July 2021 (55%). The TSS was in the range of 18.8-23 °B during winter and 20-24.2 °B during summer. The acidity of the fruits was in the range of 0.38-0.64 in winter and 0.185-0.64 in summer. Incidence of pests and diseases was significantly less.

Periyakulam: Maximum flowering percentage was observed during April (50.64 %) followed by May (36.53 %). Regarding emergence of new flushes, February (67.99) followed by January (49.60) month registered higher values over other months. The major sapota growing areas in Tamil Nadu was surveyed for the identification of emerging pest and natural enemies in sapota ecosystem. Sapota leaf midrib borer damage was noticed to the extent of 1.05 %. The bud borer damage was observed up to 9.58 %. The sapota leaf spot diseases damage was noticed up to 3.85 % and sooty mould damage was observed up to 7.52 %. On the randomly selected trees, during the year 2021, the sapota chiku moth damage was observed with 10.34 per cent and it was higher during the months of April and September 2021.

5.4.1.S. Survey and surveillance of emerging insect pests of sapota and their natural enemies

Roving and fixed plot surveys were conducted in different parts of the region to identify the key insect pests and their natural enemies and to detect any

new potential insect pests introduced. From each orchard, 10 trees were randomly selected. About 10 per cent of orchards (at least 25 – 50 orchards) in the respective region were surveyed and randomly selected 100 fruits from each orchard were observed for insect infestation so as to calculate the percentage of fruit infestation. On each tree, three twigs were selected, thus thirty twigs were observed fortnightly for the infestation of various pests.

Arabhavi: The average per cent damage by bud borer, chiku moth, seed borer, midrib folder and leaf miner were 7.32, 6.79, 9.07, 7.52, and 5.16 %. The seasonal occurrence of insect pests of sapota showed that the bud borer infestation was in peak during July and October (8.61 and 9.03%). Chiku moth infestation was maximum during November (8.72%) and seed borer damage was more during December 2021, which was 17.3%. The midrib folder incidence was maximum during July first fortnight and August 2021 (6.17 to 9.07%). The fruit fly adults trapped per trap ranged from 0.35 to 152 with the average of 34.75. Among natural enemies, predators like Spiders, Hover fly, Parasitic wasp, Ladybird beetle, Green lacewing and Dragon fly were observed on sapota.

Gandevi: Sporadic incidence (2-5% fruit damage) of fruit borer [*Phycita erythrophila* & *Conogethes* spp.] was noted during March to May. The maximum bud infestation due to bud borer was during April-June months of peak flowering phase during 2020-21 with average of 11.2%. Chiku moth showed bud infestation (14.6%) and 6% fruit damage. Similarly, the 9.1 % fruit damage due to seed borer was reported. There was even fruit damage intensity, but consistently causing fruit damage during Nov.-Dec. and March-April at fruiting stage. Midrib folder infestation was recorded (12.3%); fruit fly higher incidence noted during April-May, which recorded 4.8 % fruit damage. The damage due to fruit mite and mealy bug was recorded at very low level (<3%) and infrequently during 2020-21. New report of rugose spiralling whitefly (*Aleurodicus rugioperculatus* Martin 2004) was reported in coconut + sapota mixed orchard only. Among natural enemies, predators like dragonfly, damselfly and lady bird beetles were observed on sapota.

Kovvur: There was 5.0% damage of seed borer, chiku moth (2%) and fruit fly damage (2%). The natural enemies were not observed during this experimental period.

Periyakulam: During the reporting year, chiku moth damage ranged from 16.32 per cent and it was higher during the month of October to December and May to September 2021. Seed borer damage on an average was noticed to the tune of 4.58% and the maximum of 6.24 to 6.84 per cent was recorded during July 2021.

The midrib folder peak infestation was observed during April to July with an average incidence of 1.65. The fruit fly adults trapped per trap ranged from 2.15 to 9.65. Among natural enemies predators like dragonfly, damselfly and lady bird beetles were observed on sapota.

5.4.9.S. Slow-release pheromone formulation for the management of fruit fly in sapota

Two types of pheromone-based treatments *viz.*, slow-release pheromone formulation and conventional lure (control) were tested for the management of adult fruit fly in existing orchard of sapota at four centres. Total 20 number of traps (one trap as one replication) in each treatment were installed under orchard of commercial variety with recommended package of practices for the region. There was more than 200 m isolation distance kept between two treatments. Arabhavi used UHS trap, Gandevi used “Nauroji Stonehouse” NAU trap, and Kovvur and Periyakulam used methyl eugenol based local conventional trap (control). The observation on adult male catches count was done at each standard meteorological week (SMW). The replacement of pheromone formulation lure was done when the effectiveness of lure comes down.

Arabhavi: The adult fruit fly catches data showed significant differences among traps in all SMW at 5 per cent and 1 per cent except in few earlier SMW. The average number of fruit fly catches was found nearly higher in conventional UHS trap (control) (16.5 adults/trap) than slow-release pheromone formulation trap (14.9 adults/trap). On an average, slow-release pheromone formulation trap attracted 9.94 per cent less adult fruit flies than conventional

UHS trap (control) in sapota (Fig. 29).

Gandevi: The adult fruit fly catches result revealed significant differences among traps in all SMW at 5 per cent and 1 per cent level. The average number of fruits fly catches was counted higher in conventional “Nauroji Stonehouse NAU Trap (control) (260.0 adults/trap) than slow-release pheromone formulation trap (55.6 adults/trap). There was 78.60 per cent less trap catches in slow-release pheromone formulation than “Nauroji Stonehouse” NAU Trap (control). The plywood-based lure (“Nauroji Stonehouse”) was changed in 43rd SMW, while lure was not replaced in slow-release pheromone formulation till 52nd SMW (Fig. 30).

Kovvur: The adult fruit fly catches data showed significant differences among traps in all SMW at 5 per cent and 1 per cent levels (Fig. 31). The average number of fruits fly catches was found higher in conventional trap (control) (18.0 adults/trap) than slow-release pheromone formulation trap (6.7 adults/trap). Slow-release pheromone formulation trap attracted 63.0 per cent less adult fruit flies than conventional trap (control) in sapota.

Periyakulam: The adult fruit fly catches result revealed significant differences among traps in all SMW at 5 and 1 per cent levels (Fig. 32). The average adult fruit fly catches were reported higher in slow-release pheromone formulation trap (63.4 adults/trap) than conventional methyl eugenol lure trap (control) (22.4 adults/trap). On an average, slow-release pheromone formulation trap attracted 183.1 per cent more adult fruit fly than conventional methyl eugenol lure trap in sapota. There was not fruit fly adult catches from 41st SMW.

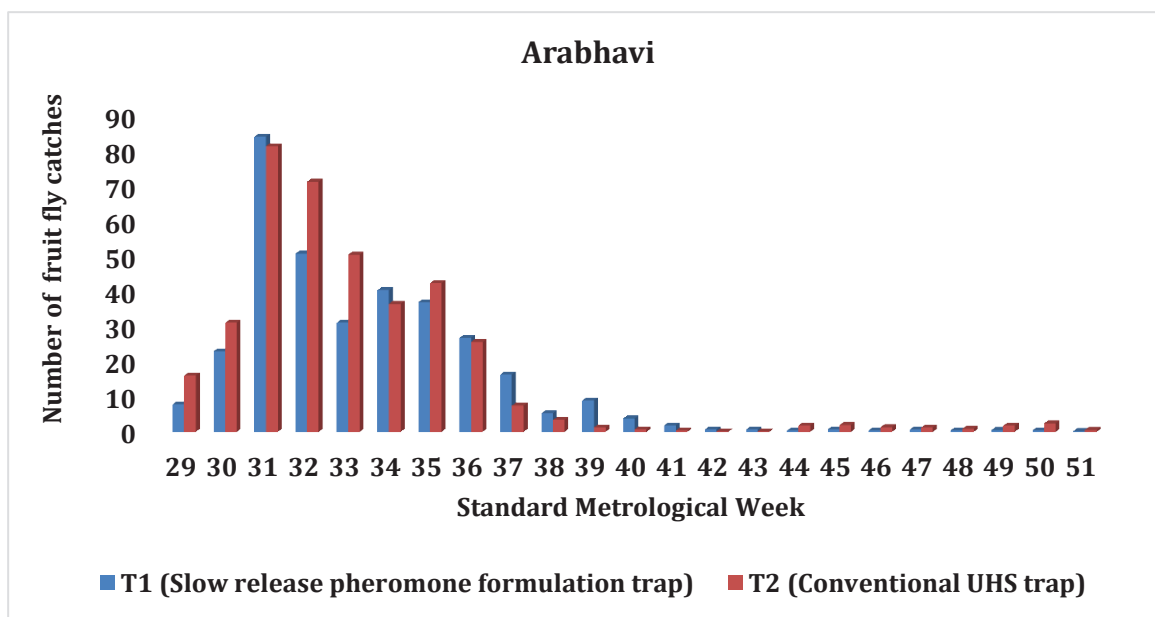


Fig. 29: Weekly adult fruit fly catches in standard meteorological weeks in sapota orchard at Arabhavi

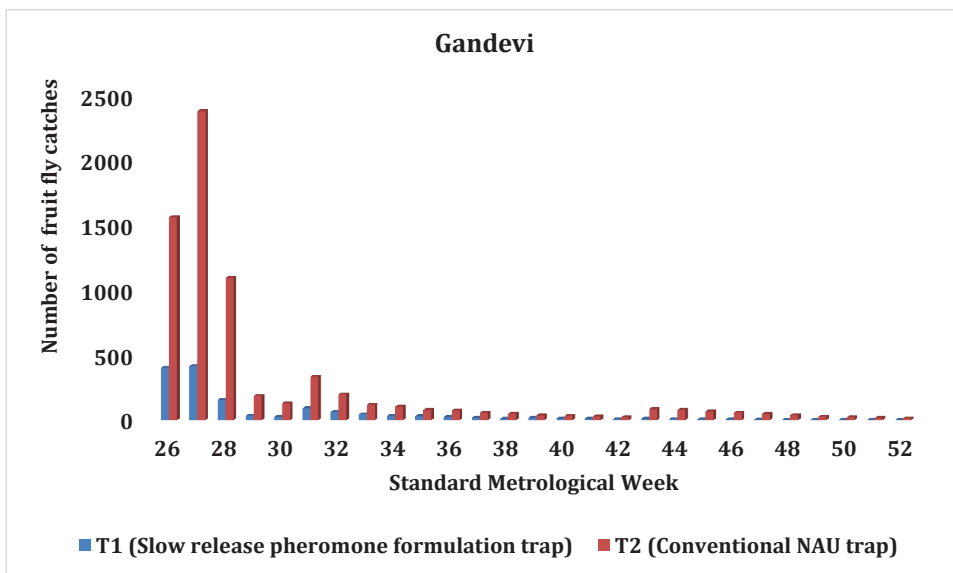


Fig. 30: Weekly adult fruit fly catches in standard meteorological weeks in sapota orchard at Gandevi

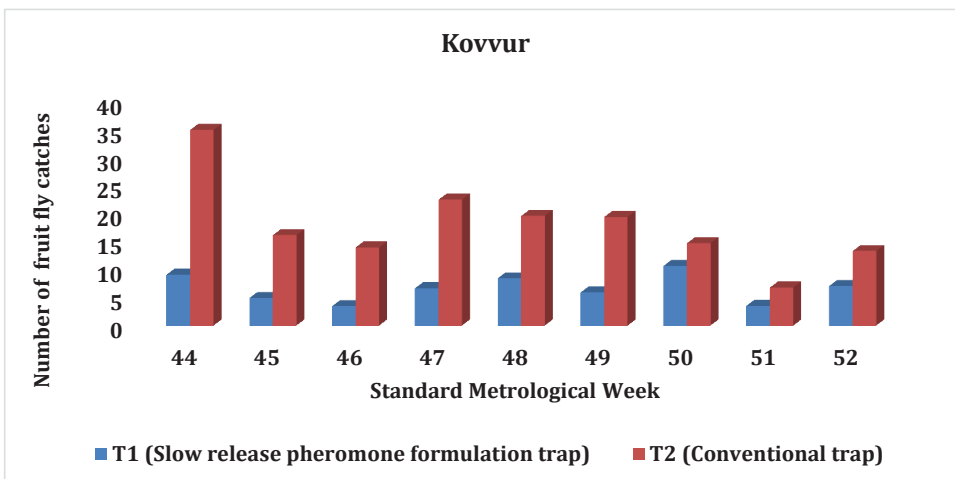


Fig. 31: Weekly adult fruit fly catches in standard meteorological weeks in sapota orchard at Kovvur

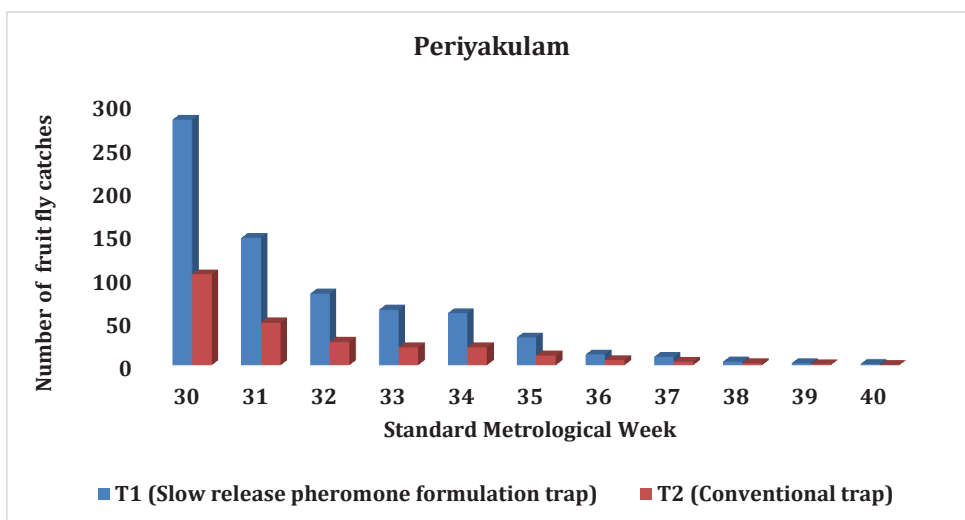


Fig. 32: Weekly adult fruit fly catches in standard meteorological weeks in sapota orchard at Periyakulam

Transfer of technology

A. Seminars/Symposium/Workshop/Group meeting attended

Akola

- Ingle YV and Paithankar DH participated in National Symposium (virtual mode) on 'Probing beneficial microorganism for next green revolution' organized by Indian Phytopathology Society, New Delhi West Zone and Association of Plant Pathologist, Dr. PDKV, Akola (25th to 26th February 2021).
- Paithankar DH and Ingle YV participated in 8th Group Discussion Meeting of ICAR-AICRP on Fruits in Virtual mode (3rd to 6th March 2021).
- Ingle YV participated in e-National symposium on 'Plant Health and Food Security: Challenges and Opportunities' organized by Indian Phytopathology Society, New Delhi, IARI, New Delhi and ICAR, New Delhi (25th to 27th March 2021).
- Ingle YV participated in State level webinar on 'Citrus crop production' organized by Rajshri Shahu College of Science, Chandur Railway Dist. Amravati (16th July 2021).
- Ingle YV attended and participated in workshop on "Citrus fruit drop management" organized by DEE, Dr. PDKV, Akola (27th August 2021).
- Paithankar DH and Ingle YV attended and participated in brain storming workshop on 'Citrus fruit drop' organized by ICAR-CCRI at Nagpur (27th September 2021).
- Ingle YV participated in National Symposium on 'Achieving Sustainability in Crop Production through Alimentation and Plant Protection' organized by Indian Phytopathology Society, West Zone, New Delhi, and VNMKV, Parbhani (MS) at College of Agriculture, Latur (17th to 18th November 2021).

Arabhavi

- Nataraja KH Suhasini Jalawadi and Siddanna Thoke attended annual Technical Meet at COH, Mysore (4th to 6th February 2021).
- Kantharaju V attended annual Technical Meet at COH, Bengaluru (8th to 9th February 2021).
- Kantharaju V, Nataraja KH, Suhasini Jalawadi and Siddanna Thoke participated in 8th Group Discussion Meeting of ICAR-AICRP on Fruits in Virtual mode (3rd to 6th March 2021).
- Kantharaju V and Nataraja KH Suhasini Jalawadi and Siddanna Thoke attended Zonal Workshop

at MHREC, Bagalkot (5th to 7th May 2021).

Bhubaneswar (OUAT)

- Saudamini Swain and Bipin Kumar Pradhan participated in 8th Group Discussion Meeting of ICAR-AICRP on Fruits in Virtual mode (3rd to 6th March 2021).

Coimbatore

- Aneesa Rani MS, Sujatha KB, Kavitha C and Manoranjitham SK attended 8th Group Discussion meeting of ICAR – AICRP on Fruits (3rd to 6th March 2021).
- Sujatha KB attended International Plant Physiology Virtual Symposium 2021 on "Physiological Interventions for Climate Smart Agriculture (11th to 12th March 2021).
- Manoranjitham SK had attended Shastri Indo Canadian Institute Sponsored International Conference (11th to 12th March 2021).
- Auxilia J attended Second International agro biodiversity congress (CGIAR, Bioversity International, CIAT, Colombia) (15th to 18th November 2021).
- Auxilia J and Kavitha C attended National online training on conservation, management and utilization of Horticultural genetic resources for livelihood and nutritional security (20th to 26th November 2021)

Gandevi

- Patel AP participated in National webinar on "Recent Advances in mango production" organized by College of Horticulture, University of Horticulture Sciences, Bidar (KA) (15th to 16th January 2021).
- Patel AP, Modi PK, Bisane KD and Naik BM participated in 8th Group Discussion Meeting of ICAR-AICRP on Fruits (Virtual mode) (3rd to 6th March 2021).
- Bisane KD participated in National webinar on "Promise of Biological Control for Sustainable Pest Management" organized by Department of Entomology, Rajasthan College of Agriculture, MPUAT, Udaipur, Rajasthan (17th May 2021).
- Bisane KD participated in National webinar on "Microbial Pesticide: Next Generation Preparedness" organized by DBT-ECAB and Department of Plant Pathology, AAU, Jorhat (2nd July 2021).
- Modi PK participated in National webinar on "Role of Micro organism in Resilient Agriculture" organized by Swami Keshwanand Rajasthan

Agricultural University, Bikaner (5th July 2021).

- Bisane KD participated in National webinar on “Invasive Pests and Diseases Problem in Indian Agriculture” organized by Department of Entomology and Plant Pathology, NMCA, NAU, Navsari (7th August 2021).
- Bisane KD participated in National webinar on “Banana Value Chain and Marketing New Business Horizons” organized by ICAR-National Research Centre for Banana, Tiruchirapalli (T.N.) (21st August 2021).
- Patel AP and Modi PK participated in National online training on conservation, management & utilization of horticultural genetic resources for livelihood and nutritional security organized by ICAR-IIHR, Bengaluru (22nd to 26th November, 2021).
- Patel AP and Modi PK participated in National webinar on “Mango Producing is not enough! Wakeup Call on Postharvest Handling, Processing Technology, and Value Chain Management” organized by Department of Agriculture and Environmental Sciences, NIFTEM, Kundli, Sonapat, Haryana (7th December 2021).
- Bisane KD participated in virtual 5th National symposium on Plant Protection in Horticulture (NSPPH-2021): Challenges and Roadmap Ahead (Oral presentation) organized by AAPMHE at ICAR-IIHR, Bengaluru (27th to 29th December 2021).
- BisaneKDparticipatedinSeminaron“Maintenance of Quality and Safety of Horticultural and Food Crops through Biological Control of Pests and Diseases” organized by NAHEP-CAAST Sub-project (Unit-4), N. M. C. A., NAU, Navsari, & Plant Protection Association of Gujarat (PPAG), Navsari Chapter (30th December 2021).

Gangian

- Navprem Singh and Sumanjit Kaur Participated in “Research & Extension Specialist workshop for Horticultural Crops” organized by Punjab Agricultural University, Ludhiana virtually (6th July 2021).

Imphal

- Ng. Piloo attended 3 days web workshop cum training on edible Insect “Edible insect and non- conventional foods as nutrient pack and livelihood security” organized by CHF, Pasighat in collaboration with Ministry of Environment, Forest and Climate Change (27th to 29th January 2021).
- Dilip Singh RK and Ng. Piloo, Romen Singh participated in National seminar on “Conservation

and Commercialisation of Citrus Biodiversity in NEH Region” at Central Agricultural University, Iroisemba, Manipur (18th to 19th February 2021).

- Dilip Singh RK, Ng. Piloo, Dayananda S and Deem Singh T participated in the “CAU-Regional Agri Fair 2020-21” at Central Agricultural University, Iroisemba, Manipur (8th to 10th March 2021).
- Dilip Singh RK, Ng. Piloo, Romen Singh S participated in National conference “Priorities in crop protection for sustainable agriculture” (16th to 18th March 2021).
- Romen Singh S attended one day National webinar on “Advancement in fruit production technologies: present situation and future strategies organized by Department of Fruit Science, BCKV, Mohanpur, West Bengal (14th September 2021).

Jalgaon

- Mendhe AR attended the online international web conference on “Global Research initiative for sustainable Agriculture and Allied Sciences.” (GRISAS) organized by Astha foundation, Meerut (U.P.) (13th to 15th December 2021).
- Mendhe AR attended the state level seminar on “Soil Health and climate Resilience: Need for sustainable Agriculture” at Dr.BSKKV, Dapoli (15th to 16th December 2021).

Jorhat

- Popy Bora attended National webinar on “Promise of Biological Control for Sustainable Pest Management” organized by the Department of Entomology, Rajasthan College of Agriculture, Maharana Pratap University of Agriculture and Technology, Udaipur, Rajasthan (17th May, 2021).
- Popy Bora attended National webinar on “Ecosystem for Sustainable FPO” organized under Azadi Ka Amrut Mahotsav by ICAR-Research Complex for Eastern Region, Patna, Bihar (30th July, 2021).
- Popy Bora attended workshop on “Investment in Modern Agricultural Biotechnology Socio-economic Impact on Livelihoods of Farmers in Asia Pacific” organized by Asia-Pacific Association of Agricultural Research Institutions (APAARI), in collaboration with PCAARRD, Philippines; Council of Agricultural (COA), Taiwan; CropLife Asia (CLA), Singapore; Federation of Seed Industry of India (FSII), India (2nd to 3rd August 2021).
- Popy Bora attended National webinar on

"Invasive Pests and Diseases Problem in Agriculture" jointly organized by Department of Entomology and Plant Pathology, N.M. College of Agriculture, Agricultural University, Navsari (7th August 2021).

- Popy Bora attended 9th Indian Horticulture Congress-2021 organised by Indian Academy of Horticultural Sciences, New Delhi (18th to 21st November 2021).

Kannara

- Pushpalatha PB, Vimi Louis, Manju PR, Gavas Ragesh attended the 43rd ZREAC (virtual) organized by RARS, Pattambi (17th November 2021).
- Pushpalatha PB, Vimi Louis Manju PR and Gavas Ragesh attended POP state level workshop (3rd December 2021).
- Pushpalatha PB, Manju PR, Vimi Louis and Gavas Ragesh attended webinar on "Climate change and banana cultivation" at BRS, Kannara (21st May 2021).
- Pushpalatha PB and Manju PR attended webinar on "Value added products of banana" on 27th May 2021 at BRS, Kannara (21st May 2021).
- Gavas Ragesh attended webinar on "Integrated Pest and Disease Management in Banana" organised by Karshika vinjana vipanana kendram, KAU, Vengeri, Kozhikode (29th May 2021).
- Pushpalatha PB attended webinar on "Entrepreneurial opportunities in banana processing" organised by Agribusiness Incubator, Kerala agricultural university, Vellanikkara (2nd June 2021).
- Pushpalatha PB and Manju PR attended webinar on "Value addition in banana" organised by Dept of Processing technology, COA, Vellayani (3rd June 2021).
- Manju PR and Gavas Ragesh attended webinar on "Scientific banana cultivation, banana varieties, pest and disease management" organised by AKC, Mannarkadu (7th June 2021).
- Manju PR and Gavas Ragesh attended webinar on "Scientific banana cultivation, banana varieties, pest and disease management" organised by Regional Agricultural Research Station, Pattambi (9th June 2021).
- Pushpalatha PB and Manju PR attended webinar on "Haritham Athijeevanam - banana webinar series on processing and value addition" by Peechi Janamaithri Police (21st to 30nd June 2021).

- Manju PR attended webinar on "Nendran Banana Cultivation (mentioning the cultivation practices of Changalikodan)" by BPKP programme - Agricultural Knowledge Centre of Mullassery block (7th July 2021).
- Pushpalatha PB attended webinar on "KILA training to local self government - entrepreneurship development opportunities in post harvest handling and value addition" by Kerala Institute of Local Administration and Kerala Agricultural University (9th July 2021).
- Pushpalatha PB attended webinar on "Orientation on Banana Research Station, Kannara" by Mathrubhumi seed programme (15th July 2021).
- Pushpalatha PB attended webinar on "Possibilities of entrepreneurship development in banana" by Kerala Bureau of Industrial Development (13th August 2021).
- Pushpalatha PB attended webinar on "Training on start ups - value addition in banana" by *Krishi Vigyan Kendra*, Kottayam (27th August 2021).
- Vimi Louis, Manju PR and Gavas Ragesh attended webinar on "Monthly Technology Advisory Meeting - banana" by *Krishi Vigyan Kendra*, Thrissur (20th September 2021).
- Manju PR attended webinar on "Online training on Macropropagation in banana" by *Krishi Vigyan Kendra*, Kottayam (5th October 2021).

Kovvur

- Ramanandam G, Snehalatha Rani A, Ashok P and Ramesh Babu B attended 8th Group Discussion of ICAR AICRP on Fruits by virtual mode (3rd to 6th March 2021).
- Ramanandam G participated in Scientific Advisory Committee Meeting (Virtual mode) of ICAR - CTRI KVK, Kavalacharla as member of the SAC Committee and interacted in the presentation of work done for the year 2021 and action plan for 2021-22 (5th April 2021).
- Ramanandam G, Naga Lakshmi R, Ravindra Kumar K and Snehalatha Rani A participated and presented lectures in virtual webinar on scientific cultivation of banana organized by Rythusalahakendram, DrYSRHU and Banana Research Station, Pulivendula (30th April 2021).
- Ramanandam G, Mamatha K, Naga Lakshmi R, Ravindra Kumar K, Snehalatha Rani A and Kishore kumar S participated in ZREAC meeting of Coastal Zone through online (2nd July 2021).
- Ramanandam G, Mamatha K, Naga Lakshmi R, Ravindra Kumar K, Snehalatha Rani A and

Kishore kumar S, participated in ZREAC meeting of Rayalaseema Zone through online (5th July 202).

- Ramanandam G, Mamatha K, Naga Lakshmi R, Ravindra Kumar K and Snehalatha Rani A attended webinar on “Sustainable integrated cropping and farming system models” with special reference to Banana being organized by NRCB, Trichy (7th July 2021).
- Ramanandam G and Ravindra Kumar K participated in Malaysia National Banana Congress 2021 – Revitalizing the banana industry in Malaysia through zoom and interacted in scientific discussions relevant to plant tissue culture (7th to 8th September 2021).
- Snehalatha Rani A participated in International Symposium of Tropical Fruits 2021 organized by TFNet, Malaysia and presented an oral presentation on “Strategic management of Banana Eumusae leaf spot severity in Andhra Pradesh, India” (28th to 30th September 2021).
- Ravindra Kumar K, Snehalatha Rani A, and Kishore kumar S participated in “Indian Horticulture Congress – 2021 – Horticulture for health, Livelihoods and Economy” organized by Indian Academy of Horticultural Sciences (IAHS), New Delhi (18th to 21st November 2021).
- Ramesh Babu B participated in webinar on “Translational genomics for improvement of horticultural crops” organized by global connect series in collaboration with Plant genomics and Biotechnology, West Virginia State University, USA (27th November 2021).
- Ramesh Babu B participated in International Webinar on Mango - Producing is not enough: A Wake Up Call on Postharvest Handling, Processing Technology, and Value Chain Management (7th December 2021).

Lembucherra

- Lembisana Devi H participated at the National seminar on ‘Conservation and commercialization of citrus biodiversity in NEH region’ organized by CAU, Imphal (18th to 19th February 2021).
- Lembisana Devi H participated in the 8th Group Discussion of ICAR-All India Coordinated Research Project on Fruits on virtual mode (3rd to 6th March 2021).
- Lembisana Devi H participated at the one day international level webinar on ‘Fruits, vegetables and Tropical tubers in shaping global food and nutrition security (12th November 2021).
- Lembisana Devi H participated in the 2nd International Agro biodiversity Congress on virtual mode (15th to 18th November 2021).

Ludhiana

- Rattanpal HS, Sandeep Singh, Anita Arora, Krishan Kumar and Manveen Kaur participated in 8th Group Discussion of ICAR-AICRP on Fruits through virtual mode (3rd to 6th March 2021).
- Sandeep Singh participated in virtual National conference on Strategic Reorientation for Climate Smart Agriculture, held in virtual mode at PAU, Ludhiana (17th to 19th March 2021).
- Anita Arora participated in National seminar on “Technological Options and Market Intelligence for Enhancing Profitability in Horticulture-I” through virtual mode organized by Biotech Kisan Hub, SKUAST-Kashmir (27th to 28th March 2021).
- Sandeep Singh organized webinar on IPM of fruit flies in fruit crops under ICAR-AICRP on Fruits, in collaboration with KVK Tarantaran, NABARD, ICAR-ATARI Ludhiana (11th May 2021).
- Anita Arora participated in virtual workshop cum training programme on “Rejuvenation Technologies for Citrus Decline in North eastern Region of India” jointly organized by ICAR-CCRI, Nagpur, Maharashtra, ICAR-ATARI, Guwahati, Assam and ICAR RC for NEH Region, Umiam, Meghalaya (6th December 2021).

Mandsaur

- Nitin Soni participated in the 8th Group Discussion of ICAR-All India Coordinated Research Project on Fruits on virtual mode (3rd to 6th March 2021).

Mohanpur

- Anamika Kar attended one day brainstorming webinar on “Managing Threats of Stink Bug in Litchi - Way Forward” organized by the ICAR NRC on Litchi (6th June 2021).
- Anamika Kar attended One day webinar on “Acaritalks 2021 Chapter 1” organized by BCKV (29th July, 2021)
- Anamika Kar attended three days National training cum webinar on “On farm and mass production protocols of bioagents and microbial agents for fall army worm management (15th to 17th November 2021)
- Anamika Kar attended and presented in National symposium on plant protection in horticulture (NSPPH – 2021): Challenges and road map ahead on “Management of Banana Pseudostem Weevil (*Odoiporus longicollis* Olivier) (Coleoptera: Curculionidae) for a benign environment in West Bengal” (27th to 29th December 2021).

Paria

- Patel CR participated in webinar on “Recent Advances in Mango Production” organized by College of Horti., Bidar, UHS, Bagalkot, Karnataka (15th to 16th January 2021).
- Patel CR, Chavan SM and Bhandari AJ participated in 8th Group Discussion of the ICAR-AICRP on Fruits organized by IIHR, Bengaluru (3rd to 6th March 2021).
- Patel CR participated in national webinar on “Canopy Architecture Management in Perennial Commercial Horticultural Crops” organized by College of Horticulture, Bidar, UHS, Bagalkot, Karnataka (19th to 20th July 2021).

Pune (ARI)

- Sujata Tetali participated in 8th GD meeting of ICAR-AICRP on Fruits virtually (3rd to 6th March 2021).
- Sujata Tetali had attended and presented centre’s research work in centre’s review meeting (21st August 2021)

Pune (NRCC)

- Somkuwar RG, Sharma AK, Sujoy Saha, Deependra Yadav and Roshni Samarth attended ICAR-AICRP 8th Group Discussion (3rd to 6th March 2021).

Rahuri

- Garande VK, Jadhav SB, Pawar PS, Palande PL, Shete MH and Bhalerao VK attended virtual 8th Group Discussion of ICAR-AICRP on Fruits (3rd to 6th March 2021).
- Shete MH attended National webinar on “Microbial Technologies for Sustainable Agriculture and Climate Change Mitigation” organized by All India Network Project on Soil Biodiversity & Biofertilizers, Department of Molecular Biology and Biotechnology, Directorate of Research, Maharana Pratap University of Agriculture and Technology, Udaipur, Rajasthan (7th July 2021).
- Shete MH attended one day webinar on Indo-Israeli Technique for citrus cultivation organized by state agriculture department with College of Agriculture Nagpur (26th September 2021).

Raipur

- Sharma GL had participated in training on Management of fruit genetic research organized by NBPGR, New Delhi and ICAR - AICRP on Fruits, IIHR, Bengaluru (1st to 2nd February 2021).
- Sharma, GL participated in 8th Group Discussion of ICAR-AICRP (Fruits) held through virtual

mode organized ICAR - AICRP on Fruits, IIHR, Bengaluru (3rd to 6th March 2021).

Rajendranagar

- Vijaya D and Baby Rani T participated in 8th GD meeting of ICAR-AICRP on Fruits virtually (3rd to 6th March 2021).
- Vijaya D and Baby Rani T participated in ZREAC meeting of ICAR-AICRP on Fruits (3rd to 6th March 2021).
- Baby Rani T participated in training programme on Innovative Agricultural extension Approaches – Agri start ups Agripreneurs conducted by MANAGE (28th to 30th April 2021).

Snagareddy

- Harikanth Porika attended 2 days National level webinar on recent advances in mango production at COH, Bidar, UHS, Bagalkot (15th to 16th January 2021).
- Harikanth Porika had participated in global conference on innovative approaches for enhancing water productivity in Horticulture crops by CHAI at PJTSAU, Rajendranagar (15th to 20th September 2021).

Tinsukia

- Kakoti RK, Saud BK and Sikha Deka attended the 8th Group Discussion of ICAR- AICRP on Fruits through virtual mode (3rd to 6th March 2021).

Tirupati

- Ramana KTV, Mukunda Lakshmi L and Srinivasa Reddy D attended review meeting on Vice-Chancellor to Village programme through webinar (11th January 2021).
- Ramana KTV, Mukunda Lakshmi L, Srinivasa Reddy D and Rajasekharam T attended Webex meeting on NHF-2021 and with Project Co-ordinator, ICAR-AICRP on Fruits (23rd January 2021).
- Venkata Ramana KT, Mukunda Lakshmi L, Srinivasa Reddy D and Rajasekharam T participated and presented technical programme in 8th Group Discussion, 2021 of ICAR-AICRP on fruits through virtual mode (3rd to 6th March 2021).
- Rajasekharam T attended plant pathology review meeting with university officers through Webinar to discuss the technical programme of Plant Pathology (10th March 2021).
- Nagaraju R, Mukunda Lakshmi L, Srinivasa Reddy D and Rajasekharam T attended online Pre-ZREAC-2021 (Rayalaseema Zone) through

webinar and presented the technical programme of work of 2020-21 (10th to 11th May 2021).

- Srinivasa Reddy D and Rajasekharam T attended virtual meeting on SCSP implementation programme and development of Mobile App by the Plant Protection Scientists with Project Co-ordinator, ICAR-AICRP on Fruits (25th May 2021).
- Nagaraju R, Mukunda Lakshmi L, Srinivasa Reddy D and Rajasekharam T attended webinar on Year of Citrus (8th June 2021).
- Mukunda Lakshmi L, Srinivasa Reddy D and Rajasekharam T attended Webex meeting on technology inventory with Project Co-ordinator, ICAR-AICRP on Fruits (10th June 2021).
- Srinivasa Reddy D attended AICRP Entomology meeting (11th June 2021).
- Nagaraju R attended a Webinar on jack fruit an upcoming fruit crop (2nd July 2021).
- Nagaraju R, Mukunda Lakshmi L, Srinivas Reddy D, and Rajasekharam T attended online ZREAC-2021-22 (Rayalaseema Zone) meeting through webinar and presented the research highlights of CRS, Tirupati for the year 2020-21 (5th July 2021).
- Mukunda Lakshmi L attended global conference on “Innovative Approaches for Enhancing Water Productivity in Agriculture including Horticulture” at PJTSAU, Rajendra Nagar, Hyderabad and presented oral paper on entitled “Water Budgeting in Important Fruit Crops of Andhra Pradesh” (16th to 19th September 2021).
- Nagaraju R attended meeting on brainstorming session on crop planning & crop diversification in Andhra Pradesh at RARS, Tirupati (15th December 2021).
- Nagaraju R, Mukunda Lakshmi L, Srinivasa Reddy D and Rajasekharam T attended webinar on Citrus processing and value addition through virtual mode conducted by Dr.YSRHU on the eve of Dr.YSRHU year of Citrus-2021 (29th December 2021).

Udaipur

- Lakhawat SS participated in IX GD Meeting of AICRP on Fruits held by PC Cell, IIHR, Bengaluru (8th to 11th March 2022).

Vengurle

- Gawankar MS, Munj AY, Chavan SS and Govekar YR participated and presented the experimental results during the 8th Group Discussion meeting of AICRP on Fruits organized by Project Coordinator at IIHR Bengaluru (3rd to 6th March 2021).

B. AIR-Doordarshan Programme and Youtube

Akola

- Ingle YV delivered radio talk (AIR) on mandarin fruit drop management (28th January 2021)
- Ingle YV delivered radio talk (AIR) on Bordeaux mixture and Bordeaux paste preparation and their application (11th June 2021)
- Ingle YV delivered radio talk (AIR) on Major diseases of acid lime and their management (26th July 2021)

Gandevi

- Patel AP and Modi PK delivered radio talk (AIR-DD Girnar, Ahmedabad) on propagation of banana plants through Macro technology (15th October 2021).

Jalgaon

- Badgujar CD delivered radio talk (AIR) on care of banana crop in rainy season (2nd July 2021)
- Badgujar CD delivered radio talk (AIR) on care of papaya and banana crop in rainy season (17th August 2021)

Kannara

- Gavas Ragesh uploaded a short YouTube video on “Management of Giant African snail” (14th December 2021).

Kovvur

- Ravindra KK delivered programme (Suman TV) on selection of best quality tissue culture banana plants and advantages (12th January 2021)
- Ravindra KK delivered radio talk (AIR) on Tissue culture *aratilo vesavilo chepattavalasina yajamanya paddhatulu* (17th March 2021)
- Ravindra KK delivered programme (Facebook live organized by ICL fertilizers, India) on nutrient management in Banana (29th June 2021)
- Ravindra KK delivered programme (ETV *Annadata*) on nutrient management in Tissue culture banana cv Grand naine and Nutrient deficiency symptoms and their management in banana (29th June 2021)
- Ravindra KK delivered programme (ETV *Annadata*) on tissue culture *aratilo poshaka yajamanyam* (26th July 2021)
- Ravindra KK delivered radio talk (AIR) on tissue culture *Aratilo samagra poshaka yajamanyam* (30th October 2021)
- Ravindra KK delivered radio talk (ETV *Annadata*) on tissue culture *Aratilo poshaka lopalu Nivarana*

marghalu (22nd July 2021)

- Ashok P delivered radio talk (AIR) on weed management in fruit crops (9th February 2021)
- Ashok P delivered radio talk (AIR) on weed control in fruit orchards (13th February 2021)
- Ashok P delivered programme (RBK channel) on best management practices in Sapota (10th May 2021)
- Ashok P delivered programme (RBK channel) on best management practices in Jack fruit (27th May 2021)
- Ashok P delivered programme (ETV *Annadata*) on Pruning in Guava (19th July 2021)
- Ramesh BB delivered radio talk (AIR) management of mango after fruit set (23rd February 2021)
- Ramesh BB delivered programme (RBK channel) best management in cultivation of guava (15th March 2021)
- Ramesh BB delivered programme (RBK channel) on importance of grafting plants in fruit crops for getting higher yields (17th May 2021)
- Ramesh BB delivered programme (RBK channel) on After harvest management of Mango orchards (29th May 2021)
- Ramesh BB delivered programme (RBK channel) on Improved practices in papaya cultivation (19th July 2021)
- Ramesh BB delivered programme (RBK channel) on Plastic usage in Horticultural crops (8th November 2021)
- Ramanandam G delivered programme (ETV *Annadata*) on *Melaina Arati rakalu* (13th July 2021)
- Ramanandam G delivered programme (DD) on Banana cultivars for commercial cultivation in Andhra Pradesh (5th November 2021)
- Snehalatha Rani A delivered programme (ETV *Annadata*) on *Eumusae* leaf spot disease of banana and its management (30th June 2021)
- Snehalatha Rani A delivered programme (ETV *Annadata*) on *Aratilo Sigatoka tegulu -Nivarana* (20th June 2021)

Ludhiana

- Rattanapal HS delivered talk (DD TV Punjabi) on *Kinnowan di sudhai te kant-shant karn de viganic dhang tareeke* (28th January 2021).

Pantnagar

- Singh AK delivered radio talk (AIR) on cultivation of papaya by adopting new technologies (17th August 2021)
- Singh AK delivered radio talk (AIR) on care & management of orchard after rainy season (17th September 2021)
- Singh AK delivered radio talk (AIR) on application of macro & micronutrients for higher yield & quality production in mango (7th December 2021)
- Poonam Srivastava delivered Radio Talk (Janvani Radio) on Control of insect-Pest in mango orchard (20th September 2021) and
- Poonam Srivastava delivered Radio Talk (Janvani Radio) on Insect-pest management in fruit crops (14th February 2021)

Periyakulam

- Delivered programme (You tube channel- *Pon Vilaiyum Bhoomi* programme) on Nursery Management, UHDP in Mango & Cultivation of Sapota (<https://youtu.be/ms86E9TvODY>, <https://youtu.be/BaxqT9f51eQ> & <https://youtu.be/E71HsEhKjLA>)

Rahuri

- Pawar PS delivered radio talk (AIR) *Limbuvargiya falpik vyavasthapan* on (27th May 2021)

Rajendranagar

- Vijaya D delivered talk (TV) on *Draksha lo poshaka lopaalu vaati nivarana* (24th February 2021)

Tirupati

- Mukunda Lakshmi L delivered talk (TV RBKs) on Best Management practices in cultivation of Sweet orange (8th April 2021)
- Venkata Ramana KT delivered talk (TV DD Saptagiri) on Integrated cultivation practices for summer in Citrus on (26th April 2021)
- Rajasekharam T delivered talk (TV DD Saptagiri) on *Varsha kaalam lo Cheeni nimma lo thegulla yajyamanyam* on (9th August 2021)
- Nagaraju R, Mukunda Lakshmi L, Srinivasa Reddy D, Rajasekharam T delivered talk (TV HMTV Nelathalli) on disease management in citrus at CRS (21st August 2021) telecasted on (25th August 2021).
- Rajasekharam delivered radio talk (AIR) on Integrated disease management in citrus on (26th August 2021).

- Dr. L. Mukunda Lakshmi delivered radio talk (AIR) on High density planting in citrus- canopy management (6th September 2021)

C. Extension and other activities

Akola

- Paithankar DH and Ingle YV conducted field day for mandarin growers on 'Integrated Nutrient Management' in collaboration with KVK, Karda Tq. Risod Dist. Washim with more than 40 farmers at Wadaji Tq. Risod Dist. Washim (19th January 2021).
- Paithankar DH and Ingle YV participated in online two days training on 'Management of fruit genetic resources' organized by ICAR-NBPGR, New Delhi and ICAR-IIHR, Bengaluru (1st to 2nd February 2021).
- Paithankar DH and Ingle YV organized one day training for SCSP Citrus growers at Dr. PDKV, Akola campus with more than 45 farmers (11th February 2021).
- VPaitankar DH participated in meeting on National level technical committee and crop specific technical subcommittee for standardization of term sheets, weather triggers and risk period for crop notified under RWBCIS organized by Assistant Commissioner Govt. of India, Ministry of Agril, and Farmers Welfare and Dept. of Agril. Cooperation (22nd February 2021).
- Paithankar DH and Ingle YV organized one day training programme on 'Mrig Bahar regulation, Pest and Disease management' with more than 45 farmers at KVK, Jalgaon Jamod Dist Buldhana and AICRP on Fruits (13th May 2021).
- Paithankar DH and Ingle YV organized one day training programme on Citrus Crop production' with more than 100 farmers at KVK, Ghatkhed Dist Amravati and AICRP on Fruits (24th May 2021).
- Ingle YV organized one day training programme on 'Citrus Crop Protection' with more than 45 farmers at KVK, Karda Tq. Risod, Dist. Washim and AICRP on Fruits (8th June 2021).
- Ingle YV participated in online training on 'Citrus Crop Protection' organized by RAMETI, Nagpur (1st September 2021).
- Paithankar DH and Ingle YV attended one day training programme and delivered talk on 'Hast bahar regulation and Canker disease management respectively at AICRP on fruits (29th September 2021).

Anantharajupet

- Sandeep Naik G participated in the 5 days training programme on "FDP on teaching competency enhancement through innovative methods at ICAR- NAARM (15th to 19th March 2022).
- Sharath Kumar Reddy Y and Sandeep Naik G visited Baliraddy palli village of Obulavaripalli Mandal for the implementation of ICAR- AICRP, SCSP programme and selection of farmers (27th October 2021).
- Sandeep Naik G has visited and conducted "Survey on disease dynamics in papaya" at Settivaripalli, Adireddipalli and Musalnayanapalli villages of Mydukur mandal (7th to 8th December 2021).

Arabhavi

- Kantharaju V provided farm advisory work for about 255 farmers on their banana field problems by suggesting the suitable remedies for the management of diseases.
- Kantharaju V has visited 12 farmers field and suggested the suitable remedies for the management of fruit diseases.
- Suhasini Jalawadi has visited 02 farmers field and suggested the suitable advanced production technologies in banana.
- Nataraja KH has visited 05 farmers field and suggested the suitable remedies for the management of diseases in banana.
- Siddanna Thoke has visited 20 farmers field and suggested the suitable remedies for the management of diseases in grapes.

Coimbatore

- Auxilia J, Sujatha KB, Kavitha C and Manoranjitham SK attended online awareness programme on 'Germplasm Registration in Horticultural Crops" (1st October 2021).

Gandevi

- Patel AP, Modi PK and Bisane KD participated in virtual training course on "Management of Fruit Genetic Resources" organized ICAR-NBPGR, New Delhi, ICAR-AICRP (Fruits), Bengaluru & ICAR-IIHR, Bengaluru (1st and 2nd February 2021).
- Bisane KD participated in online training on 'Vertebrate Pest Management – Wild Boar, Monkey and Birds' organized by National Institute of Plant Health Management (NIPHM), Hyderabad from (3rd to 5th February 2021).
- Patel AP, Modi PK, Bisane KD and Naik BM organized a "Farmers Scientist Interaction" and live virtual telecast of "National Horticulture Fair

2021” along with exhibition of sapota varieties at Kesali Village of Navsari district (11th February 2021).

- Bisane KD participated in online training on ‘Fruit Fly Surveillance and Management’ organized by National Institute of Plant Health Management (NIPHM), Hyderabad (19th to 23rd April 2021).
- Bisane KD participated in online training on ‘Rodent Pest Management’ organized by National Institute of Plant Health Management (NIPHM), Hyderabad (17th to 21st May 2021).
- Patel AP, Modi PK, Bisane KD and Naik BM organized “On Campus training and Technology demonstration” program for progressive farmers of Bharuch, Narmada and Navsari districts at FRS, NAU, Gandevi (20th July 2021).
- Patel AP, Modi PK, Bisane KD and Naik BM organized a Farmer Scientist Interaction meeting on “Recent Advances in Banana Cultivation” along with KVK, NAU, Surat at Taraj Village of Palsana block in Surat district. Also, a field Day on “Performance of Macro-propagated plants of Banana” at field of Anilbhai Solanki at Taraj. (2nd August 2021).
- Patel AP, Modi PK and Naik BM organized a Farmers Meet on “Employment generation through Horticultural Crops” under TSP scheme along with KVK, NAU, Dang and KVK, NAU, Tapi at Tekpada village, Tal.- Waghai, Dist.- The Dang. Also, Field day on “Organic Farming in Banana” was organized at field of Tusharbhay Y. Bhoys, at-Bhalkhet (9th August 2021).
- Patel AP, Modi PK, Bisane KD and Naik BM organized “On Campus Training Program and Technology Demonstration” for progressive farmers of Bharuch, Narmada and Navsari districts at FRS, NAU, Gandevi (6th September 2021).
- Patel AP, Modi PK, Bisane KD and Naik BM organized “On Campus training and Technology demonstration” program for farmers of Bharuch, The Dang, Valsad, Surat and Navsari districts at FRS, NAU, Gandevi. Also, FRS, NAU, Gandevi signed MoU with eleven farmers and one nursery for production of banana planting material at his farms and commercialization purpose through “Banana Macropropagation Technology” (18th November, 2021).
- Sumanjit Kaur organized and delivered lecture in one day training programme on “Nursery production of fruit crops” at FRS Gangian for 15 persons (24th March 2021).
- Sumanjit Kaur organized and delivered lecture in 3 days training programme on “Nursery production of fruit crops” at FRS Gangian for 15 persons (11th to 13th August 2021).
- Sumanjit Kaur had organized and delivered lecture in one day training programme on “Nursery production of fruit and vegetable crops for 25 persons at FRS, Gangian (17th August 2021).
- Sumanjit Kaur delivered lecture on cultivation of fruit crops at Farmer camp organized by KVK Bahawal (Hoshiarpur) at village Bahawal (21st October 2021).
- Sumanjit Kaur organized and delivered lecture in five days training programme for 23 SC farmers at FRS Gangian (26th to 30th October 2021).
- Sumanjit Kaur organized and delivered lecture in five days training programme for SC farmers (25persons) at FRS Gangian (22nd to 26th November 2021).

Gangian

- Sumanjit Kaur organized and delivered lecture in 2 days training programme on “Nursery production of fruit crops” at FRS Gangian for 15 persons (22nd to 23rd March 2021).

Jalgaon

- Deshmukh GP, Mendhe AR and Chaure JS participated in virtual National Horticulture fair – 2021 organized by ICAR – IIHR at Bengaluru (8th to 12th February 2021).
- Mendhe AR attended online three weeks National certificate course on “Climate Smart Organic Farming” jointly organized by NAHEP, CAAST and CSAWM, MPKV, Rahuri (15th February to 7th March 2021).
- Mendhe AR attended online three weeks National certificate course on “Soil Management for Climate Smart Agriculture” organized by NAHEP, CAAST and CSAWM, MPKV, Rahuri (14th June to 4th July, 2021).
- Badgujar CD, Deshmukh GP conducted online training on “Management of Cucumber mosaic virus and Sigatoka leaf spot disease on banana” (14th September 2021).

Imphal

- Ng. Piloo delivered talk on ‘Products, processing and packaging’ for online Faculty Development Programme (FDP) funded by DST, Govt. of India and organized by CHF, CAU, Pasighat, Arunachal Pradesh (18th to 31st January 2021).
- Ng. Piloo attended virtual training course on management of fruit genetic resources organized

by ICAR, NBPGR, New Delhi, ICAR, AICRP on Fruits, Bengaluru and ICAR-IIHR, Bengaluru (1st to 2nd February 2021).

- Ng. Piloo delivered talk on, “Advances in processing and value addition of jackfruit” during 03 days training programme on “Processing and value addition of locally available fruits and vegetables and promotion of entrepreneurship” organised by MTTC & VTC, CoA, CAU, Imphal (25th -27th March 2021).
- Ng. Piloo, participated as resource person during two days training program under AICRP on micro and secondary nutrients and pollutant elements in soils and plants (MSPE), CAU, Imphal centre at College of Agriculture, CAU, Imphal (21st to 22nd December 2021).
- Romen Singh S attended two days training programme under AICRP on micro and secondary nutrients and pollutants in soils and plants (MSPE), CAU, Imphal, centre as resource person on the topic entitled Role of micronutrients and its control of physiological disorders in fruit crops (21st to 22nd December 2021).

Kannara

- Pushpalatha PB and Manju PR, Vimi Louis and Gavas Ragesh handled classes for 22 farmers from Malampuzha block at BRS, Kannara (16th April 2021).
- Pushpalatha PB attended training cum exhibition at *Parakode block, Pathanamthitta* (6th to 8th November 2021).
- Pushpalatha PB and Manju PR, Vimi Louis and Gavas Ragesh handled classes for 14 SCSCP farmers as part of training from Kodumon Krishibhavan, Pathanamthitta at BRS, Kannara (9th November 2021)
- Pushpalatha PB and Manju PR, Vimi Louis and Gavas Ragesh took classes for farmers from VFPC Palakkad at BRS, Kannara (25th November 2021)
- Pushpalatha PB attended webinar on “Online training on processing and value addition in banana” by RAFTAR ABI (3th December 2021).
- Pushpalatha PB and Manju PR, Vimi Louis and Gavas Ragesh handled classes for 36 farmers from VFPC, Kasargod at BRS, Kannara (17th December 2021).
- Gavas Ragesh handled classes for 21 farmers from Idukki as part of ATM TSP state training at BRS, Kannara (18th December 2021).
- Manju PR attended 2 days training cum exhibition at *Kodumon, Parakode, pathanamthitta* (19th to 20th December 2021).
- Gavas Ragesh handled classes for 21 farmers from VFPC Malappuram at BRS, Kannara (29th December 2021).

Kovvur

- Ramanandam G participated as resource person in Rugoses spiralling whitefly management awareness programme for the farmers by RBKs technical and Extensions staff of Dept. of Horticulture at Ammalapadu (V), Vajrapukotture (M), Srikakulam district and demonstrated neem oil spray and yellow sticky traps for whitefly control (16th January 2021).
- Ramanandam G participated in the exhibition displaying live specimens of released varieties of banana bunches and tubers in connection with the visit of Hon’ble Minister for Agriculture, Marketing & Co-operation Govt. of Andhra Pradesh Sri. K. Kannababu and Smt. T. Vanitha, Minister for Women and Child welfare at Dr.YSR Horticultural University (19th January 2021).
- Snehalatha Rani A participated in the Kisan Ghosti organized by Horticultural Research Station, Ambajipeta (11th February 2021).
- Ramanandam G, Mamatha K, Naga Lakshmi R, Ravindra Kumar K, Sneha Latha A, Kishore Kumar S and Staff of Horticultural Research station, Kovvur in collaboration with *Rythusalaha Kendram*, Dr.YSRHU organized a webinar on Scientific cultivation of banana to all the officers of Department of Horticulture and farmers of Andhra Pradesh. (26th March 2021).
- Ramanandam G participated as a resource person in Kisan mela organized by KVK Undi, West Godavari District ANGRAU and displayed the live samples of banana varieties, tuber crops and technology for the benefit of the farmers (27th March 2021).
- Naga Lakshmi R, Snehalatha Rani A, and Kishore Kumar S conducted a diagnostic visit to banana fields and observed severe incidence of rhizome rot in Tella chakkerakeli variety in the farmers fields at Ravuripadu village (31st March 2021).
- Ashok P and Ramesh Babu B conducted a method demonstration on “Soil sampling in orchards” was conducted by HRS, V.R. Gudem to create awareness among farmers regarding soil testing at Jaggannapeta village (12th April 2021).
- Ashok P has conducted diagnostic field visit to the mango orchards and suggested control measures to fruit borer, thrips and anthracnose at Jaggannapeta village (26th April 2021).

- Ashok P and Ramesh Babu B conducted awareness programme on nematode management in guava in adopted village Ramannagudem (17th August 2021).
- Ramesh Babu B has delivered a lecture on “Production technologies of Sapota and Guava” to the fertilizer and pesticides dealers of East Godavari dist. under DAESI (22nd August 2021).
- Ramanandam G participated in the “Awareness programme on Germplasm Registration in Horticultural crops” organised by Germplasm Advisory Committee, ICAR – IIHR, Bengaluru through virtual mode (1st October 2021).
- Mamatha K, Naga Lakshmi R, Snehalatha rani A participated in the awareness programme on management of rugose spiraling white fly at Vanapalli of Kothapeta mandal, East Godavari District (10th November 2021).

Lembucherra

- Lembisana Devi H participated at the two days training programme on “Management of Plant Genetic Resources” for the scientists of ICAR-AICRP on Fruits on virtual mode (1st to 2nd February 2021).
- Lembisana Devi H participated at the national online training on conservation, management & utilization of horticultural genetic resources for livelihood and nutritional security organised by ICAR-IIHR, Bengaluru (22nd to 26th November 2021).
- Lembisana Devi H and Biswajit Das organized a three-day training programme was organized on “Scientific management of tropical and sub tropical fruits” for the fruit growers at ICAR-RC for NEH region, Tripura Centre (9th to 11th February 2021).
- Lembisana Devi H and Biswajit Das organized a two-day training programme was organized on “Nursery management of Fruit crops” for the unemployed women gardeners in collaboration with the Ristey Skill Services Private Ltd. at ICAR-Research Complex for NEH region, Tripura Centre (12th to 13th August 2021).
- Lembisana Devi H and Biswajit Das organized a three-day training programme on Quality planting material production and nursery management of horticultural crops” at ICAR RC for NEH Region, Tripura Centre, Lembucherra, West Tripura (25th to 27th October 2021).

Ludhiana

- Anita Arora delivered lecture on “Innovations in disease management of fruit crops” to HDOs during Research and Extension Specialist Virtual Workshop for Horticultural Crops (Winter) organized by Directorate of Extension Education, PAU, Ludhiana (7th January 2021).
- Krishan Kumar delivered lecture on ‘Training and pruning of Citrus plants’ in a citrus seminar organized by Citrus Estate, Abohar (21st January 2021).
- Anita Arora delivered lecture on “Disease management in fruit crops” to HDOs/KVK/PAU Scientists in “Online training course on pest and disease management in horticultural crops” organized by Skill Development Centre, PAU, Ludhiana (11th February 2021).
- Sandeep Singh delivered lecture on "Pest Management in fruit crops" during online training course on insect pest management in horticultural crops, at Skill Development Centre, PAU, Ludhiana (11th February 2021).
- Anita Arora delivered lecture on “Disease management in fruit plants” in “online three months training course on integrated crop production for young farmers of Punjab” held at Skill Development Centre, PAU, Ludhiana (23rd February 2021).
- Sandeep Singh delivered lecture on "Pest Management in fruit crops" during training on cultivation of fruits, vegetables and flowers, Skill Development Centre, PAU, Ludhiana (22nd to 26th February 2021)
- Sandeep Singh organized farmer scientist interaction under ICAR-AICRP on Fruits for SCSP component at Village Jugial, district Hoshiarpur (9th March 2021).
- Sandeep Singh delivered lecture on "Management of insect-pests of fruit crops" during training camp organised under SCSP component of ICAR-AICRP on Fruits at Village Hajipur, district Hoshiarpur (9th March 2021).
- Sandeep Singh delivered lecture on "Insect-pests of mango and litchi" during Panel discussion held during Virtual Kisan Mela at RRS Gurdaspur (18th March 2021).
- Anita Arora delivered lecture on “Post-harvest disease management of fruit crops during pack house operations” to farmers and farm women in training course on “Pack house worker” held at Skill Development Centre, PAU, Ludhiana (19th March 2021).

- Sandeep Singh delivered lecture on "Management of insect-pests of Citrus" during training camp organized by Gurraj Baag, district Faridkot (28th March 2021)
- Rattanpal HS, Sandeep Singh and Anita Arora participated in virtual Kisan Mela organized by PAU, Ludhiana (5th to 6th April 2021).
- Krishan Kumar delivered lecture on 'Fruit Nutrition Garden' in a farmer awareness camp at Kaira Khera (16th April 2021)
- Sandeep Singh delivered lecture on "Innovations in management of insect-pests of fruit crops" during Horticulture Officers Workshop, PAU, Ludhiana (11th May 2021).
- Sandeep Singh delivered lecture on "Management of insect-pests of deciduous fruit crops" during Webinar on "Management of Insect-pests and diseases of deciduous fruit crops" organized by Pear Estate, Amritsar (18th May 2021).
- Anita Arora delivered lecture on "Integrated practices for disease management in fruit crops" to HDOs/DESS/KVK/PAU Scientists in online training course on "Latest production, protection and post-harvest handling techniques of fruit and vegetable crops" organized by Skill Development Centre, PAU, Ludhiana (17th June 2021).
- Anita Arora delivered lecture on "Innovations in disease management of fruit crops" to HDOs during Research and Extension Specialist Virtual Workshop for Horticultural Crops (Summer) organized by Directorate of Extension Education, PAU, Ludhiana (6th July 2021).
- Sandeep Singh delivered lecture on "Innovations in management of insect-pests of fruit crops" during Horticulture Officers Workshop, PAU, Ludhiana (6th July 2021).
- Anita Arora delivered lecture on "Management of citrus diseases" to the farmers during field day on "Production and Protection of Citrus" held at Village Sukhchain, District Fazilka, Punjab (3rd September 2021).
- Rattanpal HS, Sandeep Singh, Anita Arora, Krishan Kumar and Manveen Kaur participated in field day on "Production and Protection of Citrus" held at Village Sukhchain, District Fazilka, Punjab (3rd September 2021).
- Sandeep Singh delivered lecture on "Eco-friendly management of fruit flies through PAU Fruit Fly Traps in citrus" during "Field Day on Production and Protection of Citrus" at village Sukhchain, district Fazilka on (3rd September 2021).
- Krishan Kumar delivered lecture on Nutritional and Health benefits of citrus fruits in a field day on 'Production and Protection of Citrus', at Sukhchain (3rd September 2021).
- Rattanpal HS, Sandeep Singh and Anita Arora participated in virtual Kisan Mela organized by PAU, Ludhiana (17th to 18th September 2021).
- Anita Arora delivered lecture on "Disease management in fruit plants" in "online three months skill development integrated crop production training course for young farmers of Punjab" organized by Skill Development Centre, PAU, Ludhiana (21st September 2021).
- Dr Sandeep Singh delivered lecture on "Management of insect-pests of fruit crops during "Young Farmers Training Course" (21st September 2021).
- Sandeep Singh and Anita Arora participated in virtual Kisan Mela organized by PAU, RRS, Gurdaspur on September 14, 2021 and organized by KVK, Rauni, Patiala (22nd September 2021).
- Krishan Kumar delivered lecture on 'Fruit Nutrition Garden' for Farmer awareness programme at Wajidpur Kattianwali (8th October 2021).
- Krishan Kumar delivered lecture on 'Importance of vegetative plant propagation in Fruit Plants' in a RKVY Training on Propagation of Fruit Plants (10th November 2021)
- Krishan Kumar delivered lecture on 'Varieties of Citrus fruits suitable for planting under South-Western Punjab' in Citrus Seminar organized by Citrus Estate, Abohar (11th November 2021)
- Krishan Kumar delivered lecture on 'Importance of Mother plants in Healthy Citrus Nursery' in a RKVY training on propagation of fruit Plants (12th November 2021).
- Sandeep Singh delivered lecture on "IPM in Fruit Crops" during 1 year Diploma in Agricultural Extension Services for input dealers, PAMETI, Ludhiana (27th November 2021).
- Sandeep Singh delivered lecture on "Biocontrol agents in Fruit Crops" during 1 year diploma in Agricultural Extension Services for input dealers, PAMETI, Ludhiana (27th November 2021).

Mandsaur

- Nitin Soni delivered lecture on "*Madhya pradesh main angoor ke khati ke sambhabhai*" in one day training programme under DG SCSP at College of Horticulture, Mandsaur (31st March 2021).
- Nitin Soni delivered lecture and conducted field visit in one day training programme organised by Department of Horticulture (9th January 2021).

Mohanpur

- Misra DK, Bauri FK, Chakraborti K, Debnath S, Majhi D, Kar A and Roy attended the training programme on “Management of Plant Genetic Resources” for the scientists of ICAR-AICRP (Fruits) on virtual mode (online), organized by ICAR-NBPGR, New Delhi (1st to 2nd February 2021).

Paria

- Patel CR participated in 2 days virtual training on “Management of Fruit Genetic Resources” organized by IIHR, Bengaluru and NBPGR, New Delhi (1st to 2nd February 2021).

Pantnagar

- Singh AK, Poonam Srivastava and Satish Chand conducted one day training programme on ‘Demonstration and transfer of technology related to mango, litchi and guava under AICRP on Fruits’ at village Chandpur Block Kahipur Dist. U.S. Nagar (3rd September 2021).
- Singh AK and Satish Chand conducted one day training programme on ‘Demonstration and transfer of technology related to mango, litchi and guava under AICRP on Fruits’ at KVK Dhakrani Dist. Dehradun (23rd September 2021).
- Singh AK, Poonam Srivastava and Satish Chand have conducted different field visits and demonstrations including lectures to the orchard growers, farmers and rural youth on commercial cultivation in mango, litchi and guava during Farmers Fair at HRC, Pattharchatta and Kisan Goshthi at Pantnagar to the farmers of Uttarakhand and adjoining states (2021).
- Singh AK, Poonam Srivastava, Satish Chand, Rajesh Kumar and Pratibha have given regular advise to the farmers through Agricultural Technology Information Centre (ATIC) of University Help Line Service, mobile and what’s App.

Pune (ARI)

- Sujata Tetali disseminated information on grape varieties developed at ARI, Pune to farmers in Kisan Mela organized virtually to commemorate ‘Azadi ka amrut mahotsav’ (21st June 2021).
- Sujata Tetali disseminated information on grape varieties developed at ARI, Pune to farmers in Kisan Mela organized virtually to commemorate ‘Azadi ka amrit mahotsav’ (6th August 2021).
- Sujata Tetali disseminated information on grape varieties developed at ARI, Pune to farmers practicing natural farming organized virtually by Mr Subhash Palekar (11th September 2021).

Pune (NRCC)

- Roshni R. Samarth attended training on ‘Management of Fruit Genetic Resources’ Organized by ICAR-National Bureau of Plant Genetic Resources, New Delhi; ICAR-All India Coordinated Research Project on Fruits, Bengaluru and ICAR-Indian Institute of Horticultural Research, Bengaluru.

Rajendranagar

- Vijaya D delivered lecture on soil health management to DAESI programme (8th March 2021).
- Vijaya D and Baby Rani T disseminated information on best performing grape varieties and packages of practices to interested farmers, students and visitors

Tirupati

- Mukunda Lakshmi L had attended training programme on “Management of Plant Genetic Resources” through virtual mode (1st to 2nd February 2021).
- Mukunda Lakshmi L, Srinivas Reddy D, Rajasekharam T, and Gopi V conducted one day training programme on “Production and Protection Technologies in Citrus (Sweet orange and Acid lime)” under SCSP programme of ICAR-AICRP on fruits and inputs like manures, fertilizers pesticides and disease free sathgudi sweet orange budlings were distributed to the growers of Chiyyedu village, Anantapur district (4th February 2021).
- Mukunda Lakshmi L, Srinivasa Reddy D, and Rajasekharam T surveyed sweet orange and acid lime orchards in Anantapur region as part of AICRP trial (24th to 26th February 2021).
- Mukunda Lakshmi L, Srinivasa Reddy D, and Rajasekharam T visited the Chiyyedu village of Ananthapur mandal in Anantapur district under SCSP programme and advised cultural practices along with pruning schedules (30th June 2021).
- Nagaraju R, Mukunda Lakshmi L, and Srinivasa Reddy D, visited adopted village of Adapareddipalli, Durgasamudram post, Tirupati Rural Mandal for demonstration of technologies namely installation of fruit fly traps in Papaya and Gauva and fruit bags in Guava (20th July 2021).
- Nagarajuv R, Mukunda Lakshmi L, and Srinivasa Reddy D visited adopted village of Adapareddipalli, Durgasamudram post, Tirupati Rural Mandal to know the efficacy of fruit fly traps in guava and conducted training programme on Mango (28th August 2021).

- Mukundalaksmi L, Srinivas Reddy D, and Rajasekharam T delivered training on latest production and protection technologies of citrus at CRS, Tirupati to crop input dealers under DAESI program, ATMA unit of Chittoor district followed by field exposure to experimental fields and nursery (21st September 2021).
- Mukundalaksmi L, Srinivas Reddy D, and Rajasekharam T visited Banana garden and diagnosed Eumusae leaf spot and thrips incidence on cultivar Grand Naine in Adapareddypalli under VC to Village programme and suggested management practices (7th October 2021).
- Mukunda Lakshmi L, Srinivasa Reddy D, and Rajasekharam T, surveyed Sathgudi sweet orange orchards in Kurnool, Vanaparathi, Gadwal and Mahaboobnagar districts as a part of AICRP technical programme (28th to 30th October 2021).
- Nagaraju R and Mukunda Lakshmi L attended National training programme on “Conservation, Management and Utilization of Horticultural Genetic Resources for Livelihood and Nutritional Security” through virtual mode (22nd to 26th November 2021).
- Rajasekharam T participated in exhibition on latest technologies and products of Dr YSRHU in the state level Ag Tech, 2021 conference and exhibition held at ANGRAU, Lam (17th to 19th December 2021).
- Srinivasa Reddy D attended farmers training programme on mango pest management awareness at chittoor to Chittoor mango farmer producer company Ltd (19th December 2021).
- Srinivas Reddy D had attended farmers training programme and delivered talk on Integrated Pest Management on mango at Irala mandalam (20th December 2021).
- Nagaraju R had participated in farmers training programme organized by Zuari and Dept of Horticulture on the eve of Kisan Divas at Kotha sarmbatla village, Chandragiri mandal and issued Soil health cards (23rd December 2021).

D. Special Programmes

D1. Achievements under SCSP Programme

The ICAR-AICRP on Fruits is implementing Schedule Caste Sub Plan Programme (SCSP) at some of the participating centres viz., Anantharajupet, Arabhavi, Coimbatore, Kannara, Ludhiana, Mohanpur, Periyakulam, Ranchi and Tirupati. During the year 2021, a total of six training and five demonstrations were organised for more than 100 farmers and distributed about 2000 quality planting materials, five quintals of fertilizers and 10 kg of micronutrients and 10 litres of pesticides and about 100 farm implements were distributed to the beneficiaries.

D2. Achievements under TSP Programme

The ICAR-AICRP on Fruits is implementing Schedule Tribe Component Programme (STC) at its centres viz., Bhubaneswar, Gandevi, Jalgaon, Jorhat, Kovvur, Medziphema, Ranchi and Udaipur. To the eligible beneficiaries about 7500 planting materials were distributed during the four training programmes organised besides the distribution of 10 litres of pesticides and 4.5 quintals of fertilizers as per the schedule.



Field day on Organic Farming in Banana organized by ICAR-AICRP (Fruits) and KVK, Dang and KVK, Tapi at field of Tusharbhai Y. Bhoje (TSP beneficiary), at- Bhalkhet, Tal.- Waghai, Dist.- The Dang by Gandevi Centre



Training on production technology of litchi and distribution of farm inputs under AICRP on Fruits TSP programme SASRD, Nagaland University, Medzhiphema Centre.

E. Commercialization of Technology

Title of Technology: MACROPROPAGATION TECHNIQUE OF BANANA

An Agreement for Licensing of Know-How was signed on 8th October, 2021 by and between ICAR - National Research Centre for Banana (ICAR - NRCB) as TECHNOLOGY INVENTOR and ICAR - All India Coordinated Research Project (AICRP) Fruits, ICAR - Indian Institute of Horticultural Research,

Bengaluru as TECHNOLOGY FACILITATOR and Fruit Research Station, Navsari Agricultural University, Gandevi as TECHNOLOGY PROVIDER on technology, MACROPROPAGATION TECHNIQUE OF BANANA

As per this agreement, ICAR - NRC for Banana has given permission to the contract party to utilize and transfer this technology at its discretion to others with the intimation to Technology Inventor and Technology Facilitator.



ICAR-NRC for Banana licenses and transfers farmers-friendly macropropagation technology to Gujarat based Jarvi Nursery facilitated by AICRP on Fruits

General Information

A. Monitoring of the projects

A1. Monitoring the centre activities: The progress of various experiments running across the country was monitored by the Project Co-ordinator and his team by regular on-line meetings. Owing to the prevailing Covid-19 pandemic situation, centres/experimental fields were not physically visited. However, during every month, online meetings were held with the nodal officers and the experiment in charge of all the fifty centres. During these meetings, budget related issues, settling of 7th pay arrears, submission of AUCs/monthly expenditure statements, status of joint publications in pipeline, submission of inputs for research report, annual report, Proceedings of Group Discussion and Technology Inventory for banana were thoroughly discussed. Besides these, follow-up action for GD recommendations, progress in SCSP/TSP related work and expenditure, progress in preparation of mobile App, short videos for YouTube were discussed. As and when required, the scientists were encouraged to write abstracts/papers to seminars/symposia. They were also asked to send proposals to CVRC/ SVRC notification for recommended technologies. The scientists were time and again motivated and financially supported to bring out technical bulletins/extension folders/pamphlets/ hand-outs in vernacular languages for the benefit of farmers. Other than these regular monthly meetings, the following meetings were held to review the progress of work in the centres.

A2 Visit to Coimbatore centre: (16th-17th September, 2021): On behalf of the Project co-ordinating Unit, Dr. S. Priya Devi, PS (Hort-Fruit Sci.) visited the papaya experimental plots at College Orchard, Tamil Nadu Agricultural University, Coimbatore. She has seen the performance of papaya grafts over seedlings in the open field and also the healthy PRSV free papaya plants inside the net house. The age of crop, durability of framework and cladding material of net house and the cost involved were discussed during the visit.

A3. Mid-term review meetings held to monitor the progress of work

A3.1. Mid-term review meeting for grape: The meeting was organized on 21st August, 2021, jointly by the AICRP Fruits, ICAR- IIHR, Bengaluru and AICRP Nodal Unit of ICAR-NRCG, Pune in the virtual mode. Dr. R.G. Somkuwar, Acting Director, ICAR-NRCG, Pune chaired the meeting. Dr. Prakash Patil, PC, made a brief presentation on the grape technologies evolved out of the programme so far. Besides National Research Centre for Grape, seven centres working on the crop participated in the

review meeting, which was attended by 11 delegates. The progress of work in each on-going experiment at the centre was presented by the nodal officers of concerned centres. Deliberations were made during the meeting on the progress and constraints. Following the meet, centre-wise recommendations and general recommendations were made and circulated to all the centres.

A3.2. Mid-term review meeting for banana:

The meeting was organized on 12th October, 2021, jointly by the AICRP Fruits, ICAR- IIHR, Bengaluru and AICRP Nodal Unit of ICAR-NRCB, Trichy in the virtual mode. Dr. (Mrs.) S. Uma, Director, ICAR-NRCB, Trichy chaired the meeting. Initially, Dr. Prakash Patil, PC, made a brief presentation on the banana technologies evolved out of the programme so far. Besides National Research Centre for Banana, 15 centres working on banana participated in the review meeting, which was attended by 53 delegates. The Pusa centre did not participate in the meeting. The progress of work in each on-going experiment at the centre was presented by the nodal officers of concerned centres. Deliberations were made during the meeting on the progress and constraints. Following the meet, centre-wise recommendations and general recommendations were made and circulated to all the centres.

A3.3. Mid-term review meeting for litchi:

The meeting was organized on 29th October, 2021 forenoon, jointly by the AICRP Fruits, ICAR- IIHR, Bengaluru and AICRP Nodal Unit of ICAR-NRCL, Muzzaffarpur, in the virtual mode. Dr. Seshdhar Pandey, Acting Director, ICAR-NRCL, Muzzaffarpur chaired the meeting. Dr. Prakash Patil, PC, made a brief presentation on the litchi technologies during his opening remarks. All the scientists from nine centres working on litchi participated in the review meeting. The progress of work in nine experiments at each centre was presented by the nodal officers of concerned centres. Deliberations were made during the meeting on the progress and constraints faced in executing the programmes.

A3.4. Mid-term review meeting for jackfruit, papaya and sapota:

The meeting was organized on 29th October, 2021, afternoon, by the AICRP Fruits, ICAR- IIHR, Bengaluru in the virtual mode. Dr. Prakash Patil, PC, chaired the meeting and made a brief presentation on the papaya and sapota technologies spread so far and those under evaluation. Then, the work done in papaya in six various experiments under eight centres were presented. Later on, nodal officers from four sapota centres presented the progress of work in eight experiments. Similarly, the progress of work on jackfruit under five different experiments in

six centres was reviewed. Deliberations were made during the meeting on the progress and constraints faced in executing the programmes.

A3.5. Mid-term review meeting for mango: The meeting was organized on 19th January, 2022, by the AICRP Fruits, ICAR- IIHR, Bengaluru in the virtual mode. Dr. Prakash Patil, PC, chaired the meeting and made a brief presentation on the mango technologies spread so far and those under evaluation. All the scientists from 24 centres working on mango participated in the review meeting. The progress of work in 21 experiments at each centre was presented by the nodal officers of concerned centres. Deliberations were made during the meeting on the progress and constraints faced in executing the programmes.

A3.6. Mid-term review meeting for Citrus: The meeting was organized on 8th February, 2022, jointly by the AICRP Fruits, ICAR- IIHR, Bengaluru and AICRP Nodal Unit of Central Citrus Research Institute, Nagpur, in the virtual mode. Dr. Dilip Ghosh, Director, ICAR-CCRI, Nagpur chaired the meeting. Initially, Dr. Prakash Patil, PC, made a brief presentation on the citrus technologies being adopted by farmers, technologies under evaluation and the constraints faced. Besides the ICAR-CCRI, 14 centres working on Citrus participated in the review meeting, 167 experiments which was attended by 30 delegates. The progress of work in each on-going experiment at the centre was presented by the nodal officers of concerned centres. Deliberations were made during the meeting on the progress and constraints faced in executing the programmes.

A3.7. Mid-term review meeting for guava: The meeting was organized on 16th February, 2022, by Project Co-ordinating Unit, AICRP Fruits, ICAR- IIHR, Bengaluru in virtual mode. Dr. Prakash Patil, PC, chaired the meeting. He made a brief presentation on the guava technologies evolved out of the programme so far. All the scientists from 19 centres working on guava participated in the review meeting. The progress of work in 13 experiments at each centre was presented by the nodal officers of concerned centres. Deliberations were made during the meeting on the progress and constraints faced in executing the programmes.

A4. Monitoring of grapes research activities at different centres under ICAR-AICRP (Fruits) by Crop Coordinator for grapes

Vijayapur (6th February, 2021): Dr. RG Somkuwar, Acting Director & Crop Coordinator visited Vijayapura for assessment of grape plot under AICRP.

Theni (17th-20th August, 2021): Dr. RG Somkuwar, Acting Director & Crop Coordinator visited Theni for

assessment of grape plot under AICRP and provided technical guidance.

A5. Review meeting for SCSP/TSP programmes:

A review meeting was organized on Apr 23, 2021, by Project Co-ordinating Unit, in virtual mode. Dr. Prakash Patil, PC, chaired the meeting. All the Officers In charge/Nodal Officer (SCSP/TSP programmes under ICAR-AICRP on Fruits) attended the meeting. Dr. Mahesh Dhakar, Ranchi and Dr. Sridhar Gutam, PC (Fruits) Unit, co-ordinated the meeting. During the meeting, the information required for baseline and periodical reporting was sought. A Questionnaire for Impact assessment of TSP activities was also circulated to the concerned scientists. Presentations for Q3 (Oct-Dec 2020) and Q4 (Jan-Mar 2021) of 2020-21 were made.

A6. Virtual meeting on AICRP Mobile App Preparation:

A meeting was organized on held on 27th October 2021, by Project Co-ordinating Unit, along with Dr. Sandeep Singh, Senior Entomologist (Fruits), Ludhiana. Collation of all the pests & diseases photographs of mandated fruit crops and preparation of logical framework of workflow for the App development were planned. It was decided to include Dr. Lokesh Jain, Associate Professor, Dept. of Electrical Engineering & Information Technology, PAU, Ludhiana to be part of the Mobile App Development Team. Project Coordinator (Fruits) has suggested to work on Citrus and Banana crops in the Ver.1 of App and later to include all the other crops.

B. Research papers

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C. Group Discussion of ICAR-AICRP on Fruits

The eighth Group Discussion of the ICAR-All India Coordinated Research Project on Fruits was virtually organised by Project Coordinator (Fruits) Unit, ICAR-

Indian Institute of Horticultural Research, Bengaluru from 3rd to 6th March 2021 in which more than 170 delegates from 50 participating centres across the country participated in the deliberations



During the Plenary session, the Chief Guest Dr. Anand Kumar Singh, DDG (Hort. Sci.), ICAR, New Delhi, in his address emphasised on the identification of trait specific genotypes for commercial cultivation in traditional and non-traditional areas. He also added that there is a need to narrow down the gaps between planting materials availability and demand with the deployment of appropriate technologies that should benefit the consumers. He said that the genomic data has to be digitalized and made available to breeders and stakeholders so as to explore research opportunities. Dr. Vikramaditya Pandey, ADG (HS-I), ICAR, New Delhi, Guest of Honour in the Plenary session suggested to give weightage to the annual targets and achievements while performance scoring the centres of AICRP on fruits. He is also of the opinion that there should be a session to discuss NEH, SCSP and TSP programmes comprehensively during the Group Discussion. Dr. B.K. Pandey, ADG (HS-II),

ICAR, New Delhi, Guest of Honour in the Plenary session while congratulating the Project Coordinator (Fruits) for the very successful organisation of the meet virtually, he stressed upon human resource development and capacity building to work more effectively and efficiently.

The event was inaugurated by Dr. B.K. Pandey, ADG (HS-II), ICAR, New Delhi. In the inaugural suggested in adopting the QR code system for the planting material supply to ease the traceability of planting material. He also emphasised to test new pesticides that are environmentally safe as few of the molecules are being restricted. He appreciated that two of the AICRP on Fruits technologies being included by third party of ICAR schemes have 97% impact in farmer's field. Dr. M. R. Dinesh, Director, ICAR-IIHR Bengaluru, in his Presidential address complimented the work being carried out under the AICRP. He suggested

that AICRP (Fruits) should take up diversity fairs to tap the wide genetic resources and suggested to give more emphasis on rootstock development for marginal soils and pollinators in mango. He also emphasised on promoting entrepreneurship for the AICRP technologies through incubation. During the inaugural function, various publications of AICRP viz Standard Operating Procedures 2021, Catalogue on banana germplasm, Mango pests and diseases and their management, Diagnostic guide for banana, papaya pests and diseases, and other technical bulletins and booklets were released.

During the meeting, Dr. Prakash Patil, Project Coordinator (Fruits), ICAR-AICRP on Fruits, presented the progress of work done at the 50 participating centres across the country on nine fruit crops (mango, Citrus, banana, guava, litchi, grapes, papaya, sapota and jackfruit). In the event, Gandevi Centre was awarded the Best Centre Award for the year 2020 and Kannara Centre was adjudged as Second Best Centre 2020. To encourage the leadership, the best lead presenter's award for 2020 was also conferred under various sessions.

During the deliberations, many technologies were recommended which include a juice variety and a coloured table variety in grape, promising hybrids/selection of guava, package for macro-propagation for banana, stage-wise nutrient doses and also water requirement in Citrus, bagging of litchi bunches for quality fruits, PGR and chemicals for early flowering in litchi, input use efficient technology in papaya, net house cultivation of papaya, stage wise requirement of nutrients in sapota and management of Citrus mites, integrated management of root rot and gummosis of mandarin and automated weather system in viticulture.

Multi location trials of three new entries (one in sweet orange and two in pummelo), validation of grafting in papaya, Nano gel pheromone technology for fruit fly management and bio-intensive disease management in grape vine was also taken up. Directors of ICAR Institutes and officials from ICAR Headquarters, ICAR Nominees participated in the Group Discussion.

D. Planting material produced

Table-1: Planting material produced during 2021

Crops	Centres	Quantity (Numbers)	Total
Banana	Arabhavi	400	188660
	Bhubaneswar	3402	
	Gandevi	5035	
	Jorhat	1800	
	Kannara	47346	
	Kovvur	126927	
	Mohanpur	3250	
	Port blair	500	
Citrus	Anantharajupet	10000	241771
	Akola	88550	
	Kovvur	10207	
	Ludhiana	2500	
	Medziphema	830	
	Periyakulam	4000	
	Rahuri	23214	
	Sriganganagar	1193	
	Tirupati	101277	
Acidlime	Tirupati	52.5 kg	52.5 kg
Grape	Pune (ARI)	13580	14156
	Rajendranagar	576	
Guava	Sangareddy	20000	21800
	Udaipur	1800	
Jackfruit	Kovvur	773	2593
	Jorhat	300	
	Periyakulam	1000	
	Mohanpur	520	

Crops	Centres	Quantity (Numbers)	Total
Litchi	Medziphema	9192	9927
	Mohanpur	735	
Mango	Anantharajupet	10000	181186
	Imphal	290	
	Kovvur	15660	
	Lembucherra	700	
	Mohanpur	3200	
	Paria	500	
	Periyakulam	5000	
	Medziphema	4261	
	Sangareddy	120000	
	Udaipur	250	
	Vengurle	21325	
Sapota	Arabhavi	50	6146
	Gandevi	2895	
	Kovvur	1401	
	Periyakulam	1800	
Papaya	Coimbatore	14 kg	14 kg
	Jorhat	200 (hybrids)	400
	Lembucherra	200	
		Total	6,66,639 (66.5 kg)

E. Physical and Chemical Properties of soil

Information on physical-chemical properties of soil is provided to different centres in facilitating the interpretation of results suiting to soil.

Sl. No.	Properties	Units	Centres								
			Akola	Anantharajupet	Arabhavi	Bengaluru	Bhubaneswar (OUAT)	Bhubaneswar (CHES)	Chettalli (CHES)	Coimbatore	Gandevi
I Physical properties											
1	Soil type		Medium	-	Silty clay	-	Loam	-	-	Sandy clay loam	Clay loam
2	Clay content	%	47.92	-	45%	-	18	11.5	-	21.8	36%
3	Bulk density	g/cc	1.30g	-	1.3g/cc	-	-	1.28	-	1.7	1.2 g/cc
4	Moisture holding capacity	%	28.00	-	58	-	-	13.0	-	41.0	60.55%
5	Moisture at field capacity	%	30.15	-	28	-	-	-	-	27.0	33%
6	Moisture at wilting	%	12.17%	-	12	-	-	-	-	15	15%
II Chemical properties											
7	pH (1:2.5)	--	7.6	7.1	8.15	-	5.10	5.15	-	8.40	6.80
8	Conductivity	dS/m	0.31	0.05	0.9 dSm ⁻¹	-	0.010	0.05	-	0.28	0.13 dS/m
9	Available N	kg/ha	202	-	2816kg/ha	-	346.0	125.0	-	134	261.3 kg/ha
10	Available P	kg/ha	44.65	34	17.80 kg/ha	-	43.0	13.9	-	11.0	59.43 kg/ha
11	Available K	kg/ha	578	568 kg/ha	852 kg/ha	-	210.9	157.0	-	577	279.0 kg/ha
12	Available Ca	µg/g	38.00	-	53.113µg/g	-	-	-	-	-	-
13	Available Mg	µg/g	10.00	-	15.78µg/g	-	-	-	-	-	-
14	Available Zn	µg/g	6.10	0.35 µg/g	0.23µg/g	-	-	1.61	-	1.43	-
15	Available Mn	µg/g	-	-	-	-	-	-	-	1.83	-
16	Available Cu	µg/g	-	-	-	-	-	-	-	3.97	-
17	Available Fe	µg	-	-	-	-	-	-	-	0.09	-
18	Organic carbon	%	-	-	-	-	2	-	-	0.55	0.34%

Sl. No	Properties	Units	Centres								
			Gangian	Imphal	Jalgaon	Jorhat	Kalimpong	Kannara	Kovvur	Lembucherra	Lucknow
I Physical properties											
1	Soil type		Loam and Sandy loam	-	Clay	Sandy loam	-	Clay loam	Clay loam	Red loam or sandy loam	Coarse sandy loam
2	Clay content	%	11	70.70	48.42	18.35	-	36	-	29.9	1.6-3.1%
3	Bulk density	g/cc	1.72	-	1.17	1.53	-	1.5	-	1.28 – 1.56	1.37-1.57
4	Moisture holding capacity	%	35-39%	-	-	60.45	-	20	-	38.02 – 52.46	19.2-24.6
5	Moisture at field capacity	%	25-28%	-	36	32	-	18	-	23.94 – 29.09	-
6	Moisture at wilting	%	9-11%	-	19	15	-	11	-	-	-
7II Chemical properties											
7	pH (1:2.5)	-	7.4	5.72	8.22	4.62	-	5.2	7.83	4.70 – 6.00	7.75
8	Conductivity	dS/m	0.1	-	0.32	0.4	-	0.10	0.48 dS/m	0.10-0.20	0.185
9	Available N	kg/ha	-	390.2	195	254.53	-	-	117.45 kg/ha	254.85	175-225
10	Available P	kg/ha	39.2	36.82	19.2	50.8	-	67	43.55 kg/ha	34.37	12-14
11	Available K	kg/ha	129.5	221.3	718	95.22	-	292	1265.60 kg/ha	187.48	120-140
12	Available Ca	µg/g	-	-	-	1.5-2.0	-	3x10 ⁻⁹	-	1.16–2.48	-
13	Available Mg	µg/g	-	-	-	0.5-1.2	-	2.2x10 ⁻⁹	-	-	-
14	Available Zn	µg/g	1.0	-	0.67	8-12	-	-	-	0.86- 4.36	0.32 ppm
15	Available Mn	µg/g	-	-	9.40	-	-	-	-	-	-
16	Available Cu	µg/g	-	-	2.60	-	-	-	-	-	-
17	Available Fe	µg/g	-	-	3.20	-	-	-	-	-	-
18	Organic carbon	%	-	1.18	0.42	-	-	0.80	0.57%	-	-

Sl. No	Properties	Units	Centres									
			Ludhiana	Malda	Mandsaur	Medziphema	Mohanpur	Muzaffarpur	Nagpur (CCRI)	New Delhi	Neri	Pantnagar
I Physical properties												
1	Soil type		Sandy loam	-	Medium Black	Sandy loam	Clay loam	-	-	Sandy clay loam	-	Sandy loam
2	Clay content	%	15	-	28	37.2%	49.91	-	-	24.7	-	10.4%
3	Bulk density	g/cc	1.4	-	1.3	-	1.28	-	-	1.52	-	1.52 g/cc
4	Moisture holding capacity	%	50	-	18	-	48.25	-	-	32.7	-	26-28%
5	Moisture at field capacity	%	30	-	35	-	31.00	-	-	13.9	-	20-22%
6	Moisture at wilting	%	6.2	-	15	-	16.00	-	-	1.21	-	8-10%
II Chemical properties												
7	pH (1:2.5)	-	8.0-8.2	-	7.30-7.80	4.3	6.7	-	-	8.48	6.98	7.39
8	Conductivity	dS/m	0.15-0.18	-	-	-	0.45	-	-	0.75	0.27	0.35dS/m
9	Available N	kg/ha	-	-	218.02	293.5	156.49	-	-	230.78	638.23	142.90 kg/ha
10	Available P	kg/ha	25-27	-	18.75	16.8	35.7	-	-	46.80	47.00	44.16 kg/ha
11	Available K	kg/ha	78-135	-	422	221.3	247.4	-	-	50.23	344.80	158.43 kg/ha
12	Available Ca	µg/g	-	-	10	-	36.4	-	-	1350.23	-	-

Sl. No	Properties	Units	Centres									
			Ludhiana	Malda	Mandsaur	Medziphema	Mohanpur	Muzaffarpur	Nagpur (CCRI)	New Delhi	Neri	Pantnagar
I Physical properties												
13	Available Mg	µg/g	-	-	7.25	-	40.22	-	-	128.45	-	-
14	Available Zn	µg/g	2.08-2.68	-	0.62	-	16.73	-	-	345.23	-	.45 µg/g
15	Available Mn	µg/g	-	-	-	-	-	-	-	-	-	15.33 µg/g
16	Available Cu	µg/g	-	-	-	-	-	-	-	-	-	1.26 µg/g
17	Available Fe	µg/g	4.40-7.62	-	-	-	-	-	-	-	-	9.26 µg/g
18	Organic carbon	%	0.720-0.900	-	-	1.51	0.51	-	-	-	1.93	0.85 %

Sl. No	Properties	Units	Centres						
			Paria	Pasighat (CAU)	Periyakulam	Port Blair	Pune (ARI)	Pune (IARI)	Pune (NRCCG)
I Physical properties									
1	Soil type		Clayey	Loamy Sand	Red sandy loam	Sandy loam	Sandy loam	-	Clay
2	Clay content	%	More than 65 %	17	30%	18	6.86	-	42.65
3	Bulk density	g/cc	1.4-1.5	2.77	1.20	1.23	1.32	-	1.38gm/cc
4	Moisture holding capacity	%	44-49	33	44	25	53.50	-	19.66
5	Moisture at field capacity	%	-	40	28	22	53.50	-	38%
6	Moisture at wilting	%	-	-	10	15	-	-	18%
II Chemical properties									
7	pH (1:2.5)	-	6.7-7.6	5.5	7.30	5.6	7.59	-	7.24
8	Conductivity	dS/m	0.16-0.55	0.033	0.20	0.63	0.18	-	1.19
9	Available N	kg/ha	290-430	290	298.00	215	106	-	78.21
10	Available P	kg/ha	19.10-58.15	18	12.10	6.5	7.88	-	37.83
11	Available K	kg/ha	330-565	120	188.00	165	1290	-	490.1
12	Available Ca	µg/g	155-190 mg/100g	48	9.80	-	11.96	-	-
13	Available Mg	µg/g	110-156 mg/100g	26.7	4.64	-	0.33	-	-
14	Available Zn	µg/g	2.5-4.1 ppm	98	-	3.6	0.04	-	11.90
15	Available Mn	µg/g	-	-	-	-	-	-	32.66
16	Available Cu	µg/g	-	-	-	-	-	-	12.4
17	Available Fe	µg/g	-	-	-	-	-	-	23.55
18	Organic carbon	%	-	-	-	-	-	-	0.91

Sl. No	Properties	Units	Centres						
			Pusa	Rahuri	Raipur	Rajendranagar	Rewa	Sabour	Sangareddy
I Physical properties									
1	Soil type		-	Medium deep	-	Sandy clay loam	-	Clay	Sandy clay loam
2	Clay content	%	-	44.3 %	-	30	-	-	33
3	Bulk density	g/cc	-	1.10 g cc ⁻¹	-	1.35	-	-	1.30
4	Moisture holding capacity	%	-	62.3 %	-	-	-	-	-
5	Moisture at field capacity	%	-	32.3 %	-	-	-	-	-
6	Moisture at wilting	%	-	16.1 %	-	-	-	-	-

Sl. No	Properties	Units	Centres						
			Pusa	Rahuri	Raipur	Rajendranagar	Rewa	Sabour	Sangareddy
I Physical properties									
II Chemical properties									
7	pH (1:2.5)	-	-	8.10	-	5.8 - 6.8	7.35	6.45 – 7.10	6.92
8	Conductivity	dS/m	-	0.31dSm ⁻¹	-	0.04 - 0.14	0.35	0.26- 0.64 (dS/m)	0.20
9	Available N	kg/ha	-	138 kg ha ⁻¹	-	289 - 364	334.33	112.90 – 150.53 (kg/ha)	242.00
10	Available P	kg/ha	-	12.30 kg ha ⁻¹	-	6 -18	17.00	5.27- 138.19 (kg/ha)	46.40
11	Available K	kg/ha	-	290 kg ha ⁻¹	-	168 - 215	345	136.35- 966.60 (kg/ha)	320.00
12	Available Ca	µg/g	-	2502 µg g ⁻¹	-	-	-	-	-
13	Available Mg	µg/g	-	418 µg g ⁻¹	-	-	-	-	-
14	Available Zn	µg/g	-	0.32 µg g ⁻¹	-	3.1- 4.3	-	0.02-0.98 (mg/kg)	0.68
15	Available Mn	µg/g	-	-	-	-	-	4.58-19.36 (mg/kg)	6.20
16	Available Cu	µg/g	-	-	-	-	-	0.76-1.32 (mg/kg)	0.20
17	Available Fe	µg/g	-	-	-	-	-	-	5.88
18	Organic carbon	%	-	-	-	-	0.55	-	-

Sl. No	Properties	Units	Centres						
			Sriganganagar	Tinsukia	Tirupathi	Tiruchirapalli	Udaipur	Vengurle	Yachuli
I Physical properties									
1.	Soil type		Sandy loam	Sandy clay loam	Sandy loam	Silty clay loam	Sandy clay loam	Sandy clay loam	-
2.	Clay content	%	10.5	25	10	35	21.50	31.64	-
3.	Bulk density	g/cc	1.55	1.42	1.5-1.6	1.31	1.51	2.67	-
4.	Moisture holding capacity	%	-	42.10	11-12	38	42.25	48.92	-
5.	Moisture at field capacity	%	16.3	23.45	9	29	22.25	-	-
6.	Moisture at wilting	%	6.3	11.18	3	12	11.75	-	-
II Chemical properties									
7.	pH (1:2.5)	-	8.3	4.69	7.2	8.2	8.20	5.52	-
8.	Conductivity	dS/m	-	0.025	0.09	0.18	0.75	0.094	-
9.	Available N	kg/ha	112.0	223.24	180	192	275	372.94	-
10.	Available P	kg/ha	36.0	3.95	12.5	7.2	23.8	13.77	-
11.	Available K	kg/ha	340.0	168.80	160	178	362	452.86	-
12.	Available Ca	µg/g	-	500.00	720	980	205	-	-
13.	Available Mg	µg/g	-	2.50	240	450	128	-	-
14.	Available Zn	µg/g	0.58	0.85	6.0	5.2	0.75	2.84	-
15.	Available Mn	µg/g	2.95	-	-	-	-	23.96	-
16.	Available Cu	µg/g	0.2	-	-	-	-	6.26	-
17.	Available Fe	µg/g	2.5-4.5	-	-	-	-	57.86	-
18.	Organic carbon	%	0.21	-	-	-	-	23.76	-

Annexure-I

Research centres of ICAR-AICRP on Fruits

Sl. No.	Centre name	Location of the centre	Mandate crops
A.	SAU based centres		
1.	Akola	Dr. Punjabrao Deshmukh Krishi Vidyapeeth, Akola-444104, Maharashtra	Citrus
2.	Anantharajupet	Horticultural Research Station (Dr.YSRHU), Anantharajupet-516105, Andhra Pradesh	Guava, Mango & Papaya
3.	Arabhavi	Kittur Rani Channama College of Horticulture (UHS), Arabhavi-591218, Gokak, Belagavi Dist. Karnataka	Banana, Grapes & Sapota
4.	Bhubaneswar	College of Agriculture, Odisha University of Agriculture and Technology, Bhubaneswar-751003, Odisha	Banana
5.	Coimbatore	Department of Fruit Crops, HC&RI, Tamil Nadu Agricultural University, Coimbatore 641003, Tamil Nadu	Banana & Papaya
6.	Gandevi	Fruit Research Station (NAU), Gandevi-396360, Dist. Navsari, Gujarat	Banana, Papaya & Sapota
7.	Gangian	M S Randhawa Fruit Research Station (PAU), Gangian, Bajwa, P.O Panwan, Dasuya, Hoshiarpur, Punjab	Litchi & Mango
8.	Jalgaon	Banana Research Station (MPKV), Jalgaon-425001, Maharashtra	Banana
9.	Jorhat	Department of Horticulture, Assam Agricultural University, Jorhat-785013, Assam	Banana & Jackfruit
10.	Kalimpong	Regional Research Station (UBKV), Hill Zone, Kalimpong-734301, West Bengal	Citrus
11.	Kannara	Banana Research Station (KAU), Marakkal, Kannara PO, Thrissur-680652, Kerala	Banana & Jackfruit
12.	Kovvur	Horticultural Research Station (Dr.YSRHU), Kovvur-534350, West Godavari Dist., Andhra Pradesh	Banana, Jackfruit, Papaya & Sapota
13.	Ludhiana	Department of Fruit Science, Punjab Agricultural University, Ludhiana - 141 004, Punjab	Citrus, Guava & Grapes
14.	Mandsaur	College of Horticulture (RVSKVV), Mandsaur-458001, Madhya Pradesh	Grapes
15.	Mohanpur	Directorate of Research, BCKV, PO: Kalyani, Dist. Nadia-741235, West Bengal	Banana, Guava, Jackfruit, Litchi & Mango
16.	Neri	College of Horticulture & Forestry, (Dr.YSPUH&F), Neri PO. Khaggal, Hamirpur - 177001 Himachal Pradesh	Mango, Guava & Litchi
17.	Pantnagar	Dept. Of Horticulture, College of Agriculture, GBPUA&T, Pantnagar-263145, Dist. Udham Singh Nagar, Uttarakhand	Guava, Litchi & Mango
18.	Paria	Agricultural Experimental Station (NAU), Paria-396145, Dist. Valsad, Gujarat	Mango
19.	Periyakulam	Department of Fruit Crops & PHT, Horticultural College and Research Institute (TNAU), Periyakulam-625604, Tamil Nadu	Citrus, Guava, Jackfruit, Mango & Sapota
20.	Rahuri	Department of Horticulture, Mahatma Phule Krishi Vidyapeeth, Rahuri-413722, Dist. Ahmednagar, Maharashtra	Citrus, Grapes & Mango
21.	Raipur	College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya, Krishak Nagar, Raipur-492012, Chhattisgarh	Mango, Guava & Litchi
22.	Rajendranagar	Grape Research Station (SKLTSHU), Rajendranagar, Hyderabad-500030, Telangana	Grapes

Sl. No.	Centre name	Location of the centre	Mandate crops
23.	Rewa	Fruit Research Station (JNKVV), Kuthulia, Rewa-486001, Madhya Pradesh	Guava & Mango
24.	Sabour	Dept. of Horticulture (Fruit & Fruit Tech), Bihar Agricultural University, Sabour, Bhagalpur -813210, Bihar	Guava, Litchi & Mango
25.	Sangareddy	Fruit Research Station (SKLTSHU), Sangareddy-502001, Dist. Medak, Telangana	Guava & Mango
26.	Sriganganagar	Agricultural Research Station, (SKRAU), Sriganganagar-335001, Rajasthan	Citrus
27.	Tinsukia	Citrus Research Station (AAU), Gelapukhuri Road, Tinsukia-786125, Assam	Citrus
28.	Tirupati	Citrus Research Station (Dr.YSRHU), Tirupati-517502, Andhra Pradesh	Citrus
29.	Udaipur	Department of Horticulture, Rajasthan College of Agriculture (MPUA&T), Udaipur-313001, Rajasthan	Guava & Mango
30.	Vengurle	Regional Fruit Research Station (DBSKKV), Vengurle-416516, Dist. Sindhudurg, Maharashtra	Mango & Banana
B.	ICAR institute-based centres		
31.	Bengaluru	Division of Fruit Crops, ICAR-Indian Institute of Horticultural Research (IIHR), Bengaluru -560089, Karnataka.	Guava, Mango & Papaya
32.	Bhubaneswar	IIHR-Central Horticultural Experiment Station, Aiginia, Bhubaneswar-751019, Odisha	Mango
33.	Chettalli	IIHR-Central Horticultural Experiment Station, Chettalli, Kodagu- 571248, Karnataka	Citrus
34.	Lucknow	ICAR-Central Institute for Subtropical Horticulture (CISH), Rehmankhara, PO Kakori, Lucknow-226101, Uttar Pradesh	Guava & Mango
35.	Malda	Regional Research Station (ICAR-CISH), Malda-732103, West Bengal	Mango
36.	Muzaffarpur	ICAR-National Research Centre for Litchi (NRCL), Muzaffarpur-842002, Bihar	Litchi
37.	Nagpur	ICAR- Central Citrus Research Institute (CCRI), Nagpur-440010, Maharashtra	Citrus
38.	New Delhi	Division of Fruits and Horticultural Technology, ICAR- IARI, New Delhi-110012	Citrus, Grapes, Mango
39.	Port Blair	Division of Horticulture and Forestry, ICAR-Central Island Agricultural Research Institute (CIARI), Port Blair-744101, Andaman & Nicobar Islands	Banana
40.	Pune (IARI-RS)	ICAR-IARI Regional Station, Survey No. 125 A, ITI Road, Aundh, Pune-411007, Maharashtra	Papaya
41.	Pune (NRCG)	ICAR- National Research Centre for Grapes (NRCG), Pune-412307, Maharashtra	Grapes
42.	Ranchi	ICAR Res Complex for Eastern Region-Research Centre (RCER-RC), Tata Road, Plandu, Ranchi-834010, Jharkhand	Guava, Litchi & Papaya
43.	Tiruchirappalli	ICAR-National Research Centre for Banana (NRCB), Tiruchirappalli-620102, Tamil Nadu	Banana
44.	Lembucherra	ICAR Research Complex for NEH Region (ICAR-RC for NEH), Tripura Centre, Lembucherra, Tripura-799210, Tripura	Guava & Mango
C.	CAU based centres		
45.	Imphal	Department of Horticulture, College of Agriculture (CAU), Imphal-795004, Manipur	Mango
46.	Medziphema	Department of Horticulture, SASRD, Nagaland University, Medziphema Campus, Medziphema -797106, Nagaland	Litchi & Mango

Sl. No.	Centre name	Location of the centre	Mandate crops
47.	Pasighat	College of Horticulture and Forestry (CAU), Pasighat-791102, Arunachal Pradesh	Citrus
48.	Pusa	Department of Horticulture, Dr. Rajendra Prasad Central Agricultural University, Pusa-848125, Dist. Samastipur, Bihar	Banana & Papaya
D.	DBT institute/State government-based centre		
49.	Pune (ARI)	Agharkar Research Institute, (MACS), Pune-411004, Maharashtra	Grapes
50.	Yachuli	Krishi Vigyan Kendra (KVK), Yachuli, Lower-Subansri dist.-791120, Arunachal Pradesh	Guava & Mango

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Annexure-II

Sanctioned and Filled staff position at different centres of ICAR-AICRP on Fruits.

No	Centre	Scientific		Technical		Administrative		Supporting		Total	
		S	F	S	F	S	F	S	F	S	F
1	Akola	2	2	2	1	1	1	4	4	9	8
2	Anantharajupet	2	2	2	2	1	-	2	-	7	4
3	Arabhavi	4	3	4	4	1	1	4	2	13	10
4	Bhubaneswar	2	2	2	1	1	1	2	-	7	4
5	Coimbatore	4	4	4	4	1	1	4	4	13	13
6	Gandevi	4	3	4	4	1	1	4	3	13	11
7	Jalgaon	3	3	3	-	1	1	3	2	10	6
8	Jorhat	3	3	3	3	1	1	4	4	11	11
9	Kannara	4	4	4	4	1	1	5	5	14	14
10	Kovvur	4	4	4	1	1	1	4	4	13	10
11	Ludhiana	5	5	5	5	1	1	6	6	17	17
12	Mandsaur	1	1	1	1	-	-	1	1	3	3
13	Mohanpur	7	7	7	4	1	1	7	5	22	17
14	Pantnagar	3	3	4	2	-	-	2	-	9	5
15	Paria	3	3	4	4	1	1	2	2	10	10
16	Pasighat	1	-	2	2	1	1	1	1	5	4
17	Periyakulam	5	4	6	5	1	1	5	5	17	15
18	Pune (ARI)	1	1	1	1	-	-	1	1	3	3
19	Rahuri	7	6	7	5	1	1	6	6	21	18
20	Rajendranagar	3	3	3	1	1	1	2	2	9	7
21	Rewa	3	3	3	1	1	-	2	-	9	4
22	Sabour	3	3	3	3	1	1	3	2	10	9
23	Sangareddy	4	4	5	3	1	-	2	2	12	9
24	Sriganganagar	1	1	1	1	1	1	2	1	5	4
25	Tinsukia	3	3	3	3	1	1	3	1	10	8
26	Tirupati	4	4	4	4	1	-	4	1	13	9
27	Udaipur	2	1	2	1	1	-	2	1	7	3
28	Vengurle	4	4	4	4	1	1	3	2	12	11
	Total	92	86	97	74	25	20	90	67	304	247

S = Sanctioned, F = Filled

Annexure - III

The budget allocation for ICAR-AICRP on Fruits (ICAR and State shares) during 2021

I. SAU/ CAU/ DBT Institute based centres

(Amount in Rupees - ICAR+State Share)

Sl. No.	Centres	Grant in aid Salary	Grant in aid General	Grant in aid Capital	Grand Total
1	Akola	3,833,325	1,120,000	-	4,953,325
2	Anantharajupet	4,332,825	892,500	345,000	5,570,325
3	Arabhavi	9,132,750	1,999,750	710,000	11,842,500
4	Bhubaneswar	2,833,250	986,500	410,000	4,229,750
5	Coimbatore	8,699,750	1,677,000	397,500	10,774,250
6	Gandevi	7,633,450	1,424,750	519,000	9,577,200
7	Gangian	-	565,000	-	565,000
8	Imphal (CAU)	-	1,995,000	18,750	2,013,750
9	Jalgaon	6,866,750	1,351,000	75,000	8,292,750
10	Jorhat	8,166,575	5,470,500	50,000	13,687,075
11	Kalimpong	-	36,750	-	36,750
12	Kannara	13,700,000	1,900,000	397,500	15,997,500
13	Kovvur	11,200,250	1,551,500	322,500	13,074,250
14	Ludhiana	13,333,000	1,952,750	135,000	15,420,750
15	Mandsaur	1,066,750	548,000	-	1,614,750
16	Medziphema (NU)	-	2,715,000	312,500	3,027,500
17	Mohanpur	13,367,250	2,462,500	285,000	16,114,750
18	Neri	-	668,500	-	668,500
19	Pantnagar	10,433,000	1,143,250	460,000	12,036,250
20	Paria	4,867,250	1,051,125	410,000	6,328,375
21	Pasighat (CAU)	2,400,000	2,737,500	91,250	5,228,750
22	Periyakulam	12,833,500	2,433,125	438,375	15,705,000
23	Pune (ARI)	3,025,000	508,750	-	3,533,750
24	Pusa (CAU)	-	732,500	-	732,500
25	Rahuri	15,066,750	2,836,500	289,500	18,192,750
26	Raipur	-	886,750	-	886,750
27	Rajendranagar	6,533,500	1,136,750	-	7,670,250
28	Rewa	5,733,250	1,088,250	-	6,821,500
29	Sabour	7,767,250	968,000	-	8,735,250
30	Sangareddy	9,733,500	1,266,500	-	11,000,000
31	Sriganganagar	2,400,250	447,500	-	2,847,750
32	Tinsukia	9,566,750	4,496,500	95,000	14,158,250
33	Tirupati	12,515,500	1,818,750	347,500	14,681,750
34	Udaipur	7,632,750	725,250	210,000	8,568,000
35	Vengurle	6,132,750	1,693,500	285,000	8,111,250
36	Yachuli (KVK)	-	75,000	-	75,000

II. ICAR based centre

(Amount in Rupees - ICAR+State Share)

Sl. No.	Centres	Grant in aid General	Grant in aid Capital	Grand Total
1	Bengaluru (PC Unit)	3,269,750	1,097,000	4,366,750
2	Bengaluru (IIHR)	662,500	-	662,500
3	Bhubaneswar (CHES)	287,500	-	287,500
4	Chettalli (CHES)	302,500	-	302,500
5	Lucknow (CISH)	482,500	-	482,500
6	Malda (CISH-RS)	43,750	-	43,750
7	Muzaffarpur (NRCL)	521,250	-	521,250
8	Nagpur (CCRI)	755,000	-	755,000
9	New Delhi (IARI)	162,500	-	162,500
10	Port Blair (CIARI)	140,000	-	140,000
11	Pune (IARI RS)	100,000	-	100,000
12	Pune (NRCG)	580,000	-	580,000
13	Ranchi (RCER RC)	862,500	-	862,500
14	Tiruchirapalli (NRCB)	1,240,000	-	1,240,000
15	Lembucherra (ICAR RC)	2,502,500	18,750	2,521,250

II. TSP Programme

(Amount in Rupees - ICAR+State Share)

Sl. No.	Centres	Grant in aid General	Grant in aid Capital	Grand Total
1	Bhubaneswar	295,000	-	295,000
2	Gandevi	542,500	50,000	592,500
3	Jalgaon	425,000	37,500	462,500
4	Jorhat	225,000	22,500	247,500
5	Kovvur	525,000	125,000	650,000
6	Medziphema	575,000	68,750	643,750
7	Ranchi	612,500	100,000	712,500
8	Udaipur	300,000	-	300,000

II. SCSP Programme

(Amount in Rupees - ICAR+State Share)

Sl. No.	Centres	Grant in aid General	Grant in aid Capital	Grand Total
1	Akola	187,500	25,000	212,500
2	Anantharajupet	512,500	75,000	587,500
3	Arabhavi	687,500	75,000	762,500
4	Coimbatore	537,500	75,000	612,500
5	Gandevi	162,500	25,000	187,500
6	Jalgaon	112,500	25,000	137,500
7	Jorhat	162,500	62,500	225,000
8	Kannara	925,000	90,000	1,015,000
9	Ludhiana	437,500	12,500	450,000
10	Mandsaur	87,500	25,000	112,500
11	Mohanpur	775,000	37,500	812,500
12	Paria	162,500	12,500	175,000
13	Periyakulam	537,500	56,250	593,750
14	Ranchi	687,500	62,500	750,000
15	Tirupati	837,500	60,000	897,500
16	Tinsukia	187,500	25,000	212,500

Annexure-IV

Meteorological data pertaining to different centres under ICAR-AICRP on Fruits

Akola

Month	Rainfall (mm)	Rainy days	Temperature (°C)		Relative Humidity (%)		Evaporation (mm/day)
			Max.	Min.	Morn.	Even.	
January 21	2.5	0	30.7	15.4	77	34	4.8
February	0.0	0	32.4	14.6	60	23	6.0
March	14.4	3	37.4	19.3	54	18	8.6
April	4.6	1	40.5	23.3	35	12	12.0
May	42.8	2	40.5	26.5	50	20	12.3
June	249.7	13	34.5	24.0	78	49	5.6
July	357.3	17	31.8	24.0	85	62	4.1
August	148.4	8	30.8	23.3	87	66	4.0
September	212.6	12	30.5	23.0	92	70	2.9
October	72.0	3	32.3	19.6	86	49	3.8
November	5.5	0	31.4	16.7	80	41	4.7
December	42.6	1	28.00	12.8	83	40	3.4

Anantharajupet

Month	Rainfall (mm)	Rainy days	Temperature (°C)		Relative Humidity (%)		Evaporation (mm/day)
			Max.	Min.	Morn.	Even.	
January 21	-	-	-	-	-	-	-
February	-	-	-	-	-	-	-
March	-	-	-	-	-	-	-
April	27	1	40.5	20.8	78.3	36.7	-
May	17	2	41.3	27.7	75.9	37.7	-
June	28	2	37.4	25.5	65.03	35	-
July	84	5	34.3	25.3	70.46	38.76	-
August	107.64	4	31.43	24.8	77.3	46.8	-
September	139.7	6	29.3	24.43	85.56	55.2	-
October	92	6	32.4	24.56	90.13	57	-
November	810.4	22	23.4	20.1	93.7	71.6	-
December	99.4	7	23.2	19.7	97.3	68	-

Arabhavi

Month	Rainfall (mm)	Rainy days	Temperature (°C)		Relative Humidity (%)		Evaporation (mm/day)
			Max.	Min.	Morn.	Even.	
January 21	17.60	-	30.4	14.4	90	44	1.8
February	7.60	-	31.2	15.1	79	39	1.9
March	-	-	35.3	17.6	76	33	2.3
April	22.20	-	37.9	18.4	78	40	2.5
May	139.60	-	34.8	16.4	81	69	2.6
June	179.00	-	29.9	13.4	88	70	4.7
July	247.80	-	29.0	13.1	85	75	3.7
August	32.80	-	30.4	14.1	85	66	1.3
September	43.40	-	29.5	13.7	85	69	1.4
October	125.60	-	30.4	14.5	78	46	1.8
November	81.20	-	29.0	14.2	83	62	1.9
December	14.00	-	28.1	13.8	86	39	1.0

Bhubaneswar (CHES)

Month	Rainfall (mm)	Rainy days	Temperature (°C)		Relative Humidity (%)		Evaporation (mm/day)
			Max.	Min.	Morn.	Even.	
January 21	0.0	0	30.5	16.3	93	39	3.6
February	0.0	0	32.8	15.3	92	28	3.9
March	7.5	1	37.7	23.0	94	33	5.7
April	7.2	2	38.5	25.8	90	44	8.3
May	200.3	9	36.5	26.1	89	58	7.5
June	352.0	15	34.0	26.3	93	69	6.0
July	265.5	14	33.5	26.1	93	75	3.7
August	285.1	17	33.3	26.1	93	75	3.1
September	579.4	16	32.4	25.5	95	80	2.4
October	77.2	8	33.0	24.7	93	67	3.1
November	82.6	4	30.2	21.8	87	69	3.0
December	72.6	3	26.8	15.2	91	73	3.0

Coimbatore

Month	Rainfall (mm)	Rainy days	Temperature (°C)		Relative Humidity (%)		Evaporation (mm/day)
			Max.	Min.	Morn.	Even.	
January 21	0.0	0	30.5	16.3	93	39	3.6
February	0.0	0	32.8	15.3	92	28	3.9
March	7.5	1	37.7	23.0	94	33	5.7
April	7.2	2	38.5	25.8	90	44	8.3
May	200.3	9	36.5	26.1	89	58	7.5
June	352.0	15	34.0	26.3	93	69	6.0
July	265.5	14	33.5	26.1	93	75	3.7
August	285.1	17	33.3	26.1	93	75	3.1
September	579.4	16	32.4	25.5	95	80	2.4
October	77.2	8	33.0	24.7	93	67	3.1
November	82.6	4	30.2	21.8	87	69	3.0
December	72.6	3	26.8	15.2	91	73	3.0

Gandevi

Month	Rainfall (mm)	Rainy days	Temperature (°C)		Relative Humidity (%)		Evaporation (mm/day)
			Max.	Min.	Morn.	Even.	
January 21	0.0	0	24.1	16.8	83.8	70.0	2.6
February	0.0	0	26.5	12.6	77.5	68.6	3.7
March	0.0	0	31.6	16.3	78.9	69.0	5.1
April	0.0	0	34.5	21.6	76.3	70.4	5.2
May	91.0	2	32.6	25.4	84.8	76.9	4.6
June	352.0	14	30.9	25.4	87.4	82.5	2.6
July	454.0	17	29.8	25.4	88.9	82.0	1.3
August	285.5	20	27.9	24.7	87.3	84.7	1.0
September	872.5	19	28.4	24.7	90.8	85.4	0.8
October	38.0	1	32.6	23.9	82.8	81.8	2.3
November	35.0	2	29.3	25.2	79.3	75.4	2.9
December	86.0	3	25.4	19.4	86.9	78.9	1.8

Gangian

Month	Rainfall (mm)	Rainy days	Temperature (°C)		Relative Humidity (%)		Evaporation (mm/day)
			Max.	Min.	Morn.	Even.	
January 21	12.8	-	17.1	7.8	91	68	-
February	4.2	-	23	10	85	58	-
March	4.7	-	24.5	13.1	80	51	-
April	32.2	-	33.2	16	70	40	-
May	11.1	-	35.9	20.1	70	35	-
June	68.7	-	36.1	29.8	64	41	2.0
July	254.9	-	29	22.8	75	62	2.8
August	60.5	-	33.8	26.1	76	67	9.1
September	149.5	-	31.6	28.3	78	71	1.4
October	34.8	-	30.8	18.1	86	61	4.5
November	0.0	-	26.4	10.2	90	59	3.5
December	0.0	-	20.8	6.5	92	61	3.1

Imphal

Month	Rainfall (mm)	Rainy days	Temperature (°C)		Relative Humidity (%)		Evaporation (mm/day)
			Max.	Min.	Morn.	Even.	
January 21	6.6	-	23.3	6.6	96.0	41.2	-
February	7.5	-	26.1	8.4	90.9	31.6	-
March	55.6	-	28.8	12.8	79.1	32.8	-
April	54.8	-	30.4	15.4	75.7	36.6	-
May	118.7	-	29.8	19.2	82.4	57.0	-
June	228.5	-	29.6	22.1	85.9	69.8	-
July	220.1	-	30.2	22.6	86.7	67.1	-
August	248.0	-	29.3	22.7	87.5	71.7	-
September	208.9	-	30.0	21.9	88.0	66.6	-
October	77.7	-	29.4	20.0	88.5	61.5	-
November	2.0	-	26.6	13.4	84.5	47.8	-
December	70.9	-	22.5	10.0	91.4	53.5	-

Jalgaon

Month	Rainfall (mm)	Rainy days	Temperature (°C)		Relative Humidity (%)		Evaporation (mm/day)
			Max.	Min.	Morn.	Even.	
January 21	3.0	01	31.1	15.2	77.0	53.0	6.3
February	1.2	00	33.2	16.2	67.0	27.0	8.8
March	9.2	01	38.3	18.0	60.0	23.0	8.4
April	00	00	40.6	24.1	60.0	25.0	8.5
May	56.0	03	40.2	27.0	62.8	29.1	9.5
June	103.2	07	37.0	25.6	77.2	49.6	7.6
July	135.7	12	33.6	25.3	84.0	64.6	6.5
August	85.5	07	31.8	24.2	87.4	63.8	7.4
September	403.6	14	31.5	24.0	91.2	72.9	7.9
October	59.5	02	33.5	20.5	88.0	61.0	7.2
November	45.5	02	32.1	17.1	79.0	43.0	6.8
December	2.0	00	28.6	14.0	81.1	46.9	4.6

Jorhat

Month	Rainfall (mm)	Rainy days	Temperature (°C)		Relative Humidity (%)		Evaporation (mm/day)
			Max.	Min.	Morn.	Even.	
January 21	14.3	3	23.48	10.39	99.74	62.87	1.03
February	2.6	3	27.29	11.51	97.14	47.39	1.89
March	52.4	10	29.35	16.18	94.58	54.77	2.43
April	42.9	4	31.71	18.61	86.87	50.67	3.25
May	171	22	30.96	21.87	92.81	73.23	2.43
June	270.1	24	32.01	24.28	96.87	75.03	2.93
July	170.4	21	33.12	25.2	93.58	73.87	2.87
August	225.5	19	32.87	24.96	93.1	76.13	2.8
September	125.8	13	33.66	24.43	93.97	69.27	2.91
October	94.71	67.81	32.60	22.82	1.44	6.78	3.40
November	96.63	55.80	28.37	14.36	1.34	8.10	0.64
December	97.90	54.87	26.01	10.79	1.17	6.76	0.02

Kannara

Month	Rainfall (mm)	Rainy days	Temperature (°C)		Relative Humidity (%)		Evaporation (mm/day)
			Max.	Min.	Morn.	Even.	
January 21	45.7	1	32.3	21.3	78	50	4.3
February	0.0	0	34.6	21.6	70	38	5.5
March	31.8	1	36.8	23.0	84	34	5.3
April	72.4	4	34.9	23.6	89	58	3.7
May	550.5	16	32.7	22.9	94	73	2.7
June	473.0	21	31.2	23.7	94	74	2.7
July	626.9	22	29.8	23.5	96	77	2.1
August	409.1	22	30.2	23.4	96	76	2.2
September	291.7	14	30.7	23.9	96	71	2.6
October	593.2	17	31.3	23.6	96	77	2.0
November	364.2	13	31.0	23.4	91	71	2.1
December	19.2	1	32.5	23.3	80	55	4.0

Kovvur

Month	Rainfall (mm)	Rainy days	Temperature (°C)		Relative Humidity (%)		Evaporation (mm/day)
			Max.	Min.	Morn.	Even.	
January 21	0	-	31.3	18.6	85.9	67.8	2.6
February	0	-	28.9	18.1	86.2	63.6	3.1
March	0	-	35.0	21.4	84.6	62.8	3.9
April	0.38	-	37.3	24.0	78.1	52.5	4.1
May	2.47	-	38.0	32.9	80.9	67.0	4.4
June	2.6	-	36.7	26.1	88.2	70.2	3.3
July	8.7	-	31.4	24.4	88.5	75.6	4.1
August	3.2	-	33.2	25.0	86.4	72.4	3.1
September	9.84	-	32.5	24.1	87.7	74.2	2.7
October	3.67	-	34.3	31.2	85.7	63.9	2.7
November	3.08	-	31.3	22.1	86.0	69.7	2.2
December	0.15	-	30.35	18.39	81.8	59.6	2.0

Lembucherra

Month	Rainfall (mm)	Rainy days	Temperature (°C)		Relative Humidity (%)		Evaporation (mm/day)
			Max.	Min.	Morn.	Even.	
January 21	3.8	1	25.3	9.6	98	58	1.4
February	0	0	28.6	11.6	95	38	2.7
March	68.5	2	33.9	18.1	88	42	3.7
April	60	3	35.6	20.2	91	46	4.2
May	288.6	9	35.3	21.5	90	60	4.1
June	359.7	20	32.5	22.8	93	78	2.8
July	406.6	17	32.6	23.1	94	78	2.6
August	243.3	15	32.5	23.1	96	79	2.4
September	145	11	34.1	22.7	95	73	3.2
October	128.1	10	33.1	21.5	96	71	2.7
November	7.7	2	29.6	14.6	96	58	1.8
December	159.7	3	26.6	11.3	96	60	1.3

Lucknow

Month	Rainfall (mm)	Rainy days	Temperature (°C)		Relative Humidity (%)		Evaporation (mm/day)
			Max.	Min.	Morn.	Even.	
January 21	0	-	20.9	6.5	88.3	69.3	4.5
February	0	-	22.6	8.02	91.3	63.8	6.1
March	0	-	33.9	13.9	92.1	64.0	8.2
April	0	-	38.7	16.2	84.1	47.8	9.7
May	111.0	5	35.6	22.4	87.2	61.1	7.6
June	208.6	7	34.2	25.2	90.6	62.4	6.4
July	209.4	6	34.3	26.2	90.2	65.8	6.9
August	219.0	6	32.9	25.5	95.8	77.7	5.9
September	226.0	4	33.1	24.6	95.4	75.2	5.9
October	162.0	4	32.4	19.6	93.8	74.6	5.4
November	0	-	28.0	10.8	91.1	61.4	5.5
December	0	-	23.5	7.5	90.4	63.8	5.6

Ludhiana (PAU)

Month	Rainfall (mm)	Rainy days	Temperature (°C)		Relative Humidity (%)		Evaporation (mm/day)
			Max.	Min.	Morn.	Even.	
January 21	11.0	0	16.9	7.1	94	65	31.6
February	17.0	0	23.8	10.2	93	54	49.6
March	5.0	0	29.5	14.9	82	37	118.1
April	14.3	5	34.2	16.9	59	20	192.0
May	37.3	7	36.3	22.6	57	32	235
June	84.8	9	36.3	25.3	68	42	208.4
July	271.2	9	34.3	27.8	75	62	158.6
August	107.6	0	33.7	27.2	81	63	135.6
September	295.8	9	31.7	25.3	86	68	86.7
October	37.6	3	31.3	19.5	87	43	92.8
November	0	0	26.8	10.7	91	32	54.8
December	0	0	20.7	6.7	95	49	34.3

Ludhiana (Abohar)

Month	Rainfall (mm)	Rainy days	Temperature (°C)		Relative Humidity (%)		Evaporation (mm/day)
			Max.	Min.	Morn.	Even.	
January 21	2.5	1	16.5	3.6	79.3	61.7	-
February	0.0	0	23.1	7.8	80.0	52.5	-
March	11.2	2	27.3	12.6	74.3	41.8	-
April	27.0	5	28.7	16.4	59.1	35.1	-
May	9.3	1	34.8	17.2	69.2	36.6	-
June	15.5	1	35.9	18.8	64.8	46.0	-
July	91.7	3	37.4	19.4	74.1	57.8	-
August	1.2	1	38.2	23.0	74.3	58.0	-
September	72.8	3	33.1	20.6	79.5	66.6	-
October	12.4	1	31.1	15.8	78.9	56.7	-
November	0.0	0	26.7	12.1	81.4	46.8	-
December	0.0	0	21.4	5.9	85.0	57.0	-

Mandsaur

Month	Rainfall (mm)	Rainy days	Temperature (°C)		Relative Humidity (%)		Evaporation (mm/day)
			Max.	Min.	Morn.	Even.	
January 21	0.00	-	23.90	7.54	89.05	48.06	-
February	0.00	-	28.79	7.66	78.93	25.57	-
March	4.00	-	33.73	16.12	55.94	21.42	-
April	0.00	-	37.82	18.61	40.61	15.16	-
May	0.00	-	41.52	26.05	38.18	14.88	-
June	7.00	-	35.1	26.83	53.73	19.69	-
July	288.00	-	31.13	25.41	87.94	65.35	-
August	186.50	-	27.95	23.34	92.84	78.23	-
September	239.40	-	29.25	23.56	94.97	73.74	-
October	30.70	-	31.10	18.41	88.84	44.62	-
November	13.50	-	27.65	9.76	88.06	37.13	-
December	8.00	-	21.79	11.27	90.39	52.74	-

Medziphema

Month	Rainfall (mm)	Rainy days	Temperature (°C)		Relative Humidity (%)		Evaporation (mm/day)
			Max.	Min.	Morn.	Even.	
January 21	3.4	-	24.0	8.9	96	50	-
February	2.3	-	27.1	9.7	95	40	-
March	43.5	-	31.1	14.9	93	41	-
April	59.6	-	33.1	17.9	87	34	-
May	85.4	-	32.8	21.9	90	58	-
June	117.4	-	33.1	24.3	93	69	-
July	272.2	-	33.3	24.8	92	72	-
August	138.8	-	32.6	24.6	93	72	-
September	116.2	-	33.1	23.8	94	68	-
October	130.0	-	32.1	22.1	95	68	-
November	0.0	-	28.5	14.8	96	51	-
December	16.4	-	25.1	11.3	95	51	-

Mohanpur

Month	Rainfall (mm)	Rainy days	Temperature (°C)		Relative Humidity (%)		Evaporation (mm/day)
			Max.	Min.	Morn.	Even.	
January 21	0	-	24.88	11.89	91.3	52.04	1.49
February	1.1	-	29.35	13.86	89.11	39.21	2.38
March	0	-	35.48	20.82	87.58	35.83	3.96
April	25.63	-	37.01	24.63	84.23	41.16	4.86
May	352.4	-	34.24	24.73	89.61	66.4	4.40
June	358.29	-	32.67	25.85	93.53	77.69	2.57
July	253.5	-	32.6	26.28	94.48	79.42	2.38
August	221.7	-	32.88	26.39	94.93	77.35	2.39
September	255.4	-	31.76	25.61	93.9	77.68	2.31
October	5.65	-	31.28	23.31	93.23	69.4	1.92
November	20.7	-	28.40	17.61	90.06	57.03	1.65
December	140.9	-	24.48	14.11	91.79	62.6	0.97

New Delhi

Month	Rainfall (mm)	Rainy days	Temperature (°C)		Relative Humidity (%)		Evaporation (mm/day)
			Max.	Min.	Morn.	Even.	
January 21	56.3	4	18.0	6.0	88.5	60.7	1.5
February	7.0	2	26.4	8.7	88.6	38.8	3.2
March	2.0	1	32.2	14.6	78.3	35.5	4.2
April	5.2	1	37.0	18.3	68.0	32.2	6.8
May	215.0	6	36.3	23.2	68.0	47.1	8.6
June	50.1	5	37.2	26.0	73.8	49.9	6.2
July	514.5	15	36.1	27.3	84.3	67.6	5.2
August	314.8	11	34.6	26.6	88.0	70.2	4.0
September	527.8	13	32.4	24.8	90.2	76.7	3.4
October	3.0	1	34.8	17.5	82.1	38.2	4.3
November	33.2	2	27.1	12.4	85.2	37.3	2.9
December	0	0	23.2	6.5	88.2	47.6	1.9

Neri

Month	Rainfall (mm)	Rainy days	Temperature (°C)		Relative Humidity (%)		Evaporation (mm/day)
			Max.	Min.	Morn.	Even.	
January 21	26.9	-	22.2	6.1	71.0	-	-
February	17.8	-	30.2	8.1	67.5	-	-
March	25.6	-	34.8	12.1	57.0	-	-
April	83.0	-	38.7	13.0	51.0	-	-
May	69.6	-	41.3	20.3	40.0	-	-
June	0.0	-	44.5	24.8	63.0	-	-
July	416.0	-	44.4	25.2	85.0	-	-
August	32.0	-	39.6	24.9	88.0	-	-
September	87.0	-	37.4	22.7	87.0	-	-
October	75.0	-	36.4	15.5	72.0	-	-
November	0.0	-	28.4	11.0	75.5	-	-
December	10.0	-	21.0	5.2	74.1	-	-

Pantnagar

Month	Rainfall (mm)	Rainy days	Temperature (°C)		Relative Humidity (%)		Evaporation (mm/day)
			Max.	Min.	Morn.	Even.	
January 21	18.6	3	18.4	8.4	96	69	1.8
February	4.6	1	25.2	8.9	92	48	2.8
March	0.0	0	30.5	13.2	85	35	4.7
April	4.1	1	34.5	15.4	58	15	8.0
May	190.6	6	37.0	21.3	73	46	5.9
June	132.0	6	37.0	24.9	80	57	5.2
July	239.8	11	32.3	26.5	85	68	5.1
August	299.7	12	32.0	25.7	89	72	3.9
September	39.0	3	31.6	24.9	86	63	4.3
October	427.5	4	30.9	19.7	89	54	3.4
November	0.0	0	27.2	12.1	91	39	2.7
December	5.0	1	24.0	8.4	91	47	1.8

Paria

Month	Rainfall (mm)	Rainy days	Temperature (°C)		Relative Humidity (%)		Evaporation (mm/day)
			Max.	Min.	Morn.	Even.	
January 21	4.2	1	30.38	10.01	81.89	47.85	2.96
February	0.0	0	33.93	12.24	77.14	33.96	4.24
March	0.0	0	37.36	15.13	82.95	54.17	4.89
April	0.0	0	39.38	23.21	85.05	54.11	7.60
May	14.4	2	37.38	26.01	84.69	64.86	6.72
June	340.4	15	32.49	23.96	90.16	85.13	5.65
July	557.8	17	31.83	24.43	93.12	84.12	5.92
August	643.9	19	30.98	23.03	94.87	83.30	4.93
September	763.2	22	30.24	22.51	95.04	87.40	4.38
October	69.0	3	33.42	21.32	91.08	69.02	4.00
November	24.5	2	34.55	17.04	88.75	57.66	4.55
December	113.1	2	29.13	12.91	93.76	75.44	3.40

Pasighat (CAU)

Month	Rainfall (mm)	Rainy days	Temperature (°C)		Relative Humidity (%)		Evaporation (mm/day)
			Max.	Min.	Morn.	Even.	
January 21	26.8	4	17.81	-	83.77	68.06	1.82
February	-	-	18.85	-	77.31	67.58	1.77
March	36.71	8	25.11	-	85.19	84.67	2.81
April	133.74	10	25.28	-	83.21	85.82	5.14
May	281.53	17	24.74	-	84.48	85.41	3.26
June	668.50	18	26.70	-	91.50	88.88	1.8
July	269.20	12	30.00	28.00	89.42	89.23	3.84
August	1521.0	21	31.10	24.80	91.50	90.70	1.0
September	162.20	6	29.23	23.23	76.53	75.87	6.28
October	196.12	6	28.10	22.10	81.93	79.86	4.80
November	2.00	1	22.50	21.13	66.43	65.47	1.83
December	0	0	19.1	24.2	65.9	55.3	1.2

Periyakulam

Month	Rainfall (mm)	Rainy days	Temperature (°C)		Relative Humidity (%)		Evaporation (mm/day)
			Max.	Min.	Morn.	Even.	
January 21	75.60	6	29.40	20.86	82.40	51.70	-
February	0.40	-	32.81	21.04	77.10	47.10	-
March	58.00	2	35.32	22.87	75.20	41.30	-
April	79.80	2	36.35	25.13	74.40	52.60	-
May	38.80	5	34.78	25.97	75.90	62.40	-
June	59.40	3	35.14	25.94	70.50	62.60	-
July	53.60	3	33.86	24.90	76.80	61.70	-
August	74.00	4	33.57	24.68	76.20	62.90	-
September	41.20	6	34.58	25.47	72.80	61.80	-
October	159.40	9	32.20	24.36	81.60	71.60	-
November	242.20	14	30.09	23.09	90.10	78.00	-
December	27.00	2	30.94	21.99	81.90	63.20	-

Port Blair

Month	Rainfall (mm)	Rainy days	Temperature (°C)		Relative Humidity (%)		Evaporation (mm/day)
			Max.	Min.	Morn.	Even.	
January 21	25.5	2.0	30.2	24.7	68.0	72.0	-
February	92.2	4.0	30.5	24.1	71.0	73.0	-
March	0	0	32.2	25.0	72.0	76.0	-
April	247.9	8.0	32.1	24.8	74.0	81.0	-
May	469.1	16.0	33.4	25.4	81.0	85.0	-
June	321.9	16.0	31.1	25.2	81.0	83.0	-
July	649.2	19.0	30.2	24.5	88.2	89.3	-
August	430.9	21.0	30.0	24.6	86.6	87.0	-
September	541.2	20.0	29.6	24.3	86.0	90.9	-
October	305.8	14.0	30.3	24.8	83.4	87.4	-
November	224.9	15.0	30.6	25.1	80.3	85.2	-
December	91.6	3.0	30.1	29.7	72.5	78.0	-

Pune (ARI)

Month	Rainfall (mm)	Rainy days	Temperature (°C)		Relative Humidity (%)		Evaporation (mm/day)
			Max.	Min.	Morn.	Even.	
January 21	-	-	29.51	13.45	94.44	50.73	-
February	-	-	31.22	13.53	86.71	37.41	-
March	-	-	36.13	16.73	74.02	26.91	-
April	13.2	1	37.28	19.36	71.96	25.59	-
May	12.7	1	36.19	22.72	73.68	38.59	-
June	122.3	8	31.21	22.70	84.48	62.00	-
July	73.2	5	30.05	22.87	86.39	69.16	-
August	9.8	2	29.58	21.26	86.03	66.72	-
September	34.6	2	30.61	21.81	91.08	66.05	-
October	126.6	6	31.50	20.01	92.65	59.61	-
November	38	6	30.40	25.31	89.34	61.58	-
December	95.8	3	27.70	14.66	95.26	60.27	-

Pune (NRCG)

Month	Rainfall (mm)	Rainy days	Temperature (°C)		Relative Humidity (%)		Evaporation (mm/day)
			Max.	Min.	Morn.	Even.	
January 21	12.40	2	31.35	15.09	98.64	48.62	104.3
February	19.61	1	31.56	12.31	95.85	38.57	120.6
March	6.40	1	34.27	15.77	84.77	30.35	188.0
April	15.50	2	34.39	19.56	83.43	31.07	206.8
May	118.50	8	33.09	22.71	89.43	51.90	158.8
June	106.40	10	29.37	22.54	97.20	75.03	61.2
July	82.4	3	30.29	22.90	94.80	79.40	57.5
August	29.90	4	28.29	21.56	76.87	82.65	51.6
September	82.20	6	28.99	21.52	65.36	67.61	56.3
October	136.80	7	31.58	18.44	43.48	47.03	93.6
November	13.60	1	24.69	12.09	78.97	34.47	89.2
December	100.20	1	30.48	12.62	99.13	48.19	63.3

Pusa

Month	Rainfall (mm)	Rainy days	Temperature (°C)		Relative Humidity (%)		Evaporation (mm/day)
			Max.	Min.	Morn.	Even.	
January 21	-	-	-	-	-	-	-
February	-	-	-	-	-	-	-
March	-	-	-	-	-	-	-
April	0.8*	0	35.8	19.7	79.3	39.1	5.4
May	282.2*	09*	32.1	22.5	86.2	64.5	3.3
June	401.9*	15*	32.5	24.8	92.8	75.5	1.9
July	204.1*	15*	32.9	25.5	91.48	79.58	1.64
August	500.8*	20*	32.3	25.2	94	82	0.75
September	127.0*	06*	32.3	26.1	90	77	2.2
October	359.1*	19*	30.4	22.9	94	72	2.3
November	0*	0	28.4	14.3	96	56	2.1
December	7.7*	02*	24.4	10.5	96	59	1.4

Rahuri

Month	Rainfall (mm)	Rainy days	Temperature (°C)		Relative Humidity (%)		Evaporation (mm/day)
			Max.	Min.	Morn.	Even.	
January 21	20.6	1.0	29.1	16.8	86.5	39.8	3.0
February	7.2	1.0	29.1	13.5	81.3	31.5	3.0
March	23.4	3.0	35.5	17.7	72.0	21.5	5.8
April	0.0	0.0	37.7	23.4	58.8	16.8	7.6
May	10.8	1.0	37.0	25.8	70.0	28.8	8.1
June	123.8	7.0	32.4	24.7	79.0	51.3	6.4
July	165.0	8.0	31.2	24.4	83.5	59.5	5.3
August	165.8	9.0	28.6	23.0	87.3	65.0	4.5
September	235.4	13.0	29.2	23.1	88.8	67.3	3.7
October	88.6	6.0	31.6	21.2	88.8	48.8	5.3
November	73.6	3.0	29.8	18.9	85.5	47.5	4.4
December	47.4	1.0	27.5	14.9	90.5	46.3	3.7

Rajendranagar

Month	Rainfall (mm)	Rainy days	Temperature (°C)		Relative Humidity (%)		Evaporation (mm/day)
			Max.	Min.	Morn.	Even.	
January 21	4.2	1	29.5	15.3	94.6	45.5	3.1
February	0.4	-	30.7	13.8	87.5	40.6	4.3
March	0.0	-	35.9	17.0	80.2	30.1	6.0
April	12.2	1	37.4	22.1	81.0	47.0	6.7
May	112.6	6	36.3	24.7	89.1	50.9	6.7
June	55.8	7	32.9	23.8	93.8	62.8	5.5
July	305.8	12	30.2	23.1	96.6	78.5	4.2
August	106.2	9	30.5	23.1	95.2	74.1	3.9
September	255.2	13	28.8	22.4	93.8	76.0	3.4
October	100.8	3	31.0	20.7	90.3	55.5	3.4
November	18.2	2	28.6	19.3	87.5	60.3	2.9
December	0.0	-	28.5	14.5	89.2	46.1	3.0

Ranchi

Month	Rainfall (mm)	Rainy days	Temperature (°C)		Relative Humidity (%)		Evaporation (mm/day)
			Max.	Min.	Morn.	Even.	
January 21	0	-	24.6	11.5	-	-	-
February	3.3	-	27.3	12.5	-	-	-
March	14	-	33.7	16.1	-	-	-
April	0	-	37.9	15.7	-	-	-
May	112.6	-	39.0	18.4	-	-	-
June	169.9	-	34.1	23.4	-	-	-
July	494.2	-	30.7	24.8	-	-	-
August	264	-	30.3	24.8	-	-	-
September	218.18	-	32.6	26.0	-	-	-
October	64.4	-	29.9	22.1	-	-	-
November	95.4	-	25.8	13.0	-	-	-
December	25.6	-	23.4	11.2	-	-	-

Rewa

Month	Rainfall (mm)	Rainy days	Temperature (°C)		Relative Humidity (%)		Evaporation (mm/day)
			Max.	Min.	Morn.	Even.	
January 21	56	10	24	9.0	65	29	-
February	10.6	3	28	10.5	72	32	-
March	0	0	36	18	75	34	-
April	0	0	38.76	17.93	46.61	19.93	-
May	103.3	9	38.43	21.62	46.04	32.29	-
June	210.5	9	35.78	24.10	69.79	47.46	-
July	319.9	15	33.63	25.64	77.54	60.07	-
August	507	14	31.35	25.07	87.32	72.79	-
September	198.9	13	33.19	25.34	85.04	74.21	-
October	5.2	1	32.61	24.24	82.07	63.54	-
November	14	2	30	13	65	30	-
December	10.6	3	28	11	60	34	-

Sabour

Month	Rainfall (mm)	Rainy days	Temperature (°C)		Relative Humidity (%)		Evaporation (mm/day)
			Max.	Min.	Morn.	Even.	
January 21	-	-	-	-	-	-	-
February	-	-	-	-	-	-	-
March	-	-	-	-	-	-	-
April	0.0	-	36.4	24.4	78.0	59.4	-
May	251.3	-	33.6	24.4	85.9	62.7	-
June	298.6	-	33.8	26.1	89.2	63.5	-
July	331.2	-	33.0	26.4	88.7	68.4	-
August	104.7	-	32.4	27.3	91.5	77.1	-
September	119.4	-	32.7	27.3	91.6	75.4	-
October	210.0	-	31.9	24.4	94.1	73.1	-
November	0.0	-	28.0	16.3	94.0	73.4	-
December	15.6	-	25.0	12.3	94.3	68.6	-

Sangareddy

Month	Rainfall (mm)	Rainy days	Temperature (°C)		Relative Humidity (%)		Evaporation (mm/day)
			Max.	Min.	Morn.	Even.	
January 21	4.2	-	29.82	15.48	92.87	58.83	-
February	0	-	30.94	13.96	87.39	50.71	-
March	0	-	36.02	17.47	82.25	41	-
April	65.79	-	37.14	21.23	81.16	45.33	-
May	48.79	-	36.72	24.16	79.38	49.93	-
June	157.7	-	32.23	22.56	87.29	66.46	-
July	248.09	-	30.21	22.18	89.64	71.77	-
August	167.79	-	30.14	22.01	88.48	64.9	-
September	280	-	29.6	21.61	90.26	69.03	-
October	116.8	-	31.23	19.67	90.09	53.35	-
November	16.6	-	29.55	18.44	89.46	52.96	-
December	0	-	29.05	13.92	87.54	38.32	-

Sriganganagar

Month	Rainfall (mm)	Rainy days	Temperature (°C)		Relative Humidity (%)		Evaporation (mm/day)
			Max.	Min.	Morn.	Even.	
January 21	8.90	-	18.44	4.32	86.71	66.03	0.65
February	0.00	-	26.91	7.24	83.25	54.43	1.95
March	6.80	-	31.03	13.05	80.84	39.97	2.32
April	4.80	-	35.99	15.42	63.30	24.47	4.59
May	28.10	-	40.04	21.96	63.55	31.39	5.60
June	80.70	-	40.47	24.97	70.20	39.37	5.93
July	13.90	-	38.85	27.41	67.74	47.03	6.42
August	1.40	-	38.06	26.15	66.06	48.52	7.04
September	111.80	-	34.35	24.01	82.33	60.47	5.61
October	30.80	-	33.22	17.87	80.71	47.03	6.28
November	0.00	-	28.73	11.47	85.00	43.97	4.88
December	0.00	-	22.51	6.05	87.45	46.61	1.97

Tinsukia

Month	Rainfall (mm)	Rainy days	Temperature (°C)		Relative Humidity (%)		Evaporation (mm/day)
			Max.	Min.	Morn.	Even.	
January 21	22.4	3	24.6	10.1	98	66	-
February	19.6	3	25.2	12.7	92	54	-
March	34.7	4	28.7	15.8	88	59	-
April	110.0	16	29.8	17.0	79	66	-
May	247.0	17	30.2	18.2	71	66	-
June	367.2	22	30.7	23.8	90	80	-
July	314.0	18	29.8	25.0	84	72	-
August	442.6	24	31.5	24.0	85	72	-
September	134.2	5	33.0	23.6	77	68	-
October	59.5	5	31.7	22.2	84	71	-
November	0.0	0	28.6	21.0	86	74	-
December	10.6	1	25.0	16.9	85	72	-

Tirupati

Month	Rainfall (mm)	Rainy days	Temperature (°C)		Relative Humidity (%)		Evaporation (mm/day)
			Max.	Min.	Morn.	Even.	
January 21	49.0	3	29.40	19.20	85.20	56.30	3.90
February	5.0	1	31.40	17.50	83.30	39.20	5.40
March	0.0	-	36.00	19.20	76.50	28.70	7.20
April	14.0	1	37.70	24.90	76.50	35.10	7.50
May	55.0	5	37.50	26.20	74.30	39.90	7.30
June	103.0	4	36.40	26.00	77.10	45.30	6.70
July	108.8	8	34.70	25.10	76.90	54.40	4.50
August	208.6	9	33.80	24.80	77.10	54.40	4.00
September	203.0	10	33.80	24.60	79.30	56.60	3.90
October	276.20	16	32.20	23.60	84.40	68.80	3.30
November	637.0	23	28.60	27.70	89.30	75.70	1.70
December	36.20	3	29.80	19.20	81.90	56.90	4.00

Tiruchirapalli

Month	Rainfall (mm)	Rainy days	Temperature (°C)		Relative Humidity (%)		Evaporation (mm/day)
			Max.	Min.	Morn.	Even.	
January 21	142.3	10	29.58	22.64	-	-	-
February	-	-	32.64	21.75	-	-	-
March	59.4	1	36.0	24.0	-	-	-
April	4.0	1	38.46	28.93	-	-	-
May	73.5	3	37.87	27.46	-	-	-
June	165.9	3	37.3	27.03	-	-	-
July	81.6	5	35.48	26.22	-	-	-
August	134.4	7	35.03	26.19	-	-	-
September	110.6	4	36.06	25.6	-	-	-
October	273.0	11	32.54	25.93	-	-	-
November	465.6	18	29.33	24.7	-	-	-
December	23.1	1	30.16	22.48	-	-	-

Udaipur

Month	Rainfall (mm)	Rainy days	Temperature (°C)		Relative Humidity (%)		Evaporation (mm/day)
			Max.	Min.	Morn.	Even.	
January 21	12.60	-	24.53	6.94	85.61	37.94	-
February	0.00	-	28.81	8.06	73.14	22.75	-
March	0.00	-	33.67	13.37	56.58	20.87	-
April	0.00	-	37.21	18.55	39.53	17.38	-
May	149.00	-	35.83	21.92	59.13	40.97	-
June	47.80	-	34.00	23.74	87.23	68.07	-
July	80.90	-	32.50	23.79	90.45	77.19	-
August	103.40	-	30.41	21.55	92.65	77.35	-
September	229.40	-	29.09	20.49	91.94	79.00	-
October	11.70	-	31.09	16.45	90.87	63.10	-
November	182.80	-	28.06	9.47	91.53	54.97	-
December	18.00	-	23.82	7.15	94.23	58.19	-

Vengurle

Month	Rainfall (mm)	Rainy days	Temperature (°C)		Relative Humidity (%)		Evaporation (mm/day)
			Max.	Min.	Morn.	Even.	
January 21	-	-	-	-	-	-	-
February	-	-	-	-	-	-	-
March	-	-	-	-	-	-	-
April	2	1	35.50	23.34	78.37	64.30	8.34
May	276.00	12	35.41	24.87	78.71	67.68	7.04
June	852	25	32.89	23.84	91.80	77.03	3.65
July	1391.6	29	30.77	23.97	94.23	86.55	2.71
August	275.40	24	31.92	23.72	91.23	78.29	3.86
September	609	27	31.64	23.37	94.70	82.77	3.13
October	145	3	34.32	23.38	87.67	73.11	6.39
November	153	9	33.90	22.11	89.30	76.03	4.89
December	100.13	4	32.42	19.33	94.45	67.32	4.14

Max=Maximum, Min=Minimum
Morn. = Morning, Even. = Evening

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