भा.कृ.अनु.प. – अखिल भारतीय समन्वित फल अनुसंधान परियोजना

ICAR-All India Coordinated Research Project on Fruits

वार्षिक प्रतिवेदन

Annual Report

2020

भा.कृ.अनु.प.–भारतीय बागवानी अनुसंधान संस्थान

हेसरघट्टा लेक पोस्ट, बेंगलूरू –५६००८९

ICAR - INDIAN INSTITUTE OF HORTICULTURAL RESEARCH

Hesaraghatta Lake Post, Bengaluru- 560 089

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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 2020. The highlights of the report are drawn from the results of the experiments conducted at different centres. During reporting period, a total of 20 accessions in banana, 41 Citrus, 15 in guava, 18 in jackfruit and 20 in mango have been added to the existing germplasm collections. Evaluation of promising of promising varieties of guava has revealed the superiority of white pulped variety, MPUAT S-2 for yield compared to check variety Allahabad Safeda at Bengaluru, Udaipur and Sabour to the tune of 138.95, 23.63 and 1.73 per cent respectively. Initial results have indicated that In papaya, Pune Selection-1 performed better with respect to yield characters (19 to 20 percent increase in yield over local check) as well as lowest PRSV infestation. Three foliar sprays of K_2HPO_4 (1%) + KNO_3 (1%) in October, November and December was found promising in advancement of flowering by 6 to 7 days in litchi cv Bombai and cv. Shahi under West Bengal and Jharkhand conditions. Yield and quality improvement in mango has been observed with application of micronutrients in mango. In papaya, drip irrigation (80% ER) + fertigation (75% RDF) + micronutrient spray ($ZnSO_4$ at 0.5% + H_3BO_3 at 0.2% at alternate months) has been promising in increasing the productivity to the tune of 1.2 to 2.3 times compared to existing farmers practice.

Survey results indicated that fruit rot of jackfruit is the common disease at all the centres. For *Eumusae* leaf spot management in banana, use of mineral oil has recorded has resulted in reduction of spray of chemicals and has been effective in controlling the disease. Management of mango hoppers and thrips using, *M. anisopliae* oil-based formulation @ 1ml/l was found most effective at Bengaluru, Vengurle, Mohanpur and Paria centres.

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 Dr. M.R. Dinesh, Director, 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 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 timely and with high quality. Assistance of Dr. Jeevitha S, Ms. Shwetha H K, Ms. Shweta Maruti Sutagatti, Ms. Pooja N U, Mr. Manjunatha C, Ms. Divya R, Ms. Gouthami S, Mr. Nagaraja M R, Mrs. Sheela S, Ms. Roja J 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.

Bengaluru

28 March 2020

(Prakash Patil)

Project Coordinator (Fruits) Acting

Contents

Acronyms and Abbreviations

AICRP	All India Coordinated Research Project
AM	*Arbuscular mycorrhiza*
B:C	Benefit to cost
BA	Benzyladenine
BAP	Benzyladenine purine
BBMV	Banana Bract Mosaic Virus
BBTV	Banana Bunchy Top Virus
BSV	Banana Streak Virus
CHES	Central Horticultural Experiment Station
CISH	Central Institute for Sub-tropical Horticulture
cv.	Cultivar
DAP	Days After Planting
DARE	Department of Agricultural Research and Education
DAS	Days After Sowing
DDG	Deputy Director General
Dr.YSRHU	DR. YSR Horticultural University
EC	Electrical Conductivity
EPN	Entamo-Pathogenic Nematode
ER	Evaporation Replenishment
$FeSO_4$	Ferrous- Sulphate
FYM	Farm Yard Manure
GA	Gibberellic acid
IAA	Indole acetic acid
IBA	Indole butyric acid
ICAR	Indian Council of Agricultural Research
IIHR	Indian Institute of Horticultural Research
K_2O	Potash (Potassium oxide)
KAU	Kerala Agricultural University
KNO_3	Potassium Nitrate
MAP	Months After Planting
$MnSO_4$	Manganese Sulphate
MOS	Months After Sowing
MT	Metric tonnes
N	Nitrogen

NAA	Naphthalene acetic acid
NAGS	National Active Germplasm Site
NaOH	Sodium hydroxide
NRCB	National Research Centre for Banana
CCRI	Central Citrus Research Institute
NRCG	National Research Centre for Grapes
NRCL	National Research Centre for Litchi
P_2O_5	Phosphorus (Phosphorus pentoxide)
PDI	Per cent Disease Incidence
ppm	Parts Per Million
PRSV	Papaya Ring Spot Virus
PSB	Phosphate Solubilising Bacteria
QRT	Quinquennial Review Team
RDF	Recommended Dose of Fertilizers
RH	Relative humidity
SAU	State Agricultural University
t/ha	Tonnes per hectare
TDZ	Thiadiazuron
TNAU	Tamil Nadu Agricultural University
TSS	Total Soluble Solids
UAS	University of Agricultural Sciences
VAM	Vesicular-Arbuscular Mycorrhizas
Var.	Variety
$ZnSO_4$	Zinc Sulphate
FN	Fortnight
CTV	Citrus Tristeza Virus
CMV	Cucumber Mosaic Virus
DASS	Days After Second Spray
IMTP	International Musa Testing Programme
BSMYV	Banana streak Mysore virus

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 20 accessions in banana, 41 Citrus, 15 in guava, 18 in jackfruit and 20 in mango 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 56 to 69 percent (5.88 to 20.53 kg/bunch) under the plantain group (AAB). Similarly, under ABB group an increased yield of 20 to 50 percent has been noticed with NRCB selection-10 (10.25 to 30.70 kg/bunch) with their respective checks at Arabhavi, Bhubaneswar, Jorhat, Kannara, Kovvur and Mohanpur.

Among the different promising clones of acid lime evaluated, superiority of clones PDKV lime at Akola (718.67 fruits/tree), TAL-94/14 at Rahuri (911.09 fruits/tree), NRCC Nimboo-3 at Periyakulam (325.20 fruits/tree respectively) has been observed and further confirmation is in progress.

Among the coloured table varieties of grapes evaluated, superiority of Manjari Shyama (A-18/3) has been observed with respect to highest yield and quality parameters. Accordingly, it has been recommended for cultivation in Maharashtra, Karnataka, Telangana and Tamil Nadu for its yield potential.

Among the evaluated juice varieties of grape, MACS 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, white pulped variety, MPUAT S-2 was superior for yield compared to check variety Allahabad Safeda at Bengaluru, Udaipur and Sabour to the tune of 138.95, 23.63 and 1.73 per cent respectively. However, at Ludhiana and Lucknow, this variety has ranked second as CISH G-35 has been superior for yield compared to local check to the tune of 4.36 and 24.39 per cent respectively.

In papaya, Pune Selection-1 performed better with respect to yield characters (19 to 20 percent increase in yield over local check yield of 23.81 to 31.50 kg/plant) as well as lowest PRSV infestation at Anantharajupet, Coimbatore and Gandevi. The reduction in percent of PSRV-P infection at fruit setting was 1.0 to 1.7 times (30.00-38.33%) over the National Check (Red Lady).

Crop production

Superiority of macro-propagated banana plants has been noticed with increased yield ranging from 2 to 37 per cent over the sucker raised banana plants at different centres. Further, the crop duration of these plants was also reduced from 14 to 18 days over the sucker raised plants at different locations *viz*., Arabhavi, Gandevi and Jorhat.

Studies on alleviation of soil moisture deficit in banana has revealed that foliar priming with acetyl salicylic acid (0.1mM) + soil moisture stress at 5th MAP as drought alleviation management, significantly decreased negative effect of drought through increased yield (13% as compared to stressed plants) and yield traits (number of hands and fingers). Additionally, it also improved the fruit development and excluded malformed fruits.

Trial on nutrient management under high density planting in mandarin has revealed that, application of 75 per cent RDF from inorganic source + 25 per cent organic source (FYM) with normal spacing has been superior for yield parameter in mandarin at Akola (133.50 fruits/tree) and Tinsukia (289 fruits/tree). 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 (1.3 to 2 times the yield over control) for mandarin at Sriganganagar and Tinsukia. However, in sweet orange, application of 50 per cent Vermicompost (on N-equivalent basis of RDF) + *Trichoderma harzianum* (30–40 ml/ plant) + Azadirachtin (1%) @ 3–4 ml/litre as spray + *Pseudomonas fluorescens* (30 – 40 ml/plant) + *Azotobacter chroococcum* (30 – 40 ml / plant) has increased the yield to the tune of 20 per cent at Tirupati.

Trial to standardize the stage-wise requirement of nutrients in mandarin has revealed that application of N: P_2O_5: K_2O at 0:0:0, 30:40:10, 30:35:10, 20:25:30,10:0:25 and 10:0:25 per cent RDF for stage I to VI has consistently recorded increase in yield to the tune of 26 to 52 per cent as compared to control at Akola and Ludhiana. Similarly, in sweet orange it has been revealed that application of N: P_2O_5: K_2O at 0:0:0, 30:40:0, 30:35:0, 40:25:30, 0:0:35, 0:0:35 percent RDF for stage I to stage VI has recorded higher yield (65.17 kg/tree; 18.05 t/ha) and TSS (10.70°B) at Tirupati.

Trial to standardise the suitable organic source of nutrients in guava indicated that, application of vermicompost (30 kg/plant) + *Azospirillum* culture+ PSB (@ 250 g/tree) has recorded maximum number of fruits per plant to the tune of 7.58-39.38 per cent at Ludhiana, Rahuri, Sabour, Sangareddy and Vengurle centres. Highest yield was recorded with application of Vermicompost (30 kg/plant) + *Azospirillum* culture @ 250 g/tree + PSB @ 250 g/ tree + vermiwash at Ludhiana (26.06%) and Rahuri (37.84%) compared to control. However, treatment of Vermicompost (30 kg/plant) + *Azotobactor*+ PSB (@ 250 g/ tree) enhanced yield to the tune of 10 and 29.46 percent at Sabour and Sangareddy.

In guava, application of Arka Microbial Consortium (AMC) on guava indicated that application of 75 per cent recommended dose of N and P_2O_5 + AMC soil application (12.5 kg/ha) twice a year along with FYM has resulted in increased fruit yield and highest TSS at Pantnagar (38.83 kg/tree, 13.68°B) Rewa (40.55 kg/tree, 14.21°B) and Udaipur (42.43 kg/tree, 13.60°B).

The trial to improve the productivity in litchi, the treatment involving girdling of branches with 4 mm level on 50 per cent primary branches has recorded maximum yield at Gangian and Medziphema (84.20 & 17.85 kg/tree), while at Neri, the maximum yield (27.70 kg/tree) was recorded in 6 mm girdling on 50 per cent primary branches.

Three foliar sprays of K_2HPO_4 (1%) + KNO_3 (1%) in October, November and December was found promising in advancement of flowering by 6 to 7 days in litchi cv Bombai and cv. Shahi under West Bengal and Jharkhand conditions.

Application of 250 g of *Azotobacter* along with 50 kg FYM has reduced the RDF by 50 per cent with sustained fruit yield in mango at Sangareddy and Mohanpur. Whereas, at Vengurle, application of $ZnSO_4$ (0.5%) + H_3BO_3 (0.2%) + $MnSO_2$ (1%) + $CaCl_2$ (0.6%) as two foliar applications (August and October) + 10 cm thick organic mulching improved the yield and fruit quality of mango and in Sabour; application of 50% RDF + 50kg FYM + 250g *Trichoderma* has showed higher yield with 50 per cent reduction in RDF.

Application of organic nutrients *viz*., vermicompost (50 kg/tree) + *Azospirillum* culture (250 g/ tree) + PSB (50 g/tree) has significantly increased the mango yield at Sangareddy (68.35 kg/tree) and Vengurle (5.29 kg/tree). However, at Rahuri inclusion of vermi-wash along with above treatment combination has been productive (143.66 kg/tree).

Trial for evaluating the effect of micronutrients in mango has revealed that soil application of RDF + 100 g $ZnSO_4$ + 50 g $CuSO_4$ + 50 g H_3BO_3 after harvest followed by foliar spray of 0.2% $ZnSO_4$ + 0.1% $CuSO_4$ + 0.1% H_3BO_3 (first spray at just before flowering and second spary at marble stage) has recorded significantly higher fruit yield as compared to control across different locations *viz*., Anantharajupet, Lucknow and Sabour to the tune of 35-119 per cent.

Trial on enhancing the input use efficiency in papaya has revealed that treatment involving raised bed cultivation with drip irrigation (80% ER) + fertigation (75% RDF) + micronutrient spray ($ZnSO_4$ at 0.5% + H_3BO_3 at 0.2% in alternate months) has enhanced the yield to the tune of 1.2 to 2.3 times compared to check at different locations *viz.*, Anantharajupet, Coimbatore and Pusa.

The papaya grown under net house performed better in recording higher marketable fruits (18 to 83%) and quality attributes besides the protection of papaya plants from PRSV incidence at three locations *viz.*, Anantharajupet, Coimbatore and Pusa.

Pruning of old sapota orchard by centre opening along with cutting of cross branches at 10 x 10 m spacing has recorded 35 to 40 per cent increase in yield over the check at Arabhavi and Periyakulam.

Crop protection

Surveys indicated the incidence of pseudostem weevil/ borer *Odoiporus longicollis* at Gandevi (10-12%), Jorhat (17-22%), Kannara (5-35%) and Mohanpur (2-3%) and rhizome/corm weevil in Gandevi (4-6%), Kannara (5-30%) and Vengurle (4%). Across the centre the incidences of new emerging pests *viz.,* rugose spiraling whitefly (*Aleurodicus rugioperculatus)* was reported from Jorhat (6-15%) and Mohanpur (6-7%). Fruit scarring beetle (*Nodostoma viridipennis*), a major pest of banana was recorded at Jorhat (28-38%).

Among the various plant parasitic nematodes associated with banana, the overall frequency of occurrence for burrowing nematode (*Radopholus similis*) in Karnataka was 100 in both soil and roots, for *Meloidogyne* spp. 0-100% in soil & roots and for *Helicotylenchus* spp., 0-100% in soil & roots respectively. Whereas in Kerala, frequency of occurrence of root knot nematode, burrowing nematode and root lesion nematode (*Pratylenchus coffeae*) were 10-70%, 10-40% and 25%, respectively. In Assam, incidence of *Meloidogyne incognita* was 45/70% and 2/12% of occurrence in soil and root respectively. Whereas the frequency of occurrence of *Helicotylenchus dihystera* was recorded as 23/56%.

Among the various bio-intensive treatments evaluated for their efficacy in managing rugose spiralling whitefly, foliar application of *Azadirachtin* 10000 ppm @ 3ml/l for three times at monthly intervals was effective for controlling leaf damage thereby recording 69 to 71 per cent reduction over control at Kannara and Periyakulam, respectively.

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 (38.89 percent disease incidence).

For *Eumusae* leaf spot management in banana, spray of chemicals (propiconazole/carbendazim/ mancozeb/ trifloxystrobin/ tebuconazole/ difenconazole) + mineral oil has recorded reduction in disease severity by 2 to 5 times over control at Arabhavi, Bhubaneswar, Jorhat and Mohanpur.

Evaluation of episomal tissue cultured plants of banana cv. Poovan has clearly indicated that, these plants are free from BSV incidence in tissue culture plants of Poovan at Arabhavi, Bhubaneswar, Coimbatore, Jalgaon and Mohanpur. However, at Kannara 2.8 per cent incidence of BSV was recorded.

Survey results indicated the occurrence of non-insect pest, snail *Lymnaea* sp. (Family: Lymnaeidae) infesting leaves of Kinnow mandarin plants (25.8% leaf infestation) and new entomopathogenic fungus, *Aschersonia aleyrodis* on pupae of citrus whitefly, *Dialeurodes citri* (Ashmead) in Kinnow mandarin orchards at Ludhiana. Tirupati centre reported outbreak of non-regular minor pest, Citron bug, *Leptoglossus* sp. in the traditional areas in majority of the sweet orange gardens in Kadapa and Prakasam districts.

For the control of fruit sucking moths, petroleum spray oil (2%) has been effective and recorded 1.3 times reduction in the fruit drop at Ludhiana.

Among the different acaricides evaluated against Citrus mites, foliar application of spiromesifen 240 SC (0.009%) spray has recorded minimum mite population at Rahuri (4.43 mites/leaf as over 50.21 mites/leaf in control) and Tirupati (5.63 mites/leaf as over 25.96 mites/leaf in control).

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), $ZnSO_4$ and $FeSO_4$ (each at 200 g/plant) has been effective, however, with disease severity ranging from 22 to 45 per cent in Akola, Ludhiana, Periyakulam, Rahuri, Tinsukia and Tirupati.

Surveys of jackfruit orchards in Kerala and Andhra Pradesh revealed the incidence of *Cerambycid xylophagous* and phytophagous beetle *Olenecamptus bilobus* @ 10.0-60.0 per cent and 1-29.4 per cent respectively. Cerambycid xylophagous and phytophagous beetles *viz., Glenea multiguttata* and *Macrochenus isabellinus* were recorded as pests of concern of jackfruit in Kerala.

With the advisory support of 'online interactive weather information-based diseases and insect pest assessment' at Periyakulam, the advisory plots have shown a saving of Rs. 14,650/- per hectare as compared to the farmer's practice plot for the management of downy mildew and powdery mildew in grapes. Similarly, at Vijayapura, a total reduction in the cost of cultivation was to the tune of Rs. 15,000/- per hectare was noticed. Further, at Rahuri and Rajendranagar also a total cost reduction was to the tune of Rs. 73,040/- and Rs. 51,560/-per hectare respectively with reduction in number of sprays (34, 2, 9, 8 and 13 at Arabhavi, Mandsaur, Periyakulam, Rajendranagar and Rahuri centres, respectively after

fruit pruning) following the online advisory system than the farmer's practice plot.

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 (14.46 & 7.50% respectively), whereas the chemical insecticide lamda-cyhalothrin @ 0.05 per cent has recorded 11.96 & 9.60% respectively as against 50.67 and 10.00 per cent respectively in control. TMB population ranged from 3.47 to 5.10 in different treatments as against 7.00-7.85 in control.

Trial on management of mango hoppers and thrips revealed that, *M. anisopliae* oil-based formulation @ 1ml/l was found most effective at Bengaluru, Vengurle, Mohanpur and Paria to the tune of 55-93 and 60-80 per cent respectively as compared to control. However, the standard check recorded minimum mango hopper and thrips population with maximum yield among the different bio control agents.

Evaluation of different botanical formulations for the management of sucking pest complex in mango revealed that the university recommended standard check has been superior for managing the pest complex. However, among the botanical formulations, spray of *Azadirachtin* 10,000 ppm at 0.003 per cent (3 ml/l) was most effective for management of sucking pests *viz*., mango hopper and thrips at Bengaluru (1.05 & 3.32), Paria (5.18 & 4.20) and Vengurle (0.60 & 3.53). Whereas, at Mohanpur (3.29 & 1.07) and Rahuri (2.84 & 2.96) spray of *Azadirachtin* 10,000 ppm (3 ml/l of water) followed by neem soap followed by Pongamia soap (IIHR product) at 10g/l of water followed by botanical formulation AAVYA was the next best treatment.

Post-harvest loss assessment

Pilot scale post-harvest loss assessment in grape has indicated a total loss of 9.9 per cent at Pune (ICAR-NRCG) 29.9 per cent at Rajendranagar, 19.0 per cent at Rahuri and 19.70 & 15.50 at Periyakulam in Sharad seedless and Thompson seedless respectively.

विशिष्ट सारांश

भारतीय कृषि अनुसंधान परिषद– अखिल भारतीय समन्वित अनुसंधान परियोजना (फल) का उद्देश्य, बहु–स्थान परीक्षण (एमएलटी) के माध्यम से किस्मों और संकरों की पहचान करना और उन्हें जारी करना है; राष्ट्रीय सक्रिय जर्मप्लाज्म साइटों (एनएजीएस) के साथ जर्मप्लाज्म के मूल्यांकन और वृद्धि के अलावा जर्मप्लाज्म के सुरक्षा डुप्लिकेट को बनाए रखनाय विभिन्न कृषि–जलवायु क्षेत्रों के तहत निवेश–उपयोग–कुशल प्रौद्योगिकियों का मूल्यांकन और पौधसंयंत्र स्वास्थ्य प्रबंधन प्रौद्योगिकियों का मूल्यांकन। वर्तमान में, भा.कृ.अनु.प.–अ.भा.स. अनु.परि. (फल) के तहत केंद्रों की कुल संख्या 50 है, जिसमें राज्य कृषि विश्वविद्यालयों से 30, भारतीय कृषि अनुसंधान परिषद 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 से 23 केंद्र आम पर, 16 अमरूद पर, 13 केले पर, 12 सिट्रस पर, 9 पपीते पर, आठ–आठ लीची और अंगूर पर, 5 कटहल पर और 4 चीकू पर काम कर रहे हैं। वर्ष 2020–21 के लिए बजट आवंटन में भा.कृ.अनु.प.की हिस्सेदारी रु 23.80 करोड़ रुपये है। विभिन्न केंद्रों पर इस परियोजना के तहत हुई प्रगति को संक्षेप में विभिन्न उप–शीर्षों के अंतरगत प्रस्तुत किया गया है।

फसल आनुवंशिक संसाधन

समीक्षाधीन अवधि के दौरान, मौजूदा जननद्रव्य संग्रह में केले में 20, नींबू वर्गीय फलो में 41, अमरूद में 15, कटहल में 18 और आम में 20 संकलन शामिल किए गए हैं।

फसल–सुधार

केले के उन्नत क्लोनों के मूल्यांकन से पता चला है कि बीआरएस सिलेक्शन पॉपोलु एसपी. प्लांटैन ग्रुप (एएबी) की 56 से 69 प्रतिशत (5.88 से 20.53 किग्रा/गुच्छा) अधिकउपज दर्ज की गई है। इसी प्रकार, एबीबी समूह के तहत एनआरसीबी चयन–10 (10.25 से 30. 70 किग्राध्गुच्छा) के साथ अरभावी, भुवनेश्वर, जोरहाट, कन्नारा, कोव्वूर और मोहनपुर में 20 से 50 प्रतिशत अधिक उपज देखी गई है।

कागजी नींबू के विभिन्न आशाजनक क्लोनों में, क्लोन पीडीकेवी लाइम (718.67 फलध्पेड़)अकोला में, टीएएल–94/14 (911.09 फल/पेड़)राहुरी में, एनआरसीसी निम्बू–3 (क्रमशः 325.20 फल/पेड़)पेरियाकुलम में श्रेष्ठ पाए गए और इनकी पुष्टि की जा रही है।

मूल्यांकित की गई अंगूरों की ताजा खाने वाली रंगीन किस्मों में, उच्चतम उपज और गुणवत्ता मानकों में मांजरी श्यामा (ए–18/3) श्रेष्ठता देखी गई है। इसकी उपज क्षमता के आधार पर महाराष्ट्र, कर्नाटक, तेलंगाना और तमिलनाडु में इसकी खेती के लिए सिफारिश की गई है।

अंगूर की मूल्यांकित जूस वाली किस्मों में, एमएसीएस 516 को उपज और गुणवत्ता मानकों (रस वसूली, टीएसएस और अम्लता) के मामले में बेहतर पाया गया, जिसके बाद मांजरी मेडिका का स्थान रहा। इसलिए जूस के उद्देश्य से महाराष्ट्र, कर्नाटक, तेलंगाना और तमिलनाडु में इसकी खेती के लिए अनुशंसित की गई है।

अमरूद की सफेद गूदे वाली किस्म के नए होनहार संकरों और चयनों में, एमपीयूएटी एस–2 उपज के लिए बेंगलुरु, उदयपुर और सबौर में चेक किस्म इलाहाबाद सफेदा की तुलना में क्रमशः 138.95, 23.63 और 1.73 प्रतिशत की तुलना में बेहतर था। हालांकि, लुधियाना और लखनऊ में, यह किस्म सीआईएस जी–35 के बाद दूसरे स्थान पर रही, जो उपज के लिए स्थानीय चेक की तुलना में क्रमशः 4.36 और 24.39 प्रतिशत बेहतर है।

पपीते में, पुणे चयन –1 ने उपज गुणों (23.81 से 31.50 किलोग्रामध्पौधे की स्थानीय चेक उपज की तुलना में उपज में 19 से 20 प्रतिशत की वृद्धि) के साथ–साथ अनंतराजुपेट, कोयंबटूर और गनदेवी में सबसे कम पीआरएसवी संक्रमण के संबंध में बेहतर प्रदर्शन किया। फलों बनने की अवस्था पर पीएसआरवी–पी संक्रमण के प्रतिशत में कमी राष्ट्रीय जांच किस्म (रेड लेडी) की तुलना में 1.0 से 1.7 गुना (30.0–38.33:) थी।

फसल–उत्पादन

विभिन्न केंद्रों पर सूक्ष्म प्रवर्धन से तैयार केले के पौधे,भूस्तारियो से तैय्यार केले के पौधों की तुलना की श्रेष्ठता पाए गए और इनमे 2 से 37 प्रतिशत तक की बढ़ी हुई उपज के साथ देखी गई । इसके अलावा, इन पौधों की फसल की अवधि भी विभिन्न स्थानों जैसे अराभवी, गनदेवी और जोरहाट में भूस्तारियो से तैयार पौधों से 14 से 18 दिनों तक कम कर दी गई थी।

केले में मिट्टी की नमी की कमी को कम करने केप्रभावके अध्ययन से पता चला है कि एसिटाइल सैलिसिलिक एसिड (0. 1mM). 5वें MAP पर मिट्टी नमी तनाव के साथ पर्ण प्राइमिंग सूखा उपशमन प्रबंधन के रूप में, बढ़ी हुई उपज के माध्यम से सूखे के नकारात्मक प्रभाव को काफी कम कर देता है (तनावग्रस्त की तुलना में 13:) पौधे) और उपज लक्षण (हथ्थों और केले की संख्या)। इसके अतिरिक्त, इसने फलों के विकास में भी सुधार किया और विकृत फलों को कम किया।

संतरा में उच्च घनत्व रोपण के तहत पोषक तत्व प्रबंधन पर परीक्षण से पता चला है कि अकार्बनिक स्रोत से 75 प्रतिशत आरडीएफ 25 प्रतिशत कार्बनिक स्रोत (एफवाईएम) सामान्य अंतराल के साथ संतरा में उपज के लिए अकोला में (133.50 फलध्पेड़)) और तिनसुकिया (289 फलध्पेड़) बेहतर रहा है । 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।

नींबू वर्गीयफल में, *ट्राइकोडर्मा हर्जियानम* (30–40 मिलीध्पौधा) और *अजादिराच्टिन* (स्प्रे के रूप में 3–4 मिलीध्ली पर 1:) और स्यूडोमोनास फ्लोरेसेंस (30–40 मिलीध्ली) के साथ वर्मीकम्पोस्ट के माध्यम से एन की 75 प्रतिशत अनुशंसित खुराक का प्रयोग करें। मि.ली.ध्पौधे) ने श्रीगंगानगर और तिनसुकिया में मंदारिन के लिए उपज (नियंत्रण से 1.3 से 2 गुना अधिक उपज) में वृद्धि की है। हालांकि, मीठे संतरे में, 50 प्रतिशत वर्मीकम्पोस्ट (आरडीएफ के एन–समतुल्य आधार पर) + *ट्राइकोडर्मा हर्जियानम* (30–40 मिलीध्पौधा). अजादिराच्टिन (1% @ 3–4 मिली/लीटर स्प्रे के रूप में + *स्यूडोमोनास फ्लोरेसेंस* (30 – 40 मिली/पौधा) + *एजोटोबैक्टर क्रोकॉकम* (30 – 40 मिली ६ पौधा) ने तिरुपति

में उपज को 20 प्रतिशत तक बढ़ा दिया है।

संतरा में पोषक तत्वों की चरण–वार आवश्यकता को मानकीकृत करने के परीक्षण से पता चला है कि नाइट्रोजनः फास्फोरसः पोटाश 0:0:0, 30:40:10, 30:35:10, 20:25:30,10:0:25 आर.डी.एफ. के प्रतिशत ने चरण I से VI के लिए अकोला और लुधियाना में नियंत्रण की तुलना में उपज में लगातार 26 से 52 प्रतिशत की वृद्धि दर्ज की है। इसी तरह मोसांबी में यह पता चला है कि नाइट्रोजनः फास्फोरसः पोटाश, 0:0:0, 30:40:0, 30:35:0, 40:25:30, 0:0:35, आर.डी.एफ. के प्रतिशत ने चरण ५ से चरण ट५ के लिए तिरुपति में उच्च उपज (65.17 किग्राध पेड़य 18.05 टनध्हेक्टेयर) और कुल घुलनशील ठोस (10.70^{0}B) दर्ज की है।

अमरूद में पोषक तत्वों के उपयुक्त जैविक स्रोत को मानकीकृत करने के परीक्षण से संकेत मिलता है कि, वर्मीकम्पोस्ट (30 किग्राध्पौधे) + *एजोस्पिरिलम* कल्चर + पीएसबी (250 ग्रामध पेड़) के प्रयोग से लुधियाना, राहुरी, सबौर, संगारेड्डी और वेंगुर्ले केंद्रों पर प्रति पौधा 7.58–39.38 प्रतिशत अधिक फल दर्ज किया गया है। नियंत्रण की तुलना में लुधियाना (26.06%) और राहुरी (37.84%) में वर्मीकम्पोस्ट (30 किग्राध्पौधे) एजोस्पिरिलम कल्चर @ 250 ग्रामध्पेड़ पीएसबी @ 250 ग्रामध्पेड़ वर्मीवाश के आवेदन के साथ उच्चतम उपज दर्ज की गई थी। हालांकि, वर्मीकम्पोस्ट (30 किग्राध्पौधा) एजोटोबैक्टर पीएसबी (@ 250 ग्रामध्पेड़) के उपचार से सबौर और संगारेड्डी में उपज में 10 और 29.46 प्रतिशत की वृद्धि हुई।

अमरूद में, अमरूद पर अर्का माइक्रोबियल कंसोर्टियम (एएमसी) के प्रयोग से संकेत मिलता है कि गोबर की खाद के साथ वर्ष में दो बार नाइट्रोजन और फास्फोरस एएमसी मिट्टी के आवेदन (12.5 किग्रा ६ हेक्टेयर) की 75 प्रतिशत अनुशंसित खुराक के उपयोग से फल उपज तथा कुल घुलनशील ठोस में पंतनगर में (38.83 किलोध्पेड़, 13.68^{0}B), रीवा (40.55 किलोध्पेड़, 14.21^{0}B) और उदयपुर (42.43 किलोध्पेड़, 13.60^{0}B) में वृद्धि हुई ।

लीची में उत्पादकता में सुधार के लिए परीक्षण, 50 प्रतिशत प्राथमिक शाखाओं पर 4.0 मिमी के स्तर के साथ शाखाओं की घेरा उपचार से गंगियन और मेद्जिफेमा (84.20 और 17.85 किलोग्रामध्पेड़) में अधिकतम उपज दर्ज की गई है, जबकि नेरी में, अधिकतम उपज (27.70 किग्राध्वृक्ष) 50 प्रतिशत प्राथमिक शाखाओं पर 6 मिमी घेरा उपचार में दर्ज किया गया था।

पश्चिम बंगाल और झारखंड की परिस्थितियों में अक्टूबर, नवंबर और दिसंबर में डाई पोटेशियम हाइड्रोजन फास्फेट (1%) पोटेशियम नाइट्रेट (1%) के तीन छिडकाव को लीची किस्म बॉम्बे और किस्म शाही में फूलों की खिलने में 6 से 7 दिनों तक जल्दी करने में आशाजनक पाया गया।

संगारेड्डी और मोहनपुर में आम में निरंतर फल उपज के साथ 50 किलोग्राम गोबर की खाद के साथ 250 ग्राम एजोटोबैक्टर के आवेदन से आरडीएफ में 50 प्रतिशत की कमी आई है। जबकि, वेंगुर्ले में, जिंक सल्फेट (0.5%) + बोरिक एसिड (0.2%) + मैंगनीज सल्फेट (1%) + कैल्शियम क्लोराइड (0.6%) को दो पर्ण अनुप्रयोगों (अगस्त और अक्टूबर) के रूप में + 10 सेमी मोटी जैविक मल्चिंग से उपज और फल में सुधार हुआ। सबौर में 50% आरडीएफ + 50 किग्रा गोबर की खाद + 250 ग्राम *ट्राइकोडर्मा* के प्रयोग ने आरडीएफ में 50 प्रतिशत की कमी के साथ आम की गुणवत्ता और उच्च उपज दिखाई है।

जैविक पोषक तत्वों जैसे वर्मीकम्पोस्ट (50 किग्राध्पेड़) + एजोस्पिरिलम कल्चर (250 ग्रामध्पेड़) + पीएसबी (50 ग्रामध्पेड़) के प्रयोग से संगारेड्डी (68.35 किग्राध्पेड़) और वेंगुरले (5.29 किग्राध्पेड़)) में आम की पैदावार में उल्लेखनीय वृद्धि हुई है। । हालांकि, राहुरी में उपरोक्त उपचार संयोजन के साथ वर्मी–वॉश का समावेश उत्पादक (143.66 किग्राध्पेड़) रहा है।

आम में सूक्ष्म पोषक तत्वों के प्रभाव के मूल्यांकन के लिए परीक्षण से पता चला है कि आरडीएफ + 100 ग्राम जिंक सल्फेट + 50 ग्राम कॉपर सल्फेट 50 ग्राम बोरिक एसिड का उपयोग फसल के बाद 0.2% जिंक सल्फेट + 0.1% कॉपर सल्फेट + 0.1% बोरिक एसिड (पहला छिड़काव केवल फूल आने से पहले और दूसरा छिड़काव मार्बल अवस्था) ने विभिन्न स्थानों जैसे अनंतराजुपेट, लखनऊ और सबौर में नियंत्रण की तुलना में 35–119 प्रतिशत अधिक फल उपज दर्ज की है।

पपीते में आदान उपयोग दक्षता बढ़ाने पर परीक्षण से पता चला है कि ऊंची क्यारी खेती के साथ ड्रिप सिंचाई (80% ई.आर.) + फर्टिगेशन (75% आर.डी.एफ.) + सूक्ष्म पोषक तत्वों का छिड़काव (जिंक सल्फेट 0.5% + बोरिक एसिड वैकल्पिक महीनों में 0.2% पर) ने विभिन्न स्थानों जैसे अनंतराजुपेट, कोयंबटूर और पूसा में चेक की तुलना में उपज को 1.2 से 2.3 गुना तक बढ़ाया।

नेट हाउस के तहत उगाए गए पपीते ने तीन स्थानों जैसे अनंतराजुपेट, कोयंबटूर और पूसा में पीआरएसवी से पपीते के पौधों की सुरक्षा के अलावा उच्च विपणन योग्य फल (18 से 83%) और गुणवत्ता विशेषताओं में बेहतर प्रदर्शन किया।

सपोटा के पुराने बाग, जहां पौधे 10 x 10 मीटर की दूरी पर लगाए गए हैं, वहां क्रॉस शाखाओं को काटने के साथ–साथ मध्य भाग को कटाई द्वारा खोलने से अराभवी और पेरियाकुलम में उपज में 35 से 40 प्रतिशत की वृद्धि दर्ज की गई है।

फसल–संरक्षण

सर्वेक्षणों ने स्यूडोस्टेम वीविलध्बोरर (*ओडोइपोरस लॉन्गिकोलिस*), का गांडेवी (10–12%), जोरहाट (17–22%), कन्नारा (5–35%) और मोहनपुर (2–3%) व राइजोमध कॉर्म वीविल, गांडेवी में (4–6%), कन्नारा (5–30%) और वेंगुर्ले (4%) में प्रकोप का संकेत दिया। विभिन्न केंद्रों में नए उभरते कीटों जैसे, रगोज स्पाइरलिंग व्हाइटफ्लाई (*एलेउरोडिकस रगियोपरकुलैटस*) के प्रकोप की घटना जोरहाट (6–15%) और मोहनपुर (6–7%) में दर्ज हुई थी। केले का एक प्रमुख कीट, फ्रूट स्कारिंग बीटल *(नोडोस्टोमा विरिडिपेनिस)* का प्रकोप जोरहाट (28–38%) में दर्ज किया गया था।

केले से जुड़े विभिन्न पादप परजीवी सूत्रकृमियों में, कर्नाटक में मृदा को खोदने वाले सूत्र कृमि *(राडोफोलस सिमिलिस)* के उपस्थिति की समग्र आवृत्ति मिट्टी और जड़ों दोनों में 100, मेलोइडोगाइन प्रजाति व हेलिकोटाइलेंचस प्रजाति की मिट्टी और जड़ों में क्रमशः 0–100% थी। जबकि केरल में, रूट नॉट सूत्रकृमि, मृदा को खोदने वाले सूत्रकृमि और जड़ों को क्षति पहुंचाने वाले सूत्रकृमि *(प्राटिलेंचस कॉफी)* के उपस्थिति की आवृत्ति क्रमशः 10–70%, 10–40% और 25% थी। असम में, *मेलोडोगाइन इनकॉग्निटा* सूत्रकृमि की उपस्थिति की आवृत्ति क्रमशः मिट्टी और जड़ में 45–70% और 2–12% थी। जबकि *हेलिकोटाइलेंचस डायहिस्टेरा* की आवृत्ति 23–56% दर्ज की गई थी।

गोज स्पाइरलिंग व्हाइटफ्लाई के प्रबंधन में उनकी प्रभावकारिता के लिए मूल्यांकन किए गए विभिन्न जैव–गहन उपचारों में, अजादिराच्टिन 10000 पीपीएम @ 3.0 मिली ६ लीटर का मासिक अंतराल पर तीन बार पर्णिम छिड़काव पत्ती क्षति को नियंत्रित करने के लिए प्रभावी था, जिससे कन्नारा और पेरियाकुलम में कंट्रोल के मुकाबले क्रमशः 69 से 71 प्रतिशत की कमी दर्ज की गई।

केले में फुसैरियम विल्ट के प्रबंधन के लिए रोग मुक्त खेत से रोग मुक्त पौधों के रोपण के साथ–साथ नीम की खली (250 ग्रामध्पौधे), कार्बेन्डाजिम (0.2%) में 30 मिनट के लिए डुबोकर, उसके बाद 0.2% घोल के साथ कार्बेन्डाजिम ड्रेंचिंग (रोपण के बाद दूसरे, चौथे और छठे महीने) और कार्बेन्डाजिम इंजेक्शन @ 3.0 मिली 2.0% घोल (रोपण के तीसरे, पांचवें और सातवें महीने) में प्रभावी (38.89 प्रतिशत रोग प्रकोप) था।

केले में यूमुसे पर्ण धब्बा रोग प्रबंधन के लिए, अरभावी, भुवनेश्वर, जोरहाट और मोहनपुर में रसायनों के स्प्रे (प्रोपिकोनाजोल / कार्बेंडेजिम / मैंकोजेब / ट्राइफ्लॉक्सीस्ट्रोबिन / टेबुकोनाजोल / डिफेनकोनाजोल) / खनिज तेल ने कंट्रोल के मुकाबले 2 से 5 गुना अधिक रोग नियंत्रण दर्ज किया है।

केले की किस्म पूवन के एपिसोडिक ऊतक संवर्धित पौधों के मूल्यांकन ने स्पष्ट रूप से संकेत दिया है कि, पूवन के टिशू कल्चर पौध अरभावी, भुवनेश्वर, कोयंबटूर, जलगांव और मोहनपुर में बीएसवी के प्रकोप से मुक्त हैं।

सर्वेक्षण के परिणामों से पता चला कि, गैर–कीट, घोंघा लिम्नेया प्रजाति (परिवारः लिम्नेइडे) लुधियाना में किन्नू मंदारिन के बागों में किन्नू मंदारिन पौधों (25.8% पत्ती संक्रमण) और नए एंटोमोपैथोजेनिक कवक, *एस्केर्सोनिया एलेरोडिस* साइट्रस व्हाइटफ्लाई के प्यूपा *डायलूरो डेसिट्री* (एशमीड) को संक्रमित करता है। तिरुपति केंद्र ने कडप्पा और प्रकाशम जिलों के मीठे संतरे के पारंपरिक क्षेत्रों के अधिकांश बागानों में गैर–नियमित मामूली कीट, सिट्रोन बग, *लेप्टोग्लोसु* प्रजाति के प्रकोप की सूचना दी।

फल चूसने वाले पतंगों के नियंत्रण के लिए पेट्रोलियम स्प्रे तेल (2.0%) प्रभावी रहा है और लुधियाना में फलों की गिरावट में 1.3 गुना कमी दर्ज की गई है।

साइट्रस माइट्स के खिलाफ मूल्यांकन किए गए विभिन्न एकरीसाइडस में, स्पाइरोमेसिफेन 240 एस.सी. (0.009%) के पर्णिम छिड़काव से राहुरी में (कंट्रोल में 50.21 के मुकाबले सिर्फ 4.43 माइट्स / पत्ता) और तिरुपति में (कंट्रोल में 25.96 के मुकाबले सिर्फ 5.63 माइट्स / पत्ता) की न्यूनतम माइट आबादी दर्ज की गई है।

साइट्रस ग्रीनिंग के एकीकृत प्रबंधन पर परीक्षणों से संकेत मिलता है कि टेट्रासाइक्लिन हाइड्रोक्लोराइड (600 पीपीएम), जिंक सल्फेट और फेरस सल्फेट (प्रत्येक 200 ग्रामध्पौधे) के साथ फास्फोरस की उच्च खुराक (अनुशंसित खुराक से 50% अधिक) का प्रयोग प्रभावी रहा है, हालांकि, अकोला, लुधियाना, पेरियाकुलम, राहुरी, तिनसुकिया और तिरुपति में रोग की गंभीरता 22 से 45 प्रतिशत के बीच है।

केरल और आंध्र प्रदेश में कटहल के बागों के सर्वेक्षण से पता चला कि *सेरामबाइसिड जाइलोफैगस* और फाइटोफैगस बीटल *ओलेनेकैंपटस बिलोबस* का प्रकोप क्रमशः @ 10.0–60.0 प्रतिशत और 1.0 –29.4 प्रतिशत था। केरल में *सेरामबाइसिड जाइलोफैगस* और फाइटोफैगस बीटल, *ग्लेनिया मल्टीगुट्टाटा* और *मैक्रोचेनु सिसाबेलिनस* को कटहल में प्रभावी कीट के रूप में दर्ज किया गया।

पेरियाकुलम में 'ऑनलाइन इंटरैक्टिव मौसम सूचना–आधारित बीमारियों और कीट मूल्यांकन' के सलाहकार समर्थन के साथ, सलाहकार भूखंडों ने अंगूर में डाउनी मिल्ड्यू और पाउडर फफूंदी के प्रबंधन के लिए किसान के प्रैक्टिस प्लॉट की तुलना में 14,650/- प्रति हेक्टेयर रुपये की बचत दिखाई है। इसी प्रकार, विजयपुरा में, खेती की लागत में कुल कमी रु. 15,000/- प्रति हेक्टेयर की दर से देखा गया। इसके अलावा किसान के प्रैक्टिस प्लॉट की तुलना में ऑनलाइन सलाहकार प्रणाली का पालन करते हुए, राहुरी और राजेंद्रनगर में भी कुल लागत में रु. 73,040/- और रु. 51,560/- प्रति हेक्टेयर की कमी के साथ, स्प्रे की संख्या में कमी (फलों की छंटाई के बाद क्रमशः अराभवी, मंदसौर, पेरियाकुलम, राजेंद्रनगर और राहुरी केंद्रों में 34, 2, 9, 8 और 13) दर्ज किया गया।

ब्यूवेरिया बेसियाना @ 12.0 ग्रामध्लीटर के प्रयोग से अमरूद में टी मोस्कियूटो बग (*हेलोपेल्टिस एंटोनी सिग्नोरेट*) के जैविक नियंत्रण ने बेंगलुरू और तिनसुकिया (क्रमशः 14.46 और 7.50ः) में न्यूनतम नुकसान दिखाया है, जबकि रासायनिक कीटनाशक लैमडा–साइहलोथ्रिन (@ 0.05%) कंट्रोल में 50.67 और 10.00 प्रतिशत के मुकाबले क्रमशः 11.96 और 9.60% नुकसान दर्ज किया है। टीएमबी की आबादी विभिन्न उपचारों में 3.47 से 5.10 के बीच थी, जबकि कंट्रोल में यह 7.00–7.85 थी।

मैंगो हॉपर और थ्रिप्स के प्रबंधन पर परीक्षण से पता चला है कि, *एम. अनिसोपलिया* तेल आधारित सूत्रीकरण @ 1.0 मिलीध ली., बेंगलुरु, वेंगुर्ले, मोहनपुर और परिया में कंट्रोल की तुलना में क्रमशः 55–93 और 60–80 प्रतिशत प्रभावी पाया गया। हालांकि, मानक जांच में विभिन्न जैव नियंत्रण एजेंटों के बीच अधिकतम उपज के साथ न्यूनतम आम हॉपर और थ्रिप्स आबादी दर्ज की गई।

आम में चूसने वाले कीट काम्पलेक्स के प्रबंधन के लिए विभिन्न वानस्पतिक योगों के मूल्यांकन से पता चला कि विश्वविद्यालय द्वारा अनुशंसित मानक जांच कीट काम्पलेक्स के प्रबंधन के लिए बेहतर रही है। हालांकि, वानस्पतिक योगों में, बेंगलुरू (1. 05 और 3.32), पारिया (5.18 और 4.20) और वेंगुर्ले (0.60 और 3.53) में चूसने वाले कीटों जैसे आम हॉपर और थ्रिप्स के प्रबंधन के लिए 0.003 प्रतिशत (3.0 मिली / लीटर) अजादिराच्टिन 10,000 पीपीएम का छिड़काव सबसे प्रभावी था। जबकि मोहनपुर (3.29 और 1.07) और राहुरी (2.84 और 2.96) में अजादिराच्टिन 10,000 पीपीएम (3.0 मिली / लीटर पानी), उसके बाद नीम साबुन और उसके बाद पोंगामिया साबुन (आईआईएचआर उत्पाद) @ 10.0 ग्राम / लीटर पानी और उसके बाद वानस्पतिक सूत्रीकरण आव्या का छिड़काव अगला सबसे अच्छा उपचार था।

सस्योत्तर नुकसान का आकलन

अंगूर में फसल कटाई के बाद के प्रायोगिक पैमाने के आकलन ने पुणे में कुल 9.9 प्रतिशत (आईसीएआर–एनआरसीजी), राजेंद्रनगर में 29.9 प्रतिशत, राहुरी में 19.0 प्रतिशत और पेरियाकुलम में शरद सीडलेस और थॉम्पसन सीडलेस में क्रमशः 19.70 और 15.50 के नुकसान का संकेत दिया है।

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Experimental Results

BANANA

1.2.1(a)B.Collectioncharacterization,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

Arabavi: A total of 61 accessions (Eight primary collection and 53 secondary collection) are being maintained in the field gene bank. Evaluation of ratoon crop revealed that, Sakkarebale has recorded maximum bunch weight (19.50 kg) followed by Dwarf Cavendish (18.90 kg) and Poovan (16.50 kg); maximum TSS was recorded in Mitli (27.50 °B) followed by Sakkarebale (26.50 °B) and Ney Poovan (25.80°B). Evaluation for incidence of Sigatoka leaf spot revealed that, minimum incidence of Sigatoka leaf spot was recorded in Sakkarebale (4.76%), Mitli (6.19%), Ney poovan (6.79%) and Gold finger (10.49%) at shooting stage of 2nd ratoon crop. A total of 26 germplasm accessions were indexed against BBTV, BSMYV, CMV and BBrMV and results revealed that all are free from aforesaid viruses.

Bhubaneswar: A total of 65 accessions are being maintained at field gene bank. One primary collection has been made from Nayagarh district and included in the field gene bank. Evaluation of germplasm accessions revealed that eight accessions *viz.,* Paunshia Batisha, Sakhigopal Patkapura, Harianta, Chini Champa, BCB-1, FHIA-17, NRCB-10, Grand Naine, Popoulu were found to be promising. Banua has recorded tolerance to abiotic stress like heat and drought.

Coimbatore: A total of 165 accessions are being maintained at field gene bank. Survey has been made for trait specific germplasm collection for dwarfness, yield and fruit quality in Tirunelvelli, Kanyakumari districts which resulted in inclusion of five primary collections to the field gene bank. One Dwarf Robusta accession was collected from Kanyakumari district and included as primary collection. Two ornamental types (ornamental red banana and ornamental yellow banana) and one wild type *M. coccinea* banana has also been collected. Out of 60 accessions screened for natural incidence of *Eumusae* leaf spot, Chakrakeli (AAA), CO 1 (AAB) and Padali Moongil (AAB) recorded maximum disease index. Banana Bunchy Top incidence was recorded in the accession Dudh Munga (ABB). Motta Poovan (AAB) and Sannachenkadali (AAA) has recorded Banana Streak virus.

Gandevi: A total of 64 accessions (10 primary and 54 secondary) are being maintained at field gene bank. Of which, 41 are in bearing stage and 23 are in vegetative stage. During the reporting period, 2 new primary germplasm from Khadsupa and Vegam village of Navsari district and one secondary germplasm (Pisang Seribu) from Kolkata respectively were collected.

Jalgaon: A total of 16 germplasm are being conserved and maintained. Seven accessions *viz.*, Mas, Ornamental, Hanuman, Ambe mohar, Straight finger, Soniyal and Mutheli were characterized. Accession Deshi Krishna was recorded high yield.

Jorhat: Five primary collections were made from lower and upper Brahmaputra Valley Zones. Ten accessions were characterized.

Kannara: During reporting period, a total of seven accessions *viz.,* Tani, Progeny no.180, Assam wild, Makkale potty, Progeny No. 5, Progeny No.6 and Borkal Baista (ratoon crop) were characterized. Evaluation of the above seven accessions revealed that Borkal Baista recorded maximum yield (16.7 kg/bunch) followed by Makkale potty (14.6kg/ bunch). Eight accessions were utilized to develop processed food preparation. SH 3640 was utilized for central stem juice, flower pickle, raw banana chips preparation. Sugandhi and Makkalepotti (KNR 303) were utilized for ripe fruit juice and jam; Charapadatti for jam, chips and fig; Kluai NamwaKhom for fig and wine; KNR 290 for Jam, pseuodostem juice and flower pickle; Paloor for Jelly and Kadali for fig preparations. Evaluation for disease and pest resistance revealed that, Pisang Mulik was highly susceptible to banana flower thrips whereas Pisang Seribu, SH-3640, Njock kon, Sanna chenkadali were moderately susceptible. BRS 1, BRS 2, Calcultta 4, Cultivar Rose, Pey kunnan and Udhayam are resistant; Njalipoovan, Manjeri Nendran and Popoulu were moderately resistant and Grand Naine, Gros Michel and Nendran were susceptible to *Eumusae* leaf spot disease.

Kovvur: During reporting period, a total of 111 accessions are being conserved and evaluated. Evaluation of various accessions revealed that maximum yield was recorded in Matti (9 kg), Yellakkibale (13 kg), Valery (17.25 kg), Pisang seribu (20.75), Pachabontha batheesa (24.75 kg), FHIA-17 (21 kg), FHIA-03 (21.75 kg) respectively.

Mohanpur: Surveys were conducted in different parts of Nakashipara in Nadia district, Baharampore in Murshidabad district and Mogra in Hooghly district of West Bengal. One primary collection has been included in the germplasm. A total of six accessions *viz.,* Tella Chakrakelli, Karim Kadali, Ladan, Kellar

Ladan, Chennali and Virupaskhi were evaluated for ratoon crop-II. Of which, Chennali recorded maximum bunch weight (11.90 kg), whereas Virupaskhi recorded minimum bunch weight (7.4 kg). Maximum TSS (22.60 °B) was recorded in Kellar Ladan. Evaluation of ratoon crop-I, revealed that, Martaman showed better performance than Champa and both are tolerant to *Fusarium* wilt and Sigatoka leaf spot.

Pusa: A total of 74 accessions are being maintained at field gene bank. Six accessions were characterized. Observation on pest and disease incidence on 74 accessions showed that incidence of scarring beetle (2-10 beetles/terminal leaf whorl) was recorded in all the varieties while pseudostem weevil incidence was observed only in cv. Chinia (AAB), Alpan (AAB), Grand Naine (AAA) and Nendran (AAB).

Port Blair: A total of 14 accessions including four wild species are being conserved in field gene bank. Surveys were conducted at Jirkatang, Sipighat and Little Andaman of South Andaman district resulted in collection of three accessions of *M. balbisiana* species and one of *M. inandamanensis* species.

Tiruchirapalli: Based on morphotaxonomic characterization, duplicate accessions of banana germplasm has been identified and found that 40 accessions are synonyms/duplicates and IC number has been assigned to 62 unique accessions. Phule Pride and Co-2 were characterized and IC number has been obtained from ICAR-NBPGR and the same has been shared to Jalgaon and Coimbatore for central variety notification, Molecular characterization has been carried out for Co-2 (a newly released variety of Coimbatore using SSR marker to facilitate varietal notification).

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 and no new clone was identified. Evaluation of three superior clones revealed that the clone 2019 Arb (S) 1A-PC-2020 performed better for vegetative, yield and yield attributing parameters *viz.,* pseudostem height (1.69 m), girth (58.50 cm), number of leaves (12.50), leaf area (3.89 m^2), bunch length (58.50 cm), bunch width (45.50 cm), hands per bunch (8.50), fingers per bunch (95.00), finger weight (49.88 g) and bunch weight (15.50 kg/plant) when compared to local check. Similarly, the above same clone recorded minimum days for shooting (221.42 days) than local check (245.31 days). The infestation of *Eumusae* leaf spot was also found to be low (28.52 %) in the same clone 2019 Arb(S) 1A-PC-2020 compared to local check (29.31 %).

Bhubaneswar: Two clones each of cultivar Champa, Patkapura and Gaja Bantal were evaluated. Clones of cv. Champa recorded 15 to 38 per cent increase in bunch weight over the local check and found to be 21 to 23 days earlier in shooting than check. The Patkapura clones recorded 35 to 40 per cent increase in yield over the local types. Similarly, the Gajabantal clones recorded 24 to 35 per cent increase in bunch weight over the local types and also early in shooting (20 to 25 days) than the check variety.

Coimbatore: Survey was carried out in Theni, Erode and Coimbatore districts of Tamil Nadu and no new clone was identified. However, the evaluation of earlier selected Quintal Nendran clone (2014-CBE-1QN-PC-2020) is in progress to check its consistency in performance.

Gandevi: Among twenty clones collected during 2014, ten best performing clones were selected and were again replanted during January, 2020 to evaluate their consistency in performance. The crop is in bunch development phase. The initial observations revealed that the clone 2017-GND-1 was found to be short statured (pseudostem height: 1.49 m) and the clone 2017-GND-4 took minimum days for shooting (216 days). All the ten clones under evaluation were found to be free from the infestation of scarring beetle, pseudostem weevil and *Fusarium* wilt.

Jalgaon: Survey was conducted in the Salgare Village, Sangli District of Maharashtra and one new clone of cv. Grand Naine was selected and evaluated. The clone 2019-JL PC_1-2020 recorded maximum bunch weight (18.22 kg) with yield attributing parameters *viz.*, hands per bunch (7.0), fingers per bunch (102.08) and finger weight (189.38 g). Infestation of pseudostem borer, scarring beetle and nematode were not observed during the evaluation. However, *Eumusae* leaf spot infection was recorded with 13.46 per cent PDI during the evaluation.

Jorhat: Survey was carried out in two agro-climatic zones *i.e.*, Upper Brahmaputra Valley Zone (UBVZ) and Lower Brahmaputra Valley Zone (LBVZ) for selection of promising local superior clone. No new superior clones were identified during the reporting period.

Kannara: Five clones of Poovan were evaluated against the Poovan clone ''Martaman'' (check). Vegetative characters *viz.,* pseudostem height, girth and number of leaves differed significantly among

the different clones evaluated and were registered maximum in clone 2017 1KA PC 2017 (Venneer Poovan). The clone, 2017 8KA PC 2017 has recorded total crop duration of 336.43 days with 240.82 days to shooting and 95.61 days to harvest from shooting. Similarly, yield characters also differed significantly among the different clones and clone 2017 1KA PC 2017 (Veneer Poovan) has recorded maximum number of hands per bunch (8.40), fingers per bunch (129.60), bunch weight (9.86 kg) and yield (25.84 kg).

Kovvur: A high yielding clone of Tellachakkerakeli was identified at Nutakki village of Guntur district and evaluated to check the consistency in performance. The clone performed better than local check with higher bunch weight (16.3 kg), hands per bunch (7.0), fingers per hand (17.3) and fingers per bunch (111.0). There was not much significant difference observed in quality parameters like TSS and acidity.

Mohanpur: Evaluation of Kanthali, Martaman and Grand Naine clones were carried out. Kanthali, Martaman and Grand Naine clones performed well in the Gangetic plain of West Bengal for yield and quality parameters *viz.,* bunch weight (24.50, 20.60 and 24.90 kg /plant), TSS (25.70, 24.50 and 23.30 °B) and BC ratio (3.90, 3.28 and 3.96) respectively. Kanthali, Martaman and Grand Naine clones has recorded 43.27, 30.37 and 27.04 per cent increase in yield as compared to check cv. Thonte, Martaman and Grand Naine respectively.

Pusa: Evaluation of four promising clones of Nepali Chinia (ABB), Martman Tepri (AAB), Martman Nemopur (AAB) and Martman Simara (AAB) revealed that values for vegetative parameters of clones are at par with the check Karpooravalli. Whereas, for yield traits, maximum bunch weight was recorded in the clone Tepri (22.4 kg). Maximum number of hands was recorded in the clone Tepri (14.0), which was at par to the clone Nemopur (11.8) and the check Karpuravalli (11.8).

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: In second plant crop (PC-2), among plantain group (ABB), Popoulu recorded higher yield (52.25 t/ha) and better fruit quality over the check variety Nendran (30.99 t/ha) whereas, in Pisang Awak group (ABB), 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* leaf spot was minimum in Popoulu and NRCB-10 was supposed to be suitable for wind prone areas.

Bhubaneswar: Among the plantain and Pisang Awak group, performance of 2nd ratoon crop recorded higher yield in Popoulu (42.46 t/ha) and NRCB Sel-10 (62.00t/ha) compared with the check variety Nendran (28.42 t/ha) and Budubale (38.42 t/ha) respectively.

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.

Jorhat: Evaluation of second ratoon crop (RC-2) showed that Popoulu recorded better yield (18.12 t/ha) over check variety Nendran.

Kannara: In third plant crop (PC3), 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 check Manjeri Nendran (13.20 kg) and Nendran (10.42 kg). Early shooting was recorded in Nendran, followed by Popoulu and Manjeri Nendran. Popoulu showed more tolerance to *Eumusae* leaf spot. Among Pisang Awak group, 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 Karpuravalli (18.21 kg /plant).

Kovvur: In Ratoon crop-2 (RC-2) among plantain group, Popoulu has recorded higher bunch weight (20.53 kg) and productivity compared with Manjeri Nendran-II and check variety Nendran (13.15 kg) whereas, fruit quality was better in Nendran and Manjeri Nendran than Popoulu. Among Pisang Awak group, NRCB-10 recorded significantly higher bunch weight (30.70 kg), productivity and TSS over check variety Nukala Bontha (13.84 kg).

Mohanpur: Evaluation of 2nd ratoon crop (RC-2) showed that among plantain group, Popoulu recorded higher bunch weight (12.52 kg), productivity (30.73 t/ha) and BC ratio (2.47) compared with Manjeri Nendran-II and check variety Nendran (10.91 kg, 26.30 t/ha & 2.13 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 (18.27 vs. 13.53 kg), productivity (43.40 vs. 32.45 t/ha) and BC ratio (3.15 vs. 2.77) over the clone NRCB Selection-10. 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 1 & 2).

Table-1: Bunch weight (kg) of banana varieties at different centres

Varieties	ARB	BBI	JRH	KAN	KVR	MHP
V_1-Popoulu (AAB)	17.28	16.8	5.88	17.67	20.53	12.52
V_2-Manjeri Nendran-II	13.59	14.2	5.35	13.20	13.43	11.11
V_3-Check-Nendran	10.25	10.4	5.58	10.42	13.15	10.91
V_4-NRCB Sel.-10 (ABB)	21.53	22.2	10.25	21.95	30.70	13.53
V_5- Centre wise check	15.85	14.8	11.04	18.21	13.84	18.27
CD at 5%	5.35	3.24	0.15	0.82	3.59	1.22
*ARB-Arabhavi, BBI-Bhubaneswar, JRH-Jorhat, KAN-Kannara, KVR-Kovvur, MHP-Mohanpur, V5 check – Budu Bale (Arabhavi, Bhubaneshwar), Karpooravalli (Coimbatore, Kannara), Manohar (Jorhat), Nukala Bontha (Kovvur) and Kanthali (Mohanpur)						

Table-2: Planting to shooting duration (days) of banana varieties at different centres

Varieties	ARB	BBI	JRH	KAN	KVR	MHP
V_1-Popoulu (AAB)	236.35	242.80	242.55	238.83	230.50	198.50
V_2-Man. Nendran-II	225.23	224.60	224.62	220.25	209.13	208.65
V_3-Check-Nendran	208.55	212.40	212.39	201.91	220.43	201.60
V_4-NRCB Sel.-10 (ABB)	248.52	257.40	258.65	258.09	257.60	212.40
V_5-Centre wise check	254.42	274.40	304.31	292.23	248.73	247.30
CD at 5%	14.35	16.48	4.39	19.19	18.66	23.75
*ARB-Arabhavi, BBI-Bhubaneswar, JRH-Jorhat, KAN-Kannara, KVR-Kovvur, MHP-Mohanpur,						

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 2x2 m. Suckers of the varieties were used as the planting material.

Pantnagar: Variety Grand Naine has recorded significantly maximum number of leaves (12.25/ plant), minimum planting to shooting duration (361 days), minimum shooting to harvesting duration (63 days), maximum finger length (19.00 cm), maximum bunch weight (21.14 kg), yield (52.84 t/ha) and maximum acidity (0.48 %). However, Monthan recorded maximum shooting to harvest duration (71 days), finger weight (198.17 g), pulp weight (119.20 g), finger diameter (5.06 cm) and shelf life (9 days). Whereas, cv. Red banana recorded maximum pseudostem height (2.95 m), leaf area per plant at shooting (16.03 m^3), planting to shooting duration (488 days). Cultivar Poovan recorded maximum pseudo stem girth (58.10 cm) and hands per bunch (12.75) while cultivar Ney Poovan recorded maximum fingers per bunch (162.50) and TSS (23.80°B).

Port Blair: Cultivar Ney Poovan recorded maximum psuedostem height (2.80 m), early shooting (294 days) and minimum number of days taken for shooting to harvest (100.3 days). Cultivar Monthan recorded maximum Psuedostem girth (53.6 cm), finger weight (140.8 g), pulp weight (109.8 g), finger length (20.4 cm) and finger diameter (14.6 cm). While, cultivar Poovan recorded maximum leaf area (13.9 m^2), number of leaves per plant (11.5), hands per bunch (11.0) and fingers per bunch (122.5), cv. Red banana recorded maximum number of days for initiation of shooting (500.3 days).

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 is in establishment stage.

Bhubaneswar (OUAT): Trial is in establishment stage.

Coimbatore: Trial is in establishment stage.

Jalgaon: Trial is in establishment stage.

Kannara: Test cultivar NCR 17 and check variety Manjeri Nendran were established and trial is in initial 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: Both TBM 9 and Phule Pride have been planted along with Grand Naine as check and the crop is in early vegetative phase.

Coimbatore: Both TBM 9 and Phule Pride was planted along with Grand Naine as check and the crop is in vegetative phase.

Gandevi: Both TBM 9 and Phule Pride have been planted along with Grand Naine as check and the crop is in early vegetative phase.

Jalgaon: Both TBM 9 and Phule Pride have been planted along with Grand Naine as check and the crop is in early vegetative phase.

Kannara: TBM 9 has been established and the crop is in shooting stage, while Phule Pride has been established and the crop is in early vegetative stage. Check variety Grand Naine has recorded better values for vegetative parameters like pseudostem height (221.4 cm), leaves per plant (12) at shooting stage and yield parameters like hands per bunch (9.3), bunch weight (20.5 kg), finger weight (169 g) and TSS (21.40 °B) than TBM 9 (8.3, 15.9 kg, 148.2 g & 15.60 °B respectively) (Table 3).

Kovvur: Result of first season crop revealed that, TBM-9 has recorded minimum pseudostem girth (49.9 cm) and 17 to 18 days early shooting to harvesting compared to check Grand Naine (55.7 cm).

Whereas, maximum yield (63.3 t/ha) and TSS (21.40°B) was recorded in Grand Naine (check) than TBM-9 (49.1 t/ha & 13.60 °B). Planting of Phule Pride will be done in next planting season.

Mohanpur: Both TBM 9 and Phule Pride have been planted along with Grand Naine as check and the crop is in early vegetative phase.

Pusa: Both TBM 9 and Phule Pride have been planted along with Grand Naine as check and the crop is in early vegetative phase.

Table-3: Growth and yield characters of TBM-09 vs Grand Naine at Kannara

Attributes	TBM-09	Grand Naine
Pseudostem height (cm)	159.4	221.4
Leaves at shooting	11.2	12
Days of harvest	280.4	298.1
Hands/ bunch	8.3	9.3
Bunch weight (kg)	15.9	20.5
Finger weight (g)	148.2	169
TSS (°B)	15.6	21.4
Eumusae leaf spot incidence (%)	25.65	17.9

2.2.4.B. Evaluation of the field performance of the macro-propagated plants of banana

A trial was conducted to evaluate the field performance of macro-propagated plant vs. Sucker plant with respect to growth and yield. Following methodology was used to produce plants through macro propagation. a) Decortication: The field extracted suckers were de-topped just above the juncture of the corm and aerial shoot; b) Decapitation: The apical meristem was removed to a depth of 2 cm leaving a cavity of 2 cm diameter in the rhizome and the rest of the corm was given 6 -8 cross wise cuts; c) 30 g of bio-fertilizers was mixed with sawdust substrate; d) The primary buds were decapitated by removing the juvenile meristem and 4-6 horizontal cuts were given for the young rhizome; e) same procedure was repeated for secondary buds to produce tertiary bud; f) Hardening of tertiary buds in media containing Red soil: Sand: Farmyard manure in the ratio 1:1:1. The plantlets produced through macro propagation were planted in the field and compared with the sucker grown plants. The field performance of 2nd crop cycle (RC-I or PC-2) of macro-propagated banana plants of two varieties (Grand Naine and one local variety) were evaluated as compared with sucker raised banana plants

Bhubaneswar: Macro-propagated plants of cultivar Grand Naine and Champa has recorded higher bunch weight, productivity (80.84 & 35.21 t/ha) and BC ratio compared with sucker raised banana plants of respective varieties (Table 4). Similarly, finger characters, organoleptic characters and shelf life of fruits were recorded superior in case of macropropagated plants of both varieties, compared with the sucker raised plants.

Kannara: The macro-propagated plants of variety Grand Naine and Nendran performed better with respect to yield (62.63 & 31.57 t/ha), quality traits

and BC ratio (3.81 & 3.21) compared with sucker plants (2.40 & 2.16).

Pusa: Macropropagated plants of Grand Naine and Alpan was superior (Table 4) with respect to higher productivity (62.64 & 40 t/ha) respectively over sucker raised plants (57.30 & 27.66 t/ha).

Table-4: Influence of treatments on growth and yield parameters at different centres

Varieties	Planting to shooting duration			Shooting to harvest duration			Yield (t/ha)			TSS (°B)		
	BBI	KNR	Pusa	BBI	KNR	Pusa	BBI	KNR	Pusa	BBI	KNR	Pusa
T_1V_1	244.4	224.66	263.97	88.4	89.84	98.87	80.84	62.63	62.64	23.2	21.47	21.33
T_2V_1	248.2	253.31	273.33	86.2	98.32	106.97	78.24	45.84	57.30	22.9	21.42	20.80
T_1V_2	298.4	213.28	316.17	92.4	81.08	126.97	35.21	31.57	40.00	20.8	27.03	22.60
T_2V_2	302.6	244.21	326.83	96.2	89.60	135.07	32.62	21.14	27.66	21.2	26.83	22.27
CD at 5%	10.2	NS	28.50	6.4	NS	26.15	5.40	2.44	7.96	0.36	2.57	0.31
* BBI-Bhubaneswar, KNR-Kannara; Refer methodology for treatment details												

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 phonological 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 15.63 days over irrigated control. The yield decreased up to 46.74 per cent over the control. Among stress treatments, (Foliar priming with Acetyl salicylic acid (0.1mM) + soil moisture stress at flowering) has recorded maximum bunch weight and yield (25.95 kg/plant & 80.09 t/ha respectively) 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.

Bhubaneswar: The soil moisture stress at flowering affected yield and yield parameters. The yield was decreased to 33 per cent over the control. Among stress treatments, the treatment T_4 (Foliar priming with Acetyl salicylic acid (0.1mM) + soil moisture stress at 5 MAP floral primordial ignition stage) has recorded maximum bunch weight and yield (22.80 kg/plant & 70.36 t/ha respectively) however, same treatment was recorded minimum per cent deviation of yield (14.00 %) over control.

Gandevi: Foliar priming with 0.1mM acetyl salicylic acid along with soil moisture stress at 5 MAP during floral primordial initiation stage has recorded higher yield (25.21 kg) and yield attributing characters *viz.,* hands per bunch (10.92), fingers per hand (193.6) as well as minimum malformed fruits (5.88) in comparison with the soil moisture stress (SMS) at 5 MAP and at flowering. However, minimum yield deviation (17.66 %) was recorded with the same treatment as compare to all stress treatment.

Jalgaon: The soil moisture stress at 5 MAP at floral primordial initiation stage increased the duration of flowering by 14.1 days and also affected the yield and yield parameters. The yield was decreased by 47.59 per cent over control. The finger length and girth were decreased by 19.41 per cent and 21.41 per cent respectively. The same treatment resulted in malformed fruits.

Kovvur: Among the different treatments, maximum bunch weight (17.7 kg/plant) was recorded in irrigated control followed by T_3 involving soil moisture stress at flowering (16.50 kg/plant). There was no significant difference recorded among the different treatments. However, minimum yield (14.6 kg/plant) was recorded in treatment T_2 involving soil moisture stress at 5th MAP during floral primordial initiation stage due to moisture stress effect.

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: No extreme weather conditions occurred during reporting period and no distinct changes observed in phenology of Rajapuri and Grand Naine. However, high incidence of *Eumusae* leaf spot disease was noticed due to heavy rainfall.

Bhubaneswar: No extreme weather conditions was observed hence no insect pest or disease incidence occurred during the reporting period and the banana cv. Champa showed a normal growth and yield.

Coimbatore: The daily weather data was recorded and minimum incidence of insect pests and diseases

(Sigatoka leaf spot-11.2 PDI) were observed that caused no major damage to crop.

Gandevi: No extreme weather conditions occurred during reporting period and no distinct changes observed in the phenology of banana cv. Grand Naine. However, higher incidence of Sigatoka leaf spot disease as well as new pitting disease occurred (July –Sept., 2020) due to high rainfall and a greater number of rainy days.

Jalgaon: There was no extreme weathers conditions observed but the higher monthly average temperature of 42 °C in April and May has adversely affected growth and yield traits of banana due to scorching of leaves and developing fingers. The continuous rains from June to September and minimum temperature ranging from 24.3 to 25.5 °C has resulted in increased CMV disease incidence in Muktainagar (63.35%), Raver (53.30%) and Yawal (31.05%)

Jorhat: No extreme weather events were observed except for some instances of high rainfall. The highest daily rainfall (65.1 mm) was recorded on 15th July 2020 and 58.2 mm rainfall was recorded on 7th October 2020. There were no distinct changes on growth and yield, pest and disease incidence observed during reporting period.

Kannara: During the reporting period, no extreme climatic conditions were observed and hence, no occurrence of any drastic change in phenology of Nendran. However, heavy rainfall received and longer duration of rainy days resulted in increased *Eumusae* leaf spot disease incidence. Blast and Pitting disease also appeared as maturity of Nendran banana (August – September) coincided with heavy rainfall. Incidence of new insect pests like flower thrips (*Thrips hawaiensis,* 5-35%) and Leaf thrips (*Hercinothrips bicinctus*, 5-35%) was noted during the bunch maturation period during the heavy rainfall period.

Kovvur: Heavy rainfall in the months of July, August and September affected the crop in terms of yield and quality. Lower leaves were dried and damaged due to one-week water logging in the field. Incidence of sigatoka leaf spot was observed due to high humidity.

Mohanpur: No notable impact was observed on phenology, productivity, fruit quality except the damage due to "Amphan" cyclone on 20th May, 2020. As the experimental fields were at pre-bearing stage and protected by boundary wall and wind break trees, damage was restricted to leaf shredding which recovered after removing the damaged leaves and application of nutrients. However, farmers of banana fields in Bengal reported complete damage to plants.

Pusa: Heavy rainfall occurred during the reporting period that resulted in crop loss. Lower incidence of pests like spodoptera, skipper butter fly, psuedostem weevil and sigatoka disease were observed that caused many significant changes in crop yield and quality.

Vengurle: Heavy rainfall (4873 mm) was occurred during the reporting period that resulted crop loss. Lower incidence of pests like spodoptera, skipper butter fly, psuedostem weevil and sigatoka disease were observed that caused many significant changes in crop yield and quality.

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 than previous year in banana area of south Gujarat during 2020. Major pests were pseudo-stem weevil/borer and thrips complex recorded during survey. New pest was not reported in banana growing area during survey. Rust and flower thrips (Fig 8) were emerging pests in few pockets of Surat dist. There was no minor pest became major in surveyed area. Banana cv. Grand Naine was found planted in almost all area and 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 observed through later stage during cropping season of banana. Pseudo-stem weevil/borer was observed on cv. Grand Naine in all the banana growing areas with low to moderate incidence (10-12%) in banana growing area at maturity phase. The blemished fruits due to rust thrips infestation was noticed mqveyed parts at maturity of fruits, while flower thrips caused moderate fruit damage (15-25%) on tender fruits unevenly at different lSSocations. The corm weevil (Fig 11) infestation was observed very low (4-6%) in almost banana growing area. The leaf damage due to leaf eating caterpillar (*Spodoptera litura*) (3-4%) and semi-looper (3-4%) also was observed low and unevenly at early stage of crop. The infestation level of hairy caterpillar and lace-wing (Tingid) bug was found sporadic (<3%), while that of aphid and mite found very negligible in almost all locations during 2020. The different predators viz., dragonfly, damselfly and lady bird beetles were reported during early vegetative

stage, while spider and earwigs observed through later stage during cropping season of banana.

Jorhat: Results of roving survey conducted during the period January to December, 2020 in five districts *viz.,* Jorhat, Sibsagar, Golaghat, Dibrugarh and Lakhimpur of Assam revealed that the commonly occurring major and regular insect pests of banana were leaf and fruit scarring beetle (28-38%) (Fig 3 & 4), pseudostem weevil (17-22%) and banana aphid (15-20%). Rugose spiralling whitefly (6-15%) is becoming a threat to banana cultivation as the pest is spreading in all banana growing areas (Fig 1 &2). The pest was observed this time in Jorhat district infesting banana.

Kannara: Weevil pests of banana *viz*., pseudostem borer and rhizome weevils were recorded as major pests in the surveyed areas with 5-35% and 5-30% incidences respectively. Varieties like Nendran, along with Palayamkodan and Red banana had high incidences. As reported in previous years slug caterpillar (*Miresa decedens*) became a major defoliator and pest of concern during monsoon and post monsoon in Kerala closely followed by banana leaf eating caterpillars, *Spodoptera litura* and *Pericallia ricini*. Severe defoliation by *Miresa decedens* (Fig 5) was seen in Nendran plots across Kerala. Heavy infestations in Kozhikode, Ernakulam, Thrissur, Kottayam and Palakkad districts, causing 5-40% damage to leaves was recorded. Incidences of invasive pest banana skipper butterfly (*Erionota torus*) remained same indicating its adaption as an endemic pest species of banana in Kerala (Fig 6), high incidences another invasive pest, Rugose spiraling whitefly, (*Aleurodicus rugioperculatus)*, a pest of concern in coconut-banana intercropping system were recorded from surveyed areas. Infestations of sucking pests *viz.,* mealy bug (*Ferrisia virgata*), white flies (*Dialeurodicus disperses*), banana spittle bugs (*Phymatostetha deschampis*) were also recorded (Fig 7) Incidences of fruit flies from cv. Poovan, Palaamkodan, Nendran etc. were recorded.

During the months of March to June, 2020 heavy outbreaks of spotted grasshoppers/ coffee locusts (*Aularches miliaris)* (Fig 9) were reported from Vellamunda, Pulpally, Mullankolli (Wayanadu district), Konni (Pathanamthitta district), Thoprankudi, Rajakkadu, Mariapuram and Vellathooval (Idukki district), Mattannur (Kannur district), Thrissur Kollam, etc. Large swarms of coffee locust nymphs were observed feeding heavily on banana and mango. During August-September, adult grasshoppers were observed in the field feeding on both banana and other economically important crops, thus emerging as a pest of concern in Kerala.

Caterpillars/larvae resembling noctuid species were observed to be damaging banana plants in Wayanad district, Kerala. The larvae collected were identified as *Spodoptera frugiperda* (J. E. Smith) (Lepidoptera, Noctuidae) commonly known as Fall Armyworm (FAW) (Fig 10) using larval, pupal and adult differentials. In the surveys they were recorded to cause numerous feeding damages and bore holes of 3-5 cm diameter on the pseudostem with 1-3 cm depth on young banana plants of variety Nendran. The incidence ranged from 1-3 larvae per plant with maximum incidence of 20% recorded from the orchards. This is the first report of Fall Armyworm as a pest of banana in India. During the surveys conducted in the fag-end of the reporting period, parasites and fungal pathogens of fall armyworm were collected. Mummified fungal-affected FAW specimens suspected of infected by an Entomopathogenic fungus (EPF), *Nomuraea riley* was collected. Their isolation and culturing were done to carry out identification of EPF species, its molecular studies and developing it as a potent EPF against FAW in the field. Two distinct tachinid flies (Diptera: Tachinidae), were found to parasitize the larvae of fall armyworm

Ludhiana: A new natural enemy, predatory spider, *Olios* sp. was observed in banana plantations of Ludhiana

Mohanpur: Roving survey was carried out at the different banana growing areas covering two districts (Nadia and North 24 Parganas) of West Bengal to record the occurrence of key and potential (if any) insect and mite pests associated with the crop. Among the insect pests, banana leaf and fruit scarring beetle, *Basilepta subcostata* was found most prevalent with 100% frequency of occurrence in the surveyed area. Occurrence of red spider mite, *Oligonychus sp.* was also recorded from banana growing areas of West Bengal although damage caused by this mite is not yet estimated. Rugose spiraling whitefly is becoming an emerging pest of banana in West Bengal. Another pest *Spodoptera furgiperda* was recorded first time in West Bengal associated with banana.

Vengurle: Incidence of the new emerging pest (skipper butterfly-*Erionota tonus*) was found to be spread in the areas where it was not present previously i.e. Kudal, Malvan and Kankavali talukas of Sindhudurg district. The other pests *viz*., leaf eating caterpillar and rhizome weevil are regular pests of this region and semilooper is found occasionally.

Fig. 1: Rugose whitefly infestation in banana leaf (Jorhat)

Fig. 2: Microscopic observation of Rugose whitefly (Jorhat)

Fig. 3: Infestation of banana leaf and fruit scarring beetle (Jorhat)

Fig. 4: Adults of leaf and fruit scarring beetle in leaf whorl (Jorhat)

Fig.5: Banana Slug caterpillar (*Miresadecendens*) infestation on cv. Nendran (Thrissur District)

Fig. 6: Banana Skipper Butterfly (*Erionota torus*) infestation on cv. Nendran (Idukki District)

Fig. 7: Banana spittle bugs (*Phymatostethade* schampis) infestation on cv. Nendran (Idukki District)

Fig. 8: Banana Flower Thrips (*Thrips hawaiiensis*) infestation on cv. Nendran (Pathanamthitta)

Fig. 9: Hopper bands of Spotted Locust, *Aularchesmiliaris* defoliating on bananacv. Nendran (Wayanadu district)

Fig. 10: Damages *Spodoptera frugiperda*(J. E. Smith) (Lepidoptera, Noctuidae)on banana cv. Nendran (Wayanadu district)

Fig. 11: Infestation of corm weevil (Gandevi)

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 (250cc) and roots (10 g) was maximum in (279 and 133) Munavalli of Belagavi district in Rajapuri variety where suckers are planted in medium black soil and 251 and 121 in Yarazarvi of Belagavi district on TC Grand Naine variety planted as mono crop. The overall frequency of occurrence for *R. similis* was 100 & 100 in soil & roots respectively. For *Meloidogyne* spp 0-100% in soil & roots respectively. Similarly, for *Helicotylenchus* spp., 0-100% frequency of occurrence was recorded in soil & roots respectively. No new nematode pest was recorded from the survey.

Jorhat: Frequency of occurrence of 45-70% and 2-12% (soil and root respectively) was recorded for *Meloidogyne incognita* from Jahaji and Chenichampa cultivar of banana from the surveyed areas. *Helicotylenchus dihystera* was recorded 23- 56% (Soil) among the cultivars Jahaji, chenichampa and Bhimkol.

Kannara: Severe infections of burrowing nematodes (*Radopholus similis*) with 10- 65% (Fig 12) and 10-40% frequency of occurrence in soil and roots respectively were recorded. High incidences were observed from Thrissur, Wayanad, Kozhikode and Ernakulam district leading to decay and death of roots, yellowing of leaves, stunted growth. Similarly high incidences of *Meloidogyne spp.* (Fig 13) was observed in banana from the surveyed districts with 10- 40 % and 10-70% frequency of occurrence in soil and roots respectively. . Banana spiral nematode, *Helicotylenchus spp.* was more in Wayanad district, a hilly terrain and in districts of central Kerala with a frequency of occurrence of 25%. As reported in the previous year, *Meloidogyne incognita* was predominant in Thiruvananthapuram district whereas *M. javanica* was predominant in Idukki. The incidence of *Pratylenchus coffeae* was more at Wayanad, Thrissur, Ernakulam, Kozhikode, Idukki and Kottayam districts with with10- 55% frequency of occurrence. *Radopholus similis* was observed to heavily infest banana roots along with *Pratylenchus coffeae.*

Mohanpur: The survey revealed that no new nematode pest was recorded during 2020. Banana variety mortarman planted in sandy clay loam soil was infested by root knot nematode (*Meloidogyne* sp.). The root knot nematode *Meloidogyne* sp. was mainly observed with 100% frequency of occurrence in soil at Nadia and North 24 Parganas districts. Nematode population was also higher in different locations of Nadia district. Highest population of root knot nematode i.e. 74-238/ 250 cc soil and 18-32 J2/10g roots was recorded from Habibpur.

Fig. 12: Severe infestation of burrowing nematode (*Radopholus similis*) on cv. Nendran (Wayanadu District)

Fig. 13: Banana roots severely infected by Root Knot Nematode, *Meloidogyne incognita* on cv. Nendran showing excessive root proliferation (Thrissur district)

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*+ *Psuedomonas 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: 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 171.25 and 122.25 in 250 cc soil and 23.00 and 33.25 in 10g of roots at vegetative and shooting stage respectively as against standard check (199.25 & 163.00 in soil and 36.25 & 41.50 in root respectively). With regard to root necrosis, lowest incidence of 8.82 and 13.57 as against 19.91 and 29.60 in standard check at vegetative and shooting stage respectively (Table 5).

Jorhat: Planting and lay out was done during the month of June, 2020 and hence the plants are in vegetative stage.

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 94.50 and 36.25 in 250 cc soil and 25.60 and 32.63 in 10 g of roots at vegetative and shooting stage respectively as against maximum in standard check (110.50 & 61.33 in soil and 39.25 &41.25 in root respectively). with regard to root necrosis, lowest incidence of f 15.50 & 19.50 as against 18.00 and 25.50 in standard check at vegetative and shooting stage respectively (Table 6). Among the bioagent treatments, the maximum B:C of 2.85 was recorded in the same treatment as against untreated check (1.85).

Table-5: Effect of different treatments on nematode parameters of banana at Arabhavi

Treatment	Initial Nematode population		Nematode population				Root Necrosis (%)	
			Soil (250 cc)		Roots (10 g)			
	(250 cc)	Roots (10 g)	Vegetative stage	Shooting stage	Vegetative stage	Shoting stage	Vegetative stage	Shooting stage
T_1	301.00	41.50	210.75	22.00	42.75	59.00	23.97	39.97
T_2	308.25	45.25	171.25	122.25	23.00	33.25	8.82	13.57
T_3	2999.50	40.00	187.00	140.50	31.50	38.00	11.73	19.91
T_4	305.25	38.75	199.25	163.00	36.25	41.50	19.91	29.60
T_5	295.50	46.00	178.25	148.50	39.50	45.25	13.32	23.85
T_6	304.25	36.25	321.50	346.75	73.50	88.75	44.42	55.25
CD at 5%	5.40	4.12	4.46	5.23	4.13	4.15	2.02	2.43

T_1- Soil drenching of Bacillus pumilus @ 5 ml /l in polybags with TC seedlings 5 days before planting; T_2 - T1 + Bacillus pumilusenriched farm yard manure @ 5 kg /plant at the time of planting and 2.5 kg/plant at 6 MAP; T_3 - T1 + Bacillus pumilus enriched neem cake @ 100 g/plant at the time of planting and 100 g/plant at 6 MAP; T_4 – Paecilomyces lilacinus+ Psuedomonas fluorescens each @ 12.5 g/ plant at the time of planting and 3 MAP (Standard Check); T_5 - Cartap hydrochloride 4G @ 10 g/plant at the time of planting and at 3 MAP (Chemical Check); T_6 - Untreated Check

Table-6: Effect of different treatments on nematode parameters of banana at Kannara

Treatment	Initial Nematode population		Nematode population				Root Necrosis (%)	
			Soil (250 cc)		Roots (10 g)			
	(250 cc)	Roots (10 g)	Vegetative stage	Shooting stage	Vegetative stage	Shoting stage	Vegetative stage	Shooting stage
T_1	161.33	39.50	112.00	69.00	29.25	37.75	29.00	23.75
T_2	171.00	38.25	94.50	36.25	25.60	32.63	15.50	19.50
T_3	173.75	36.75	100.25	74.64	34.75	38.75	20.00	25.50
T_4	156.00	38.00	110.50	61.33	39.25	41.25	18.00	25.50
T_5	155.67	38.25	97.75	26.25	30.00	35.00	19.00	23.75
T_6	153.70	39.75	179.50	191.25	72.00	85.75	58.25	66.50
CD at 5%	NS	NS	18.93	17.41	7.01	7.45	4.71	5.48

(T_1- Soil drenching of Bacillus pumilus @ 5 ml /l in polybags with TC seedlings 5 days before planting; T_2 - T1 + Bacillus pumilus enriched farm yard manure @ 5 kg /plant at the time of planting and 2.5 kg/plant at 6 MAP; T_3 - T1 + Bacillus pumilus enriched neem cake @ 100 g/plant at the time of planting and 100 g/plant at 6 MAP; T_4 – Paecilomyces lilacinus+ Psuedomonas fluorescens each @ 12.5 g/plant at the time of planting and 3 MAP (Standard Check); T_5 - Cartap hydrochloride 4G @ 10 g/plant at the time of planting and at 3 MAP (Chemical Check); T_6 - Untreated Check)

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

To develop control measures for the invasive and emerging pest, Rugose Spiraling 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 spiraling white fly population (3.66 /leaf) and least per cent leaf infestation of 5.65%. This efficacy was closely followed by foliar application of botanical consortium @ 2g/l and botanical pesticide (Aavya) @ 4g/litre (5.30 and 6.95 and leaf infestation of 8.50% and 9.17% respectively). Population per leaf and per cent leaf damage was significantly higher in untreated control plants (17.01 adult populations per leaf and 19.50 % infestation) (Table 7). Application of Azadirachtin 10000 ppm @ 3ml/l three times at monthly intervals gave 78.48% reduction over control. This was closely followed by T4 and T5 with 68.84% and 61.32 % population reduction respectively over control.

Periyakulam: Foliar application of Azadirachtin 10000 ppm @ 3ml/l three times at monthly intervals recorded minimum rugose spiraling white fly population (10.08/leaf) and per cent leaf infestation (1974%). This was followed by foliar application of botanical consortium@ 2g/l and botanical pesticide (Aavya) @ 4g/litre and recorded reduced rugose spiraling white fly population in leaf (13.67 and 16.48 population/leaf) and leaf infestation (23.84% and 26.87%) respectively as against control (32.62 population/leaf and 65.83 per cent). Foliar application of azadirachtin 10000 ppm @ 3ml/ lit reduced the population to the tune of 68.62%, followed by the application of botanical consortium @ 2ml/lit (57.45%) and in botanical pesticide (48.71%) (Aavya) application (Table 7).

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

Treatment	Per cent leaf damage * (Month after spray) +									
	Pre-treatment count		First spray		Second spray		Third spray		Mean	
	KNR	PKM	KNR	PKM	KNR	PKM	KNR	PKM	KNR	PKM
T_1	17.00 (24.34)	54.58 (47.35)	8.00 (16.41)	31.28 (33.79)	5.75 (13.8)	18.56 (25.56)	3.25 (13.84)	9.78 (17.96)	5.65 (14.68)	19.74 (25.80)
T_2	16.00 (23.57)	62.84 (52.24)	12.25 (20.44)	37.25 (37.43)	11.25 (19.30)	25.42 (30.07)	8.75 (17.16)	16.54 (23.86)	10.66 (18.97)	26.18 (30.46)
T_3	17.00 (24.32)	60.25 (50.69	13.25 (21.33)	42.45 (40.32)	11.75 (20.0)	34.85 (36.17)	11 (19.32)	22.76 (28.47)	12.00 (20.22)	33.18 (34.99)
T_4	16.25 (23.7)	56.85 (48.68	10.50 (18.90)	35.65 (36.47)	8.25 (10.68)	24.35 (29.67)	6.75 (15.03)	11.45 (19.85)	8.5 (14.87)	23.84 (28.68)
T_5	15.25 (22.90	58.16 (49.45	10.48 (18.88)	39.05 (38.52)	10.25 (18.66)	26.45 (31.02	6.75 (15.03)	15.48 (22.91)	9.17 (17.52)	26.87 (30.81)
T_6	17.23 (24.34)	63.45 (52.61	17.50 (24.70)	64.85 (53.44)	18.25 (25.22)	64.89 (53.73)	22.75 (28.46)	67.76 (55.36)	19.50 (26.13)	65.76 (54.17)
CD at 5%	NS	NS	0.66	0.204	0.55	0.37	0.62	0.575	0.61	6.53

KNR: Kannara, PKM: Periyakulam

T_1 - Foliar application of Azadirachtin 10000 ppm @ 3ml/l three times at monthly intervals as and when the infestation is noticed.
T_2 - Foliar application of Pongamia soap IIHR @ 10g/l three times at monthly intervals as and when the infestation is noticed.
T_3 - Foliar application of Neem oil 2% @ 20ml/l three times at monthly intervals as and when the infestation is noticed.
T_4 - Foliar application of Botanical consortium@ 2ml/l with 1st spray when the infestation is noticed and 2nd spray two months later.
T_5 – Botanical esticide (Aavya) @4g/ litre sprayed in the afternoon, three times at monthly intervals as and when the infestation is noticed.
T_6 - 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 (Table 8-11).

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: A roving survey was conducted Feb – March 2020 and July – September 2020 and Oct – Nov 2020 in Belagavi, Dharwad, Bagalkote, Vijayapura, and Bellary districts of northern Karnataka on Grand Naine, Rajapuri, and Ney Poovan 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 and BBTV diseases. The Eumusae leaf spot intensity ranged from 4.80 to 34.47 with an average of 20.20 PDI. It is highest in Belagavi district and in October-November months in Rajapuri and Grand Naine varieties at 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 2.0 to 8.80 with an average incidence of 4.15 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 2.0 to 70.00 percent in Ney Poovan variety with an average incidence of 22.40 at shooting to harvesting stage and the increased incidence is because of planting of infected suckers, monocropping system, and flood irrigation in the command area. The BBTV ranged from 1.0 to 5.0 with an average of 1.57 percent (Table 8-9).

Bhubaneswar: The survey was conducted during April 2020- January, 2021 in 4 districts of Odisha i.e Jagatsinghpur Khurdha, Puri and Jajpur. During survey, Panama wilt (56-66%), Banana bunchy top virus (4-5%), Anthracnose (3-5%), Freckle leaf spot (3-5 PDI), Rhizome rot (1-5%), Banana streak virus (2-11%) and *Eumusae leaf* spot disease (31-39 PDI) were reported as emerging diseases of banana in Odisha.

(b)Isolation of causal organism and identification for new disease: 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* f. sp. *cubense* for *Fusarium* wilt and *Guignardia musae* for Freckle Leaf Spot disease.

Coimbatore: The roving survey was conducted in major banana growing districts viz., Coimbatore, Theni and Erode of Tamil Nadu. No new disease was recorded during the reporting period. The incidence of *Fusarium* wilt, *Eumusae* leaf spot, rhizome rot incidence, and viral diseases was observed. The survey was carried out in Gobichettipalayam of Erode district where *Eumusae* leaf spot 30.5-40 PDI was recorded in Grand naine, Nendran, Ney Proven, Rasthali, and Red banana during July 2020 and October 2020. In Theni and Ambasamuthiram blocks, *Eumusae* leaf spot was 26 PDI in Nendran, Ney Poovan and Red banana. Severity was noticed in Nanjundapuram (Near Thadagam) in month of November, 2020. The incidence ranged from 10-15 PDI during the reporting period. *Fusarium* wilt 10-15.0% was observed in Coimbatore, Erode, and Kanyakumari. Wilt incidence of 5-10% was observed in cv Rasakadali, Vellatholuvan, Nendran and Rasthali in Kallidaikurichi, Sivanthipuram Vagaikulam, Oorkadu, Premadesam, Vellankuli, Karatupuliyur, Pedarankulam of Ambasamuthiram taluk. Wilt incidence was up to 10-15% in Karpooravalli and Neypoovan in Coimbatore and Erode districts. Banana bract mosaic incidence was recorded in Ney Poovan, Grand naine, and Nendran up to 5-10% in Coimbatore and Erode districts. In Red banana and Ney Poovan, banana bract mosaic incidence of was found up to 10 PDI in Gobichettipalaym. BBTV incidence was less than 2%. During survey below 5% Erwinia rot incidence was recorded in Nendran and Grand Naine.

(b)Isolation of causal organism and identification for new disease: No new disease was recorded during period under report. The wilt pathogen isolated from cvs Ney Poovan and Karpooravalli was confirmed as *Fusarium oxysporum f.sp. cubense.* The rhizome rot pathogen from Grand Naine was isolated and confirmed as *Erwinia carotovora pv. carotovora.*

Gandevi: The new and emerging disease was not observed from the banana-growing belt of south Gujarat. There is no change of minor disease into major one. 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 in 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 banana were observed to be negligible.

Jalgaon: During period under report CMV was observed as a major viral disease problem in Jalgaon district of Maharashtra with 63% incidence. 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 previous year.

Jorhat: The survey was conducted in some selected banana growing areas of Assam covering small and commercial orchards wherein 20-25 plants were selected from each orchard. .Goalpara, Kamrup Rural (under Lower Brahmaputra Valley Zone), Jorhat under Upper Brahmaputra valley zone, and Sonitpur under North Bank Plain zone were selected. *Fusarium* wilt with 34% incidence was prevalent in cv. Mabhog in Goalpara and Kamrup district. *Eumusae* leaf spot (32 PDI) and Bunchy top were prevalent in all the surveyed areas with varied magnitude (0-5%). Moreover, Banana streak disease (6%) was also reported from Jorhat and Sonitpur district.

Kannara: During the reporting period, the roving surveys were conducted in Pathanamthitta, Alappuzha, Ernakulam, Thrissur, Palakkad, Malappuram, Kozhikode, and Waynad districts. The mean percent disease index (PDI) of the *Eumusae* leaf spot observed was 19 which was 2% more than the previous year. The PDI observed was in the range of 16 - 25 %. High PDI was recorded in the rainy season and the highest PDI was recorded from Kavassery of Palakkad district. The mean percent incidence of *Fusarium* wilt observed was 17 which was 10% less than the previous year. The maximum incidence recorded was 50% from Tharoor of Malappuram 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 Kunnan (AB) and infection was not recorded from the most popular variety Nendran (AAB). Continuous cultivation/ ratoon cropping of susceptible varieties enhanced the pathogen population in soil and thereby the disease incidence. The mean percent incidence of Deightoniella leaf spot observed was 12% which was 12.60% less than the previous year. The maximum incidence was recorded in Pudukkad, Thrissur (18%). The major factors affecting the disease incidence are close planting, less sunlight, and imbalanced fertilizer application.

The mean percent incidence of Blast and Pitting disease was 21 which was 8% less than the previous year. It is an emerging banana disease in Kerala. The disease is observed for the first time in a variety of Nendran from Alangad Panchayat of Ernakulam district in August 2019. The symptoms of the disease are characteristic reddish-brown spots on the peel of mature fruits which later develop too dark brown spots with a pit in the center. Later splitting occurred on the peel which resulted in fruit fly attack and fruit rotting. The disease itself was not causing any damage to the fruit pulp. But a secondary attack by fruit flies caused the decay of the fruit. Apart from fruit, infection also occurred on other plant parts like boot leaf, pseudostem, petiole, midrib, and peduncle as spindle-shaped small brown lesions. The pathogen was identified as *Pyricularia angulata* and the sequence has been deposited in the NCBI data bank (Accession no: MW269689). Heavy rain during the bunch maturity stage is conducive to the occurrence of the disease.

The mean percent incidence of Rhizome rot observed in the current year was 10% and this was 6 % less than the previous year. Maximum incidence was recorded in Ayiloor of Palakkad district (20%) in the mature Nendran plants. Intermittent rainfall, high temperature, water logging, and heavy use of chemical fertilizers are the contributory factors for the disease. Nendran, the most popular variety in Kerala is very susceptible to rhizome rot disease. The mean incidence of BBTV, BBrMV, CMV, and BSMyV observed in the survey were 3, 5.00, 2, and 4 percent respectively. An increase in the incidence of BBTV, BBrMV, and CMV and a decrease in the incidence of BSMyV were observed in the current year over the previous year. The BSMyV infection was noticed only in variety Mysore Poovan (AAB).

b) Isolation of causal organism and identification: The pathogen of *Fusarium* wilt disease was isolated in Potato Dextrose Agar (PDA) medium, purified and maintained as pure culture.

Kovvur: Surveys were conducted in East Godavari, West Godavari of the coastal zone, Kadapa, and Anantapuramu of Rayalaseema zone in Andhra Pradesh. Incidence of rhizome rot was observed in T.C. Keli and K.C. Keli varieties. *Eumusae* leaf spot, Rhizome rot, *Fusarium* wilt, BBrMV, BBTV, and CMV are the major diseases observed in the surveyed districts. Among the diseases, severe *Eumusae* leaf spot disease incidence was observed in coastal districts and the average disease severity recorded was 24%. Rhizome rot was observed in T.C. Keli, Kovvurbontha, and in K.C Keli varieties and the average disease incidence recorded was 14%. Among the viral diseases, BBrMV, BBTV, and CMV were observed during the surveys. BBrMV incidence was observed in Karpurachakkerakeli and Red banana. Incidence of bacterial and viral diseases was observed in Rayalaseema districts when compared to *Eumusae* leaf spot. Viral diseases aggravated by less nutrient status were observed particularly in Kadapa and Anantapur districts. Incidence of pre-harvest Cigar end rot was also observed in Tellachakkerakeli

and Kovvurbontha varieties along with other post-harvest diseases, Crown rot, and Anthracnose (Table 10-11).

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 intensity (PDI) of the disease was unchanged (average PDI of susceptible varieties was (42 PDI). Incidence of the Panama wilt (7.0%) and some other diseases (Bunchy top, Rhizome rot, CMV & Anthracnose) were also unchanged as compared to previous years.

b) Isolation of causal organism and identification**:** *Botryodiplodia* sp and *Gloeosporium gloeosporioides* were isolated from infected ripe fruit of Martaman during this period.

Pusa: During a survey in April, 2020-March, 2021 of the state, Panama wilt was observed as a major problem of tall bananas *i.e*. Malbhog (AAB), Alpan (AAB), Champa (AAB), Chini Champa (AB), Kanthali (AAB), Kothia (ABB) in Zone –I comprising of (Samastipur Muzaffarpur, Vaishali, Hazipur districts). The incidence of the disease (8-30%) was less as compared to the previous year in this zone. However, during the last 5-6 years, Panama wilt disease was unexpectedly observed (6-42%) 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. It needs to underline that Zone- II (Vaishali belt) is free from the presence of TR4 to date under report. Thus, the first time Pusa center confirmed the presence of TR4 in Bihar states of India. Work on the management of Panama wilt of banana incited by *Fusarium oxysporum* f.sp. *cubense* tropical race 4 is in progress. *Eumusae* leaf spot (4-24 PDI) and BBTV (10-16%) were observed as major problems in both the zones. In the case of *Eumusae* leaf spot and BBTV, the trend of disease development was comparable with their incidence in the previous year. It needs to mention 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 banana at the initial stage of crop growth but the overall scenario showed no change trend as compared to the previous year i.e. 2019-2020. First-time anthracnose complex disease was observed in the agro-climatic conditions in Zone-I and Zone II of Bihar with 5-10% and 0-5% incidence respectively in the month of July-August, 2020. The possible reason may be the appearance of disease in agro-climatic conditions of Bihar was due to high humidity and low temperature as compared to normal environmental conditions. Diseased samples were brought to the laboratory and isolation was made and found association of 3 different fungi as pathogen frequently i.e. *Colletotrichum* sp., *Lasidiplodia* sp, and *Fusarium* sp.

(b) Isolation of the pathogen: First-time *Fusarium* wilt of banana incited by *Fusarium oxysporum* f.sp. *cubense* was isolated from samples collected from the Koshi belt of Bihar (Purnea, Katihar, Navgachhiya, Madhepura, and KisanGanj) in cv Robusta and Grand naine, and the pathogen was identified by ARI, Pune as *Fusarium oxysporum* f.sp. *cubense* race TR4 biotype B2. The disease has created havoc among banana growers of Bihar with a 20-65% incidence. Incidence of the disease increased in the new areas very fast.

Fusarium oxysporum f sp. *cubense* was also isolated from cv Malbhog, Alpan, and Kothia. *Colletotrichum* sp., *Lasidiplodia* sp, and *Fusarium* sp. were also isolated from an infected bunch of cv Grand naine.

Table-8: Area surveyed by different centres at different locations in various states to know various fungal and bacterial diseases of banana

Name of centre	Area surveyed (Name of districts only)
Arabhavi	Belagavi, Bagalkote, Vijayapura, Dharwad and Bellary
Bhubaneswar	Jagatsinghpur Khurdha,Puri, Jajpur.
Coimbatore	Coimbatore, Theni and Erode districts
Gandevi	Bharuch, Narmada, Navsari Surat, Valsad
Jalgaon	Jalgaon ,Solapur, Pune, Satara, Sangli, (Maharashtra), Burhanpur(MP)
Jorhat	Goalpara, Kamrup, Jorhat,Sonitpur
Kannara	Pathanamthitta, Alappuzha, Ernakulam, Thrissur, Palakkad,Malappuram, Kozhikode and Waynad
Kovvur	East Godavari, West Godavari, Kadapa and Anantapuramu
Mohanpur	Nadia, North 24 parganas,Hooghly district
Pusa	Zone- I (Samastipur, Muzaffarpur, Vaishali, Siwan and Saran)
	Zone- II (Katihar, Saharsa, Purnea, Bhagalpur, Madhepura and Kishanganj)

Table-9: Scenario of various fungal and bacterial diseases of banana at different locations /states

Name of centre		Disease incidence (%)/Percent Disease severity(PDI)								
		Eumusae leaf spot#	Freckle leaf spot#	*Deightoniella leaf spot#*	Cordana leaf spot#	Pitting disease	Anthracnose	Panama wilt	Rhizome rot	Any new
Arabhavi		21 (19)	(1)	-	0	-	-	3 (1)	4 (2)	-
Bhubaneswar		39 (29)	5 (2)	-	-	-	5 (2)	66 (56)	5 (2)	-
Coimbatore		20-40 (20)	-	-	-	-	-	15 (10)	5 (5-7)	-
Gandevi		16-27 (16-28)	-	-	-	18-20 (0)	-	8 (0)	0-2 2-3	Wilt incidence in Cavendish group of banana
Jalgaon		2-25 (11-34)	-	-	-	-	-	-	0-4 2-6	-
Jorhat		32 (33)	-	-	-	-	-	34 (33)		
Kannara		19 (17)	0	12 (25)	0	21(30)	-	17 (27)	10 (16)	-
Kovvur		24 (25)	5 (0)	-	3 (0)	-	-	9 (5)	14 (13)	-
Mohanpur		42 (42)	6 (6)	0	12 (12)	0	4 (5)	7 (6)	2 (2)	
Pusa	Zone-I	4-20 (4-18)	-	-	0-2		5-10	8-30* (16-34)	2-12 (2-10)	Anthracnose complex of banana with 5-10% incidence
	Zone-II	4-24 (6-22)	-	-	-		0-5	6-42** (14-34)	2-14 (4-14)	

#PDI-Percent disease index; Data in parenthesis () indicate the average disease incidence/severity during last five years; **Panama wilt of banana incited by *Fusarium oxysporum* f.sp. cubense race I & II in Vaishali belt of Bihar in tall banana (Malbhog, Alpan, Chinia, Kanthali and Kothia) ;***Panama wilt of banana incited by *Fusarium oxysporum* f.sp. cubense race TR4 in Koshi belt of Bihar in Robusta and Grand naine

Table-10: Scenario of various viral diseases of banana at different locations /states

Name of centre		Disease incidence (%)			
		Banana bunchy top virus	Banana bract mosaic	BSV	CMV
Arabhavi		1.57 (0.75)	-	-	1.50 (0.20)
Bubaneswar		5 (1.75)	-	11 (3.43)	-
Coimbatore		-	5-10 (5)	-	-
Gandevi		1-2 (0-1)	-	-	-
Jalgaon		2 (1-5)	-	-	0-63 (1-5)
Jorhat		5 (6)	-	-	-
Kannara*		3 (1)	5 (5)	4 (6)	2 (0)
Kovvur		3 (4)	8 (7)	-	2 (5)
Mohanpur		2 (2)	-	-	2 (2)
Pusa	Zone- I	0-16 (10-16)	- (-)	- (-)	0-4
	Zone- II	12-16 (12-16)	- (-)	2-3 (-)	4-6 (4-6)

() Data in parenthesis indicate the average disease incidence/severity during last five years

Table-11: Identity of various pathogens isolated by different centres

Name of centre	Name of pathogen isolated
Arabhavi (UHS)	No
Bhubaneswar (OAU&T)	Pseudocercospora musae , Gloeosporium musarum,Guignardia musae, Fusarium oxysporum f. sp. Cubense
Coimbatore (TNAU)	Fusarium oxysporum f. sp. cubense, Erwinia carotovora pv carotovora
Gandevi (NAU)	No
Jalgaon (MPKV)	No
Jorhat (AAU)	Ralstonia solanacearum
Kannara (KAU)	Fusarium oxysporum f.sp. cubense
Kovvur (Dr YSRHU)	Fusarium oxysporum fsp cubense, Pectobacterium carotovora, Cordana musae, Colletotrichum gleosporoides
Mohanpur (BCKV)	Nil
Pusa (RAU)	*Fusarium oxysporum* f.sp. cubense race TR4 biotype B2 from Grand Naine & Robusta. *Fusarium oxysporum* f sp. cubense was also isolated from cv Malbhog, Alpan and Kothia and Collettotrichum sp., Lasidiplodia sp and *Fusarium* sp. from banana fruits

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: Per cent disease incidence was recorded in all the treatments. The external wilt index varied between 51.67 to 58.05 and the internal wilt index varied between 53.29 to 58.19 and all treatments were on par. Observations on agronomic characters showed that there was no significant difference between treatments. Flowering was observed in all treatments but maximum flowering (50 per cent) was recorded in the treatment involving 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.

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 significant reduction in disease incidence (38.89) and wilt index (18.06) as against treatment involving disease free suckers from disease free field + Application of Neem cake @ 250 g/plant or vermicompost (100% and 68.05). There was no significant difference among the treatments with respect to growth parameters. Flowering was delayed and affected by *Fusarium* wilt disease and harvesting is yet to be reported (Table 12).

Table-12: Effect of various treatments on disease severity of *Fusarium* wilt in banana at Kannara and Kovvur centres

Treatment#	Kannara			Kovvur		
	Plants infected (%)	Plants flowered (%)	Plants harvested (%)	Plants infected (%)	Plants flowered (%)	Plants harvested (%)
T_1	100	25.00	0.00	100.00	0.00	-
T_2	100	20.83	0.00	69.44	5.55	-
T_3	100	50.00	20.83	38.89	44.44	-
T_4	100	12.50	0.00	83.33	5.55	-
CD at 5%	NS	*	*	25.09	*	-

T_1: Disease free suckers from disease free field + Application of Neem cake @ 250 g/plant or or vermicompost, T_2: T_1 + dipping in carbendazim (0.2%) for 45 min., T_3: T_1 + dipping in carbendazim (0.2%) for 30 min. followed by carbendazim drenching 0.2% solution (2^{nd}, 4^{th} and 6^{th} month after planting) and carbendazim injection @ 3 ml of 2% solution (3^{rd}, 5^{th} and 7^{th} month after planting), T_4: T_1 + dipping in carbendazim (0.2%) for 30 min. followed by carbendazim drenching 0.2% solution (2^{nd}, 4^{th} and 6^{th} month after planting) and carbendazim injection @ 3 ml of 2% solution (3^{rd}, 5^{th} and 7^{th} month after planting)
(In all the treatments, cartap hydrochloride 10 g/plant is common)
* Statistical analysis was not possible because of small number of plants for data and high variation among the replication

6.2.5.(b).B. Management of *Eumusae* leaf spot disease of banana

The trial was laid out with a total of six to eight sprays given at 25-day interval with five treatments and six replications in RBD. Propiconazole and mineral oil were used as a standard check to control the disease. Planting time was adjusted such that the crop's vulenarable stage (shooting to harvest) coincides with congenial period for the disease *i.e* rainy season with high RH. First spray was given 5 months after planting. Selected varieties are Grand Naine at Arabhavi, Bhubaneswar, Coimbatore, Jalgaon and Kovvur; Jahaji at Jorhat; Nendran at Kannara and Martman at Mohanpur.

Arabhavi: Among the four treatments, application of chemicals + mineral oil was recorded lower per cent disease index (15.55%) as compared to control (53.66%). It also recorded significantly highest YLS (12.14) and INSL (69.58) as against 1.55 and 5.32 respectively in control. The treatment also recorded superior growth parameters and bunch weight (32.50kg/ bunch) with a BC ratio of 1.82 as against 0.83 of control. During 2020-21, fresh planting was done during September, 2020 and the trial is in vegetative stage.

Bhubaneswar: Application of chemicals + mineral oil was recorded significantly lowest disease severity (12.45) and highest YLS (14.12) when compared to control (PDI: 40.31; YLS: 2.45). It also recorded significantly highest bunch yield (22.13kg/ bunch) and BC ratio (2.20) among the treatments.

Coimbatore: Among the four treatments, application of propiconazole (0.1%) + mineral oil (1%) 3 sprays at 25 days interval was recorded significantly lowest percent disease index of 14.7 with maximum hands per bunch (11.0) and it was on par with application of chemicals + mineral oil (14.0 &10.67) when compared to untreated control (30.5). However, application of propiconazole (0.1%) + mineral oil (1%) 3 sprays at 25 days interval recorded significantly highest bunch yield (22.58kg/bunch) with higher cost benefit ratio (2.30) when compared to other treatments. New trial was laid out as per the recommended treatments and four sprays were completed. The trial is in progress.

Jalgaon: Application of propiconazole (0.1%) + mineral oil (1%) 3 sprays at 15 days intervals was recorded lowest percent disease index of 10.94 when compared to other treatments. The untreated control showed maximum percent disease index of 34.09. Youngest leaf spotted was also maximum in propiconazole (0.1%) + mineral oil (1%) 3 sprays at 15 days intervals (8.67) and the same treatment recorded significantly highest bunch weight (27.67 kg/ bunch) along with highest BC ratio of 2.47.

Jorhat: Application of chemicals + mineral oil was found effective and recorded significantly lowest disease severity (9.32) and highest YLS (10.08) when compared to control (PDI: 58.47; YLS: 3.02). It also recorded significantly highest bunch yield (21.59kg/ bunch) with a BC ratio of 2.12 among the treatments.

Kannara: There is significant difference between the treatments in percent disease index at vegetative (5MAP) and flowering stage. Significantly lowest percent disease index was recorded in treatments T_2 (Propiconazole (0.1%) + mineral oil (1%) 3 sprays at 25 days interval), T_3 (Chemicals + mineral oil) and T_5 (Mineral Oil (1%) 3 sprays at 25 days interval) at flowering stage (19.46, 19.60 & 25.73) and these were par. There was no significant difference between treatments in YLS, vegetative and yield characters.

Kovvur: Of the various treatments imposed for management of *Eumusae* leaf spot of banana, treatment T_4 (Alternation of chemicals alone) recorded lowest disease severity of 9.69 as against 26.60 in control and is on par with T_3 (Chemicals + mineral oil) which recorded PDI of 10.72.

Mohanpur: Application of chemicals + mineral oil was found effective and recorded significantly lowest disease severity (17.75) and highest YLS (8.20) when compared to control (PDI: 41.20; YLS: 4.12). It also recorded significantly highest bunch yield (16.58kg/ bunch) with a BC ratio of 1.72 among the treatments (Table 13).

Table-13: Effect of chemical and mineral oil treatments on disease severity of Eumusae leaf spot of banana

Treatment	Disease Severity (PDI) (%)							
	ARB	BBI	COB	JLG	JRH	KNR	KVR	MHR
T_1: Control (Untreated)	53.66	40.31	30.50	34.09 (35.70)	58.47	33.42 (5.72)	26.60	41.20
T_2: Propiconazole (0.1%) + mineral oil (1%) 3 sprays at 25 days interval	27.90	23.53	14.70	10.94 (19.26)	26.81	19.46 (4.40)	13.13	28.65
T_3: Chemicals + mineral oil	15.55	12.45	14.00	14.57 (22.42)	9.32	19.60 (4.41)	10.72	17.75
T_4: Alternation of chemicals alone	33.41	26.38	18.80	14.73 (22.55)	28.61	31.88 (5.62)	9.69	23.42
T_5: Mineral Oil (1%) 3 sprays at 25 days interval	38.75	30.37	-	16.14 (23.66)	34.76	25.73 (5.06)	17.94	-
CD at 5%	1.93	3.32	3.37	2.59	1.16	0.97	9.55	2.25
ARB-Arabhavi, BBI-Bhubaneswar, COB-Coimbatore, JLG-Jalgaon, JRH-Jorhat, KNR-Kannara, KVR-Kovvur, MHR-Mohanpur								

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 mother plants used in experiments. The indexing was carried out by NRCB, Trichy for Arabhavi and Gandevi centers where as by respective centres in the case of Bhubaneswar, Coimbatore, Jalgaon, Kannara, Kovvur and Pusa.

Arabhavi: Out of 57 accessions screened, none of the accessions were infected with viruses.

Bhubaneswar: Out of 15 accessions screened, one accession Grand Naine was infected with BBTV and one accession Balipatana Champa was infected with BSV (Table 14).

Coimbatore: Out of 206 germplasm accessions, one accession Dudh Munga was infected with BBTV; seven accessions *viz*., Kathabale, Muthiah, Bhodibale, Karpooravalli, Pachabontha Bathesa, H531 and NPH 02-01 were infected with BBrMV and two accessions *viz.,* Mottapoovan and Sanachenkadali were infected with BSV.

Gandevi: Out of 20 accessions screened, none of the accessions were infected with viruses.

Jalgaon: Out of 86 accessions screened, 16 accessions viz., Manoranjitham, Karpoora Chakkara Keli, Champa, Booth Bale, Poovan, Pacchakadali, Ney Poovan, Anaikomban, Ankur II, Pisang, Linen, FHIA, Ornamental, Selection-9, Alukhel and FHIA-03 were infected by BBrMV and two accessions *viz*., Saba Karpu and Chakkara Keli were infected by CMV. BBTV and BSV infections were not recorded in any accessions.

Kannara: Out of 240 germplasm accessions screened, one accession Agniswar was infected with BBTV; four accessions *viz.*, Charapadathi, Sugandhi, Karpoorachakkarakeli and Nendran hybrid were infected with BBrMV; two accessions *viz.*, Alpan and Mottapoovan were infected with BSV. CMV infection was not recorded in any accessions.

Kovvur: Out of 112 germplasm accessions screened, five accessions *viz*., Pisang Mas, H-531, Chinia, Nepalivannan and BCB-2 were infected with BBrMV. 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, one accession Grand Naine was infected by both CMV and BSV whereas BBrMV infection was not recorded in any accessions.

Table-14: Infection of viruses in banana germplasm at co-ordinated centres

Centre	Germplasm Accessions Screened (Nos)	Positive Accessions (No)				Place of Indexing
		BBTV	BBrMV	CMV	BSV	
Arabhavi	57	0	0	0	0	NRCB, Tiruchirapalli
Bhubaneswar	15	1	0	0	1	OUAT, Bhubaneswar
Coimbatore	206	1	7	0	2	TNAU Coimbatore and NRCB, Tiruchirapalli
Gandevi	20	0	0	0	0	NRCB, Tiruchirapalli
Jalgaon	86	0	16	2	0	BRS, Jalgaon
Kannara	244	1	4	0	2	BRS, Kannara
Kovvur	112	0	5	0	0	HRS, Kovvur
Pusa	74	5	0	1	1	Pusa

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

The experiment was laid out at a hot spot (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 Neypoovan, Rasthali, Karpuravalli, Grand naine, Malbhog, Rasthali, Amritapani and Martaman at Arabhavi, Bhubaneswar, Coimbatore, Gandevi, Jorhat, Kannara, Kovvur and Mohanpur respectively.

Arabhavi: Trial was initiated in the farmer field (sick plot) at Bellary district in January 2021 with cv. Neypoovan.

Bhubaneswar: Trial was initiated in June 2020 and the plants are four months old. cv. Rasthali.

Coimbatore: A trial was laid out in ratoon crop at kangayampalayam, sulur block where severe incidence (70 to 80%) of Fusarial wilt was noted in the previous year. Module 1 recorded less disease incidence, external wilt index and internal wilt index. The module also recorded higher bunch yield, higher percentage of plants flowered and plants harvested (Table 15 & 16).

Jorhat: Significantly minimum per cent disease incidence (20.5%), external wilt index (18.0) and internal wilt index (23.4) were recorded in module 1 when compared to module 2 (42.25%). Same module also recorded significantly highest per cent of plants flowered (87.3) and plants harvested (87.3), when compared to module 2 (73.0 & 73.0).

Gandevi: Module 1 recorded minimum disease incidence (12.82%) and external wilt index (41.03%) when compared to module 2 (disease incidence: 20.51%; External wilt index: 57.44). It also recorded highest per centage of flowering (46.15) when compared to module 2 (33.33). The data on number of plants harvested and internal wilt index was not recorded due to lockdown in experimental area.

Kannara: Maximum disease incidence (97.92%), external wilt index (62.22-63.89) and internal wilt index (63.93-72.56) was recorded in both the treatments. Flowering was observed in few plants of T_1 (18.75%) and T_2 (27.08%). Harvestable bunches were produced only in 6.25% of plants of T_1 and 8.33% of plants of T_2. There was no significant difference between the treatments in growth characters. Harvestable bunches are very low in both the treatments. As the experimental field is highly sick, treatments were not found effective for managing the disease.

Kovvur: Module 1 recorded 20.51 per cent disease incidence when compared to module 2 (30.76%) during the reporting year. Both the treatments recorded higher percentage of flowering and harvestable bunches. The treatments also recorded low external wilt index and internal wilt index. Various growth and yield parameters recorded non-significant difference between the treatments (Fig-14).

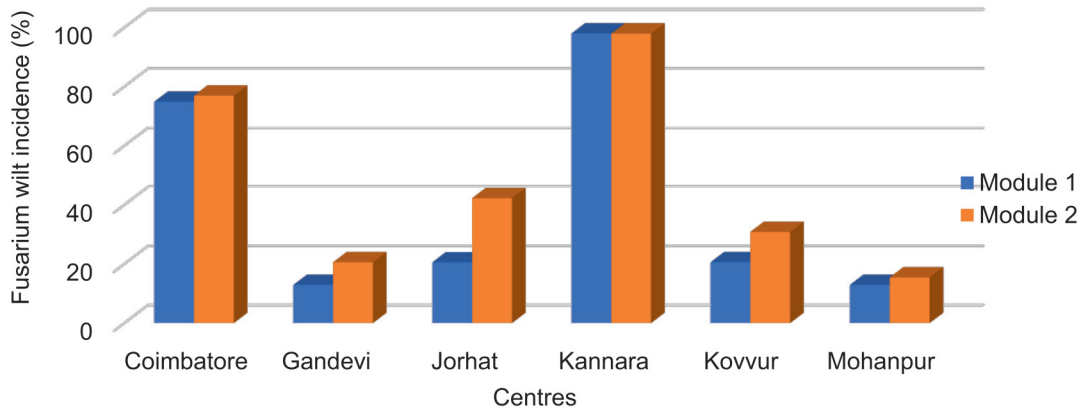
Mohanpur: Both the treatments recorded less disease incidence (12.82 and 15.38%), external wilt index and internal wilt index, however, non-significant difference was observed between the treatments with respect to growth and yield parameters.

Table 15: Effect of treatments on disease incidence of Fusarium wilt in banana at different centres

Treatment#	Coimbatore		Gandevi		Jorhat	
	Plants flowered (%)	Plants harvested (%)	Plants flowered (%)	Plants harvested (%)	Plants flowered (%)	Plants harvested (%)
T_1	35.37	34.01	46.15	NA	87.3	87.3
T_2	29.23	26.15	33.33	NA	73.0	73.0
CD at 5%	-	-	-	-	4.2	2.1
# Refer methodology for treatment details						

Table 16: Effect of treatments on disease incidence of Fusarium wilt in banana at different centres

Treatment#	Kannara		Kovvur		Mohanpur	
	Plants flowered (%)	Plants harvested (%)	Plants flowered (%)	Plants harvested (%)	Plants flowered (%)	Plants harvested (%)
T_1	18.75	6.25	84.61	84.61	87.18	82.05
T_2	27.08	8.33	82.05	82.05	89.74	89.74
CD at 5%	-	-	NS	NS	-	-
# Refer methodology for treatment details						



Module 1 - Application of CSSRI bioformulation at monthly interval

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

Fig. 14: *Fusarium* wilt incidence in banana at different centres

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 tissue culture plants of Poovan. Bunch weight (17.36 kg/ plant) and yield (53.57 t/ha) was significantly maximum in tissue culture poovan than local poovan (15.10 kg/ plant, 46.59 t/ha). Quality attributes of tissue culture poovan (TSS- 21.42 °B, Acidity- 0.43%) was significantly maximum than local poovan (18.45°B, 0.56%). Significant increase in growth parameters like plant height, stem girth and number of leaves was recorded in tissue culture poovan (2.61m, 56.33cm and 14.46 res.) than local poovan (2.24m, 53.63cm and 12.10 res.). Crop duration recorded was less in tissue culture poovan (386.78days) than local poovan (402.56 days) (Table 17 & 18). Evaluation of sucker raised tissue culture poovan is ongoing.

Bhubaneswar: No symptoms of occurrence of BSV were noticed in the tissue culture plants of Poovan. Bunch weight (16.92 kg/ plant) and yield (42.30 t/ha) was significantly maximum in tissue culture poovan than local poovan (13.24 kg/ plant, 33.10 t/ha). TSS and acidity of tissue culture poovan and local poovan were on par. Significant increase in growth parameters like plant height (2.68 m), stem girth (58.42 cm) and number of leaves (12.32) was recorded in tissue culture poovan than local poovan (2.42m, 54.26cm and 11.46 respectively.). Crop duration recorded in tissue culture poovan and local poovan were on par.

Coimbatore: Bunch weight (10.84 kg/ plant) and yield (31.78 t/ha) was significantly maximum in tissue culture poovan than local poovan (9.77 kg/ plant, 28.25 t/ha). Quality attributes of tissue culture poovan (TSS, 22°B, Acidity- 0.43%) was significantly maximum than local poovan (21.17°B, 0.48%). Significant increase in growth parameters like stem girth (51.00cm) and number of leaves (13.58) was recorded in tissue culture poovan than local poovan (47.54cm and 10.82 res.) whereas plant height and crop duration recorded in tissue culture poovan and local poovan were on par.

Jalgaon: As there were no plants of local Poovan available for planting, data of virus free tissue culture Poovan (Ratoon1) is presented. No symptoms of occurrence of BSV were noticed in the tissue culture Poovan. Yield contributing characters like bunch weight (8.40 kg/ plant), number of hands (10.38) and yield (25.92 t/ha) of tissue culture poovan were recorded. Quality attributes *viz* TSS (20.78 °B) and acidity (0.41%) were also recorded in tissue culture Poovan

Kannara: Incidence of BSV was recorded in tissue culture plants of Poovan (2.80%). Bunch weight (18.86 kg/ plant) and yield (47.16 t/ha) was significantly maximum in tissue culture poovan than local poovan (11.74kg/ plant, 29.36 t/ha). Quality attributes of tissue culture poovan, ie acidity (0.45%) was significantly low than local poovan (0.50%) whereas TSS were on par.

Mohanpur: No symptoms of occurrence of BSV were noticed in the tissue culture plants of Poovan. Bunch weight (14.90 kg/ plant) and yield (37.25 t/ ha) was significantly high for tissue culture poovan than local poovan (13.44 kg/ plant, 33.60 t/ha). Significant increase in growth parameters like plant height and stem girth was recorded in tissue culture poovan (2.54m, 64.60cm) than local poovan (2.38m, 61.56cm) whereas number of leaves and crop duration was on par.

Tiruchirapalli: No symptoms of occurrence of BSV were noticed in the tissue culture plants of Poovan. Bunch weight (19.50 kg/plant) and yield (44.07 t/ha) was significantly maximum in tissue culture poovan than local poovan (14.83 kg/ plant, 33.51 t/ha). Yield contributing characters like number of hands, number of fingers, finger length, finger girth, finger weight and pulp weight also recorded significantly high values for tissue culture poovan. In quality attributes, tissue culture poovan recorded low acidity (0.76%) and low TSS (21.02 °B) where as local poovan recorded high acidity (0.78%) and high TSS (22.65° B). Significant increase in growth parameters like plant height, stem girth and number of leaves was recorded in tissue culture poovan (3.31m, 72cm and 11.17 res.) than local poovan (2.94m, 65.25cm and 9.42 res.). Crop duration recorded was less in tissue culture poovan (380.58days) than local poovan (403.92 days).

Table-17: Incidence of BSV in Ratoon crop of Tissue culture Poovan

Centre	Incidence of BSV (Yes / No)	Per cent incidence of BSV	Stage (vegetative / flowering / maturity) and month of symptom appearance
Arabhavi	No	NA	NA
Bhubaneswar	No	NA	NA
Coimbatore	No	NA	NA
Kannara	Yes	2.80	Flowering, October 2019
Jalgaon	No	NA	NA
Mohanpur	No	NA	NA
Tiruchirapalli	No	NA	NA

Table-18: Evaluation of tissue culture banana cv. Poovan with respect to yield parameters at different centres

Treatment	Bunch weight (kg/plant)						Yield (t/ha)					
	ARB	BBI	COB	KNR	MHR	TCH	ARB	BBI	COB	KNR	MHR	TCH
T_1	17.36	16.92	10.84	18.86	14.90	19.50	53.57	42.30	31.78	47.16	37.25	44.07
T_2	15.10	13.24	9.77	11.74	13.44	14.83	46.59	33.10	28.25	29.36	33.60	33.51
CD at 5 %	1.49	0.74	0.85	1.15	1.20	0.56	3.43	3.96	3.44	2.87	3.46	2.20

T_1 – Tissue culture Poovan, T_2 - Local Poovan (BSV infected)
ARB-Arabhavi, BBI-Bhubaneswar, COB-Coimbatore, KNR-Kannara, MHR-Mohanpur, TCH-Tiruchirapalli
Note - Data of Ratoon 1 crop of Bhubaneswar, Coimbatore, Kannara and Tiruchirapalli and Ratoon 2 crop of Arabhavi and Mohanpur

CITRUS

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

Germplasm collected, maintained, characterized and evaluated at different centres are mentioned in table 19. During the period a total of 145 accessions were characterized at different centres.

Ludhiana: Among the sixteen sweet orange varieties evaluated, maximum canopy volume in Early Gold (30.0 m^3), minimum canopy volume in Saugni Blood (9.7 m^3), maximum stock girth in Torocco Blood (172.0 cm), maximum fruit weight in Cara Cara Navel (280.3 g), maximum yield per tree in Trovita (40.5 kg), maximum TSS in Westin (11.7°B) and maximum acidity in Vernia (1.20 %) were recorded.

Nagpur: A total of sixteen Citrus accessions were characterized for 75 morphological characters based on IPGRI descriptors.

Pasighat: Thirty-three superior type Citrus species/ genotypes were collected and they exhibited noticeable variation in the morphological and biochemical characteristics.

Rahuri: Total 21 Citrus germplasm accessions are maintained for characterization and evaluation.

Sriganganagar: No new germplasms were collected. Two germplasm collected during the year of 2019 were conserved in germplasm repository. Total 40 citrus germplasm evaluated.

Tinsukia: Eight new collections of germplasm were added to existing germplasm and are being conserved

for further evaluation. This year total 145 accession were characterized and conservation.

Tirupati: One sweet orange Malta accessions was collected from farmer's field of Sri. Mallikarjun Reddy, Kalva palli, Ananthapur District of Andhra Pradesh and budded on Rangpur lime root stock. A total of 107 citrus germplasm accessions comprising of sweet orange (21), sour orange (5), pummelo (3), grape fruit (3), rough Lemon (4), trifoliate orange & hybrids (2), mandarins (5), acid lime (48), lemons (2) and other species (14) are being maintained for evaluation and characterization.

Table 19: Collection, characterization, conservation, evaluation and utilization of Citrus germplasm at different centres during 1st January to 31st December

Category	Ludhiana	Pasighat	Rahuri	Sriganganagar	Tinsukia	Tirupati	Total
Total collection	16	33	21	-	8	01	79
Characterization	-	-	-	-	145	-	145
Conservation	16	33	21	02	145	46	263
Evaluation	16	-	-	40	-	-	56
Utilization	-	-	-	02	08	-	10
New collection	-	-	-	-	08	-	08

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 (3.74 m), canopy volume (16.47 m^3), number of fruits per tree (701.30), yield (115.95 kg/tree) and juice content (43.78%) as compared to other mandarin varieties. However, Mudkhed seedless recorded maximum TSS (10.91°B).

Ludhiana: Khasi mandarin recorded maximum canopy volume (33.1 m^3) followed by Mudkhed seedless (31.8 m^3). However, Kinnow mandarin recorded maximum yield (81.69 kg/tree having average weight 181.50 g) with juicy fruits (47.30%).

Nagpur: Kinnow mandarin recorded maximum fruit weight (166.00 g). The number of seeds was minimum in Sikkim mandarin (2.17), whereas, Nagpur mandarin recoded maximum TSS: Acidity ratio (11.47).

Sriganganagar: Growth parameters recorded revealed maximum plant height (3.80 m) in Mudkhed seedless which was at par with Kinnow mandarin (3.80 m). Whereas, maximum canopy volume (27.93 m^3), yield (71.67 kg/tree), fruit weight (224.80 g) and TSS (12.03°B) were recorded in Kinnow mandarin (Table 20-22).

Tinsukia: Coorg mandarin recorded the maximum plant height (2.78 m), whereas canopy volume was recorded maximum in Nagpur mandarin (4.69 m^3). Darjeeling mandarin reported maximum number of fruits (80/tree), while Mudkhed seedless recorded maximum yield (13.15 kg/tree). The maximum TSS (10.24°B) with minimum acidity (1.00%) was observed in Khasi mandarin (Table 20-22).

Table- 20: Growth and yield performance of different mandarin cultivars at different centres

Varieties	Plant height (m)				Canopy volume (m^3)				Fruits/tree		
	AKL	LDH	SRG	TNK	AKL	LDH	SRG	TNK	AKL	LDH	TNK
Mudkhed seedless	3.45	4.3	3.80	3.40	14.87	29.6	27.01	15.54	569.10	361.50	129.00
Nagpur seedless	3.68	4.1	3.26	4.21	16.14	31.8	10.41	18.65	613.20	527.00	116.00
Nagpur mandarin	3.74	3.7	3.71	4.62	16.47	20.5	20.54	29.15	701.30	297.00	130.00
Kinnow mandarin	3.14	2.9	3.80	3.21	8.80	17.6	27.93	13.43	84.10	450.10	120.00
Coorg mandarin	3.27	3.9	3.37	4.89	10.15	23.6	10.19	23.57	388.30	408.00	125.00
Khasi mandarin	3.16	4.5	2.93	3.75	9.78	33.1	13.87	17.28	432.40	392.00	148.00
Darjeeling mandarin	3.45	3.9	3.28	4.47	9.85	27.2	18.01	18.78	417.60	462.30	136.00
CD at 5%	0.33	12.1	0.45	0.39	1.50	20.7	7.34	0.49	65.04	28.20	0.27
AKL-Akola, LDH-Ludhiana, SRG-Sriganganagar, TNK-Tinsukia											

Table-21: Yield and quality performance of different mandarin cultivars at different centres

Varieties	Yield (kg/tree)				Fruit weight (g)					TSS (°B)				
	AKL	LDH	SRG	TNK	AKL	LDH	NGP	TNK	SRG	AKL	LDH	NGP	TNK	SRG
Mudkhed seedless	88.00	55.67	37.15	20.80	162.77	154.00	159.44	169.01	133.90	10.91	7.50	8.74	8.87	8.00
Nagpur seedless	97.88	2.04	44.30	18.24	168.02	136.70	160.67	165.00	120.40	10.19	7.60	8.70	8.98	7.90
Nagpur mandarin	115.95	42.26	31.03	20.48	174.04	142.30	145.33	159.12	113.37	10.26	7.50	8.56	8.50	7.37
Kinnow mandarin	10.99	81.69	71.69	19.58	137.55	181.50	166.00	161.03	224.80	8.94	9.90	10.10	9.45	12.03
Coorg mandarin	58.27	55.49	30.33	17.44	157.95	136.00	145.22	150.00	170.70	9.56	8.10	9.16	9.76	8.23
Khasi mandarin	58.08	57.04	27.90	24.80	141.39	145.50	155.11	163.25	148.27	10.72	6.50	10.75	10.54	6.67
Darjeeling mandarin	60.95	70.50	24.97	21.95	153.64	152.50	139.11	155.16	112.30	10.79	8.30	9.04	9.90	7.64
CD at 5%	11.73	12.25	11.56	0.53	24.23	14.40	NS	1.29	5.17	NS	0.96	0.56	2.86	0.58
AKL-Akola, LDH-Ludhiana, SRG-Sriganganagar, TNK-Tinsukia, NGP-Nagpur														

Table-22: Quality performance of different mandarin cultivars at different centres

Varieties	Acidity (%)					Juice (%)			
	AKL	NGP	LDH	SRG	TNK	AKL	LDH	NGP	TNK
Mudkhed seedless	0.70	0.89	0.91	1.12	1.86	43.65	37.2	42.17	53.80
Nagpur seedless	0.71	0.72	0.77	1.07	1.74	41.78	37.9	48.84	35.00
Nagpur mandarin	0.64	0.75	0.87	1.06	1.84	43.78	34.2	42.54	36.36
Kinnow mandarin	0.75	0.72	0.81	0.92	1.50	-	47.3	38.62	35.71
Coorg mandarin	0.67	0.97	0.84	1.13	1.55	42.03	36.6	48.44	30.06
Khasi mandarin	0.65	0.62	0.79	1.26	1.04	42.11	35.6	42.18	32.19
Darjeeling mandarin	0.73	0.83	1.28	1.31	1.22	41.15	36.6	44.56	42.66
CD at 5%	NS	0.075	0.17	0.17	0.58	5.73	4.00	1.57	1.86
AKL-Akola, LDH-Ludhiana, SRG-Sriganganagar, TNK-Tinsukia, NGP-Nagpur									

(c) Acid lime

Five acid lime varieties *viz.*, Pramalini, Vikram, Jai-Devi, Sai Sharbati and Balaji have been evaluated at Tirupati.

Tirupati: The pooled mean (2016-20) data on biometric growth parameters of acid lime cultivars planted during 2011 indicated that, significantly maximum plant height (3.36 m) and canopy volume (25.98 m^3) were recorded in check variety Balaji followed by Vikram. Whereas, minimum growth was noticed in Pramalini cultivar. Significantly highest mean fruit yield (628 fruits/tree, 30.13 kg/tree, 8.35 t/ha) was recorded in Balaji followed by Jai-Devi cultivar (528 fruits/tree, 25 kg/tree, 6.92 t/ha). Fruit quality parameters were also found significant. Fruit juice content was also recorded maximum in Balaji acid lime clone (47.34 %) followed by Pramalini (46.64 %). Maximum acidity (6.89 %) and ascorbic acid (52.18 mg/100g) were noticed in Vikram clone (Table 23). Balaji and Jai-devi were accepted based on colour, texture and appearance by consumers followed by Sai Sharbati and Pramalini.

Table-23: Growth, yield and quality attributes of acid lime cultivars at Tirupati (2016-20)

Treatment	Plant height (m)	Stem Girth (cm)	Canopy volume (m^3)	Fruits/ tree	Fruit weight (g)	Yield (kg/ tree)	Juice (%)	TSS (°B)	Acidity (%)
T_1- Pramalini	2.76	37.30	16.76	461.55	49.95	21.71	46.64	8.67	6.63
T_2 – Vikram	3.11	44.43	25.24	354.20	46.06	15.94	44.50	8.38	6.89
T_3-Jai-Devi	3.00	41.08	22.87	528.43	48.45	24.99	46.46	8.74	6.75
T_4 - Sai Sharbati	2.90	40.37	20.85	485.33	48.41	23.36	45.27	7.82	6.74
T_5 – Balaji	3.36	41.77	25.98	628.48	48.23	30.13	47.34	8.01	6.71
CD at 5%	0.23	NS	3.76	110.07	NS	5.04	1.03	0.33	0.12

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, Clone11, Clone-12, Clone-13, Clone-14, Clone-15, Clone-16, Clone-17, Clone- 18, Clone-19, Clone-20.

Chettalli: Clone-8 was found to be superior among other clones with respect to total yield (22.41 kg/tree) and average fruit weight (124.52 g) compared to check-clone 11 (17.08 kg/tree, 98.32 g), whereas, quality parameters were recorded non-significant among the clones (Table 24).

Ludhiana: Among the different clones of Kinnow mandarin evaluated, Kinnow-11 recorded the maximum plant height (3.1 m) and canopy volume (9.8 m^3) and Kinnow 2 recorded minimum seeds (1.5/fruits). However Kinnow mandarin (check) registered maximum yield (59.0 kg/tree having 380.20 fruits/tree) (Table 25).

Tinsukia: Clone CRS-4 recorded maximum fruits per tree (48.0), fruit weight (137.4 g), yield (65.7 kg/tree) and TSS (11.4°B) with juicy fruits (52.03%) compared to check CRS 9 (20.0, 115.3 g, 23.15 kg/tree and 8.0°B with 49.68%) (Table 26).

Table-24: Growth, yield and quality characters of different clones of Coorg mandarin during 2020 at Chettalli

Clones	Plant height (m)	Fruits/tree	Yield (kg/tree)	Fruit weight (g)	Juice content (%)	Acidity (%)	Ascorbic acid (mg/100g)
Clone -1	3.42	163.1	18.21	92.32	42.5	0.36	33.9
Clone 2	3.34	172.8	17.02	93.21	41.0	0.39	27.3
Clone 3	3.21	115.9	21.32	102.51	43.2	0.29	30.6
Clone 4	3.39	143.6	16.31	89.22	36.8	0.25	29.5
Clone 5	3.31	179.2	19.21	97.35	47.6	0.38	28.3
Clone 6	3.37	152.6	17.25	102.8	51.0	0.41	22.4
Clone 7	3.42	174.7	19.23	94.13	41.2	0.29	34.5
Clone 8	2.81	211.5	22.41	124.52	52.4	0.22	32.8
Clone 9	3.23	116.4	13.48	96.18	41.6	0.36	29.9
Clone 10	3.39	128.6	15.22	98.35	43.9	0.36	31.3
Clone 11	3.31	164.5	17.08	98.32	41.2	0.33	26.7
Clone 12	3.33	121.8	14.32	97.21	39.6	0.36	27.4
Clone 13	3.41	138.6	17.91	102.19	35.6	0.33	29.4
Clone 14	3.29	158.9	19.36	103.21	36.5	0.35	32.4
Clone15	2.32	136.2	18.19	109.11	37.8	0.31	29.3
Clone16	3.28	118.6	16.42	104.21	41.3	0.39	31.9
Clone 17	3.21	108.3	14.41	89.15	39.6	0.31	32.5
Clone 18	3.32	137.4	17.22	97.46	41.9	0.36	29.8
Clone19	3.21	142.6	15.51	108.21	38.4	0.41	31.2
Clone 20	2.86	182.6	19.78	118.32	37.2	0.28	26.22
CD at 5%	NS	NS	8.76	21.31	NS	NS	NS

Table -25: Growth, yield and quality performance of Kinnow mandarin clones at Ludhiana

Clone	Plant height (m)	Canopy volume (m^3)	TSS (°B)	Acidity (%)	Fruit weight (g)	Fruits/ tree	Yield (kg/ tree)
Kinnow-1	2.8	7.9	8.9	0.77	171.2	309.3	52.9
Kinnow-2	2.9	8.1	9.1	0.98	153.0	308.3	47.2
Kinnow-3	2.7	9.2	9.2	0.80	144.8	307.3	44.5
Kinnow-4	2.8	9.4	9.5	0.88	141.0	334.5	47.2
Kinnow-5	2.9	9.4	8.4	0.86	154.0	346.2	53.3

Clone	Plant height (m)	Canopy volume (m^3)	TSS (°B)	Acidity (%)	Fruit weight (g)	Fruits/ tree	Yield (kg/ tree)
Kinnow-6	2.9	7.2	9.1	0.72	161.6	295.0	47.7
Kinnow-7	2.8	7.2	8.5	0.72	181.6	213.7	38.8
Kinnow-8	2.7	7.3	10.1	0.86	168.4	278.4	46.9
Kinnow-9	3.0	6.8	9.3	0.72	163.2	260.0	42.4
Kinnow-10	2.4	4.6	9.1	0.82	177.6	141.9	25.2
Kinnow-11	3.1	9.8	10.5	0.88	124.2	376.7	46.8
Kinnow (Check)	2.8	7.6	11.1	0.86	155.2	380.2	59.0
CD at 5%	0.2	1.7	0.8	0.08	15.5	64.5	8.0

Table-26: Growth, yield and quality performance of different clones of mandarin under Tinsukia conditions

Clone	Plant height (m)	Canopy volume (m^3)	Stem girth (cm)	Fruits/ tree	Yield (kg/ tree)	Yield (t/ ha)	Fruit weight (g)	Juice content (%)	TSS (°B)	Acidity (%)
CRS-1	5.06	26.82	23.80	15.00	16.94	6.78	113.32	42.17	8.3	0.8
CRS-2	4.32	22.31	20.62	35.00	44.20	17.68	126.55	38.19	9.2	0.7
CRS-3	4.51	28.06	21.53	11.00	13.61	5.44	123.71	31.37	10.1	1.0
CRS-4	6.45	40.54	25.26	48.00	65.76	26.30	137.40	52.03	11.4	0.6
CRS-5	5.04	25.34	21.00	21.00	25.11	10.04	119.30	36.24	9.7	0.9
CRS-6	5.92	30.94	24.53	17.00	18.72	7.48	110.45	34.69	8.3	1.2
CRS-7	5.30	25.20	20.71	18.00	20.80	8.32	116.91	46.13	9.1	0.8
CRS-8	4.61	24.00	22.30	29.00	35.83	14.33	123.63	52.80	9.3	0.8
CRS-9 (Local check)	4.84	22.72	22.86	20.00	23.15	9.26	115.33	49.68	8.0	0.7
CD at 5%	0.23	1.20	2.10	2.33	2.66	2.79	1.12	2.47	0.64	0.52

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: Performance of ten clones of sweet orange cultivar Malta was assessed against two check varieties viz., Pusa Sharad and Pusa Round for growth, yield and fruit quality traits. Plant height of selected clones varied from 4.30 m in MS-1 to 2.87 m in MS-17. Most of the clones had canopy diameter less than 4.5 meter except MS-1, MS-2 and MS-15 suggesting the suitability of their planting at 5 x 5 m distance *i.e.,* moderate plant density. Moreover, canopy volume varied from 45.74 m^3 in MS-17 to 226.72 m^3 in MS-1. Among these clones, fruit weight varied from 96.6 g in MS-15 to 310.00 g in MS-7 as compared to Pusa Sharad (193.33 g) and Pusa Round (162.33 g). MS-7 clone has yielded the maximum fruit yield (57.16 kg/tree) as compared to check varieties Pusa Sharad (53.11 kg/ tree) and Pusa Round (45.69 kg/tree) (Table 27).

Rahuri: Of the ten promising clones of sweet orange cv. Mosambi evaluated, the maximum plant height (3.45 m), canopy volume (15.30 m^3), scion girth (46.50 cm), number of fruits (241.30 fruits/tree) and yield (44.11 kg/tree, 12.21 t/tree) were recorded in Clone-7. For quality parameters, significantly the maximum juice (47.90 %), TSS (9.95°B) with minimum acidity (0.35 %), TSS: Acidity (29.11) and ascorbic acid (55.83 mg/100 ml juice) were recorded in the same clone after 8.5 years of planting (Table 28).

Tirupati: Among the six promising clones of sweet orange cv. Sathgudi evaluated along with local check Sathgudi, the clone TS_6 recorded the maximum plant height (2.56 m), scion girth (48.00 cm), canopy volume (12.94 m^3), number of fruits per tree (277.67) and yield (42.58 kg/plant, 11.80 t/ha) after twelve years of planting (Table 29).

Table- 27: Growth, yield and fruit quality attributes of sweet orange clones at New Delhi

Clones	Plant height (m)	Canopy volume (m^3)	Fruit weight (g)	Yield (kg/tree)	Juice (%)	TSS (ºB)	Ascorbic acid (mg/100 ml juice)
MS-1	4.30	226.72	293.33	55.35	55.11	7.88	44.88
MS-2	3.50	144.13	136.67	28.26	58.25	8.12	47.70
MS-4	3.35	95.31	216.67	45.82	53.52	7.54	35.68
MS-7	3.33	98.30	310.00	57.16	53.67	7.26	43.82
MS-8	3.57	91.94	112.33	25.31	52.49	7.86	44.53
MS-9	3.73	98.98	275.00	53.14	58.56	7.68	48.22
MS-10	3.50	91.54	165.00	45..26	53.06	7.10	46.11
MS-15	3.58	107.69	96.67	24.88	37.56	8.62	56.50
MS-17	2.87	54.74	115.67	28.24	57.22	7.32	44.88
MS-21	3.33	106.99	212.33	50.21	47.94	7.30	51.22
Pusa Sharad	3.77	120.40	193.33	53.11	50.64	7.02	48.75
Pusa Round	3.70	139.96	162.33	45.69	50.91	6.80	46.46
CD at 5%	0.40	24.02	31.286	9.31	6.68	0.71	5.16

Table-28: Growth, yield and quality attributes of different clones of sweet orange at Rahuri

Clones	Rahuri (Age: 8.5 years)			
	Plant height (m)	Canopy volume (m^3)	Fruits/tree	Yield (kg/tree)
Clone 1	2.88	11.90	214.70	35.47
Clone 2	3.05	12.40	220.40	37.20
Clone 3	3.40	14.80	234.50	42.02
Clone 4	3.20	13.20	226.90	38.3
Clone 5	3.32	14.10	231.60	40.11
Clone 6	2.40	10.99	194.00	31.77
Clone 7	3.45	15.30	241.30	44.11
Clone 8	2.96	10.90	198.90	32.42
Clone 9	2.82	12.10	217.20	36.31
Clone 10	2.67	10.86	188.50	37.09
Phule Mosambi check	2.80	12.50	214.80	39.80
CD at 5%	0.33	1.10	7.15	2.76

Table-29: Growth, yield and quality attributes of different clones of sweet orange at Tirupati

Clones	Tirupati (Age: 12 years)								
	Plant height (m)	Scion girth (cm)	Canopy volume (m3)	Fruits/ tree	Fruit yield (kg/tree)	Juice (%)	TSS (°B)	Acidity (%)	TSS: Acidity
TS_1	1.84	33.50	5.63	75.67	11.90	43.95	9.30	0.47	20.17
TS_2	2.05	36.75	7.41	89.33	13.85	44.76	9.20	0.58	15.97
TS_3	1.99	35.50	7.49	148.67	22.55	46.40	10.33	0.60	17.50
TS_4	2.29	40.50	10.54	161.33	24.57	42.83	9.70	0.58	16.74
TS_5	2.11	40.00	9.38	139.33	21.25	41.48	9.97	0.60	16.61
TS_6	2.56	48.00	12.94	277.67	42.58	45.11	10.27	0.57	18.29
TS_7 (Sathgudi)	2.30	47.00	11.95	180.33	27.01	47.13	9.63	0.62	15.75
CD at 5%	0.05	1.35	0.44	15.67	2.68	1.63	0.46	NS	NS

TS_1 : Venkata Reddy Gari Palle, Tadepatri (Mandal) Ananthapur ; TS_2 : Ammavaripeta, B.K. Samudram (Mandal) Ananthapur ; TS_3 : Madugula Tipparthi (Mandal) Nalgonda, TS_4: Peddavuru Vill & Mandal, Nalgonda; TS_5: Veligandla (Vill & Mandal) Prakasam; TS_6: Cheruvukomuu palem, P.C. Palle (Mandal) Ananthapur ; TS_7: Sathgudi (Check)

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: Among 17 acid lime genotypes also with 02 check varieties evaluated, the genotype ALC-4 genotype recorded the maximum fruit weight (45.38 g). Whereas, the check variety Pusa Udit recorded the maximum number of fruits/tree (433.33) and the check variety Pusa Abhinav recorded the maximum yield (17.49 kg/tree and 10.93 t/ha). For quality attributes, the genotype ALC-5 recorded the maximum juice (43.37 %) with minimum rind thickness (0.76 mm) and the check variety Pusa Abhinav recorded the maximum TSS (8.62ºB). However, the genotype ALC-113 recorded the maximum acidity (6.06 %). The ALC-83 genotype recorded the maximum ascorbic acid (32.20 mg/100 g) and the ALC-101 genotype recorded the minimum seeds/fruit (3.80) after 6 years of planting (Table 30).

Rahuri: Among nine acid lime clones, the clone No.4 recorded the maximum plant height (3.23 m), canopy volume (19.20 m^3), stem girth (45.70 cm), fruit weight (47.20 g), number of fruits per tree (1096.60) and yield (51.74 kg/tree and 14.32 t/ha). Whereas, with respect to yield and fruit quality performance, the same clone *i.e.* Clone no. 4 recorded 4.06 % increase in yield over control also recorded the maximum ascorbic acid (40.80 mg/100 ml juice) with minimum rind thickness (1.60 mm). The check variety Phule Sharbati recorded significantly the maximum juice (50.30 %), TSS (7.22 ºB), acidity (6.80 %) with minimum seeds/fruit (6.20) and weight of seeds/fruit (0.50 g) after 9.5 years of planting (Table 31).

Tirupati: Among 37 acid lime clones and 01 check variety, the clone TAL 94/8 recorded the maximum fruit weight (49.18 g). Whereas, the clone CRS-1 recorded the maximum number of fruits/tree (1763) and yield (80.52 kg/tree and 22.30 t/ha). For quality parameter, the acid lime clone BKS-4 recorded the maximum juice (51.34 %). The clone TAL 94/17 recorded the maximum TSS (9.25°B). The acid lime clone KL-12 recorded the minimum rind thickness (0.86 mm) and the acid lime clone C.R.S.-1 recorded the minimum canker disease incidence (3.17) after 7 years of planting (Table 32).

Table-30: Growth and yield performance of different genotypes of acid lime at New Delhi

Genotype	Plant height (m)	Canopy volume (m^3)	Stem girth (cm)	Fruit weight (g)	Fruits / tree	Yield (kg/tree)	Yield (t/ha)	Juice (%)	TSS (ºB)	Acidity (%)	Ascorbic acid (mg/ 100 g)
ALC-4	2.90	109.67	28.67	45.38	268.33	12.18	7.61	21.23	7.78	5.57	28.89
ALC-5	3.40	172.22	35.00	43.55	87.67	3.82	2.39	43.37	7.08	5.46	25.84
ALC-11	3.34	166.53	32.67	25.04	98.33	2.46	1.54	36.20	7.32	4.35	22.24
ALC-13	3.35	134.25	46.33	23.81	188.33	4.48	2.80	31.83	8.10	5.67	19.53
ALC-15	3.08	147.48	39.00	32.07	216.67	6.95	4.34	32.75	7.10	5.08	23.63
ALC-21	3.60	155.60	44.00	35.44	263.33	9.33	5.83	42.01	7.20	5.38	24.30
ALC-24	3.02	130.44	35.33	34.31	80.67	2.77	1.73	39.63	7.68	5.29	21.69
ALC-35	3.18	146.59	35.67	37.68	70.00	2.64	1.65	35.02	7.80	5.42	21.00
ALC-50	3.63	146.93	40.00	33.42	133.33	4.46	2.78	35.65	7.24º	5.80	22.02
ALC-52	2.94	117.30	30.67	30.82	56.67	1.75	1.09	29.39	7.00	5.12	20.75
ALC-56	2.92	108.09	39.00	30.40	230.33	7.00	4.38	35.21	6.98	5.63	22.49
ALC-59	3.07	108.21	31.00	30.92	28.33	0.88	0.55	27.87	8.32	5.93	30.83
ALC-67	2.92	115.29	35.33	25.18	193.33	4.87	3.04	36.69	7.50	5.55	20.84
ALC-73	2.97	136.44	32.67	32.26	166.67	5.38	3.36	34.23	7.56	5.59	19.10
ALC-83	2.88	92.90	32.67	30.55	241.67	7.38	4.61	28.04	7.62	5.42	32.20
ALC-101	2.50	91.94	28.67	35.59	263.33	9.37	5.86	36.50	7.42	5.89	28.47
ALC-113	3.11	109.64	35.33	33.07	253.33	8.38	5.24	31.01	7.78	6.06	26.21
Pusa Abhinav	3.12	145.84	35.00	40.84	428.33	17.49	10.93	38.62	8.62	5.50	21.20
Pusa Udit	3.14	134.26	44.00	37.76	433.33	16.36	10.23	31.34	7.38	5.80	26.47
CD at 5%	0.38	53.42	6.76	6.53	65.96	2.35	2.36	7.94	0.68	0.46	2.18
Tree age : New Delhi - 6 years											

Table -31: Growth, yield and quality performance of different clones of acid lime at Rahuri

Treatment (Clones)	Plant height (m)	Canopy volume (m3)	Stem girth (cm)	Fruit weight (g)	Fruits/ tree	Yield (kg/ tree)	Yield (t/ ha)	Yield efficiency (kg/m^3)	Juice (%)	TSS (°B)	Acidity (%)
Clone no.1	2.63	14.60	33.35	38.70	1023.40	39.60	10.96	2.70	36.45	6.00	4.85
Clone no.2	3.01	15.67	35.15	43.80	1044.60	45.74	12.66	2.91	41.30	6.90	6.20
Clone no.3	3.16	17.63	42.30	45.60	1069.40	48.73	13.49	2.76	43.95	7.00	6.52
Clone no.4	3.23	19.20	45.70	47.20	1096.60	51.74	14.32	2.72	47.62	7.10	6.60
Clone no.5	2.99	15.50	37.40	41.40	1041.40	43.11	11.93	2.78	39.39	6.84	6.02
Clone no.6	2.82	14.80	32.90	42.70	1035.60	44.23	12.25	2.99	40.74	6.81	5.80
Clone no.7	2.12	8.00	29.80	32.90	752.00	24.73	6.84	3.65	33.40	6.11	5.15
Clone no.8	2.36	9.06	35.66	39.80	766.00	30.47	8.43	3.49	38.25	6.64	5.62
Clone no.9	2.60	10.81	33.25	40.50	780.20	31.63	8.75	2.96	39.17	6.25	5.36
Phule Sharbati (check)	3.10	18.75	43.90	46.00	1073.40	49.72	13.76	2.66	50.30	7.22	6.80
CD at 5 %	0.37	2.90	4.48	4.73	109.55	6.87	1.90	NS	3.69	0.19	0.30
Tree age : Rahuri - 9.5 years											

Table-32: Growth, yield and quality performance of different acid lime clones at Tirupati

Acid lime clones	Plant height (m)	Canopy volume (m^3)	Stem girth (cm)	Fruit weight (g)	Fruits/ tree	Yield (kg/tree)	Yield (t/ha)	Juice (%)	TSS (°B)	Acidity (%)
TAL94/13	2.42	12.65	37.00	46.84	852	39.92	11.06	46.05	7.65	5.37
TAL 94/14	1.97	7.32	29.67	46.72	646	30.19	8.36	40.70	8.65	6.01
TAL 94/10	2.17	9.02	23.83	45.62	426	19.60	5.43	49.92	8.85	5.80
RHRL 49	3.00	26.50	43.67	45.74	689	31.53	8.73	46.63	9.05	9.00
TAL94/17	2.25	10.66	33.67	45.38	696	31.59	8.75	45.60	9.25	5.80
TAL95/3	2.15	11.70	40.33	33.23	522	17.37	4.81	46.50	8.55	5.80
TAL 94/4	2.08	7.91	36.33	47.37	426	20.19	5.59	45.45	9.25	5.80
TAL 94/5	2.00	7.99	29.00	45.34	1039	47.14	13.06	45.33	8.85	5.80
RHRL 124	2.47	18.36	39.33	42.40	613	26.00	7.20	44.90	8.45	5.26
TAL 95/1	2.08	8.60	32.33	46.28	1226	56.76	15.72	43.79	7.95	6.87
TAL 94/7	2.33	11.78	33.33	44.15	663	29.30	8.12	40.82	7.45	6.80
TAL 94/8	2.67	13.12	36.33	49.18	511	25.15	6.97	49.20	8.85	4.73
RHRL 159	2.67	22.32	36.33	47.63	1200	57.18	15.84	44.80	8.55	4.73
TAL 95/2	2.15	9.23	31.33	46.21	681	31.50	8.73	40.90	9.25	5.36
TAL 94/9	2.12	6.70	29.33	44.34	695	30.83	8.54	44.20	7.15	6.72
Slection - 18	2.83	22.38	49.67	39.61	723	28.66	7.94	34.80	8.75	6.86
Slection - 30	2.50	14.18	41.00	44.92	913	41.04	11.37	44.80	8.25	6.33
RHRL - 122	2.25	15.98	39.33	45.37	976	44.33	12.28	44.20	7.95	6.87
K.L - 12	2.55	15.97	37.00	44.67	710	31.74	8.79	45.50	8.85	7.40
Punjab lime	2.60	16.29	35.33	48.00	1140	54.75	15.16	49.20	7.55	6.30
Sel - 8	2.95	23.85	41.67	38.14	1053	40.18	11.13	36.00	8.75	5.93

Acid lime clones	Plant height (m)	Canopy volume (m^3)	Stem girth (cm)	Fruit weight (g)	Fruits/ tree	Yield (kg/tree)	Yield (t/ha)	Juice (%)	TSS (°B)	Acidity (%)
TAL - 94/11	2.55	14.57	38.00	40.81	984	40.18	11.13	46.20	7.95	6.87
SEL -21	2.50	13.38	39.00	46.60	1026	47.80	13.24	46.34	8.55	5.37
SEL -33	2.50	14.39	35.33	43.05	616	26.56	7.36	44.43	6.65	5.37
SEL - 32	2.83	17.31	43.00	46.00	699	32.18	8.91	49.60	8.75	5.27
SEL -27	2.65	19.31	36.33	47.76	847	40.49	11.22	47.20	7.71	6.86
SEL - 7	3.00	19.49	38.67	46.11	833	38.42	10.64	48.80	8.35	6.30
SEL - 25	3.08	26.88	46.33	48.37	827	40.04	11.09	47.09	7.55	5.80
B.K.S - 4	2.43	11.87	33.00	46.00	721	33.21	9.20	51.34	8.85	4.73
SEL - 17	2.73	18.61	42.00	46.77	592	27.73	7.68	48.10	8.75	5.80
SEL-20	2.73	20.26	49.00	46.26	940	43.53	12.06	45.20	8.05	5.80
SEL - 16	2.83	21.78	38.67	47.68	1023	48.79	13.51	49.00	7.55	7.40
SEL - 3	2.77	18.09	39.33	45.49	852	38.80	10.75	44.75	8.65	6.20
Nalgonda	2.32	7.80	34.67	47.48	690	32.80	9.08	47.42	8.25	5.30
P.K.M - 1	3.00	20.80	41.33	43.99	614	27.01	7.48	42.63	7.77	5.75
Balaji	2.62	16.76	42.00	45.33	816	37.04	10.26	48.80	8.15	6.33
C.R.S - 1	3.02	23.22	48.00	45.67	1763	80.52	22.30	45.86	8.55	5.60
Local	2.17	10.80	33.67	44.32	622	27.58	7.64	47.76	7.15	6.30
Max	3.08	26.88	49.67	49.18	1763	80.52	22.30	51.34	9.25	9.00
Min	1.97	6.70	23.83	33.23	426	17.37	4.81	34.80	6.65	4.73
CD at 5 %	0.25	2.57	3.38	1.41	23.57	1.19	0.33	3.73	0.01	0.01
Tree age : Tirupati - 7 years										

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 (462.50 fruits /tree & 70.69 kg/tree), whereas clone N- 28 recorded highest juice percentage (44.93%).

Ludhiana: Among all the mandarin clones, maximum height (4.32 m) was recorded in N-34 and the maximum canopy volume was recorded in Kinnow (33.4 m^3).

Nagpur: Clone N-4 recorded the maximum plant height (3.58 m) while, Nagpur mandarin registered the maximum canopy volume (32.76 m^3). The clone 11 recorded maximum fruit weight (147.67 g) and juice content (44.59%) and N-4 recorded minimum number of seeds (1.00 /fruit).

Sriganganagar: Clone N-34 recorded maximum fruit weight (146.33 g) and TSS (10.3^{0}B) however, Clone N-28 registered significantly higher yield (7.06 t/ha) among the clones evaluated (Table 33).

Tinsukia: The maximum values for growth parameters (plant height 4.25 m and canopy volume 24.31 m^3) were recorded in clone N-51. The maximum number of fruits per tree (126) and TSS (10.67°B) with lowest acidity (1.12%) were observed in CRS-4. However only clone N-4 recorded maximum values for the yield (22.66 kg/tree).

Table-33: Yield and quality attributes of mandarin clones at different centres

Clones	Fruits/tree		Tield (kg/tree)		TSS (°B)				Juice (%)		
	AKL	TNK	AKL	TNK	AKL	NGP	SRG	TNK	AKL	NGP	NK
N-4	376.17	115	57.08	22.66	10.25	8.42	9.67	8.78	43.90	41.40	36.24
N-28	368.33	84	54.53	13.33	9.95	8.80	9.53	8.32	44.93	41.74	42.61
N-34	462.50	113	70.69	18.42	10.60	10.36	10.30	9.01	43.43	37.32	40.16
N-38	264.17	100	38.88	16.73	9.90	8.37	10.27	9.65	44.62	39.70	46.32
N-43	434.50	105	63.19	14.91	10.90	9.18	9.80	8.86	44.62	37.34	39.50
N-51	350.25	110	56.32	15.46	10.25	8.77	10.23	9.76	44.02	42.13	35.00
Mandarin-182	447.00	89	66.89	15.05	11.02	8.32	10.10	8.50	44.75	37.28	32.34
CRS- 4	300.25	126	5.94	20.42	10.70	8.97	8.07	10.67	43.02	40.25	45.68
Clone-11	409.33	96	63.28	14.26	11.00	8.76	9.87	8.40	42.0	44.59	41.22
Nagpur mandarin	395.25	-	62.54	-	10.80	8.14	-	-	44.02	38.80	-
Kinnow mandarin	-	-	-	-	-	-	-	-	-	-	-
CD at 5%	106.6	1.60	12.71	1.8	0.09	0.4314	1.06	2.75	2.52	2.007	1.94
AKL-Akola, LDH-Ludhiana, NGP-Nagpur, SRG-Sriganganagar, TNK-Tinsukia											

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 plant height (3.20 m), canopy volume (22.9 m^3), number of fruits per tree (358.3) and yield (62.6 kg/plant) were recorded in Kodur sathgudi. The maximum TSS was recorded in M-8 Clones and Phule Mosambi (9.0°B).

Nagpur: The maximum plant height was recorded by Phule Mosambi (3.02 m). Maximum canopy volume was recorded by Shamouti orange (23.72 m^3). The maximum of 402 fruits per plant were recorded by M-4. Shamouti orange recorded maximum fruit weight (225.78 g), whereas Kodur sathgudi recorded the maximum TSS (10.32°B). The highest juice content (39.71%) was recorded in Phule Mosambi.

Rahuri: Promising clone Phule Mosambi recorded significantly the maximum plant height (2.80 m), canopy volume (12.50 m^3), scion girth (38.60 cm), fruit weight (185.40 g), number of fruits per tree (215) and yield (39.80 kg/tree and 11.02 t/ha) as compared to other promising clones of sweet orange. There was non-significant difference between the treatments for yield efficiency. The promising clone Phule Mosambi recorded 13.47 % increase in yield over check also recorded significantly the maximum juice (43.20 %), TSS (9.10°B), TSS: Acid (22.74), ascorbic acid (52.60 mg/100 ml juice), reducing sugars (4.10 %), non-reducing sugars (3.05 %), total sugars (7.15 %) with minimum acidity (0.40 %), rind (30.62 %) and rag (15.90 %).

Tirupati: There was no significant difference for growth parameters, however, maximum canopy volume (13.98 m^3) was noticed in M-8 clone. Significantly highest fruit yield (130 fruits/plant, 19.98 kg/plant, 5.54t/ha) and fruit weight (156.14g) were recorded in Kodur Sathgudi clone followed by Phule Mosambi clone (108 fruits/plant, 16.79 kg/plant, 4.65 t/ha) and Phule Mosambi (37.06 kg/plant) clones. However, highest yield efficiency was noticed in M3 clone (1.96 kg/m3) followed by Kodur Sathgudi clone. There was 66 % increase in yield in Kodur Sathgudi clone followed by Phule Mosambi (39.64 %) (Table 34 & 35).

Table-34: Growth performance of promising clones of sweet orange at different centres

Clones	Plant height (m)				Canopy volume (m^3)			
	Ludhiana	Nagpur	Rahuri	Tirupati	Ludhiana	Nagpur	Rahuri	Tirupati
Phule Mosambi	3.0	3.02	2.80	2.26	15.1	18.75	12.50	10.44
M-3	3.0	2.82	2.26	2.03	13.2	15.43	9.60	8.50
M-4	3.0	2.71	2.39	2.35	21.7	14.57	10.20	11.95
M-8	2.9	2.85	2.77	2.35	16.5	14.10	11.90	13.98

Clones	Plant height (m)				Canopy volume (m^3)			
	Ludhiana	Nagpur	Rahuri	Tirupati	Ludhiana	Nagpur	Rahuri	Tirupati
Kodur Sathgudi	3.2	2.72	2.35	2.26	22.9	13.10	9.88	10.40
Shamouti orange	-	3.00	2.60	2.53	-	23.72	10.60	11.82
Local checks *	3.3	3.00	2.78	2.15	20.0	20.38	12.10	8.92
CD at 5%	0.14	0.23	0.38	NS	6.15	8.80	2.09	NS
Local checks: *Mosambi at Nagpur, Ludhiana & Rahuri * Sathgudi at Tirupati								

Table-35: Yield and quality performance of promising clones of sweet orange at different centres

Clones	Fruits/tree				Yield (kg/tree)			TSS (°B)			
	Ludhiana	Nagpur	Rahuri	Tirupati	Ludhiana	Rahuri	Tirupati	Ludhiana	Nagpur	Rahuri	Tirupati
Phule Mosambi	156.2	336.67	214.80	107.50	23.6	39.80	16.79	9.0	8.99	9.10	8.13
M-3	141.3	360.00	163.25	95.83	24.2	26.27	14.66	8.6	10.00	7.26	7.83
M-4	212.1	402.00	192.45	76.92	35.1	31.35	11.94	8.5	10.12	8.33	8.20
M-8	178.1	340.33	208.30	81.25	26.7	32.34	12.37	9.0	8.59	9.00	8.00
Kodur Sathgudi	358.3	308.33	188.60	13.03	62.6	31.04	19.98	8.9	10.32	7.86	8.60
Shamouti orange	-	305.00	198.50	-	-	31.49	-	-	7.62	8.40	-
Local checks*	262.3	308.33	210.40	77.44	45.1	35.11	12.03	8.7	9.12	9.00	8.63
CD at 5%	74.13	43.454	35.86	8.56	13.94	7.14	1.13	0.2	0.36	0.76	0.11
Local checks: *Mosambi at Nagpur, Ludhiana & Rahuri * Sathgudi at Tirupati											

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

A trial has been initiated to evaluate eight promising clones *viz*., TAL-94/13 and TAL-94/14 from Tirupati, Phule-Sharbati 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: Maximum plant height (3.02 m), canopy volume (9.41 m^3) and number of fruits per plant (718.67) was recorded in Akola lime (PDKV lime) (Table 36).

Nagpur: Among all the clones evaluated highest number (485 fruits/plant) was harvested in TAL-94/13, followed by Phule Sharbati (463 fruits/plant).

Periyakulam: The clone NRCC Nimboo–3 recorded the maximum plant height (4.10 m), canopy volume (33.16 m^3) and number of fruits (325.20).

Rahuri: The clone NRCC Nimboo-3 recorded the maximum plant height (3.08 m) and canopy volume (18.95 m^3). However, the maximum number of fruits per tree (911.09) was recorded in clone TAL-94/14.

Tirupati: Although non-significant differences were recorded in growth parameters, Balaji clone recorded maximum number of fruits per tree (988.67).

Table-36: Growth and yield parameters of acid lime clones

Clones	Canopy volume (m^3)					Fruits/tree				
	Akola	Nagpur	PKM	Rahuri	Tirupati	Akola	Nagpur	PKM	Rahuri	Tirupati
TAL-94/13	4.63	9.64	12.80	14.75	17.46	160.83	485.0	80.56	719.50	699.67
TAL-94/14	2.53	8.02	20.94	17.25	21.05	403.50	375.3	140.38	911.09	917.33
Phule Sharbati	5.35	17.14	6.11	16.10	19.40	461.33	463.0	72.50	782.52	707.67
Akola lime (PDKV lime)	9.41	14.56	6.84	13.25	17.02	718.67	425.2	48.36	730.60	928.67
NRCC, Nimboo-2	4.10	12.41	10.48	15.20	26.64	520.50	407.5	120.58	772.02	772.67
NRCC, Nimboo-3	4.00	14.45	33.16	18.95	22.45	635.50	426.0	325.20	745.50	770.33
NRCC, Nimboo-4	4.91	12.48	25.52	12.05	15.02	497.00	430.7	136.28	693.20	453.00
KL-12	1.91	17.23	24.50	15.60	14.87	204.67	339.2	70.56	752.02	541.33
K. lime local	0.96	10.62	-	-	-	279.67	339.7	-	-	-
PKM-1	-	-	16.38	-	-	-		248.60	-	-
Sai Sharbati	-	-	-	16.00	-	-		-	776.50	-
Balaji	-	-	-	-	25.03	-		-	-	988.67
CD at 5%	0.37	4.45	6.40	5.35	NS	87.06	23.49	40.36	193.34	96.13
PKM: Periyakulam										

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

A trial has been 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 plant height (4.8m) was recorded in NRCC P-3 clone, whereas, maximum canopy volume (47.6 m^3) was recorded in NRCC P-2. Maximum fruit number per tree was recorded in NRCC P-3 (143 fruits/tree) closely followed by NRCC P-2(141 fruits/tree). Largest fruits were noticed in NRCC P-5 (1156 g) with maximum juice content (36.2%). Maximum yield per hectare was recorded in PTF-4 (12.8t/ha) with 23.83% increase in yield over check and minimum in NRCC P-1(3 t/ha). Organoleptic rating was maximum in NRCC P-2 with high TSS (9.3°B). Lowest seed number per fruit (61) was recorded in PTF-1 clone and acidity was very low (0.72%) in NRCC P-4 clone.

Nagpur: The maximum plant height was recorded in NRCC P–1 (4.60 m), maximum canopy volume (36.20 m^3) was observed in NRCC P – 5. Highest number of fruits per tree (257) were recorded in PTF-2 and maximum fruit weight (1478.67 g) was recorded in NRCC P-5 followed by in PTF-1 (1065.67 g). On the contrary, in PTF -3 the lowest fruit weight of 418.67g. TSS ranged from 6.27°B to 12.43°B and acidity ranged between 0.98 % to 1.34%.

Tinsukia: Significantly maximum plant height (5.64 m) and canopy volume (27.53 m^3) were recorded in NRCC Pummelo-4 clone**.** Maximum number of fruits per tree was recorded in NRCC P-4 (122 fruits/tree) closely followed by NRCC P-3 (110 fruits/tree) Maximum yield per hectare was recorded in NRCC P -3 (52.36 t/ha) with largest fruits (1930 g) and also there was 211% increase in yield over check.

Tirupati: Among nine pummelo clones, NRCC Pummelo -2 clone recorded significantly highest plant height (3.12 m) whereas, highest canopy volume (18.83 m^3) was recorded in PTF-2 clone. Significantly maximum number of fruits and fruit yield were recorded in NRCC Pummelo -5 clone (93 fruits/plant, 83.83 kg/plant, 23.22 t/ha). There was 118 % increase in yield compared to Pummelo pink (check). Highest juice content was recorded in NRCC Pummelo -1 (36.19%) and maximum TSS was recorded in NRCC Pummelo -5 clone (13.07°B) (Table 37 & 38).

Table-37: Growth and yield performance of promising clones of pummelo

Clone	Plant height (m)				Canopy volume (m^3)				Fruit/tree		
	LDH	Nagpur	TNK	TPT	LDH	Nagpur	TNK	TPT	LDH	Nagpur	TPT
PTF- 1	4.0	3.77	3.04	1.88	33.2	30.54	11.43	9.95	68.3	133.33	29.67
PTF- 2	3.1	3.37	2.91	2.87	22.6	30.65	10.91	18.83	72.0	256.67	10.67
PTF- 3	3.5	2.73	2.84	2.44	21.0	20.21	9.19	3.84	43.0	84.33	-
PTF- 4	4.0	2.65	3.12	2.04	27.6	19.67	11.31	3.5	132.0	46.33	-
NRCC P -1	2.0	4.60	4.76	2.25	6.3	32.53	21.89	8.41	62.5	109.67	28.00
NRCC P -2	4.6	4.31	4.33	3.12	47.6	28.26	20.14	16.81	141.2	120	79.33
NRCC P -3	4.8	3.23	3.69	2.14	44.3	22.36	16.16	6.50	142.7	103	87.33
NRCC P -4	3.8	3.28	5.64	1.68	16.1	27.22	27.53	1.71	79.3	116.33	35.33
NRCC P -5	3.6	3.45	3.73	2.83	25.7	36.20	14.85	11.98	78.3	120.67	92.67
Local Check*	3.3	-	3.38	3.33	19.6	-	13.56	31.76	94.1	-	65.00
CD at 5%	0.75	0.62	1.03	0.58	3.97	7.62	1.55	7.51	33.41	39.87	14.93
LDH-Ludhiana: 8-year-old; TPT-Tirupati: 8 years old; *local check: White pummel at Ludhiana, Rabab Tanga at Tinsukia (TNK) and pummelo pink at Tirupati											

Table-38: Growth and yield performance of promising clones of pummelo

Clones	TSS (°B)				Acidity (%)			
	Ludhiana	Nagpur	Tinsukia	Tirupati	Ludhiana	Nagpur	Tinsukia	Tirupati
PTF- 1	8.0	8.30	6.8	11.03	0.88	1.21	0.77	0.74
PTF- 2	8.4	6.27	8.4	11.07	1.33	1.68	0.80	0.82
PTF- 3	8.3	11.07	7.8	-	1.54	1.06	0.65	-
PTF- 4	8.3	12.43	8.1	-	1.12	1.04	0.73	-
NRCC P -1	8.7	8.07	7.0	8.50	0.80	0.98	0.55	0.75
NRCC P -2	9.3	8.67	7.0	11.70	0.88	1.34	0.50	0.71
NRCC P -3	7.3	8.67	7.0	11.87	0.83	1.02	0.64	0.78
NRCC P -4	7.4	10.47	8.0	10.33	0.72	0.69	0.53	0.79
NRCC P -5	8.4	8.37	8.0	13.07	1.70	1.59	0.66	0.70
Local Check*	9.1	-	7.0	9.47	1.18	-	0.71	0.82
CD at 5%	0.6	0.95	0.79	1.29	0.32	0.09	0.66	0.08
Ludhiana: 8-year-old; Tirupati: 8 years old; *local check: White pummelo at Ludhiana, Rabab Tanga at Tinsukia and pummelo pink at Tirupati								

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, NRCC6 grapefruit, Star Ruby, Red Blush, Imperial, Foster and Marsh Seedless with local check for growth, yield and quality characters at different centres.

Chettalli: The different grapefruit genotypes did not differ significantly for either of the three growth attributes during the reporting period.

Ludhiana: The maximum plant height (1.29 m) and canopy volume (1.13 m^3) were recorded in the clone NRCC grapefruit-6, while the maximum stem girth was noted in Flame grapefruit (13.3 cm). The NRCC grapefruit-6 and Flame grapefruit were statistically on par with each other for the above-mentioned growth attributes at this centre.

Rahuri: The maximum plant height (1.73 m), canopy volume (3.25 m^3) and stem girth (21.37 cm) were recorded in Imperial grapefruit. The lowest plant height (1.25 m), canopy volume (0.85 m^3) and stem girth (15.00 cm) were recorded in Red Blush. At this centre, the plants of Imperial, Foster and NRCC Grapefruit-6 bore some fruits in the year 2020.

Nagpur: The maximum plant height (1.49 m) and canopy volume (3.2 m^3) was recorded in Red Blush grapefruit. The stem girth though was found maximum in Marsh Seedless (23.25 cm) but it was statistically on par with Red Blush. At this centre, the grapefruit genotypes produced 9.33 (Marsh Seedless) to 13.67 fruits/ plant (Red Blush) this year. The fruit weight ranged from 205 (for Star Ruby) to 477.67 (for NRCC grapefruit-6). The maximum fruit juice (38.01%) was obtained in the Flame grapefruit. All other quality attributes of Flame grapefruit (seeds: 2.0, TSS: 8.17°B and acidity: 0.89%) were either superior or statistically on par with the superior genotype.

Tinsukia: The Local check had the maximum plant height (1.40 m). Whereas, maximum canopy volume (2.29 m^3) and stem girth (4.0 cm) were obtained in Star Ruby grapefruit.

Tirupati: The grapefruit varieties significantly differed for plant height but were statistically similar for the other two growth attributes *viz.*, canopy volume and stem girth. The maximum plant height was recorded in Red Blush (1.95 m) which was significantly higher over two grapefruit varieties namely Flame, Imperial and Star Ruby (Table 39).

Table-39: Growth performance of promising clones of grapefruit

Clone	Plant height (m)						Canopy volume (m^3)					
	CHL	LDH	NGP	RHR	TNK	TPT	CHL	LDH	NGP	RHR	TNK	TPT
Flame grapefruit	1.97	1.25	1.25	1.27	1.00	1.29	0.41	1.06	0.92	1.05	0.95	3.06
NRCC grapefruit-6	1.82	1.29	1.20	1.61	1.18	1.77	0.34	1.13	1.69	2.20	2.20	5.54
Star ruby	1.57	0.97	1.39	1.42	0.90	1.20	0.53	0.38	2.27	1.71	2.29	2.66
Red blush	1.64	0.79	1.49	1.25	0.90	1.95	0.71	0.15	3.20	0.85	1.35	7.31
Imperial	1.35	0.50	0.91	1.73	-	1.03	0.09	0.11	0.46	3.25	-	0.90
Foster	0.91	0.91	0.84	1.48	-	1.37	0.09	0.34	0.51	2.07	-	3.44
Marsh seedless	1.76	0.87	1.35	1.42	0.70	-	0.26	0.21	2.54	1.52	0.79	-
Local Check*	1.64	-	-	-	1.22	-	0.47	-	-	-	1.53	
CD at 5%	NS	0.31	0.33	0.17	-	0.61	NS	0.28	1.27	1.58	-	NS
CHL-Chettalli, LDH-Ludhiana, NGP-Nagpur, RHR-Rahuri, TNK-Tinsukia, TPT-Tirupati												

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, Chettalli, Ludhiana, Sriganganagar, Tinsukia and Nagpur.

Akola: The average plant height of Nagpur mandarin plant was 2.26 m while PDKV mandarin recorded 2.13 m. PDKV mandarin recorded maximum canopy volume (1.51 m^3).

Ludhiana: Kinnow mandarin recorded significantly maximum plant height (2.48 m) and canopy volume (8.18 m^3).

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

Sriganganagar: Nagpur mandarin recorded maximum plant height (2.66 m), whereas Kinnow mandarin recorded maximum canopy volume (5.19 m^3).

Tinsukia: No significant difference reported 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, Sriganganagar and Arabhavi (Vijaypura) has been initiated.

Akola: PDKV Chakradhar recorded maximum plant height (1.32 m), stem girth (10.97 cm) and canopy volume (0.41 m^3) with minimum thorn intensity. Incidence of leaf miner and citrus canker was reported however as non-significant.

Nagpur: Planting was done in the year 2017 in RBD with three replications. Plant growth characters were recorded that showed no much variation.

Periyakulam: The trial is in vegetative stage.

Sriganganagar: Among all the acid lime clones evaluated, maximum plant height (2.60 m) and canopy volume (1.97 m^2) were recorded in NRCC AL - 8. Minimum thorn intensity was recorded in PDKV Chakkardhar (19.33 per meter length). The pest and disease occurrence in different clone/varieties were also recorded. Only leaf miner was observed with minimum infestation in SGNR AL-1 (3.33 %), which however was free from citrus canker disease. Other varieties were infected with Citrus canker.

Tirupati: Procured the acid lime planting material from Akola, Sriganganagar, Nagpur and New Delhi centers and planted during September, 2018. First flowering was noticed in PDKV Chakradhar and SGNR-AL -1 clones during December, 2020 and February, 2021. Maximum canopy volume (5.93m^3) was noticed in NRCC AL-7 followed by Check (Balaji).

1.1.7. C. Rootstock breeding in Citrus

Controlled hybridizations of Rough lemon and Rangpur lime with trifoliate 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 parts: garden soil 1 part: vermi-compost 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.

Result: During the March, 2020, a respective total of 481 and five flowers of Rough lemon and Rangpur lime were emasculated and controlled pollinated with Rubidoux trifoliate (an accession of *Poncirus trifoliata*) pollen. A total of 78 and three fruits were obtained from crossed flowers of Rough lemon × *P. trifoliata* and Rangpur lime × *P. trifoliata* crosses, respectively. These fruits yielded 1,195 and 30 seeds. From the extracted seeds, 66.6% and 60% seeds have so far germinated in Rough lemon × *P. trifoliata* and Rangpur lime × *P. trifoliata* crosses, respectively. The trifoliate leaf of *Poncirus trifoliata* is reported to be dominant over monofoliate leaves of citrus. So far, 45 trifoliate hybrids have been obtained from germinated seeds of Rough lemon × *P. trifoliata* cross. In 2019, a total of five trifoliate hybrids were obtained from the same cross. In the cross of Rangpur lime × *P. trifoliata,* three hybrids were obtained. The exact number of hybrids established will be known only after passage of summer season (Table 40).

Table-40: Summary of hybridization and hybrids recovery from the crosses of Rough lemon and Rangpur lime with Poncirus trifoliata at Ludhiana

Particulars	Cross	
	Rough lemon x *P. trifoliate*	Rangpur lime x *P. trifoliata*
Total flowers crossed	481	05
Total set fruits	100 (20.7%)	04 (80.0%)
Total retained fruits	78	03
Number of seeds obtained	1195	30
Number of seeds germinated	796 (66.6%)	18 (60.0%)
Trifoliate hybrids	45	03
Hybrids established	-	-

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 includes fresh planting budded on rough lemon. Trial was planted at 5 x 5 m spacing. Status of the trial is new. 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 (0.96 m) and stem girth (2.45 cm). Whereas, Mosambi clone recorded the maximum canopy volume (0.65 m^3).

Rahuri: The trial was planted in the field during November-2019. The growth performance and pest and disease (%) data revealed that, there was non-significant difference between the treatments for plant height, canopy volume, stem girth and pest and disease (%) as the plants are only one-year-old.

Tinsukia: The trial was planted in the year 2020. The growth performance data revealed that, Cutter Valencia clone recorded the maximum plant height (0.62 m) and stem girth (2.17 cm). There was non-significant difference between the treatments for canopy volume.

Tirupati: Procured the planting material of Cutter Valencia from CCRI, Nagpur and planting was done in August, 2019. Mosambi buddings were planted in August, 2020. All clones are established well.

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, Sriganganagar and Tinsukia.

(a) Mandarin

Ludhiana: For Kinnow mandarin, NRCC-6 recorded maximum plant height (3.60 m), whereas NRCC-2 rootstock recorded maximum canopy volume (19.9 m^3). Maximum number of fruits per tree (450.1) and yield (79.8 kg/tree) was recorded in Jatti khatti (Table 41 & 42).

Sriganganagar: Jatti khatti recorded maximum plant height (2.98 m) and canopy volume (14.50 m^3). CRH 12 rootstock could not survive under Sriganganagar condition.

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

Table-41: Performance of different rootstocks for mandarin at different centres

Rootstocks	Plant height (m)			Canopy volume (m^3)		
	Ludhiana	Sriganganagar	Tinsukia	Ludhiana	Sriganganagar	Tinsukia
NRCC-2	3.3	2.75	1.23	19.9	14.50	4.05
NRCC-4	3.5	2.84	2.31	19.7	12.81	8.40
NRCC-5	3.3	2.30	2.46	14.0	9.21	9.07
NRCC-6	3.6	2.38	1.85	19.3	9.92	6.67
CRH-12	3.4	1.33	1.59	14.1	4.02	5.70
Alemow	2.9	2.72	2.63	11.0	11.64	9.75
Jatti Khatti	-	2.98	-	-	13.59	-
Carrizo*	-	-	-	-	-	-
Rangpur lime	-	-	-	-	-	-
Rough lemon	3.3	2.89	2.96	18.0	10.77	11.81
CD at 5%	0.3	0.36	NS	3.5	3.42	NS
Carrizo* rootstock is included at Ludhiana centre as per proceedings of 5th GD held at NRC Banana, Tiruchirapalli						

Table-42: Performance of different rootstocks for mandarin at Ludhiana

Rootstocks	Fruit weight (g)	Fruits/tree	Yield (kg/tree)	TSS (°B)	Acidity (%)
NRCC-2	186.0	271.2	50.4	10.5	0.83
NRCC-4	178.5	364.4	65.0	10.3	0.79
NRCC-5	193.5	317.8	61.5	10.1	0.81
NRCC-6	163.5	328.0	53.6	10.6	0.84
CRH-12	188.8	369.6	69.8	10.5	0.86
Alemow	152.3	373.7	56.9	10.2	0.88
Jatti Khatti	177.3	450.1	79.8	10.7	0.84
Carrizo*	-	-	-	-	-
Rangpur lime	-	-	-	-	-
Rough lemon	-	-	-	-	-
CD at 5%	14.6	56.0	10.1	NS	NS
Carrizo* rootstock is included at Ludhiana centre as per proceedings of 5th GD held at NRC Banana, Tiruchirapalli					

(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: Rough lemon rootstock has recorded significantly maximum plant height (2.98 m) followed by CRH-12 (2.88 m). Whereas, maximum canopy volume (16.09 m^3) was recorded in Rangpur lime which is at par with CRH-12 (14.65 m^3) and yield (14.34 kg/tree) was recorded in NRCC-4. Maximum N (269.29 kg/h) was recorded in NRCC rootstock-4 while P (38.83 kg/ha) in Rough lemon and K content (638.4 kg/h) was maximum in NRCC-2.

Rahuri: Significantly higher plant height (2.88 m) and canopy volume (11.35 m^3) were recorded in Phule mosambi sweet orange budded on Rangpur lime rootstock. Maximum fruit weight (187.50 g), number of fruits (228.30 fruits/tree) and yield (42.79 kg/tree) were also recorded on Rangpur lime (Table 43).

Tirupati: Significantly maximum number of fruits per tree (363.33 fruits/tree) and yield (55.49 kg/tree) were noticed in NRCC-6 rootstock.

Table-43: Performance of different rootstocks for sweet orange at different centres

Rootstocks	Plant height (m)			Canopy volume (m^3)			Fruits/tree		Yield (kg/tree)		
	RHR	NGP	TPT	RHR	NGP	TPT	RHR	TPT	RHR	NGP	TPT
NRCC -2	2.72	2.69	1.77	9.80	9.86	4.30	212.75	363.33	36.22	10.35	55.49
NRCC -4	2.78	2.74	2.09	9.85	13.55	8.80	210.90	238.89	36.40	14.34	29.50
NRCC -5	2.50	2.72	2.03	8.60	11.47	7.98	196.50	222.89	32.97	13.86	34.29
NRCC -6	2.80	2.71	2.20	9.90	11.62	10.33	215.45	151.89	37.27	11.15	23.34
CRH-12	2.13	2.88	1.18	5.45	14.65	1.16	151.20	20.00	21.60	7.88	2.75
Alemow	2.24	2.43	1.93	6.60	8.19	7.64	168.10	211.78	27.48	12.36	32.80
Rangpur lime	2.88	2.73	1.81	11.35	16.09	6.39	228.30	162.00	42.79	14.26	25.42
Rough lemon	-	2.98	2.10	-	12.43	10.70	-	252.78	-	11.18	38.40
CD at 5%	0.23	0.131	0.05	1.11	1.149	0.45	23.21	9.61	6.60	0.111	7.69
RHR-Rahuri: Phule Mosambi; TPT-Tirupati: Sathgudi; NGP-Nagpur: Mosambi											

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 (6x6m, 6x5m, 6x4m) 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, interaction effect of spacing level 6 X 6 m spacing and 75% inorganic source + 25% organic source (FYM) recorded significantly better yield (133.50 fruits/ tree; 18.71 kg/plant) and improved the leaf nutrient status.

Ludhiana: Spacing and nutrient levels alone and combination did not affect plant height and canopy volume. Number of fruits per plant (640), average fruit weight (204.7g) and fruit yield per plant (131.01 kg) was significantly maximum under the treatment 6 X 6 m spacing with 75% N in organic nutrition+ 25 % N organic nutrition (FYM). However, fruit yield (47.40 t/ha) was significantly maximum in 6 X 4 m spacing with 75% N as organic nutrition + 25 % N in organic form. Percentage of soil organic carbon, P and K content were recorded maximum under the treatment combination of 6 X 4 spacing with 50 % N (inorganic source) + 50 % (organic source).

Tinsukia: Maximum canopy volume (24.73m^3), yield (33.58 kg/ tree; 13.43 t/h) maximum organic carbon and soil N and K_2O content were recorded in treatment combination of plant spacing of 5m X 4m with 75% N in organic nutrition + 25 % N organic nutrition. No significant difference was observed in different micro nutrient levels of soil as well as leaf nutrient content (Table 44).

Table -44: Vegetative growth and fruit yield parameters affected by nutrition and spacing interaction under high density planting

Treatment#	Canopy volume (m^3)	Fruits/tree		Fruit yield (kg/ tree)
	Tinsukia	Akola	Tinsukia	Tinsukia
S_1L_1	21.11	133.50	282	30.60
S_1L_2	14.00	129.63	210	23.86
S_1L_3	17.43	111.51	198	22.08
S_2L_1	24.73	112.69	289	33.58
S_2L_2	19.12	122.14	227	25.17
S_2L_3	16.19	104.08	208	22.30
S_3L_1	23.04	103.89	268	32.83
S_3L_2	18.81	105.75	216	23.72
S_3L_3	21.69	95.75	201	23.14
CD at 5%	.4	7.15	14.1	3.9
S_1= Recommended spacing (6x6 m), S_2= 20% increase in density (6x5 m), S_3= 50% increase in density (6x4 m), L_1: 75% N (Inorganic source) + 25% N (Organic source- FYM) + P (100% through inorganic source) & K (100% K supplied through FYM), L_2: 50% N (Inorganic source) + 50% N (Organic source - Vermicompost) + P (100% through inorganic) & K (100% supplied through Vermicompost), L_3: 100% Inorganic only (Check)				

(b) Sweet orange

Rahuri: The interaction effect due to different spacing and levels of nutrients were significant. Maximum plant height (3. 56 m), canopy volume (21.83 m^3), fruit weight (181.24 g), number of fruits per plant (381.39), yield (68.99 kg/tree), juice content (49.22%), TSS (10.79°B) with minimum acidity (0.50%) were recorded in treatment S_1L_2 with 6 x 6 m spacing with 50% N (inorganic source) + 50% N (organic source - Vermicompost) + P (100% through Inorganic and K supplied through vermicompost).

Tirupati: Maximum number of fruits (207.58 fruits/plant) were recorded when plants were spaced at 6 x 5m (333 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 (12 t/ha) with minimum acidity (0.56 %) was recorded when plants were spaced at 6 x 4m (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). Juice content was recorded maximum (51.46 %) by plants spaced at 6 x 6m and 50% N (Inorganic source) + 50% N (Organic source - Vermicompost) + P (100% through inorganic) & K (100% supplied through Vermicompost) (Table 45).

Table-45: Effect of different spacing and nutrient levels on growth, yield and fruit quality in sweet orange

Treatment	Canopy volume (m^3)		Fruit yield (kg/tree)		Juice (%)		TSS (°B)		Acidity (%)	
	Rahuri	Tirupati	Rahuri	Tirupati	Rahuri	Tirupati	Rahuri	Tirupati	Rahuri	Tirupati
(S_1L_1)	19.26	17.24	64.32	28.84	47.24	45.69	10.62	10.00	0.53	0.63
(S_1L_2)	21.83	18.53	68.99	26.71	49.22	51.46	10.79	10.87	0.50	0.66
(S_1L_3)	18.75	17.40	63.34	27.39	45.29	43.70	10.33	11.14	0.51	0.71
(S_2L_1)	18.72	11.91	55.29	29.67	46.28	47.61	10.42	10.66	0.54	0.68
(S_2L_2)	20.41	13.19	63.28	32.74	48.30	44.04	10.65	10.26	0.56	0.66
(S_2L_3)	18.57	11.04	55.24	32.85	44.66	43.78	10.25	10.69	0.57	0.70
(S_3L_1)	17.42	18.04	51.35	27.42	44.23	46.54	10.18	10.80	0.59	0.63
(S_3L_2)	17.74	16.90	54.46	28.85	46.75	45.07	10.35	10.50	0.55	0.56
(S_3L_3)	16.92	15.74	50.39	28.43	42.08	46.77	10.18	10.86	0.61	0.59
CD at 5%	0.74	1.24	0.63	1.31	NS	2.55	0.028	NS	0.38	0.06

S_1= Recommended spacing (6x6 m), S_2= 20% increase in density (6x5 m), S_3= 50% increase in density (6x4 m), L_1: 75% N (Inorganic source) + 25% N (Organic source- FYM) + 100% P & K (100% Inorganic – P & K supplied through FYM), L_2: 50% N (Inorganic source) + 50% N (Organic source - Vermicompost) + P (100% through inorganic) & K (100% supplied through Vermicompost), L_3: 100% Inorganic only (Check)

(c) Acid lime

Periyakulam: The maximum plant height (6.48 m) and canopy volume (86.20 m^3) were recorded under 6 x 6 m spacing with 50 % N (Inorganic source) + 50% N (Organic source – Vermicompost) + P (100% through inorganic) & K (100% supplied through Vermicompost). Maximum, number of fruits per tree (942.20) and yield (46.08 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) (Table 46 & 47).

Rahuri: The interaction effect of spacing and levels of nutrients recorded maximum plant height (3.75 m), canopy volume (40.15 m^3), fruit weight (48.95 g), number of fruits per tree (1610.47) and yield (76.70 kg/tree) in treatment involving 6 x 6 m spacing with 50% N (Inorganic source) + 50 % N (Organic source - Vermicompost) + P (100% through inorganic) & K (100% supplied through Vermicompost). Also the same treatment combination was the best for fruit quality with maximum juice content (43.86 %), TSS (7.49°B), acidity (7.29 %) and ascorbic acid (36.05 mg / 100 ml juice).

Tirupati: The interaction effect of spacing (6 x 6 m) and nutrition (50% N as inorganic source + 50% N as organic source (Vermicompost) + P (100% through inorganic) & K (100% supplied through Vermicompost), recorded significantly maximum plant height (3.33 m) and canopy volume (39.26 m^3). However, maximum number of fruits per tree (1252.55) and yield (52.56 kg/tree) were recorded in treatment 6 x 4 m spacing with 75 % N (inorganic source) + 25% (Organic source-FYM) + P (100% through inorganic) & K (100% supplied FYM).

Table-46: Effect of different spacing and nutrient levels on growth, yield and fruit quality of acid lime

Treatment	Canopy volume (m^3)			Fruits/tree			Yield (kg/tree)		
	Periyakulam	Rahuri	Tirupati	Periyakulam	Rahuri	Tirupati	Periyakulam	Rahuri	Tirupati
(S_1L_1)	76.80	38.21	34.17	876.10	1580.47	608.55	42.92	72.71	26.21
(S_1L_2)	86.20	40.15	39.26	760.00	1610.47	856.00	36.46	76.70	38.48
(S_1L_3)	79.12	36.25	28.40	672.30	1532.46	755.67	32.30	69.38	34.89
(S_2L_1)	75.90	36.20	28.30	942.20	1510.68	850.56	46.08	63.54	36.16
(S_2L_2)	72.04	39.45	21.42	774.90	1564.30	869.44	36.18	68.53	36.92
(S_2L_3)	62.50	35.65	25.56	684.40	1480.58	840.22	32.92	61.59	36.30
(S_3L_1)	52.40	34.55	30.48	796.00	1462.27	1252.55	38.22	57.69	52.56
(S_3L_2)	64.20	36.17	30.25	730.60	1480.55	1198.56	35.10	59.58	51.15
(S_3L_3)	60.36	31.42	25.40	642.20	1411.24	1162.89	30.08	53.78	50.99
CD at 5%	12.86	0.46	1.60	12.92	2.93	100.66	4.22	0.37	4.28

S_1= Recommended spacing (6x6 m), S_2= 20% increase in density (6x5 m), S_3= 50% increase in density (6x4 m), L_1: 75% N (Inorganic source) + 25% N (Organic source- FYM) + 100% P & K (100% Inorganic – P & K supplied through FYM), L_2: 50% N (Inorganic source) + 50% N (Organic source - Vermicompost) + 100% P & K (100% Inorganic P & K Supplied through Vermicompost), L_3: 100% Inorganic only (Check)

Table-47: Effect of different spacing and nutrient levels on fruit quality of acid lime at Rahuri

Treatments	Juice (%)	TSS (°B)	Acidity (%)	Ascorbic acid (mg/ 100 ml juice)
(S_1L_1)	43.78	7.39	7.27	33.78
(S_1L_2)	43.86	7.49	7.29	36.05
(S_1L_3)	43.15	7.29	7.23	33.06
(S_2L_1)	41.95	7.24	7.12	32.84
(S_2L_2)	42.65	7.35	7.16	32.94
(S_2L_3)	41.54	7.23	7.07	31.09
(S_3L_1)	40.78	7.11	6.77	30.78
(S_3L_2)	41.68	7.28	6.65	30.88
(S_3L_3)	40.32	7.23	6.77	30.12
CD at 5%	0.040	0.024	0.09	0.032

S_1= Recommended spacing (6x6 m), S_2= 20% increase in density (6x5 m), S_3= 50% increase in density (6x4 m), L_1: 75% N (Inorganic source) + 25% N (Organic source- FYM) + 100% P & K (100% Inorganic – P & K supplied through FYM), L_2: 50% N (Inorganic source) + 50% N (Organic source - Vermicompost) + 100% P & K (100% Inorganic P & K Supplied through Vermicompost), L_3: 100% Inorganic only (Check)

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% R DF 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).

(a) Mandarin

Akola: Maximum plant height (5.27 m), canopy volume (82.87 m^3), number of fruits per tree (571.33) and fruit yield (81.22 kg/tree) were recorded under interactive treatment T_8: A_3B_2 (Application of 1/6 of RDF for 6 year and 80% of RDF after 8 years).

Ludhiana: The maximum fruit yield (139.64 Kg/ tree, 38.7 t/ha), number of fruits per tree (648), fruit weight (215.50 g) and juice content (52.45%) were observed under treatment T_7: A_3B_1 (application of 1/6 RDF for 6 years followed by application of 100% RDF after 10 years).

Nagpur: Maximum canopy volume (0.81 m^3), macronutrients (2.52% N, 0.16% P and 1.52% K) and micronutrient (78.4 ppm Fe, 52.3 ppm Mn and 27.1 ppm Zn) and maximum fruit yield (56.40 kg/tree) and maximum juice content (47.20%) and TSS (10.10ºB) with minimum acidity (0.57 %) were observed under the treatment T_9 - application of 1/6 of RDF up to six years followed by addition of 60% of RDF upto next six years. These results have shown there is no necessity of application of 100% RDF annually and the dose needs to be adjusted in the context of nutrient residual pattern adjudged from cumulative response of applied fertilizers with their annual residual effects (Table 48-49).

Sriganganagar: Maximum plant height (4.01 m) and canopy volume (33.93 m^3) were recorded under interactive treatment T_8: A_3B_2 (Application of 1/6 of RDF for 6 year and 80% of RDF after 8 years) and macronutrients (2.56% N, 0.22% P and 1.54% K) were recorded under the treatment T_9 as A_3B_3 carrying application of 1/6 of RDF up to six years followed by addition of 60% of RDF up to next six years.

Tinsukia: The interactive treatment had no significant influence on growth parameters.

Table-48: Effect of age wise nutrient levels and age wise nutrient doses on fruit yield and quality parameters in mandarins

Treatments#	Yield (kg/tree)			Juice (%)				
	Akola	Ludhiana	Nagpur	Akola	Ludhiana	Nagpur	SGR	Tinsukia
A_1	66.21	-	42.41	43.35	-	44.4	49.29	-
A_2	72.69	-	47.63	43.15	-	45.6	50.44	-
A_3	77.95	-	51.87	43.95	-	46.1	51.99	-
CD at 5%	NS	-	4.80	NS	-	0.76	NS	-
B_1	67.84	-	43.97	44.91	-	44.1	50.14	-
B_2	75.53	-	47.34	41.84	-	45.3	50.81	-
B_3	73.4	-	50.61	43.71	-	46.7	50.77	-
CD at 5%	NS	-	3.60	NS	-	0.60	NS	-
T_1: A_1B_1	63.30	111.06	40.10	46.01	50.35	43.1	48.50	42.0
T_2: A_1B_2	70.93	106.04	42.82	41.12	50.10	44.1	49.15	42.2
T_3: A_1B_3	64.41	100.33	44.32	42.92	49.80	46.2	50.23	43.6
T_4: A_2B_1	68.57	122.69	44.70	42.52	51.20	44.2	50.45	42.2
T_5: A_2B_2	74.45	122.54	47.10	41.48	51.10	45.8	50.67	44.5
T_6: A_2B_3	5.04	115.55	51.10	45.47	50.75	46.8	50.21	45.1
T_7: A_3B_1	71.66	139.64	47.10	46.19	52.45	45.2	51.48	42.8
T_8: A_3B_2	81.22	133.16	52.10	42.92	52.20	46.0	52.62	43.9
T_9: A_3B_3	80.96	128.19	56.40	42.74	51.80	47.2	51.86	45.9
CD at 5%	NS	2.36	5.94	NS	0.79	0.92	NS	NS

Table-49: Effect of age wise nutrient levels and age wise nutrient doses on fruit quality parameters in mandarins

Treatments#	TSS (°B)					Acidity (%)				
	Akola	Ludhiana	Nagpur	SGR	Tinsukia	Akola	Ludhiana	Nagpur	SGR	Tinsukia
A1	10.87	-	9.54	11.44	-	0.63	-	0.68	1.12	-
A2	10.67	-	9.83	12.32	-	0.67	-	0.63	0.96	-
A3	10.83	-	9.72	12.34	-	0.60	-	0.61	0.89	-
CD at 5%	NS	-	0.12	0.85	-	NS	-	0.04	0.07	-
B1	10.69	-	9.66	11.77	-	0.65	-	0.69	1.06	-
B2	10.96	-	9.77	12.33	-	0.64	-	0.65	0.93	-
B3	10.73	-	9.92	12.01	-	0.62	-	0.69	0.98	-
CD at 5%	NS	-	0.10	0.85	-	NS	-	0.03	0.07	-
T1: A1B1	10.05	10.60	9.40	10.83	8.0	0.69	0.81	0.74	1.25	0.43
T2: A1B2	11.49	10.54	9.52	11.90	8.0	0.58	0.79	0.70	1.07	0.43
T3: A1B3	11.08	10.40	9.70	11.60	9.0	0.62	0.83	0.61	1.05	0.42
T4: A2B1	10.67	10.68	9.70	12.27	8.0	0.68	0.78	0.70	0.98	0.43
T5: A2B2	10.46	10.66	9.82	12.60	8.0	0.69	0.80	0.65	0.88	0.42
T6: A2B3	10.87	10.64	9.98	12.10	9.0	0.63	0.79	0.59	1.01	0.41
T7: A3B1	11.34	10.80	9.90	12.20	8.0	0.56	0.76	0.65	0.95	0.41
T8: A3B2	10.94	10.76	9.96	12.50	9.0	0.65	0.76	0.61	0.83	0.40
T9: A3B3	10.22	10.70	10.10	12.33	10.0	0.60	0.78	0.57	0.89	0.39
CD at 5%	NS	NS	0.16	1.47	NS	NS	NS	0.06	0.13	NS
#Refer methodology for treatment details, SRG-Sriganganagar										

(b) Sweet orange

Rahuri: Maximum plant height (3.71 m), canopy volume (24.07 m^3), fruit weight (188.27 g), fruits per tree (398.15) and yield (74.63 kg /tree and 20.67 t/ha) were observed under the interactive treatment T_1: A_1B_1 (Application of 1/10 of RDF for 1 to 10 years followed by application of 100% RDF after 10 years). Best quality fruit, juice content (48.92 %), TSS (10.37°B), minimum acidity (0.43 %) and maximum ascorbic acid (55.34 mg/100 ml juice) was observed under T_6: A_2B_3 i.e. application of 1/8 RDF for 8 years followed by application of 60% RDF (Table 50 & 51).

Tirupati: The interaction effect of different treatments had no significant influences on growth parameters. Maximum fruit weight (183.74 g), yield (13.46 kg/tree and 3.73 t/ha) were observed under the interactive treatment T_1: A_1B_1 (Application of 1/10 of RDF for1 to 10 years followed by application of 100% RDF after 10 years). Best fruit quality attribute, maximum TSS (8.65 °B) was recorded under the treatment T_7: A_3B_1.

Table-50: Effect of age wise nutrient levels and age wise nutrient doses on growth and yield attributes of sweet orange

Treatments#	Canopy volume (m^3)		Fruit weight (g)		Fruits/tree		Yield (kg/tree)		Yield (t/ha)	
	Rahuri	Tirupati	Rahuri	Tirupati	Rahuri	Tirupati	Rahuri	Tirupati	Rahuri	Tirupati
A_1	23.02	8.11	181.06	168.22	383.02	66.33	69.21	11.28	19.17	3.12
A_2	19.49	7.22	166.50	155.87	352.45	63.56	58.91	9.81	16.32	2.72
A_3	20.41	7.60	170.86	156.17	359.31	65.56	61.29	10.24	16.98	2.84
CD at 5%	0.20	0.43	0.18	4.00	0.71	NS	0.62	0.74	0.17	0.20
B_1	21.00	7.58	171.82	165.78	265.60	68.89	62.98	11.44	17.44	3.17
B_2	21.05	7.79	172.83	156.01	366.76	58.00	63.35	9.05	17.55	2.51
B_3	20.88	7.57	173.77	157.47	362.00	68.56	63.08	10.85	17.47	3.01
CD at 5%	NS	NS	0.18	4.00	0.71	4.70	NS	0.74	NS	0.20
T_1: A_1B_1	24.07	8.66	188.27	183.74	398.15	73.33	74.63	13.46	20.67	3.73
T_2: A_1B_2	22.66	9.00	178.52	147.46	379.21	50.33	67.69	7.41	18.75	2.05
T_3: A_1B_3	22.33	6.67	176.39	173.47	371.69	75.33	65.31	12.99	18.09	3.60
T_4: A_2B_1	19.69	6.56	160.83	157.46	350.41	65.33	56.54	10.25	15.66	2.84
T_5: A_2B_2	19.83	7.34	167.41	164.38	350.43	54.00	58.62	8.82	16.24	2.44
T_6: A_2B_3	18.95	7.77	171.26	145.76	356.52	71.33	61.57	10.37	17.05	2.87
T_7: A_3B_1	19.24	7.51	166.36	156.14	348.25	68.00	57.76	10.62	16.00	2.94
T_8: A_3B_2	20.65	7.02	172.56	156.19	370.63	69.67	63.73	10.92	17.65	3.03
T_9: A_3B_3	21.35	8.27	173.66	156.19	359.04	59.00	62.37	9.18	17.28	2.55
CD at 5%	0.35	0.74	0.31	6.91	1.22	8.14	1.08	1.28	0.30	0.35
#Refer methodology for the treatment details										

Table-51: Effect of age wise nutrient levels and age wise nutrient doses on fruit quality of sweet orange

Treatments#	Juice (%)		TSS (°B)		Acidity (%)		A.A.*	
	Rahuri	Tirupati	Rahuri	Tirupati	Rahuri	Tirupati	Rahuri	Tirupati
A_1	45.24	48.44	9.86	8.38	0.59	0.64	52.31	46.67
A_2	47.44	50.89	9.72	8.38	0.48	0.64	53.33	45.41
A_3	46.48	48.28	9.61	8.21	0.53	0.61	53.23	47.04
CD at 5%	0.88	NS	0.16	0.004	0.019	NS	0.020	0.89
B_1	45.05	48.25	9.81	8.18	0.55	0.62	52.60	48.63
B_2	46.72	50.98	9.85	8.28	0.50	0.68	53.48	47.23
B_3	47.38	46.38	9.52	8.52	0.55	0.60	52.78	43.26
CD at 5%	0.88	NS	0.028	0.008	0.034	0.08	0.034	1.55
T_1: A_1B_1	44.26	45.64	0.16	0.004	0.019	0.05	0.020	0.89
T_2: A_1B_2	44.11	52.81	9.90	8.25	0.54	0.62	51.13	44.78
T_3: A_1B_3	47.35	46.87	9.58	8.35	0.59	0.67	52.65	43.23
T_4: A_2B_1	44.26	49.46	10.11	8.55	0.64	0.63	53.15	52.01
T_5: A_2B_2	49.13	50.11	9.68	8.05	0.51	0.58	52.56	53.34
T_6: A_2B_3	48.92	53.09	10.37	8.45	0.43	0.73	55.34	47.12
T_7: A_3B_1	46.65	49.65	9.11	8.65	0.51	0.62	52.10	35.78
T_8: A_3B_2	47.14	50.02	9.87	8.25	0.61	0.65	54.13	47.78
T_9: A_3B_3	45.66	45.18	9.60	8.05	0.49	0.63	52.46	51.34
CD at 5%	1.53	NS	9.35	8.35	0.50	0.56	53.11	42.00
#Refer methodology section for the treatment details; *A.A.- Ascorbic acid (mg/100 ml juice)								

(c) Acid lime

Periyakulam: The maximum canopy volume (63.56 m^3), number of fruits per tree (762.60) and fruit yield (38.40 kg/tree, 10.64 t/ha) was recorded under T_8: A_3B_2 (Application of 1/6 of RDF for 6 year and three age wise dose of nutrients viz. 80% RDF after 10/8/6 years) given in table 52 & 53.

Rahuri: The maximum canopy volume (40.36 m^3), number of fruits per tree (1605.58), fruit yield (77.50 kg/tree, 21.47 t/ha), juice (56.27 %), TSS (7.80 °B) and ascorbic acid content (40.29 mg/ 100 ml juice) were recorded under the treatments T_3: A_1B_3 (Application of 1/10 of RDF for 1 to 10 years followed by application of 80% RDF after 6 years) given in table 52 & 53.

Tirupati: Maximum number of fruits per tree (2469) and yield (114.18 kg/tree) was recorded under the treatment T_9: A_3B_3 (Application of 1/6 of RDF for 6 year followed by 60% RDF after 10/8/6 years), whereas, significantly maximum juice content (50.73 %) was recorded under the treatments T_6: A_2B_3 (Application of 1/8 of RDF for 8 years and 60% RDF after 10/8/6 years).

Table-52: Effect of age wise nutrient levels and nutrient doses on growth and yield parameters in acid lime

Treatments#	Plant height (m)			Canopy volume (m^3)			Fruits/tree			Yield (kg/tree)		
	PKM	RHR	TPT	PKM	RHR	TPT	PKM	RHR	TPT	PKM	RHR	TPT
A_1	5.56	3.70	3.16	47.58	38.25	30.87	610.00	1550.59	2234	31.72	71.87	102.78
A_2	5.70	3.54	3.15	53.86	35.84	31.50	712.20	1468.32	2352	35.08	65.27	106.24
A_3	5.78	3.59	3.20	64.40	34.64	29.04	696.00	1473.40	2405	34.96	62.56	113.86
CD at 5%	NS	0.09	NS	12.18	0.16	0.81	11.40	54.18	48.59	1.02	0.27	NS
B_1	5.78	3.59	3.10	54.68	35.56	28.62	652.10	1490.15	2303	32.40	64.58	105.17
B_2	5.64	3.59	3.28	55.10	36.14	32.78	696.30	1481.85	2381	34.86	65.95	110..35
B_3	5.60	3.66	3.13	55.02	37.02	30.01	718.00	1520.31	2307	36.10	69.17	107.30
CD at 5%	NS	NS	0.11	4.02	0.16	0.81	9.42	54.18	48.59	1.18	0.27	NS
T_1: A_1B_1	5.90	3.66	3.22	46.02	36.90	32.65	510.00	1535.95	2240	33.10	69.65	100.08
T_2: A_1B_2	5.42	3.69	3.23	45.19	37.46	31.99	618.50	1510.24	2324	33.82	68.47	107.89
T_3: A_1B_3	5.36	3.76	3.03	46.10	40.36	27.97	634.20	1605.58	2137	33.12	77.50	100.20
T_4: A_2B_1	5.54	3.55	3.07	52.98	36.33	28.10	648.50	1468.88	2370	35.20	65.42	103.35
T_5: A_2B_2	5.70	3.57	3.42	52.30	36.28	37.75	692.20	1470.23	2370	35.06	65.90	107.85
T_6: A_2B_3	5.58	3.53	2.96	53.12	34.91	28.65	702.10	1465.84	2315	34.42	64.50	107.52
T_7: A_3B_1	5.19	3.58	3.02	63.40	33.44	25.12	670.00	1465.61	2298	32.18	58.67	112.09
T_8: A_3B_2	5.78	3.50	3.18	63.56	34.67	28.60	762.60	1465.08	2448	38.40	63.49	115.30
T_9: A_3B_3	5.70	3.68	3.40	62.80	35.81	33.40	748.20	1489.50	2469	33.46	65.52	114.18
CD at 5%	0.62	0.15	0.19	0.78	0.28	1.40	20.58	48.68	84.17	3.60	0.47	8.38
#Refer methodology for the treatment details; PKM -Periyakulam, RHR-Rahuri, TPT-Tirupati												

Table- 53: Effect of age wise nutrient levels and age wise nutrient doses on fruit quality in acid lime

Treatments#-	Juice (%)			TSS (°B)			Acidity (%)			Ascorbic acid (mg/100 ml juice)	
	PKM	RHR	TPT	PKM	RHR	TPT	PKM	RHR	TPT	PKM	RHR
A_1	47.20	45.51	46.70	7.20	7.64	8.83	6.48	7.28	7.98	28.42	39.09
A_2	47.16	45.65	49.10	7.38	7.24	8.86	6.26	6.81	7.29	30.12	38.05
A_3	47.42	42.91	49.02	7.18	7.25	8.84	6.52	6.71	7.08	29.04	36.05
CD at 5%	0.14	0.69	1.46	NS	0.022	NS	0.20	0.027	0.45	0.16	0.046
B_1	47.10	42.51	48.99	7.40	7.38	8.81	6.36	7.11	7.52	29.42	37.54
B_2	47.36	41.87	47.91	7.30	7.39	8.86	6.42	6.79	7.03	29.04	37.13
B_3	48.10	49.70	47.92	7.52	7.37	8.86	6.18	6.90	7.80	29.56	38.52
CD at 5%	0.12	0.69	NS	NS	NS	NS	0.18	0.027	0.45	0.04	0.046
T_1: A_1B_1	47.10	44.12	49.00	7.36	7.52	8.63	6.56	7.08	8.16	30.12	38.05
T_2: A_1B_2	47.20	36.14	46.58	7.40	7.60	8.93	6.42	7.35	7.36	31.04	38.95
T_3: A_1B_3	47.68	56.27	44.52	7.30	7.80	8.93	6.18	7.41	8.41	30.18	40.29
T_4: A_2B_1	47.36	42.15	48.98	7.24	7.45	9.10	6.04	7.15	7.47	29.28	38.54
T_5: A_2B_2	47.12	46.23	47.59	7.18	7.12	8.60	6.72	6.48	6.82	29.12	37.20
T_6: A_2B_3	47.50	48.58	50.73	7.40	7.15	8.87	6.08	6.80	7.57	30.02	38.41
T_7: A_3B_1	47.22	41.25	49.00	7.18	7.16	8.70	6.16	7.11	6.92	29.70	36.05
T_8: A_3B_2	48.16	43.25	49.56	7.52	7.43	9.05	6.40	6.55	6.90	30.46	35.24
T_9: A_3B_3	47.18	44.25	48.50	7.32	7.15	8.78	6.20	6.48	7.43	30.12	36.88
CD at 5%	1.60	1.19	2.53	0.02	0.038	NS	0.04	0.047	0.78	0.62	0.079
#Refer methodology for the treatment details; PKM -Periyakulam, RHR-Rahuri, TPT-Tirupati											

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_2O_5	K_2O	N	P_2O_5	K_2O	N	P_2O_5	K_2O	N	P_2O_5	K_2O	N	P_2O_5	K_2O	N	P_2O_5	K_2O
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																		

a) Mandarin

Akola: Maximum canopy volume (86.34 m^3), number of fruits per plant (610.40 fruits/plant) and yield (96.75 kg/plant and 26.80 t/ha) with higher percentage of juice (49.11 %), TSS (10.61 °Brix) with minimum acidity (0.64 %) were recorded in the treatment T_2 i.e. 0:0:0, 30:40:10, 30:35:10, 20:25:30, 10:0:25, 10:0:25 % recommended dose of N:P_2O_5:K_2O for stage –I (Jan-Feb) to stage –VI (Nov.- Dec), respectively.

Ludhiana: Maximum canopy volume (25.17 m^3), number of fruits per plant (595 fruits/plant), yield (116.03 kg/tree) and juice (52.5 %) were recorded significantly higher in treatment T_2 i.e. 0:0:0, 30:40:10, 30:35:10, 20:25:30, 10:0:25 and 10:0:25 % RDF of N:P_2O_5:K_2O at stage –I (Jan- Feb) and stage –VI (Nov.-Dec), respectively (Table 54).

Table-54: Effect of stage-wise application of nutrients on growth, yield and fruit quality in mandarin

Treatment	Canopy volume (m^3)		Fruits/plant		Yield (kg/tree)		Juice (%)		TSS (°B)		Acidity (%)	
	AKL	LDH	AKL	LDH	AKL	LDH	AKL	LDH	AKL	LDH	AKL	LDH
T_1	84.78	22.12	399.8	545.0	77.16	95.6	48.02	48.5	10.29	10.4	0.70	0.83
T_2	86.34	25.17	610.4	595.0	96.75	116.0	49.11	52.5	10.61	10.8	0.64	0.78
T_3	62.57	24.14	406.8	560.0	61.03	106.4	44.99	50.7	9.70	10.5	0.78	0.80
T_4	71.85	23.15	430.8	510.0	63.86	92.9	43.08	49.0	9.80	10.3	0.72	0.81
CD at 5%	NS	0.72	163.1	23.31	15.66	1.26	4.00	1.58	0.15	NS	NS	0.03
#Refer methodology for the treatment details; AKL-Akola, LDH-Ludhiana												

b) Sweet orange

Tirupati: The significantly maximum number of fruits (419.60), yield (65.17 kg/tree; 18.05 t/ha) with highest TSS of 10.70 °Brix was recorded by the treatment T_3 i.e. 0:0:0, 30:40:0, 30:35:0, 40:25:30, 0:0:35, 0:0:35 % recommended dose of N:P_2O_5:K_2O for stage –I (Jan-Feb) to stage –VI (Nov.- Dec), respectively. Similarly, maximum available N (183.75 kg/ha) and available P (21.25 kg/ha) was recorded by same treatments as compared to the remaining treatments.

c) Acid lime

Periyakulam: Maximum canopy volume (36.02 m^3), number of fruits per tree (710.02), yield (34.90 kg/tree, 9.70 t/ha) and juice content (48.10%) were recorded in treatment T_2 *i.e* 0:0:0, 30:40:10, 30:35:10, 20:25:30, 10:0:25 and 10:0:25 percent RDF of N: P_20_5: K_20 for stage – I to stage – VI, respectively (Table 55).

Table-55: Effect of stage-wise application of nutrients on growth, yield and fruit quality at Periyakulam

Treatment	Plant height (m)	Canopy volume (m^3)	Fruits/ plant	Yield (kg/ tree)	Juice (%)	TSS (°B)	Acidity (%)	Ascorbic acid (mg/100 ml juice)
T_1	5.18	35.80	660.10	32.40	47.20	7.42	6.26	29.04
T_2	5.02	36.02	710.02	34.90	48.10	7.52	6.59	29.60
T_3	4.86	24.50	610.40	29.70	46.90	7.60	6.48	29.28
T_4	4.70	24.10	620.30	30.46	47.80	7.30	6.36	29.12
CD at 5%	0.94	1.14	20.40	3.42	0.26	NS	NS	0.18
#Refer methodology for the treatment details								

3.1.3 C. Organic production in 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

Sriganganagar: Application of 75 % of 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/lit as spray) has recorded maximum plant height (3.87 m), canopy volume (28.43 m^3), number of fruits per tree (449), yield (82.15 kg / tree), juice content (51.35 %), TSS (11.05 °B) with minimum acidity (0.90%) as given in table 56.

Tinsukia: Maximum plant height (4.56 m), canopy volume (33.21 m^3), fruits per plant (490), fruit weight (120.28 g), juice (48.5 %), TSS (11.2 °B) and also maximum soil nutrient status and higher organic carbon content and microbial population of bacteria, fungi, *Actionomycetes* and *Azospirillium* in soil were also recorded higher in the treatment T_4, i.e. application of 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/lit as spray) as given in table 56.

Table-56: Effect of organic manures and bio agents on growth and yield

Treatments	Canopy volume (m^3)		Yield (kg/tree)		Juice (%)		TSS (°B)		Acidity (%)	
	TNK	SRG	TNK	SRG	TNK	SRG	TNK	SRG	TNK	SRG
T_1	20.19	15.16	31.57	34.46	42.9	44.12	7.7	9.80	0.42	1.90
T_2	22.37	19.61	39.44	45.80	43.8	46.25	9.0	9.98	0.42	1.70
T_3	29.73	20.88	40.72	64.25	45.7	48.65	9.5	10.30	0.39	1.05
T_4	33.21	28.43	58.94	82.15	48.5	51.35	11.2	11.05	0.38	0.90
T_5	20.74	21.56	33.68	76.20	42.7	50.22	7.7	10.58	0.40	0.93
CD at 5%	2.6	4.26	11.6	2.55	0.5	3.43	2.8	0.71	0.02	0.11

T_1: Control (800:300:600 g NPK + 20 Kg FYM + 15 kg neem cake/plant/year + Inorganic plant protection; T_2: 100% Vermicompost (On N-equivalent basis of RDF); T_3: 75% Vermicompost (On N-equivalent basis of RDF) + *Trichoderma harzianum* (30-40 ml/plant) + Azadirachtin (1% at 3 - 4 ml / l as spray); T_4: 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); T_5: 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).
*TNK:Tinsukia; SRG: Sriganganagar

b. Sweet orange

Tirupati: Application of 50 % Vermicompost (On N-equivalent basis of RDF) + *Trichoderma harzianum* (30–40 ml/plant) + Azadirachtin (1% at 3–4 ml/liter as spray) + Pseudomonas *fluorescens* (30 – 40 ml/plant) + *Azotobacter chroococcum* (30 – 40 ml / plant) was recorded significantly maximum number of fruits per plant (186.67), maximum fruit yield (30.09 kg/tree and 8.34 t/ha) and juice content (48.81%) given in table 57.

Table-57: Effect of organic manures and bio agents on growth, yield and quality of sweet orange at Tirupati

Treatment	Plant height (m)	Canopy volume (m^3)	Fruits/ plant	Fruit weight (g)	Yield (kg/ tree)	Yield (t/ha)	TSS (°B)	Juice (%)	Ascorbic acid (mg/100g)
T_1	2.01	8.71	149.17	171.01	25.50	7.07	8.00	43.15	40.92
T_2	1.90	6.85	152.67	168.58	25.72	7.13	8.80	47.77	40.25
T_3	2.11	9.58	121.58	163.78	19.90	5.51	8.30	45.40	47.25
T_4	2.04	9.35	128.42	160.31	20.59	5.71	8.50	47.52	48.25
T_5	2.06	7.75	186.67	161.20	30.09	8.34	8.58	48.81	45.25
CD at 5%	NS	0.23	2.52	2.19	0.38	0.10	0.41	1.81	1.09

T_1: Control (800:300:600 g NPK + 20 Kg FYM + 15 kg neem cake/plant/year + Inorganic plant protection; T_2: 100% Vermicompost (On N-equivalent basis of RDF); T_3: 75% Vermicompost (On N-equivalent basis of RDF) + *Trichoderma harzianum* (30-40 ml/plant) + Azadirachtin (1% at 3 - 4 ml / litre as spray); T_4: 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 / litre as spray); T_5: 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/litre as spray).

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 (25.11 m^3), fruit weight (112.25 g), number of fruits per tree (168), yield (18.86 kg/tree, 7.54 t/ha) and available N (350 kg/ha) were recorded in the treatment T_4, i.e. application of irrigation at 80:80:80:80:80:80 % ER (Table 58).

Table-58: Effect of different water management practices on growth and yield of Khasi mandarin at Tinsukia

Treatment	Plant height (m)	Canopy volume (m^3)	Stem girth (cm)	Fruit weight (g)	Fruits/ tree	Yield (kg/tree)	Yield (t/ha)
T_1	3.28	17.32	21.10	101.20	105	10.63	4.25
T_2	3.21	16.80	21.30	104.70	118	12.35	4.94
T_3	3.36	18.38	23.18	106.50	135	14.38	5.75
T_4	3.52	25.11	23.39	112.25	168	18.86	7.54
T_5	3.27	17.19	21.18	103.10	102	10.52	4.21
CD at 5 %	NS	3.40	NS	1.50	8.70	3.60	1.98
Tree age-8 years T_1 - 30:40:30:40:30:40 % ER, T_2 - 40:60:40:60:40:60 % ER, T_3 - 60:80:60:80:60:80 % ER, T_4 - 80:80:80:80:80:80 % ER, T_5 - 30:30:30:30:30:30 % ER at stage-I to VI							

c) Acid lime

Tirupati: Stage wise water application has significantly influenced plant growth and fruit yield of 10 year old trees of acid lime (Balaji). Significantly maximum canopy volume (40.11 m^3), number of fruits (2530), fruit yield (116.44 kg/plant and 35.25 t/ha) and juice content (49.12%) were recorded in treatment T_4-(80-80-80-80-80-80 % ER) from stage I to VI, where plants were supplied with 7784 litre water/ plant/year through drip irrigation. Whereas, irrigation treatment T_5 (30-30-30-30-30-30 % ER) where plants were supplied with 2919 litre per plant per year through drip irrigation from stage I to VI respectively has recorded minimum growth and yield parameters (Table 59).

Table-59: Effect of stage wise application of water on growth, yield and quality of acid lime at Tirupati

Treatments	Canopy Volume (m^3)	Fruits/ plant	Fruit Weight (g)	Yield (kg/plant)	Yield (t/ha)	Juice (%)
T_1	36.61	1,463	46.00	67.38	18.67	48.13
T_2	37.52	1,541	47.54	73.24	20.29	46.48
T_3	38.39	1,849	45.90	84.83	23.50	45.84
T_4	40.11	2,530	46.00	116.44	32.25	49.12
T_5	20.76	1,259	45.96	57.91	16.04	47.61
CD at 5%	1.76	109.38	NS	7.03	1.95	1.86

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 centers 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: Maximum temperature ranged from 27.14 °C (January) to 42.89 °C (April). During October 2019 lesser temperature was recorded with deviation of –10.49 per cent (Table 60). Minimum temperature ranged from 14.32°C (January) to 28.0°C (May). Lower temperatures were recorded in the months of December and January-20 over decennial averages with deviation of 30.26 and 20.39 percent respectively. Excess rain fall was recorded during many of the months except May 2020 which recorded deficit rain fall of 296.78 percent. Evaporation rates are observed lesser over the decennial averages in all the months except March 20 where a deviation of 38.66 per cent was noticed. *Ambia*

flowering was observed for 30 days in January and *Mrig* flowering for 20 days in July. Flowering for *Ambia* crop was found in January and extended up to February. *Mrig* flowering was observed in July.

Table-60: Daily maximum and minimum temperature (ºC) at Akola

Month	Maximum	Minimum	Decennial average (Max.)	Decennial average (Min.)	Max. temp Deviation in %	Min. temp Deviation in %	Decennial average	Deviation in %
Sept, 2019	29.90	19.90	32.50	22.20	-8.70	-11.56	27.35	-9.84
Oct, 2019	30.50	17.90	33.70	18.60	-10.49	-3.91	26.15	-8.06
Nov, 2019	30.50	14.70	31.60	14.10	-3.61	4.08	22.85	-1.11
Dec, 2019	27.90	15.20	28.30	10.60	-1.43	30.26	19.45	9.74
Jan, 2020	27.14	14.32	29.80	11.40	-9.81	20.39	20.60	0.62
Feb,2020	30.73	14.97	32.50	13.30	-5.78	11.14	22.90	-0.23
Mar, 2020	34.64	19.61	37.30	17.80	-7.69	9.21	27.55	-1.58
Apr,2020	40.54	24.88	41.20	23.20	-1.62	6.76	32.20	1.57
May, 2020	42.89	28.04	42.50	27.00	0.91	3.72	34.75	2.02
June,2020	35.16	24.64	37.20	25.60	-5.81	-3.91	31.40	-5.03
July, 2020	32.72	23.73	32.50	23.70	0.67	0.12	28.10	0.44
Aug, 2020	29.61	22.66	30.40	23.00	-2.66	-1.49	26.70	-2.15
Sept,2020	32.81	22.04	32.50	22.20	0.93	-0.74	27.35	0.26
Oct, 2020	33.19	19.65	33.70	18.60	-1.55	5.34	26.15	1.01

Ludhiana (Abohar): Temperature data from January to October, 2020, comparison of the average monthly temperature with decennial average revealed that the current year was a relatively cooler year. Of the different months in this year, only June month, had slightly higher average temperature than the decennial average temperature. 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 temperature of February, 2020 (22.6 °C) was slightly higher than that of the corresponding decennial average maximum temperature (21.7 °C). The average maximum temperature of all other months in 2020 was lower than that of the corresponding decennial maximum temperature. Abohar has a semi-arid climate. In the year 2020, a well distributed rainfall of low to high intensity has been observed from January to September months. June to August recorded as normal rainy months of the region. The maximum daily rainfall observed in July (6.4 mm) and August (7.7 mm), indicate the normal distribution of rainfall in this year. In past few years, the occurrence of rainfall of high intensity in September month was a usual phenomenon, but the daily average rainfall of this month in 2020 was lower than the decennial average.

Sriganganagar: First vegetative flush was observed in the last week of February, 2020. Flowering was observed from the first week of March to 5th April 2020. Normal fruit yield of Kinnow observed this year (15-16 t/ha) may be due to slightly higher rainfall throughout the year and decrease in maximum and minimum temperatures in the month of March 2020 and consequently good flowering and fruit set under Sriganganagar conditions. Colour break in fruit was observed in the first week of November 2020. Increase in maximum and minimum temperatures in the month of September and October 2020 tends to sun burning in fruits caused slightly low yield. Maximum temperature decreased in the months of January to December except in the month of June, September & October 2020 over the mean values for 1983-2020, likewise, minimum temperature also decreased throughout the year 2020 over mean values for 37 years. Decrease in minimum & maximum temperatures in the month of March 2020 resulted in good flowering and fruit set under Sriganganagar conditions. Maximum rainfall was observed in the month of July (131.2 mm) followed by August, 2020 (127.4 mm). Total rainfall of the year 2020 was higher over past 37 years' average value. Number of Rainy days also increased. In the same way sunshine hours were lesser in maximum months of year except June to August, 2020. Lower pan evaporation and sunshine hours during fruit development month increased the fruit growth. Fruit drop was also recorded lesser during April to September months.

Tinsukia: Maximum temperatures ranged from 23.00 °C to 31.05 °C during 2020 and minimum from 9.6 °C to 24.7 °C was recorded. Highest rainfall of 706 mm was recorded in June, 2020. Flowering was initiated in the last fortnight of February and extended up to the end of March. Fruit maturity was observed in the month of November which took 170 – 180 days.

b) Sweet orange

Rahuri: The experiment on impact of climate change

in *Ambia bahar* of sweet orange was conducted from January, 2020 onwards. Maximum temperatures ranged from 29.42 °C in October to 42 °C in May. Minimum temperature varied from 7.30 °C in January to 22.90 °C in May. Monsoon was in time in June. Highest rain fall was received in the months of June, July and September 2020. Higher evapo transpirations have been recorded in the months of April, May and June. Sunshine hours were found higher from February to May. Highest hours of sunshine were recorded in April (10.16 h).

Tirupati: A noticeable change occurred in the average maximum temperature during March, May and June as compared to the decennial average maximum temperatures. An increase of 1.62 °C (March), 1.28 °C (May) and 1.81°C (June) has been observed in the average maximum temperature from the decennial average maximum temperature. The upper temperature limit during March is critical for fruit set and during May and June for fruit development of *ambe bahar* crop. And also there was decrease in average maximum temperature from July to November. The average minimum temperature were also low in all the months except January and February. Due to large difference in diurnal temperatures during March post set drop was noticed in citrus orchards. The decennial average annual rainfall is 1049.98 mm distributed in 55 rainy days. Total rainfall of 1364 mm (65 rainy days) was recorded during 2020. Highest rain fall of 435 mm was recorded during July with 15 rainy days. However, the observation of past years showed that maximum rain fall was recorded during November month. Due to continuous and heavy rains during harvesting period (August-October) the fruit quality was poor and also premature fruit drop was very high. A relative increase in the maximum relative humidity has been observed all months except March.

c) Acid lime

Akola: Maximum temperature ranged from 27.14 °C (January) to 42.89 °C (April). During October 2019, lesser temperature was recorded with deviation of –10.49 per cent. Minimum temperatures ranged from 14.32 °C (January) to 28.04 °C (May). Lower temperatures have been recorded in the months of December and January-20 over decennial averages with deviation of 30.26 and 20.39 percent respectively. Excess rain fall was recorded during many of the months except May 2020 which recorded deficit rain fall of 296.78 percent. Evaporation rates are observed lesser over the decennial averages in all the months except March 20 where a deviation of 38.66 per cent was noticed. Actual rainfall recorded during monsoon months was slightly higher compared to the normal recorded. Early flowering was observed during November and January by 10 and 8 days. However, June flowering was delayed by 3 days. Fruit maturity has occurred in the month of June which took 165 days from flowering and it was found early by 15 days. Emergence of new flush has occurred by one month early in the month of September. Other two flushes emerged during normal time in January and June. Flowering was observed in September and January which was early by 30 days in both the seasons.

Rahuri: There was moderate incidence of Psylla and mites throughout the year. In general, the incidence of canker in acid lime was increased because of continues rainfall during the month of June to August, 2020.

Tirupati: *Ambia* flowering was initiated during third week of January in acid lime. Flower and post set fruit drop were reported during March. *Hasta* Bahar fruiting was good (30-40%) and the fruits were harvested during April-May with good quality.

Periyakulam: Maximum temperature ranged from 27.94°C to 33.23 °C and minimum from 22.44 to 30.52 °C. Higher temperatures have been recorded during March resulting in the deviation of -13.08 per cent. During the reporting year highest rainfall was received during September (265.8 mm) against the normal of 130.20 mm. The rainfall was deficit during October which recorded 28.2 mm against normal of 150.26 mm during both the years 2019 and 2020. Higher evaporation was recorded during the months of October, September and April during the year 2020. Days to fruit maturity was lesser by 13 and 6 days for January and July crops which reached maturity in 140 and 154 days respectively. Appearance of new flush was found normal which has occurred during October to December and June to August. Flowering for *Ambia* crop has occurred one month early during January and *Mrig* crop flowering though commenced early in June extended up to July.

B. Impact on pest incidence

a) Mandarin

Akola: Incidence of citrus leaf miner was recorded maximum during July to August which ranged from 21.82 to 24.49 per cent and fruit sucking moth from October to December (22.56 to 34.17%).

Ludhiana (Abohar): The citrus psyllid is the main insect pest of Kinnow mandarin in the region. The adult population of citrus psyllid was noted in all months and ranged from 4.2 adults/ 10 leaves (November) to 74.5 adults/ 10 leaves (April). The nymphal population remained high in the months

of March, April and May. Aphid infestation was also recorded and its maximum incidence (38.8 aphids/ 10 cm twig) was recorded in February month. The leaf miner is the second most important insect pest of the Kinnow mandarin and like citrus psyllid, it was present in all the months, with incidence ranging from 0.2 per cent in January to 11.2 per cent in September. A survey of orchards on the infested fruits during September revealed that thrips and mite complex was recorded in the range of 0.32 to 5.0 per cent in the year 2020. A sporadic incidence of fruit sucking moth was also observed during September end.

Sriganganagar: Regarding monitoring of insect pest of Kinnow mandarin, Citrus psylla, Leaf minor and thrips was the major enemy during the year except January, February, November and December months. Citrus psylla caused maximum damage in the months of March (11-20%) – April (21-35%)) followed by July to September months. Leaf miner was most active in March to April and July to September months. Thrips caused maximum damage in the month of April-May months. Lemon butterfly caused maximum damage in the month of April. Fruit sucking moth again caused serious damage in the Months of October and November.

Tinsukia: Higher incidences of leaf miner (15.6%) and lemon butterfly (12.3%) were recorded during reporting period.

b. Sweet orange

Rahuri: Incidence of Psylla, fruit sucking moth and mites was increased throughout the year. In general, there was average incidence of psylla and mites were observed.

Tirupati: The incidence of citrus leaf miner was low to moderate from December to February. Rust mite infestation was recorded from March to June and green mite infestation was severe during February to July. Among the other pests thrips infestation was found to be high on fruits during February to July and Ash weevil incidence was moderate during February to April. Severe citrus fruit sucking moth infestation was noticed during August to November.

c. Acid lime

Akola: Citrus psylla population ranged between 0.32 to 17.02 /5 cm twig. It was maximum (17.02) in second fortnight of February and showed significant negative correlation with maximum and minimum temperature. The leaf miner infestation was low to medium throughout the year and ranged from 5.06 to 27.62 per cent infestation from April 2018 to March 2019. The highest infestation was in second fortnight of August; whereas it was lowest in April first fortnight and reported significant negative correlation with maximum temperature and bright sunshine hours and positive significant correlation with morning and evening relative humidity. Maximum of 17.33 % leaf folder damage was noted in August second fortnight and lowest in May first fortnight with 0.93 % damage. The leaf folder infestation on acid lime had significant negative correlation with maximum temperature and bright sunshine hours and positive significant correlation with morning and evening relative humidity. In the fixed plot survey the incidence of citrus blackfly was very meagre on acid lime and ranged from 0.00 to 2.93 egg/nymphs/pseudo pupae/ sq. cm with maximum in second fortnight of June and had significant negative correlation with rainfall.

Rahuri: Moderate incidence of psylla and mites throughout the year was observed.

Tirupati: Acid lime pest calendar revealed that leaf miner damage was moderate during July to October and citrus butterfly was also low to moderate during July- September. Rust mite and thrips damage was high during February to May months. Among minor pests low snow scale damage was noticed on tree trunk region during February and continued up to May month. Citrus green mite damage showed moderate damage on leaves from February to July.

Periyakulam: The pest disease calendar for 2020 in citrus was developed using the fortnightly major pests incidence recorded through fixed plot survey. In the survey period, the incidence of leaf miner, citrus butterfly, Psylla population and citrus rust mite damage on fruits were recorded.

C. Impact on disease incidence

a) Mandarin

Akola: Incidence of twig bight was severe from January to March (9.2 to 9.5) and gummosis during November to January.

Ludhiana: The pathological fruit drop occurred in the month of September and including brown rot (2-4%). The *Phytotphthora* incidence was observed during March and again in September-October. The percent incidence of *Phytophthora* associated foot rot ranged from 9.72 to 17.35 per cent. The foot rot was more associated with the initial infection status of planting material and system of irrigation. Due to the frequent rains in this year, the incidence of canker was found on Kinnow in September-October, which otherwise does not occur. The greening was observed in the range of 2.3 to 7.0 per cent.

Sriganganagar: Among the diseases, incidence of

Citrus canker was maximum in August. *Phytophthora* root rot recorded maximum in June – July (20-35%) and Twig blight recorded highest in May - July with 10-35 per cent damage.

Tinsukia: Two major fungal diseases *viz.*, Phytophthora root rot (*Phytophthora sp.*) with an infestation of 3.5 per cent and 2 per cent infestation of twig blight (*Colletotrichum gloeosporioides*) along with minor diseases *viz.*, Scab (7.9%) were recorded in Khasi mandarin. Citrus greening was also recorded with an infestation of 2.9 percent.

b) Sweet orange

Rahuri: The incidence of stem end rot was increased because there was continuous rain during the month of June to August, 2020.

Tirupati: Canker, twig blight and greasy spot incidence was high during July-September.

c) Acid lime

Akola: Bacterial canker (*Xanthomonas citri*) was predominant in all acid lime gardens with minimum incidence in first fortnight of July (16.38%) and maximum (40%) was recorded in second fortnight of September. Significant correlation was observed between bacterial canker incidence and temperature (maximum and minimum). Other weather parameters, sunshine, evaporation and rainfall and rainy days showed non-significant correlation.

Rahuri: Incidence of canker in acid lime was increased because there was continues rain during the month of June to August, 2020.

Tirupati: Acid lime bacterial canker incidence was very high during August, 2020, whereas, Twig blight and Greasy spot disease incidence was severe during December, 2020.

Periyakulam: The disease calendar for 2020 was developed using the fortnightly disease incidence recorded through fixed plot survey. The diseases recorded were twig blight, bacterial canker, gummosis and citrus greening.

5.1.1.C. Status of emerging 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) and new entomopathogenic fungus, *Aschersonia aleyrodis* on pupae of citrus whitefly, *Dialeurodes citri* (Ashmead) in Kinnow mandarin orchards in District Hoshiarpur were recorded.

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: New insect-pests were reported and resulted into outbreak of non-regular minor pest, Citron bug, *Leptoglossus* spp. In the traditional areas of the sweet orange gardens in Kadapa and Prakasam district during March, April and May, 2020 there was 13-25 per cent damage to the fruits. New natural enemies like 19 spider species from Khasi mandarin orchards were recorded *viz.,* *Oxyopes birmanicus, Tylorida* sp., Tylorida sp., *Carrhotus* sp., Thomisus sp., Hasarius sp., Telamonia elegans, heteropoda sp., Thelacantha sp., *Eriovixia laglaizei, Neoscona* sp., *Araneus* sp., *Hersilia savigynii, Phintella vitatta, Carhottus decorate, Oxyopes shwetha, Eriovixia laglaizei, Nilus albocinctus, Brettus sp.* and *Telamonia dimidata.*

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: Minimum fallen fruits due to fruit sucking moth was recorded in T_3 (Petroleum spray oil @ 2%) at 10, 20 and 30 DAT (18.9%, 20.4% and 22.3% respectively) compared to control (44.4%, 48.3% and 51.3% respectively) given in table 61. Same treatment also recorded maximum fruit yield (16.8 t/ha) and BC ratio (10.5: 1).

Rahuri: Among different repellents, minimum fallen fruits (8.83%) due to fruit sucking moth was recorded in Neem oil @ 1% but it was at par with Petroleum Spray oil @ 2% (9.67%) and Azadirachtin 1% (10.17%) at 10 DAT. Similarly, at 20 and 30 DAT, Neem oil @ 1% recorded significantly low (10.17 & 11.67%) fruit drop and it was at par with Petroleum Spray oil @ 2% (11.17 & 12.00%) as against control (17 & 18.67%) fruit drop at 30 DAT (Table 61). Similarly, the same treatment i.e., Neem oil @ 1% recorded the maximum yield (7.87 t/ha) and BC ratio (1.56) which was at par with Petroleum Spray oil @ 2% (7.66 t/ha & 1.39) compared to untreated control (6.18 t/ha & 1.24).

Tinsukia: Petroleum spray oil @ 2% (T_3) recorded significantly low (12.10%, 11.30% & 9.40%

respectively) fruit drop due to fruit sucking moth damage at 10, 20 and 30 DAT compared to control (30.43%, 38.56% & 33.70% respectively) given in table 61. Same treatment also recorded highest yield (18.20 t/ha) and BC ratio (2.75).

Tirupati: Spray of Neem oil @ 1% (T_1) recorded significantly low per cent fallen fruits due to fruit sucking moth at 10, 20 and 30 DAT (12.63%, 13.59% & 12.01% respectively) which was at par with Petroleum Spray oil @ 2% (12.86%, 13.93% & 11.56% respectively) at 10, 20 and 30 DAT as compared to control (37.21, 40.91 & 42.06% respectively). The treatment with Neem oil @ 1% (T_1) also recorded the highest yield (18.81 t/ha) and BC ratio (2.05) which was at par with Petroleum Spray oil @ 2% (18.12 t/ha & 1.98) given in table 61.

Table-61: 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			
	Ludhiana	Rahuri	Tinsukia	Tirupati	Ludhiana	Rahuri	Tinsukia	Tirupati	Ludhiana	Rahuri	Tinsukia	Tirupati
T_1: Neem oil 1%	22.9 (28.6)	8.83 (17.27)	26.30 (30.85)	12.63 (20.80)	25.3 (30.2)	10.17 (18.59)	19.60 (26.28)	13.59 (21.62)	28.6 (32.3)	11.67 (19.96)	18.30 (25.33)	12.01 (20.26)
T2: Azadirachtin 1% @ 3ml/l	29.3 (32.8)	10.17 (18.56)	27.30 (31.50)	13.38 (21.44)	32.1 (34.5)	11.50 (19.81)	18.70 (25.62)	14.91 (22.70)	35.3 (36.5)	14.50 (22.34)	14.90 (22.71)	13.84 (21.83)
T3:Petroleum spray oil 2%	18.9 (25.8)	9.67 (18.09)	12.10 (20.36)	12.86 (21.00)	20.4 (26.9)	11.17 (19.51)	11.30 (19.64)	13.93 (21.90)	22.3 (28.2)	12.00 (20.25)	9.40 (17.85)	11.56 (19.86)
T4: Citronella oil 2%	34.5 (36.0)	11.33 (18.72)	23.41 (28.94)	14.56 (22.41)	37.3 (37.6)	14.50 (22.34)	20.30 (26.78)	17.01 (24.34)	41.3 (40.1)	16.33 (23.78)	19.90 (26.49)	17.49 (24.70)
T5:Soapnut extract 2%	29.1 (32.6)	11.83 (20.10)	22.56 (28.36)	18.97 (25.79)	31.3 (34.0)	14.83 (21.61)	19.40 (26.13)	18.20 (25.23)	36.1 (36.9)	16.67 (23.97)	14.30 (22.22)	22.01 (27.96)
T6:Mustard oil 2%	33.2 (35.2)	11.17 (19.47)	26.36 (30.89)	21.71 (27.75)	41.3 (40.0)	14.33 (22.24)	12.39 20.61	23.83 (29.20)	42.3 (40.6)	17.00 (24.34)	10.43 (18.84)	26.91 (31.23)
T7: Jatropha oil 2%	32.3 (34.6)	13.33 (21.32)	19.40 (26.13)	17.59 (24.78)	35.3 (36.5)	15.17 (22.80)	18.30 (25.33)	16.61 (24.04)	41.9 (41.3)	16.67 (22.08)	9.50 (17.95)	14.76 (22.57)
T8: Pongamia oil 2%	33.2 (35.2)	13.50 (21.55)	21.50 (27.62)	21.49 (27.60)	37.1 (37.5)	14.67 (22.47)	18.50 (25.47)	21.97 (27.94)	38.3 (38.2)	17.00 (24.34)	16.32 (23.83)	25.06 (30.02)
T9: Control	44.4 (41.8)	18.67 (34.48)	30.43 (33.48)	37.21 (37.57)	48.3 (44.0)	17.00 (24.34)	38.56 (38.39)	40.91 (39.74)	51.3 (45.7)	18.67 (25.57)	33.70 (35.49)	42.06 (40.41)
T10: Botanical pesticide	32.3 (34.6)	-	19.60 (26.28)	-	38.0 (38.1)	-	16.80 (24.20)	-	39.3 (38.8)	-	14.90 (22.71)	-
CD at 5%	4.51	2.25	2.04	1.126	4.08	3.73	2.70	0.952	3.55	4.45	2.10	0.937
*Days after treatment; Figures in parentheses are arc sin transformed values;												

5.1.3(X).C. Evaluation of new acaricides against Citrus mites

Different acaricides were tested against citrus mites at different locations. Treatments were given during active period of the pest twice at 15 days interval. Observations on population counts of mites per leaf before and 3, 7 and 14 days after treatment and infested fruits (%) before harvest were taken. The trial was laid out in RBD replicated four times.

Periyakulam: The pooled data results showed that, Propargite maintained its superior efficacy against leaf mites (0.33 mites/leaf) as against 4.15 per leaf in dicofol and 14.03 per leaf in control at 14 DAT (Fig-15). Pooled mean of three years data indicated that propargite recorded less incidence of mite on citrus fruits (4.04%), which was lesser than other treatments tested against rust mite. Maximum fruit yield (24.90 kg/ha) and economic return (1:2.04) was also recorded in same treatment i.e., propargite 57 EC.

Rahuri: The mite population/leaf were significantly low in spiromesifen 240 SC (0.009%) at 3 days (24.52 mites/ leaf) followed by propargite 57EC (0.057%) (26.25 mites/ leaf). At 7 days Spiromesifen 240 SC (0.009%) recorded least population (14.73 mites/leaf) which was at par with propargite 57EC (0.057%) (16.87 mites/leaf). Similarly, at 14 days after second spray, population (4.43 mites/ leaf) recorded in the same treatment spiromesifen 240 SC (0.009%) was at par with propagite 57 EC (0.057%) (5.98 mites/leaf) as against control (50.21 mites/leaf) as in fig-15. The yield data showed that the treatment with spiromacifen 240 SC (0.009%) recorded significantly maximum yield (15.05 t/ha)

with highest BC ratio (2.31) followed by proporgite 57 EC (0.057%) recorded BC ratio of 2.20.

Tinsukia: Propargite was significantly more effective in reducing mite population. After 14 DAT significant reduction of mite population was observed in the treatment of propargite (1.40 mites / leaf). However, it was observed that spiromesifen 240 SC was also at par in suppressing the mite population (1.89 mites/ leaf). Propargite 57 EC (0.057%) has also recorded maximum BC ratio (2.80) given in fig-15.

Tirupati: The pooled results of three year findings recorded that foliar application of T_1-spiromesifen 240 SC (0.009%) on Sathgudi sweet orange was significantly superior in recording lowest leaf mites population (5.63 mites/leaf) at 14 days after spray and rust mite infestation on fruits (4.83%) at harvest with a maximum yield of 20.13 t/ha and a higher BC ratio (2.67) as compared to control (25.96 leaf mites/leaf; 35.36% rust mite damaged fruits; yield-16.08t/ha).

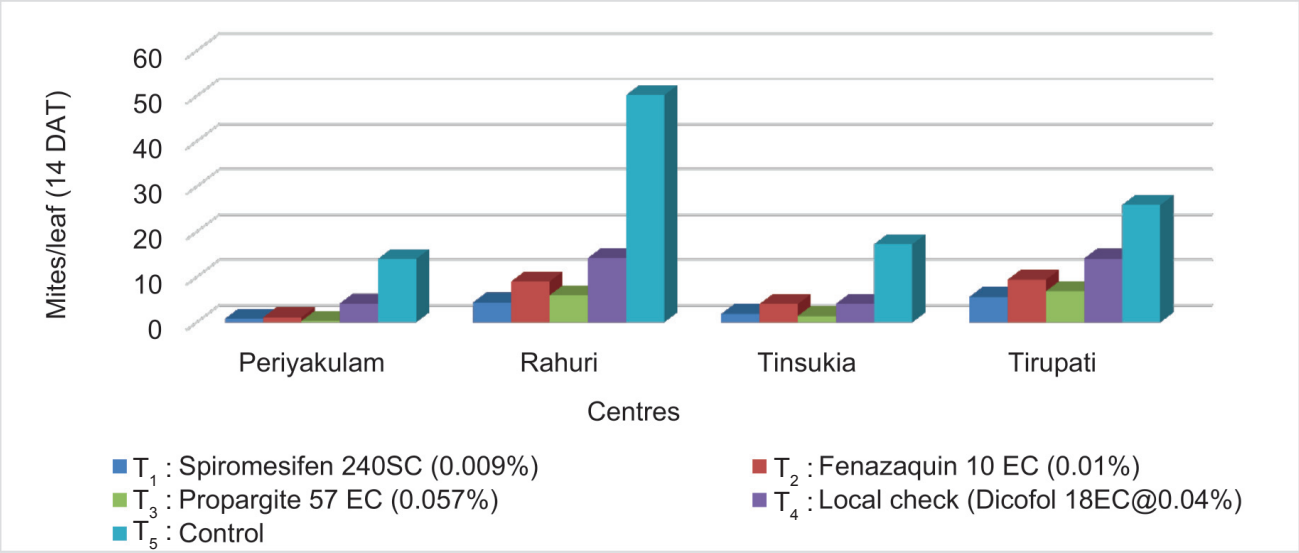


Fig. 15: Effect of acaricides against leaf mite population infesting Citrus

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

The experiment was laid out in kin now 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.,* T_1: Crop phenology-based insect pest management modules and T_2: 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 phonological stages.

Ludhiana: The population of Citrus aphids (10.30 nymphs/twig), blackfly (6.40 nymphs/twig) lemon butterfly (2.25 caterpillar per 10 twig) and leaf mite (13.30 population/leaves) were low in Crop phenology-based module (Table 62, 64, 66, & 69). Likewise, infestation of thrips (14.70 I % on fruits), rust mite (4.30 % on fruits), fruit drop due to fruit sucking moths (10.30 %), fruit drop due to fruit flies (4.20%) were lesser in Crop phenology-based module than in Farmers Practice (Table 67, 68 & 70). However, minimum psylla population (11.30 psylla/twig) and leaf miner infestation (28.30%) were observed in Farmers Practice (Table 63 & 65). The maximum yield (18.70 t/ha) and BC ratio (4.32) was recorded in the phenology-based insect pest management module (Table 71).

Periyakulam: Incidence of sucking pests like aphids (9.77 population/twig) and psylla (3.76 population/ twig) were observed minimum in the module-imposed treatment than in the farmers practice (Table 62 & 63). The incidence of blackfly, thrips and leaf mite were not observed in Periyakulam. The population of lemon butterfly (0.52 caterpillar per 10 twig) was low in Crop phenology-based module (Table 66). Likewise, infestation of rust mite (5.05 %) on fruits was lesser in Crop phenology-based module than in Farmers Practice (Table 68). The maximum yield (10.24 t/ha) and benefit cost ratio (2.58) was recorded in the phenology-based insect pest management module (Table 71).

Rahuri: Incidence of pest was observed minimum in the module-imposed plots than in the farmers practice. Aphids (18.35) psylla (11.52) and black fly (9.14) population per twig was low in module-imposed plots as against farmers practice which recorded 30.70, 14.92 and 15.21 population per twig, respectively (Table 62, 63 & 64). Likewise, minimum

infestation of leaf miner (30.45%), lemon butterfly (3.18 per 10 twig), thrips (21.25% on fruits), rust mite (4.16% on fruits), leaf mite (13.82/leaf), fruit drop due to fruit sucking moths (11.92%), were observed in Crop phenology-based module than in Farmers Practice (Table 65, 66, 67, 68, 69 & 70). The maximum yield (10.56 t/ha) and benefit cost ratio (2.28) was recorded in the phenology-based insect pest management module (Table 71).

Tinsukia: Incidence of sucking pest was observed minimum in the module-imposed plots than in the farmers' practice recording citrus aphids (7.30 nymphs/twig), psylla (6.52 nymphs/twig) and blackfly (7.18 nymphs/twig) in Crop phenology-based module (Table 62, 63 & 64). Likewise, infestation of leaf miner (15.15%), lemon butterfly (2.90/10 twig), thrips (4.50% on fruits), fruit drop due to fruit sucking moths (12.18%), leaf mite (7.50 /leaf), fruit drop due to fruit flies (8.45%) were lesser in Crop phenology-based module than in Farmers Practice (Table 65, 66, 67, 69 & 70). The incidence of rust mite was not observed in Tinsukia. The maximum yield (15.60 t/ha) and benefit: cost ratio (2.75) was recorded in the phenology-based insect pest management module (Table 71).

Tirupati: The population of citrus aphids (2.01 nymphs/twig), psylla (3.45 nymphs/twig), blackfly (0.97 nymphs/twig) and leaf mite (5.34 population/ leaves) were low in Crop phenology-based module (Table 62, 63, 64 & 69). Likewise, infestation of leaf miner (3.01%), thrips (6.14% on fruits) and rust mite (5.03% on fruits) were minimum in Crop phenology-based module than in Farmers' Practice (Table 65, 67 & 68). However, minimum incidence of lemon butterfly (4.89%) was observed in Farmers Practice (Table 66). The maximum yield (23.46 t/ha) and benefit cost ratio (2.31) was recorded in the phenology-based insect pest management module (Table 71).

Table-62: Comparative efficacy of different modules against sucking insect pests

Treatments#	Aphid (population/twig) before treatment					Aphid (population/twig) 15 days after spray				
	LDH	PKM	RHR	TSK	TPT	LDH	PKM	RHR	TSK	TPT
T_1	22.20	39.00	27.25	25.24	7.13	10.30	9.77	18.35	7.30	2.01
T_2	24.50	37.00	31.30	29.10	8.02	14.30	18.19	30.17	10.12	6.91
T- test	10.80*	0.47	14.07*	1.07	2.34*	8.40*	5.33*	11.77*	2.24*	0.043

LDH- Ludhiana, PKM- Periyakulam, RHR- Rahuri, TSK- Tinsukia, TPT- Tirupati, *Significant at 5% level

Refer methodology for treatment details

Table-63: Comparative efficacy of different modules against sucking insect pests

Treatments#	Psylla (population/twig) before treatment					Psylla (population/twig) 15 days after spray				
	LDH	PKM	RHR	TSK	TPT	LDH	PKM	RHR	TSK	TPT
T_1	20.30	10.00	16.87	14.40	14.01	13.40	3.76	11.52	6.52	3.45
T_2	23.70	8.23	17.70	16.70	16.89	11.30	5.16	14.92	10.22	12.93
T- test	10.30*	2.12*	9.23*	1.20	3.56*	12.40*	3.09*	8.55*	3.55*	0.049

LDH- Ludhiana, PKM- Periyakulam, RHR- Rahuri, TSK - Tinsukia, TPT- Tirupati, *Significant at 5% level

Refer methodology for treatment details

Table-64: Comparative efficacy of different modules against sucking insect pests

Treatments#	Blackfly (population/twig)									
	Before treatment					15 days after spray				
	LDH	PKM	RHR	TSK	TPT	LDH	PKM	RHR	TSK	TPT
T_1	10.80	-	12.27	13.56	6.56	6.40	-	9.14	7.18	0.97
T_2	13.30	-	14.10	15.10	6.80	10.3	-	15.21	13.25	5.97
T- test	6.20*		7.18*	1.14	0.23	5.70*		6.21*	5.21*	0.049

LDH- Ludhiana, PKM- Periyakulam, RHR- Rahuri, TSK - Tinsukia, TPT- Tirupati, *Significant at 5% level

Refer methodology for treatment details

Table-65: Comparative efficacy of different modules against leaf miner

Treatments#	Leaf miner infestation (%)									
	Before treatment					15 days after spray				
	LDH	PKM	RHR	TSK	TPT	LDH	PKM	RHR	TSK	TPT
T_1	35.30	11.56	40.30	35.25	11.23	28.70	3.16	30.45	15.15	3.01
T_2	38.50	11.16	50.78	39.70	11.56	28.30	8.37	50.15	30.10	10.54
T- test	10.30*	0.45	14.10*	5.18*	1.81	8.50*	9.82*	13.21*	10.25*	0.04

LDH- Ludhiana, PKM- Periyakulam, RHR- Rahuri, TSK - Tinsukia, TPT- Tirupati, *Significant at 5% level
#Refer methodology for treatment details

Table-66: Comparative efficacy of different modules against lemon butterfly

Treatments#	Incidence of lemon butterfly (Caterpillar population per 10 twig)									
	Before treatment					15 days after spray				
	LDH	PKM	RHR	TSK	TPT	LDH	PKM	RHR	TSK	TPT
T1	5.83	2.20	4.82	5.15	8.12	2.25	0.52	3.18	2.90	5.04
T2	7.23	2.00	6.07	6.36	5.02	4.31	1.20	5.26	5.95	4.89
T- test	3.10*	0.64	2.13*	3.10*	1.32	2.51*	5.19*	2.10*	2.40*	0.19

LDH- Ludhiana, PKM- Periyakulam, RHR- Rahuri, TSK - Tinsukia, TPT- Tirupati, *Significant at 5% level
#Refer methodology for treatment details

Table-67: Comparative efficacy of different modules against thrips (Infestation % on fruits)

Treatments#	Before treatment					15 days after spray				
	LDH	PKM	RHR	TSK	TPT	LDH	PKM	RHR	TSK	TPT
T1	33.30	-	28.90	6.35	9.23	14.70	-	21.25	4.50	6.14
T2	35.80	-	30.50	7.40	9.01	16.70	-	32..15	6.65	15.03
T- test	14.30*		11.24*	2.45*	0.45	10.30*		9.48*	1.65	0.0003

LDH- Ludhiana, PKM- Periyakulam, RHR- Rahuri, TSK - Tinsukia, TPT- Tirupati, *Significant at 5% level
#Refer methodology for treatment details

Table-68: Comparative efficacy of different modules against rust mite infestation on fruits (%) at harvest

Treatments#	Before treatment					15 days after spray				
	LDH	PKM	RHR	TSK	TPT	LDH	PKM	RHR	TSK	TPT
T_1	10.30	20.21	6.10	-	9.23	4.30	5.05	4.16	-	5.03
T_2	12.70	19.91	9.17	-	10.01	6.10	14.93	7.23	-	14.67
T- test	4.32*	0.216	2.77*			3.20*	11.77*	2.13*		0.00

LDH- Ludhiana, PKM- Periyakulam, RHR- Rahuri, TSK - Tinsukia, TPT- Tirupati, *Significant at 5% level
#Refer methodology for treatment details

Table-69: Comparative efficacy of different modules against leaf mite (population/leaves)

Treatments#	Before treatment					15 days after spray				
	LDH	PKM	RHR	TSK	TPT	LDH	PKM	RHR	TSK	TPT
T_1	25.30	-	22.60	12.80	14.70	13.30	-	13.82	7.50	5.34
T_2	28.70	-	26.65	16.32	16.85	20.70	-	27.55	10.25	13.26
T- test	10.30*		9.41*	6.60*	1.80	7.30*		7.99*	5.80*	0.008

LDH- Ludhiana, PKM- Periyakulam, RHR- Rahuri, TSK - Tinsukia, TPT- Tirupati, *Significant at 5% level
#Refer methodology for treatment details

Table-70: Comparative efficacy of different modules against fruit sucking moth and fruit fly

Treatments #	Fruit drop due to fruit sucking moth (%)					Fruit drop due to fruit fly (%)				
	LDH	PKM	RHR	TSK	TPT	LDH	PKM	RHR	TSK	TPT
T_1	10.30	-	11.92	12.18	-	4.20	-	-	8.45	-
T_2	12.70	-	19.17	14.20	-	8.30	-	-	12.60	-
T- test	5.43*		6.49*	5.49*		3.20*			3.11*	
LDH- Ludhiana, PKM- Periyakulam, RHR- Rahuri, TSK - Tinsukia, TPT- Tirupati, *Significant at 5% level #Refer methodology for treatment details										

Table-71: Effect of different module on yield and BC ratio

Treatments#	Yield (t/ha)					B:C				
	LDH	PKM	RHR	TSK	TPT	LDH	PKM	RHR	TSK	TPT
T_1	18.70	10.24	10.56	15.60	23.46	4.32	2.58	2.28	2.75	2.31
T_2	13.30	7.52	8.60	12.15	21.16	3.18	1.53	1.78	2.06	1.78
T- test	7.82*	-	5.43*	2.43*	0.043	4.13*	-	-	-	-
LDH- Ludhiana, PKM- Periyakulam, RHR- Rahuri, TSK- Tinsukia, TPT- Tirupati, *Significant at 5% level #Refer methodology for treatment details										

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, 53 Nagpur mandarin orchards of different age groups, 21 sweet orange orchards and 32 acid lime orchards from Vidarbha region of Maharashtra, 12 sweet orange and 13 acid lime from Tirupati, 29 acid lime from Periyakulam, 15 sweet orange and 27 acid lime from Rahuri, 38 Kinnow mandarin orchards in the three agro-climatic zones of Punjab and 24 Khasi mandarin orchards from Assam were surveyed during roving survey for the year 2020.

a) Mandarin

Akola: Twig blight (3.11 – 29.66 % incidence), Stem end rot (4.60 – 18.80 %), Brown rot (9.60 – 40.50 %) and Gummosis (0.50 – 3.90 %) were recorded.

Ludhiana: *Phytophthora* foot rot/gummosis (6.39 – 19.57 %), Twig blight (3.82 – 20.93 %) were recorded. Other commonly occurring diseases *viz.,* citrus greening (2.00 – 14.90 %), Bacterial canker (3.02 – 13.85 %) and Citrus ring spot (1.0 – 10.94 %) were most wide spread and serious diseases.

Tinsukia: Twig blight (10.0 -36.66%), Gummosis/ Foot rot (3.33 – 26.66%), Fruit drop due to pre-harvest stem end rot (up to 30.0%) and minor fungal diseases like Scab (3.33-23.33%) and Sooty mould (up to 13.33%) were recorded. Among virus and virus-like pathogen i.e., CTV was recorded up to incidence level of 46.66 per cent while Citrus greening disease (CGD) was observed up to 45.00 per cent.

b) Sweet orange

Akola: Brown rot (30.20 – 45.90 %), Twig blight (6.33 – 24.94 %), Gummosis (1.20 – 4.90 %) and greening (up to 2.40 %) were recorded.

Rahuri: Major diseases observed in Western Maharashtra were Phytophthora foot rot/Gummosis (12.22 – 16.84 %), Twig blight (9.44 – 47.27 %), Citrus greening (14.29 – 31.82 %) and Tristeza (0.29 – 0.57 %).

Tirupati: Citrus greening (2.40-56.80 %), citrus yellow mosaic (up to 23.20 %), greasy spot (4.96-12.00 %) and dry root rot (up to 16.80 %), *Diplodia* gummosis (up to 16%) and gummosis (up to 8.00 %) were observed along with severe Zinc and Magnesium deficiency.

c) Acid lime

Akola: Prevalence of Bacterial Canker, Twig blight, Sooty mould, Witches broom and Phytophthora foot rot/Gummosis recorded in the surveyed areas. Bacterial canker (12.52 to 49.94%) and twig blight (4.55 to 20.46%) were predominant in all age group of surveyed orchards. Witches broom prevalence mostly was recorded in Akola district to the tune of 1.80 to 5.10 per cent.

Periyakulam: Twig blight, bacterial canker and Citrus Greening diseases were recorded to be the major diseases. Average incidence of twig blight (21.93%), bacterial canker (26.26%), stem end rot (6.68%), gummosis (11.34%) and greening (22.62%) were recorded.

Rahuri: Major diseases observed in Western Maharashtra were bacterial canker (17.28 to 52.97%), Twig blight

(24.18 to 38.38%), Phytophthora foot rot/Gummosis (3.19 to 18.18 %) and Tristeza (0.17 to 1.23 %).

Tirupati: Occurrence of bacterial canker (1.60 -21.44 %), Greasy spot (1.12 - 19.20 %), Dry root rot (up to 14.40 %) and Gummosis (up to 16.80 %) were recorded in all locations in Andhra Pradesh. Longitudinal bark and wood splitting disease (up to 52.0 %), Twig blight (up to 42.0 %) and *Diplodia* Gummosis (up to 39.0%) and Greening (up to 35.20%) were also reported during survey.

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 seedling mortality (14.44%), per cent seedling (13.33 %) and feeder root rating (1.23) were observed in Rangpur lime whereas, maximum seedling mortality (25.56%) and feeder root rating (3.0) was recorded in rough lemon (*Citrus jambheri*).

Ludhiana: The minimum per cent seedling mortality (16.66 %), feeder root rating (1.43) and lowest leaf fall (17.27%) was observed in Australian Sour orange while, maximum seedling mortality (36.66%) was recorded in CRH-12.

Rahuri: Rangpur lime Rahuri (Marmalade orange) recorded minimum per cent mortality (11.11 %), feeder root rating (0.93) and leaf fall (13.11 %) while, maximum seedling height (32.27 cm), tap root length (17.75 cm) in *C. jambhiri* and maximum seedling girth (1.42 cm) in Rangpur lime Rahuri was recorded.

Fusarium, Rizoctonia

Tirupati: The percent mortality was significantly low in case of Australian Sour orange (5.0%), Alemow (10.0%) and CRH-12 (10.00 %) when compared to susceptible check Jambheri (60.00 %).

6.1.8.C. Isolation of bio-agents against *Phytophthora* foot 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: *Pseudomonas fluorescens, Bacillus subtilis* and three isolates of *Trichoderma harzianum* were isolated from the rhizosphere region of Citrus crop for the evaluation against *Phytophthora* spp. during reporting period. The bioagent, *P. fluorescens* PDKV was very effective by recording the highest per cent inhibition of *Phytophthora* spp. *i.e.* 78.48 per cent. The next best bio-agent was *T. harzianum 1,* which recorded 69.53 per cent inhibition over control and *B. subtilis* recorded the least inhibition (52.68%).

Ludhiana: Among the collected soil samples, five isolates of *Trichoderma* were recovered. *Trichoderma* spp., IRS_4 recorded maximum per cent growth inhibition of 70.38 per cent on the in vitro growth of *Phytophthora sp.* and *Trichoderma* (IRS_4) proved to be the most effective in pot culture experiment.

Periyakulam: Among the bioagents, compatibility studies with bioagents revealed that all the bioagents were compatible with each other except *Bacillus subtilis* (BS3) which was not compatible with other bioagents. *P. fluorescens (BPKM)* was found to be effective in pot culture studies. *Pseudomonas fluorescens* (BPKM 27) has recorded 63.63 per cent reduction over control and *Bacillus subtilis* (BS3) was 62.61 per cent reduction over control.

Tirupati: Four isolates of *Trichoderma* and one isolate of *P. fluorescens* were recovered. *Trichoderma sp*. TKaP1 recorded maximum per cent growth inhibition of 73.95 on the in vitro growth of *Phytophthora* sp. and pot culture experiment is in progress.

Tinsukia: Among the five isolates of *Trichoderma* spp. The maximum per cent inhibition (75.83 %) of *Fusarium solani* was recorded in *Trichoderma* spp 14. Next best bio-agent is *Trichoderma* spp. 13 which recorded 75.28 per cent inhibition over control. Pot culture experiment is in progress.

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.

Akola: The treatment T_4 (50% more than recommended dose of Phosphorus (RDP) + Tetracycline hydrochloride 600 ppm + $ZnSO_4$ + $FeSO_4$ (200g each) recorded minimum disease severity (22.83%) and maximum yield (48.0 kg/tree) followed by treatment T_5 (T_1 + $ZnSO_4$ +$FeSO_4$ (200g each)) and T_3 (Tetracycline hydrochloride 600 ppm + $ZnSO_4$ + $FeSO_4$ (200g each)) that was effective in reducing the severity of the disease and higher yield as compared to control.

Ludhiana: The treatment T_4 with 50% more than recommended dose of Phosphorus (RDP) + Tetracycline hydrochloride 600ppm + $ZnSO_4$ +$FeSO_4$ (200g each) was most effective in reducing the disease severity (40.00 %), and maximum canopy volume (10.32 m^3), yield (55.0 kg/tree) and B:C ratio (3.18).

Rahuri: Treatment T_4 (i.e. 50% more than recommended dose of phosphorus + Tetracycline hydrochloride 600 ppm + $ZnSO_4$ +$FeSO_4$ (200g each)) has recorded minimum disease severity 21.88 per cent with 12.50 per cent disease control as compared to other treatments. Maximum canopy volume (8.50 m^3), yield (50.42 kg/tree) and BC ratio (2.50) was also recorded by the same treatment as compared to other treatments.

Tinsukia: The treatment T_4 (50% more than recommended dose of Phosphorus (RDP) + Tetracycline hydrochloride 600ppm + $ZnSO_4$ +$FeSO_4$ of 200g each) was better in terms of per cent disease control (45.85 %) and yield (46.04 kg/tree) followed by treatment T_5 {50% more than recommended dose of Phosphorus (RDP)+ $ZnSO_4$ + $FeSO_4$ (200g each)}.

Tirupati: Among the different treatments, maximum per cent disease reduction of 27.38 and 24.52 was recorded in T_4 and T_5, respectively and which were on par with each other. Whereas, maximum yield (21.89 kg/tree) and BC ratio (1.3) was recorded in T_4 (50% more than recommended dose of Phosphorus (RDP) + Tetracycline hydrochloride 600ppm + $ZnSO_4$ +$FeSO_4$ of 200g each).

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1.4.7. Gr. Evaluation of coloured F 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 (Vijayapura): Among the different table grape varieties maximum bunch weight (489 g), 100 berries weight (456 g) and berry diameter (23.5 mm) was recorded in Red Globe. However, more than 25 sugar acid ratio was recorded in all the varieties. Fantasy Seedless, Manjari Shyama, Nanasaheb Purple Seedless and Sharad Seedless took 135-148 days for harvest.

Mandsaur: Planting of grafted vines on Dogridge rootstock has been done and the crop is in establishment stage.

Pune (NRCG): During the period, heavy yield losses were occurred at the centre due to severe incidence of downy mildew. The minimum yield and number of bunches were obtained in the variety Nanasaheb Purple Seedless. Maximum bunch weight (417 g), 100 berries weight (513 g), berry diameter (24.1 mm) and shelf life (22.3 days) for 5 per cent PLW was obtained in the Red Globe. Maximum fruitful canes were obtained in Manjari Shyama (15.3).

Periyakulam (Theni): During the period, heavy yield losses were also reported due to severe downy mildew incidence at Theni. After the bunch losses, the remaining yield was ranged from 3.16 kg/vine (Nanasaheb Purple Seedless) to 5.50 kg per vine (Manjari Shyama), while the bunch weight was ranged from 215 g (Crimson Seedless) to 404 g (Red Globe).

Rahuri: Planting of grafted vines on Dogridge rootstock has been done and the crop is in establishment stage.

Rajendranagar: Among the different table grape varieties the bunch weight ranged between 359 g (Fantasy Seedless) to 820 g (Red Globe). Very low fruitfulness was obtained in Nanasaheb Purple Seedless. Bunches per vine ranged from 6.48 (Nanasaheb Purple Seedless) to 42.3 (Manjari Shyama). Except Red Globe, more than 25 sugar acid ratio was recovered in all other varieties (Table 72-74).

Table-72: Evaluation of table grape varieties for fruit yield and bunch weight at different centres

Varieties	Yield (kg/vine)				Bunch weight (g)			
	ARB	PKM	PNG (NRCG)	RGR	ARB	PKM	PNG (NRCG)	RGR
Red Globe	8.19	4.81	3.32	25.9	489	404	417	820
Fantasy Seedless	2.70	4.48	2.31	8.30	268	328	212	359
Crimson Seedless	9.31	3.60	3.17	13.3	315	215	333	401
Manjari Shyama (A-18/3)	8.97	5.50	3.62	21.4	347	219	223	511
Nanasaheb Purple Seedless	5.11	3.16	0.51	2.40	343	305	257	389
Sharad Seedless (Check)	4.09	5.20	0.97	16.6	293	295	207	514
CD at 5%	3.29	0.36	1.13	8.30	37.5	13.9	22.72	52.2
ARB: Arabhavi, PKM: Periyakulam, PNG (NRCG): Pune (ICAR-NRCG) and RGR: Rajendranagar								

Table-73: Evaluation of table grape varieties for 100 berries weight and berry diameter at different centres

Varieties	100 Berries weight (g)			Berry diameter (mm)		
	ARB	PNG (NRCG)	RGR	ARB	PNG (NRCG)	RGR
Red Globe	456	513	616	23.55	24.1	19.9
Fantasy Seedless	216	181	455	17.28	17.1	19.4
Crimson Seedless	252	213	429	16.30	16.0	16.9
Manjari Shyama (A-18/3)	215	222	284	16.68	16.6	16.8
Nanasaheb Purple Seedless	270	216	508	16.25	21.5	19.9
Sharad Seedless (Check)	225	161	362	16.18	19.9	18.7
CD at 5%	16.6	14.63	31.6	4.24	0.73	1.9
ARB: Arabhavi, PNG (NRCG): Pune (ICAR-NRCG) & RGR: Rajendranagar						

Table-74: Evaluation of table grape varieties for bunches per vine and sugar acid ratio at different centres

Varieties	Bunches per vine (Number)			Sugar acid ratio (Ratio)		
	ARB	PNG (NRCG)	RGR	ARB	PNG (NRCG)	RGR
Red Globe	18.3	7.64	31.5	26.1	35.3	20.6
Fantasy Seedless	11.8	10.6	23.4	39.3	34.2	36.6
Crimson Seedless	32.0	9.56	33.1	31.9	31.5	28.9
Manjari Shyama (A-18/3)	27.0	16.2	42.3	35.5	32.0	31.0
Nanasaheb Purple Seedless	16.3	1.96	6.48	35.0	27.5	30.0
Sharad Seedless (Check)	15.3	4.73	32.4	31.1	27.6	27.1
CD at 5%	7.52	3.97	11.8	3.69	2.79	2.88
ARB: Arabhavi, PNG (NRCG): Pune (ICAR-NRCG) & RGR: Rajendranagar						

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 evaluated bunch weight ranged between 285 g (Merbein Seedless) to 319 g (Thompson Seedless) (Table 75-77). Raisin recovery was recorded in ranged from 26.0 per cent (Thomson seedlesss) to 27.8 per cent (Merbein Seedless). Maximum number of raisins per 100 g was recorded in 2A-Clone (332). More than 23°B was recorded in all the varieties. In the sensory evaluation, Manjari Kishmish scored maximum in overall acceptability followed by Thompson Seedless (Fig-17).

Mandsaur: The vines are at establishment stage.

Periyakulam (Theni): Centre has reported heavy yield losses due to downy mildew incidence. Maximum bunch weight 301 g was recorded in 2A-Clone. Raisin recovery ranged from 21.7 per cent (2A-Clone) to 24.6 per cent (Merbein Seedless) and berry diameter ranged between 9.83 mm (Merbein Seedless) and 11.2 mm (Manjari Kishmish).

Pune (NRCG): Lower yield was recorded due to downy mildew incidence during the year. The average bunch weight was ranged from 104 g (Manjari Kishmish) to 163 g (Merbein Seedless). However, comparatively maximum raisin recovery was recorded in Manajri Kishmish (25.2%), maximum number of raisins per 100 g was recorded in 2A Clone (345). Minimum 124 days to harvest was taken by all the varieties to attain more than 22°B (Fig-16).

Rajendranagar: At Rajendranagar, maximum yield (21.9 kg/vine) and bunch weight (445 g) was achieved in Thompson Seedless. However, the total soluble solids ranged from 18.1°B (2A-Clone) to 21.8°B (Merbein seedless), while no much differences were recorded for acidity.

Rahuri: Vines are at establishment stage.

Table-75: Evaluation of raisin grape varieties for fruit yield and raisin recovery at different centres

Varieties	Yield (kg/vine)				Raisin recovery (%)			
	ARB	PKM	PNG (NRCG)	RGR	ARB	PKM	PNG (NRCG)	RGR
Merbein Seedless	7.84	2.63	0.80	13.41	27.8	24.6	22.7	25.5
2A- Clone	10.50	5.51	0.82	14.65	26.5	21.7	23.4	22.4
Manjari Kishmish	9.74	2.79	0.40	11.05	27.0	23.7	25.2	24.6
Thomson Seedless (Check)	12.41	5.86	0.77	21.92	26.0	23.2	24.1	23.3

Varieties	Yield (kg/vine)				Raisin recovery (%)			
	ARB	PKM	PNG (NRCG)	RGR	ARB	PKM	PNG (NRCG)	RGR
CD at 5%	2.36	0.48	0.57	2.77	1.22	0.90	0.06	1.6
ARB: Arabhavi, PKM: Periyakulam, PNG (NRCG): Pune (ICAR-NRCG) and RGR: Rajendranagar								

Table-76: Evaluation of raisin grape varieties for number of raisins per 100 g and bunch weight at different centres

Varieties	Raisins/100 g (No.)				Bunch weight (g)			
	ARB	PKM	PNG (NRCG)	RGR	ARB	PKM	PNG (NRCG)	RGR
Merbein Seedless	286	-	273	137	285	163	163	357
2A- Clone	332	-	345	143	299	301	128	354
Manjari Kishmish	316	-	312	142	305	262	104	313
Thomson Seedless (Check)	322	-	313	140	319	289	125	445
CD at 5%	7.07	-	5.48	-	22.39	7.22	46.3	34.7
ARB: Arabhavi, PKM: Periyakulam, PNG (NRCG): Pune (ICAR-NRCG) and RGR: Rajendranagar								

Table-77: Evaluation of raisin grape varieties for total soluble solids and acidity at different centres

Varieties	TSS (˚B)				Acidity (%)			
	ARB	PKM	PNG (NRCG)	RGR	ARB	PKM	PNG (NRCG)	RGR
Merbein Seedless	23.6	22.8	23.0	21.8	0.46	0.39	0.57	0.62
2A- Clone	23.9	21.2	22.8	18.1	0.42	0.51	0.57	0.69
Manjari Kishmish	23.1	21.2	22.9	20.8	0.48	0.47	0.58	0.68
Thomson Seedless (Check)	24.4	20.4	22.5	21.2	0.41	0.55	0.52	0.67
CD at 5%	0.91	22.84	1.26	1.20	0.03	0.04	0.05	0.03
ARB: Arabhavi, PKM: Periyakulam, PNG (NRCG): Pune (ICAR-NRCG) & RGR: Rajendranagar								

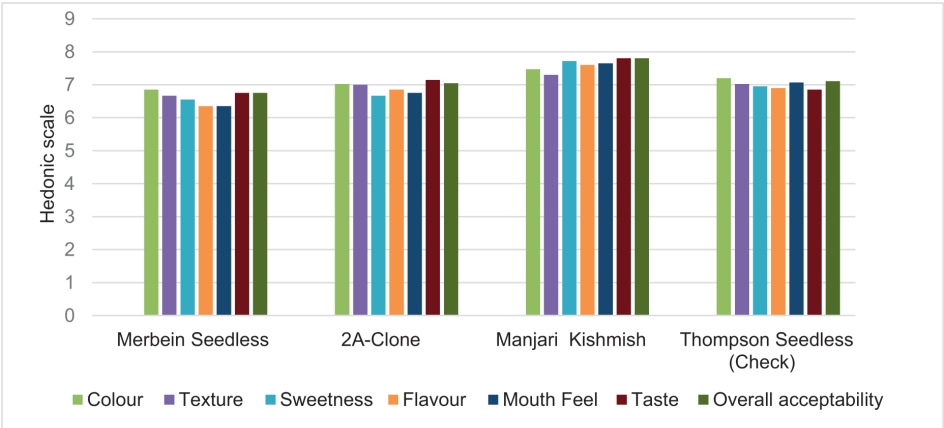


Fig. 16: Sensory evaluation of four raisin grape varieties by Pune NRCG

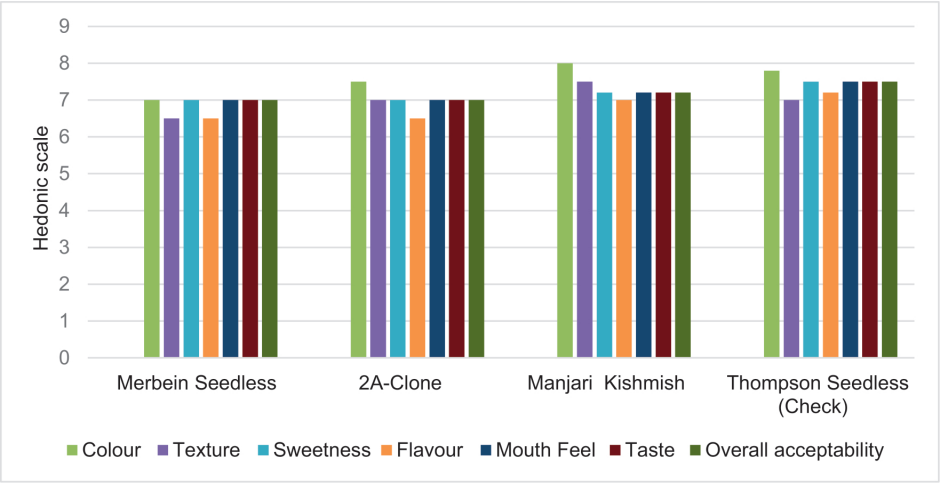


Fig. 17: Sensory evaluation of four raisin grape varieties by Arabhavi

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 (Vijayapura): Among the different juice grape varieties evaluated, significantly maximum bunches per vine was recorded in ARI 516 (86.25) whereas maximum bunch weight was recorded in Manjari Medika (304.50 g). However, other quality parameters were non-significant among the treatments.

Mandsaur: The vines are at establishment stage.

Periyakulam (Theni): Among the different juice grape varieties evaluated, higher bunch weight was recorded in Manjari Medika (391.46 g). Whereas, the highest number of bunches (54.58/vine), juice recovery (58.46%) and highest TSS (22.04°B) was recorded in ARI 516. In sensory evaluation test highest score was recorded in ARI 516 for juice flavour, consistency, mouth feel and overall acceptability and Manjari Medika for colour.

Pune (ARI): Among the different juice grape varieties evaluated, maximum yield of 13.00 kg per vine, maximum bunches per vine (94.38) was recorded in ARI 516. Significantly maximum bunch weight was recorded in Manjari Medika (215.71 g). Juice recovered in all the varieties was flavoured except Medika which is having neutral flavour.

Pune (NRCG): During the year, severe yield losses were observed in the varieties due to downy mildew incidence. Yield ranged from 1.42 kg per vine in Gulabi x Bangalore Purple to 9.27 kg per vine in ARI 516. Maximum bunch weight (409 g), juice colour intensity (5.72) was recorded in Manjari Medika.

Rahuri: The vines are at establishment stage.

Rajendranagar: Among the different juice grape varieties evaluated, significantly maximum bunches per vine was recorded in ARI 516 (232.8) compared to check Bangalore blue (170.3). Maximum weight of 100 berries (335.25 g) was recorded in Gulabi x Bangalore Purple. All varieties were flavored having soft mesocarp except Medika which was neutral in flavour having firm mesocarp.

In general, ARI 516 and Manjari Medika performed better at all the remaining five centres reported compared to check Bangalore Blue (Table 78-80).

Table-78: Evaluation of juice varieties for yield and number of bunches per vine at different centres

Varieties	Yield (kg/vine)					Number of bunches per vine				
	PKM	PNG (ARI)	PNG (NRCG)	RGR	ARB	PKM	PNG (ARI)	PNG (NRCG)	RGR	ARB
Age (in years)	4	4	4	4	2	4	4	4	4	2
V-1	10.60	10.46	6.85	24.76	13.33	27.11	48.75	17.9	102.3	43.00
V-2	8.47	2.35	1.42	23.40	11.81	27.82	25.79	9.50	104.1	60.75
V-3	9.56	13.00	9.27	27.80	12.21	54.58	94.38	36.70	232.8	86.25
V-4	2.56	9.18	5.90	20.81	7.44	20.75	57.25	41.1	143.9	62.00
V-5	-	8.06	7.77	14.47	5.34	-	70.04	46.5	78.78	46.75
V-6(c)	7.26	8.88	5.93	22.33	8.53	29.55	58.75	41.9	170.3	62.50
CD (0.05)	1.28	1.82	2.61	5.32	2.68	1.74	7.19	15.0	30.97	12.42

PKM: Periyakulam, PNG (ARI): Pune (ARI), PNG(NRCG): Pune (ICAR-NRCG), RGR: Rajendranagar, ARB: Arabhavi (Vijayapura)
V-1: Manjari Medika, V-2: Gulabix Bangalore Purple, V-3: ARI 516, V-4: Concord, V-5: Arka Shyam, V-6: Bangalore Blue (Check)

Table-79: Evaluation of juice varieties for bunch weight and 100 berries weight per vine at different centres

Varieties	Bunch weight (g)					Weight of 100 berries (g)				
	PKM	PNG (ARI)	PNG (NRCG)	RGR	ARB	PKM	PNG (ARI)	PNG (NRCG)	RGR	ARB
Age (years)	4	4	4	4	2	4	4	4	4	2
V-1	391.46	215.71	409	241.1	304.50	213.60	209.25	220	199.25	189.75
V-2	304.89	90.89	165	225.5	193.25	199.24	212.33	298	335.25	261.75
V-3	175.36	138.03	270	120.2	139.00	118.62	121.83	166	137.50	131.25
V-4	123.54	140.18	122	145.9	115.50	190.31	200.65	237	228.41	172.25
V-5	-	148.18	164	183	110.75	-	173.78	169	184.00	182.25
V-6(c)	245.65	144.50	128	162.2	132.25	203.45	218.00	242	211.50	170.50
CD (0.05)	14.36	18.83	91.5	24.88	26.21	16.55	22.75	39.7	35.99	20.85

PKM: Periyakulam, PNG (ARI): Pune (ARI), PNG(NRCG): Pune (ICAR-NRCG), RGR: Rajendranagar, ARB: Arabhavi (Vijayapura)
V-1: Manjari Medika, V-2: Gulabix Bangalore Purple, V-3: ARI 516, V-4: Concord, V-5: Arka Shyam, V-6: Bangalore Blue (Check)

Table-80: Evaluation of juice varieties for juice recovery and flavour at different centres

Varieties	Juice recovery (%)					Colour intensity				
	PKM	PNG (ARI)	PNG (NRCG)	RGR	ARB	PKM	PNG (ARI)	PNG (NRCG)	RGR	ARB
Age (years)	4	4	4	4	2	4	4	4	4	2
V-1	54.65	75.00	63.3	62.13	71.83	0.230	0.246	5.72	-	-
V-2	52.38	68.53	59.5	60.8	68.63	0.178	0.123	4.60	-	-
V-3	58.46	69.97	61.0	57.1	70.05	0.319	0.302	5.11	-	-
V-4	52.14	56.11	57.8	50.39	65.33	0.094	0.064	4.42	-	-
V-5	-	64.48	61.8	55.03	67.18	-	0.087	4.21	-	-
V-6(c)	49.82	56.25	56.0	58.77	63.20	0.113	0.101	4.39	-	-
CD (0.05)	1.65	10.00	2.55	7.32	3.27	-	-	0.15	-	-

PKM: Periyakulam, PNG (ARI): Pune (ARI), PNG(NRCG): Pune (ICAR-NRCG), RGR: Rajendranagar, ARB: Arabhavi (Vijayapura)
V-1: Manjari Medika, V-2: Gulabix Bangalore Purple, V-3: ARI 516, V-4: Concord, V-5: Arka Shyam, V-6: Bangalore Blue (Check)

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 & Mandsaur and Flame Seedless for Ludhiana) on three rootstocks (1103 P, SO4, 110R and Dogridge).

Arabhavi (Vijayapura): Among the different rootstocks, Thompson seedless grafted on Dogridge registered highest yield (21.5 t/ha), maximum bunch weight (316 g) and weight of 100 berries (206g) (Table 81).

Ludhiana: The training and establishment of grafted vines on Y trellises is in progress. No graft incompatibility was observed.

Mandsaur: The experiment had been laid out in March, 2018. The training and establishment of grafted vines on Y trellises is in progress. No graft incompatibility was observed.

Periyakulam: The training and establishment of grafted vines on Y trellises is in progress. No graft incompatibility was observed. Crop is in vegetative stage.

Pune (NRCG): The first-year fruiting was obtained with 4-7 bunches per vine. But due to severe incidence of downy mildew, bunches were dried resulted to zero yield recovery.

Rahuri: The grafting was done in September, 2018 and framework was developed on Y trellises

Rajendranagar: Rooted cuttings were planted in March 2019.The training and establishment of grafted vines on Y trellises is in progress. No graft incompatibility was observed.

Table-81: Evaluation of commercial grapes varieties on different rootstocks at Arabhavi

Variety	Rootstock used for grafting	Yield (kg/vine)	Yield (t/ha)	100 Berry Weight (g)	Bunches/ vine	Bunch weight (g)
Thompson Seedless	1103P	5.93	14.3	186	23.3	289.43
Thompson Seedless	110R	7.65	18.4	193	28.0	303.63
Thompson Seedless	SO4	4.22	10.1	179	18.3	275.40
Thompson Seedless	Dogridge (Check)	8.95	21.5	206	31.3	315.78
Thompson Seedless	Own root (Check)	2.98	7.16	172	13.8	262.95
CD at 5%		1.31	3.15	6.72	4.82	20.97

4.4.1. Gr. Assessment of post-harvest losses in grapes

Two to three vineyards of most popular variety such as Thompson Seedless/ Tas-A-Ganesh/ Sonaka and Sharad Seedless/ its clones was targeted to record post-harvest losses.

Pune (ICAR-NRCG): During the period of report, the compliance of package of practices revealed that cutting above knot is comply by 100% followed by placing of grape filled crates in shade (90%) and lining of crates (80%). The least complied parameter was harvesting of grapes before 10 AM and staying of filled crates in vineyards not more than 2 hrs (10%). Only 9.9 per cent losses were recorded in grapes when data was collected at harvesting, transport and retailing stages.

Periyakulam: Among the parameters for standard package of practices, maximum compliance was recorded in cutting above knot (84.60%) followed by harvesting time before 10 am (83.9%). The post-harvest losses at field level during July to August,

2020 was recorded at local retailing points was 19.70 and 15.50 per cent recorded in Sharad Seedless and Thompson Seedless grape varieties, respectively.

Rahuri: A cent per cent of compliance was recorded in harvesting time before 10 am, holding bunch by rachis, crates in shade and crates lined with paper/ bubble sheet. However, least compliance (33.3%) was recorded in consideration of moisture on berries. Overall 19.0 per cent post-harvest losses (cleaning/ grading and sorting: 6%, farm level: 4.5% and market level: 4.5%) were reported.

Rajendranagar: Data collected on compliance on standard package of practices showed that maximum compliance was recorded in placing of crates in shade (85.6%) followed by cutting above knot. A total of 29.9 per cent losses were recorded from farm to retailing. Maximum loss (21.2%) was recorded at farm level (Table 82).

Table-82: Data collected on post-harvest losses (%) in grapes through interview

Process of post handling of grapes	Pune (NRCG)	Rajendranagar	Rahuri	Periyakulam	
				Sharad Seedless	Thompson Seedless/clones
a. Farm level (Interview)	3.10	21.2	4.5	4.40	4.4
b. Farm level (Observation)	-	-	-	5.70	5.3
c. Losses during cleaning/grading and sorting	-	-	6.00	6.80	5.8
d. Losses at market level (personal interview)	-	-	4.5	6.70	3.2
e. Losses at market level (Observation)	-	-	-	3.70	2.0
f. Estimation of loss during retailing by Personal interview	3.60	5.20	4.0	3.50	2.4
Not recorded	-	3.50%	-	-	-
Total loss (%)	9.9	29.9	19.0	19.70	15.50

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

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

Pune (NRCG): During reporting period, *Dervishiya cadambae* moth was reported in variety Sharad Seedless at Nashik district in the vineyards aged between 10-15 years. The infestation was ranged from 12-48 per cent with an average of 23.4 per cent. While the fruit fly infestation was observed between 1.96 to 23.1 per cent in the variety Crimson Seedless in the month of February (Table 83).

Mandsaur: During reporting period, infestation of flea beetle was increased by 10 per cent. Cent per cent infestation of thrips, mealy bugs (50%) and Stem borer (50%) was recorded (Table 85).

Periyakulam: The flea beetle (15%), thrips (13.8%), mealy bugs (9.19%) for *Ferrisia virgata* and 3.8 per cent for *Macconellicoccus hirsutus* and mites (7.68%) infestation were recorded in the vineyard (Table 86).

Ludhiana: During reporting period, Infestation rate was recorded for thrips (6%), Mealy bug (4.40%), hopper (3%), six-spotted beetle (3%), grey weevil (2%), berry borer (3%), termite, caterpillar (2%), and blackfly (2%). Low infestation of all the insect was reported at the centre (Table 87).

Rahuri: No new insect pest has been reported, while slight increase in infestation of flea beetle (26.7%) and mites (23.3%) was recorded, while reduction in incidence by 23.0 per cent was recorded for mealy bugs (Table 84).

Table-83: Status of new emerging insect-pests and their natural enemies of grapes in Maharashtra (ICAR-NRCG)

Insect pest	Past average incidence reported (%)	Current incidence (%) (2020)	Remarks (+=increased -=decreased)
Dervishiya cadambae (Lepidoptera: Cossidae)	26.9	23.4	-3.5
Fruit fly	-	12.5	12.5

Table- 84: Status of insect-pests and their natural enemies of grapes at Rahuri

Insect pest	Past Average Incidence reported (%)	Current incidence reported (%)	Remarks (+= increase / - =decrease)
Flea beetle	23.46	26.67	+3.21
Thrips	100.00	100	0.00
Mealy bug	49.68	26.67	-23.01

Insect pest	Past Average Incidence reported (%)	Current incidence reported (%)	Remarks (+= increase / - =decrease)
Stem borer	55.03	53.33	-1.70
Mites	16.11	23.34	+7.23

Table-85: Status of insect-pests and their natural enemies of grapes at Mandsaur

Insect pest	Past Average Incidence reported (%)	Current incidence reported (%)	Remarks (+=Increase/-=decrease)
Flea beetle	20.00	30.00	+10.00
Thrips	100.00	100.00	-
Mealy bug	60.00	50.00	-10.00
Stem borer	50.00	50.00	-
Mites	0.00	0.00	-
Spodoptera	10.00	10.00	-
Helicoverpa	0.00	0.00	-

Table-86: Status of new insect-pests and their natural enemies of grapes at Periyakulam

Insect pest	Past Average Incidence reported (%)	Current incidence reported (%)	Remarks (+=Increase/-=decrease)
Flea beetle – Scelodonta strigicollis	16.2	15.0	-1.20
Thrips-Rhipiphorothrip scruentus	13.7	13.8	0.05
Mealy bug -Ferrisia virgata	7.89	9.19	1.30
Mealy bug – Macconellicoccus hirsutus	14.4	14.8	0.39
Stem borer	Nil	Nil	
Mites-Tetranychus aeurtic	7.39	7.68	0.29

Table-87: Status of new insect pests and their natural enemies of grapes at Ludhiana

Insect pest	Past Average incidence reported (%)	Current incidence reported (%)	Remarks (+=Increase/-=decrease)
Flea beetle	-	-	-
Black thrips, Rhipiphorothrips cruentatus Hood and Haplothrips sp.	4.80	6.00	1.20
Mealybugs, Nipaecoccus viridis (Newstead), Maconellicoccus hirsutus Green and Paracoccus marginatus Williams and Granara de Willink	5.20	4.40	-0.80
Stem borer	-	-	-
Mites	-	-	-
Chafer beetles, Apogonia sp. and Adoretus sp.	Low	Low	-
Hopper, Arboritia viniferata Sohi and Sandhu	2.00	3.00	1.00
Six-spotted beetle, Scelodonta strigicollis Motschulsky	1.80	3.00	1.20
Chafer beetle, Holotrichia consanguinea (Blanchard)	4.40	4.00	-0.40
Gray weevil, Myllocerus undecimpustulatus Faust	1.40	2.00	0.60
Tortrix berry borer, Lobesia sp.	1.00	3.00	2.00
Termite, Odontotermes obesus (Rambur) and Microtermes spp.	1.40	1.00	-0.40
Bark eating caterpillar, Indarbela sp.	1.00	2.00	1.00
Blackfly, Aleurocanthus sp.	1.00	2.00	1.00
Hawk moth, Theretraalecto Linnaeus	1.00	2.00	1.00
Tobacco caterpillar, Spodoptera litura (Fabricius)	0.80	Nil	-0.80
Metallic shield bug, Scutelleraperplexa (Westwood) (= S. nobilisFabricius)	0.80	2.00	1.20
Wasps, Polistes hebraeus (Fabricius) and Vespa orientalis Linnaeus;	3.40	4.00	0.60
Giant honey bee, Apis dorsata Fabricius	1.00	1.00	0.00

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 at different crop growth stages was recorded. The GPS data was collected and attempts are being made to prepare digital disease map.

Ludhiana: Nine vineyards were surveyed during reporting period. Percent disease index of Anthracnose disease was recorded with the average of 0.67 (0-1.33), 1.0 (0-2), 7.17 (2-12.3) and 19.78 (11.0-28.5) during 31-60, 61-90, 91-135days and 136-180 days after pruning respectively. Downy mildew disease was recorded with average PDI 2.5 (0.0-5.0) and 10.09 (6.5 to 13.67) during 91-135 days and 136-180 days after pruning, respectively. Powdery mildew disease was recorded with 0.5 PDI (0-1) and 2.0 PDI (0-4) during 61-90 days and 91-135 days after pruning respectively.

Mandsaur: During the reporting period Anthracnose disease was recorded in the range of 0 to 60 and 0 to 45 PDI during 61-90 days and 91-140 days, respectively after foundation pruning respectively. The PDI of Anthracnose disease recorded was 5 (0-10), 15 (0-30), 5 (0-10) and 10 (0-20) during 0-30 days, 31-60 days, 61-90 days and 91-140 days, respectively after forward pruning respectively. Downy mildew incidence on the leaves was recorded in the range of 0 to 20, and 0 to 10 PDI during 61-90 days and 91-140 days after forward pruning, respectively. Powdery mildew on leaves recorded was 10.5 PDI (0-21), 19 PDI (0-38) and 21 PDI (0-42) PDI during 31-60 days, 61-90 days and 91-140 days after forward pruning respectively.

Pune (ICAR-NRCG): Thirty vineyards were surveyed during reporting period. After fruit pruning, the PDI for anthracnose, downy mildew and powdery mildew was observed in range of 0-11.4, 13.4-17.12 and 14.3-22.1 PDI at Pune, respectively. At Nashik, disease PDI observed was in the range of 4.35-13.2 for downy mildew and 1.05-5.45 for powdery mildew. A PDI range of 0-3.14 for anthracnose, 4.52-12.6 for downy mildew and 2.02-4.52 for powdery mildew was recorded at Sangli. Low PDI range was recorded downy mildew (0-3.25) and powdery mildew (1.05-6.00) at Solapur district.

Periyakulam (Theni): During the reporting period Downy mildew PDI was recorded with the average of 23.3 (2.70- 43.9), 22.8 (0-45.7), 8.72 (0-17.4) and 5.08 (0-10.15) during 0-30 days, 31-60 days, 61-90 days and 91-140 days after pruning, respectively. Powdery mildew disease incidence (PDI) was recorded with average of 9.13 (0-18.3), 22.3 (0-44.6), 34.3 (23.2 to 45.4) and 30.3 (15.27-45.3) during 0-30 days, 31-60 days, 61-90 days and 91-140 days after pruning respectively. After the bunches were harvested, the unpruned block observed with 21.44 PDI at 120 days after pruning.

Rahuri: During the reporting period, thirteen vineyards were surveyed. The percent disease index of Anthracnose disease recorded was 3.06 (0-6.12) and 3.56 (0-7.11) during 1 to 30 days and 31 to 60 days, respectively. The Anthracnose on leaves recorded with the average of 21.4 PDI (4.55-38.25) and 8.68 PDI (8.68-48.24) during 61-90 days and 91-140 days respectively after foundation pruning respectively. For downy mildew, PDI on leaves recorded was 19.43 (0-38.86), 9.06 (0-18.12), 9.77 (0-19.54) and 6.71 (0-13.41) during 1 to 30 days, 31 to 60 days 61-90 days and 91-135 days after fruit pruning respectively. PDI of downy mildew disease on leaves recorded was 4.3 (0-8.6) and 9.24 (0-18.48) during 61-90 days and 91-135 days after foundation pruning respectively. Powdery mildew incidence on leaves recorded was 1.25 PDI (0-2.5), 2.28 PDI (0-4.55), 6.27 PDI (0-12.54) and 4.58 PDI (0-9.15) during 1 to 30 days, 31-60 days, 61-90 days and 91-135 days after fruit pruning, respectively.

Rajendranagar: During reporting period, thirteen vineyards were surveyed. Percent disease index (PDI) of downy mildew disease on leaves was 5.88 (2.5 to 9.25) during 31-60 days after forward pruning, while powdery mildew disease on leaves was 6.63 (2.5 to 10.75) during 61–90 days and 9.88 (5 to 14.75) during 91–135 days after forward pruning. For Alternaria disease on leaves and on rachis of bunches, PDI on leaves was 3.13 (0 to 6.25) during 31–60 days, 9.63 (2.5 to 16.75) during 61–90 days and 20.63 (8.75–32.5) during 91–135 days after forward pruning respectively. PDI on necrosis of rachis of bunches was recorded in the range of 3.13 (0 to 6.25) during 61–90 days and 7.88 (3.75 to 12) during 91–135 after forward pruning respectively.

Vijayapura: Twenty-five vineyards were surveyed. PDI of anthracnose disease recorded was 10 (5-15), 7.5 (5-10) and 2.5 (0-5) during 0-30 days, 31-60 days and 61-90 days after forward pruning respectively. Downy mildew disease incidence on leaves recorded 25 PDI (5-45), 15 PDI (5-25), 11.3 (5-17.5) and 3.75 PDI (0-7.5) during 0-30 days, 31-60 days, 61-90 days and 91-140 days after forward pruning respectively. Powdery mildew incidence on leaves documented was 2.5 PDI (0-5), 7.5 PDI (0-15) and 8.75 PDI (5-12.5) during 31-60 days, 61-90 days and 91-140 days after forward pruning.

6.4.2. Gr. Validation of online interactive weather information-based disease and insect pest management

The experiment was carried out to validate online interactive weather information based advisory on disease assessment and management. Two vineyard

plots of about 0.5 acre were selected. In Vineyard-I, the management measures of downy mildew and powdery mildew were adopted based on online advisory. In Vineyard II, diseases were managed with schedule-based practices followed by the farmers in their locality. Both the vineyards were managed with best possible control of the diseases and only number of sprays required, time of sprays etc., was recorded for validation of the advisory.

Mandsaur: Less incidence of downy and powdery was recorded at farmers plot. Total two sprays were saved. Expenditure saved on chemicals was Rs. 32,550/- and additional income generated through quality produce was Rs. 22,000/-. Also, four sprays of insecticides were reduced following the advisory system

Periyakulam (Theni): After fruit pruning, total 9 sprays (4 for downy mildew and 5 for powdery mildew) were reduced. A total of Rs. 67,630/- (14,650/- saved on chemicals and 52,980/- additional income on quality produce).

Rahuri: Twelve sprays were reduced (7 for downy mildew and 5 for powdery mildew) due to adoption of advisory system. This has resulted into saving of chemical cost by Rs. 73,040 and generated additional income of Rs. 92,870 through quality produce. Also, four sprays were reduced for pesticide application (Table 88 & 89).

Rajendranagar: Total 8 sprays were saved following the advisory system. Expenditure saved on chemicals was Rs. 51,560, while an additional income was generated on quality produce was Rs. 89,880.

Vijayapura: Lower incidence of downy mildew was recorded at advisory (0.45%) and farmers (0.90%) plot. For downy mildew incidence, 18 sprays and 16 sprays for powdery mildew were reduced respectively. Total 24 sprays were reduced and saved Rs. 15,000/- on chemicals.

Table-88: Comparative disease (downy and powdery mildew) management in advisory and farmers practice plot

Disease incidence	Arabhavi		Mandsaur		Periyakulam		Rajendranagar		Rahuri	
	AP	FP	AP	FP	AP	FP	AP	FP	AP	FP
Variety	Thompson Seedless		Thompson Seedless		Krishna Seedless, Sharad Seedless		Thompson Seedless		Thompson Seedless	
Foundation Pruning										
Downy mildew (%)	-	-	0.0	0.0	-	-	-	-	1.86	3.93
Powdery mildew (%)	-	-	0.0	0.0	-	-	-	-	1.31	3.00
Sprays for Downy mildew	-	-	0.0	0.0	-	-	-	-	7	13
Sprays for Powdery mildew	-	-	0.0	0.0	-	-	-	-	2	8
Number of sprays reduced	-		0.0		-		-		12	
Fruit pruning										
Downy mildew (%)	0.45	0.90	17.5	14.5	3.80	8.28	2.50	5.25	1.35	2.75
Powdery mildew (%)	0.00	0.00	20.6	11.5	12.1	18.2	3.75	6.50	3.02	4.35
Sprays for Downy mildew	13	31	1	2	7	11	7	12	8	15
Sprays for Powdery mildew	6	22	2	3	10	15	3	6	8	13
Number of sprays reduced	34		2		9		8		12	
Cost savings/ha (Rs.)	15,000/-		32,550/-		14,650/-		51,560/-		73,040/-	
Additional income due to quality fruit production (Rs.)/ha	-		22,000/-		52,980/-		89,880/-		92,870/-	
*AR: Advisory plot & FR: Farmer's practice plot										

Table-89: Pest management in advisory and farmer's practice plot

Parameter	Arabhavi		Mandsaur		PKM		RNG		Rahuri	
	AP	FP	AP	FP	AP	FP	AP	FP	AP	FP
Mean per cent mealybug bunch infestation	-	-	2.00	2.00	-	-	-	-	4.39	6.15
Mean per cent berry scarring per bunch	-	-	1.00	4.00	-	-	-	-	5.79	7.21
Mean number of mites per leaf	-	-	4.00	3.00	-	-	-	-	4.48	10.24
Mean per cent jassid leaf damage per shoot	-	-	1.00	2.00	-	-	-	-	8.06	9.07
Mean per cent caterpillar leaf damage per shoot	-	-	0.00	1.00	-		-	-	1.59	3.41
Number of insecticide sprays	-	-	4	8	-	-	-	-	7	11
PKM: Periyakulam & RNG: Rajendranagar *AR: Advisory plot & FR: Farmer's practice plot										

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 (Table 90).

Udaipur: A total of 79 accessions were conserved and 30 accessions are being characterized and evaluated 23 accessions. During the reporting period nine new accessions were collected.

Ludhiana: During reporting period, two new accessions were collected and totally 44 accessions were conserved in genetic repository. Evaluated one accession for desirable characters like peel colour, pulp content and TSS.

Bengaluru: During the reporting period, two new accession were included. Being a NAGS, a total of 162 accessions were being maintained.

Pantnagar: During the reporting period, 13 accessions were conserved and five accessions were evaluated. Among the five, the highest yield (69.55 kg/tree) and fruit weight (196.26 g) recorded in the germplasm KG guava. Whereas, maximum ascorbic acid (159.57 mg/100 g pulp) and 100 seeds weight (1.30 g) were recorded in cultivar Hisar Safeda.

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

Rewa: During reporting period, two new accessions were collected and added to the existing 77 accessions in the field gene bank and 20 accessions were evaluated for yield and quality.

Raipur: The programme was initiated in the reporting period.

Table-90: Collection, characterization, conservation and utilization of guava germplasm at different centres

Category	Prior to reporting period	Reporting period (Sept., 2019 to Oct., 2020)	Total
1	2	3	4 (2+3)
Centres	Number of explorations/ surveys	Number of explorations/surveys	Number
A. Collection			
Bengaluru	68	0	68
Lucknow NAGS	88	2	90
Ludhiana	35	2	37
Pantnagar	13	0	13
Rewa	75	2	77
Sangareddy	25	0	25
Udaipur	70	09	79
Grand Total (A)	374	15	389
B. Characterization			
Bengaluru	65	0	65
Lucknow	70	6	76
Ludhiana	34	0	34
Pantnagar	9	0	09
Rewa	43	0	43
Sangareddy	24	0	24
Udaipur	37	30	67
Grand Total (B)	282	36	318
C. Conservation			
Bengaluru	68	0	68
Lucknow	160	2	162
Ludhiana	44	0	44
Pantnagar	13	0	13

Category	Prior to reporting period	Reporting period (Sept., 2019 to Oct., 2020)	Total
1	2	3	4 (2+3)
Rewa	75	2	77
Sangareddy	25	0	25
Udaipur	79	09	88
Grand Total (C)	466	16	481
D. Evaluation			
Bengaluru	65	0	65
Lucknow	37	13	50
Ludhiana	20	1	21
Pantnagar	6	5	11
Rewa	20	0	20
Sangareddy	24	0	24
Udaipur	44	23	67
Grand Total (D)	216	42	258
E. Utilization			
Bengaluru	10	0	10
Lucknow	28	12	40
Ludhiana	8	1	9
Pantnagar	6	0	6
Rewa	12	3	15
Sangareddy	8	0	8
Udaipur	9	2	11
Grand Total (E)	81	18	99

Area explored:

Bengaluru: Districts of Karnataka and other states

Lucknow: Districts of UP, Allahabad

Ludhiana: Patiala and Sangrur Districts

Pantnagar: -

Rewa: Satna, Jabalpur, Sidhi, Rewa

Sangareddy: -

Udaipur: Rajsamand, Pratapgarh, Chittorgarh, Bundi, Kota and Udaipur

Desired traits: Tree height, girth, spread, canopy volume, crown shape, fruits/tree, fruit weight, fruit length, width, fruit shape, peel color, peel thickness, dots presence, TSS, yield /tree, seed size, total number of seed, 100 seed weight, colour of seed and TSS

Number of accessions deposited to NAGS: Nil

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).

Bengaluru: Among the different varieties maximum fruit yield was recorded by variety Arka Mridula (51.50 kg/tree & 20.66 t/ha) and Lalit recorded maximum acidity (0.62%) and maximum seed weight (4.71 g/fruit). Whereas, no significant difference was recorded for other quality parameters among Arka Mridula and Lalit variety (Table 91-93).

Rewa: Among different varieties tested, variety Shweta recorded maximum number of fruits per tree (215.30), maximum fruit weight (220.50 g), maximum fruit yield (47.47 kg/tree & 18.99 t/ha) and maximum pulp weight (217.05 g/fruit).

Sabour: Variety CISH-G-1 exhibited the highest fruit yield (12.51 kg/tree), whereas maximum acidity was recorded in Arka mridula (0.42%). Among the varieties for other parameters no-significant differences were found.

Udaipur: Among the varieties no significant difference was recorded for the quality and yield parameters.

Table-91: Fruit yield of guava varieties at different centres

Hybrids/selections	Yield (kg/tree)				Yield (t/ha)			
	Bengaluru	Rewa	Udaipur	Sabour	Bengaluru	Rewa	Udaipur	Sabour
Arka Amulya	46.10	34.95	52.38	--	18.44	13.98	21.00	--
Arka Mridula	51.50	30.33	54.23	9.61	20.66	12.13	21.70	3.85
Lalit	47.10	28.96	65.70	10.83	18.84	11.58	26.30	4.33
Shweta	25.10	47.47	62.30	11.43	10.04	18.99	24.90	4.57
MPUAT S-1/ CISH-G-1	22.10	33.37	50.78	12.51	8.84	13.35	20.28	5.00
MPUAT S-2/ IIHR-H-21	-	-	62.23	-	-	-	24.90	-
CD at 5%	3.67	5.42	7.73	1.00	1.05	3.43	3.12	0.40
Note: - Either variety is not available at the center or the parameter was not observed during reporting year								

Table-92: Fruit weight and fruits per tree of guava varieties at different centres

Hybrids/selections	Fruit weight (g)				Fruits/tree			
	Bengaluru	Rewa	Udaipur	Sabour	Bengaluru	Rewa	Udaipur	Sabour
Arka Amulya	140.00	170.30	195.40	--	329.00	205.20	268.00	--
Arka Mridula	154.00	165.20	210.00	106.20	337.00	195.40	258.23	90.60
Lalit	136.00	155.50	220.40	102.40	347.00	192.40	298.00	105.80
Shweta	158.00	220.50	265.00	108.40	160.00	215.30	235.20	105.40
MPUAT S-1/ CISH- G-1	150.00	164.70	190.20	111.60	163.00	202.60	267.00	111.80
MPUAT S-2/ IIHR-H-21	-	-	245.00	-	-	-	254.00	-
CD at 5%	7.49	10.59	29.47	6.36	11.88	5.99	33.94	7.19
Note:-Either variety is not available at the center or the parameter was not recorded during reporting year								

Table-93: Acidity and TSS of guava varieties at different centres during 2020

Hybrids/selections	Acidity (%)				TSS (°B)			
	Bengaluru	Rewa	Udaipur	Sabour	Bengaluru	Rewa	Udaipur	Sabour
Arka Amulya	0.48	0.90	0.36	--	11.10	9.39	12.63	--
Arka Mridula	0.43	0.77	0.34	0.42	11.80	8.79	12.30	8.40
Lalit	0.62	0.90	0.39	0.33	11.30	9.69	13.40	9.38
Shweta	0.56	0.62	0.33	0.29	11.80	9.70	14.80	9.76
MPUAT S-1/ CISH-G-1	0.58	0.65	0.31	0.32	11.60	9.49	15.10	10.24
MPUAT S-2/ IIHR-H-21	--	--	0.34	--	--	--	13.73	--
CD at 5%	0.03	0.08	0.05	0.05	NS	0.30	1.76	0.56
Note: - Either variety is not available at the center or the parameter was not recorded during reporting year								

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.

Bengaluru: Among the new promising hybrids, Arka Kiran had recorded maximum number of fruits (352) and yield (56.60 kg/tree & 22.64 t/ha).

Ludhiana: Among the new promising hybrids, CISHG-35 had recorded maximum fruit yield (31.20 t/ha), fruit weight (195.0 g), pulp weight (160.3 g/fruit) and TSS (13.0°B). However maximum number of fruits per tree were recorded in Allahabad Safeda as standard check (466.0) (Table 94-96).

Lucknow: CISHG-35 has recorded maximum fruit weight (221.0 g) and pulp weight (217.50 g/fruit). Whereas, MPUAT S-2 has recorded maximum fruits per tree (196.0) among the new promising hybrids.

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

Pantnagar: While, no significant difference was recorded for other yield parameters among the varieties, the new promising hybrid, RCGH-1 has recorded maximum vitamin C content (192.1 mg/100 g fruit).

Rahuri: Among the new promising hybrids/ selections, no significant difference was recorded am in the yield and quality parameters.

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

Rewa: Variety Allahabad Safeda had significantly recorded maximum number of fruits (210), yield (43.09 kg/tree & 17.24 t/ha) and pulp weight (203.7 g/fruit).

Sabour: No significant difference was recorded am in the yield and quality parameters among the new promising hybrids/selections.

Udaipur: MPUAT S-2 has recorded maximum yield (59.78 kg/tree & 23.91 t/ha), fruit weight (245 g), pulp weight (238.7g/fruit) and number of fruits per tree (265).

Table-94: Fruit yield (t/ha) of guava varieties at different centres

Varieties	BLR	LDH	LKO	PNT	RHR	REW	UDP	SBR
White pulp var.								
MPUAT S-1	17.01	24.00	9.53	24.05	13.00	9.94	18.77	5.14
MPUAT S-2	18.16	28.70	13.87	13.25	13.02	6.50	23.91	5.29
SRD H-4	-	25.50	10.87	-	13.65	8.61	15.68	4.58
CISH G-35	6.36	31.20	14.77	9.18	12.86	8.25	18.92	3.67
RCGH-1	6.60	-	10.83	7.67	16.43	7.51	20.15	-
RCGH-7	6.20	-	0.81	19.16	-	9.68	16.29	-
RCGH-11	7.12	-	1.07	10.20	-	7.58	17.77	-
CISH G-5	-	19.80	11.55	-	-	-	-	3.85
Allahabad Safeda (Check)	7.60	27.50	11.15	21.84	15.03	17.24	19.39	5.20
Red pulp var.								
Arka Kiran	22.64	26.70	9.99	16.38	12.08	14.26	17.23	3.79
SRD H-1	20.02	26.90	9.68	-	11.06	8.93	15.82	4.69
RCGH-4	7.24	-	0.93	20.27	-	8.58	15.49	-
CD at 5%	0.83	2.90	1.24	8.33	1.95	3.57	2.99	-

BLR: Bengaluru, LDH: Ludhiana, LKO: Lucknow, PNT: Pantnagar, RHR: Rahuri, REW: Rewa, UDP: Udaipur, SBR: Sabour, RNC: Ranchi, NER: Neri, RPR: Raipur
* At Ranchi & Neri centres plants are under juvenile stage.

Table-95: Fruit weight (g) of guava varieties at different centres

Varieties	BLR	LDH	LKO	PNT	RHR	REW	UDP	SBR
White pulp var.								
MPUAT S-1	151.2	171.3	180.9	179.7	123.0	125.5	181.0	113.6
MPUAT S-2	159.1	174.6	176.9	133.5	121.0	98.0	245.0	117.6
SRD H-4	-	172.0	196.8	-	127.4	120.0	185.4	105.8
CISH G-35	163.1	195.0	221.0	74.5	120.7	111.1	190.0	93.8
RCGH-1	168.0	-	160.7	115.9	141.3	125.0	188.0	-
RCGH-7	150.2	-	128.3	168.3	-	142.0	182.4	-
RCGH-11	149.4	-	140.7	122.4	-	130.0	172.2	-
CISH G-5	-	141.6	183.1	-	-	-	-	90.00
Allahabad Safeda (Check)	155.1	147.3	170.1	170.4	134.9	205.2	197.0	121.6
Red pulp var.								
Arka Kiran	161.0	155.0	196.1	105.6	113.0	198.0	180.2	100.4
SRD H-1	158.4	168.0	191.5	-	102.7	135.0	175.0	104.2
RCGH-4	154.6	-	176.7	161.1	-	130.0	175.0	-
CD at 5%	9.9	15.2	18.7	37.9	19.2	11.6	21.5	16.3

BLR: Bengaluru, LDH: Ludhiana, LKO: Lucknow, PNT: Pantnagar, RHR: Rahuri, REW: Rewa, UDP: Udaipur, SBR: Sabour, RNC: Ranchi, NER: Neri, RPR: Raipur
* At Ranchi & Neri centres plants are under juvenile stage.

Table-96: TSS (°B) of guava varieties at different centres

Varieties	BLR	LDH	LKO	PNT	RHR	REW	UDP	SBR
White pulp var.								
MPUAT S-1	11.2	10.8	11.3	11.1	11.1	9.6	14.9	10.3
MPUAT S-2	11.4	11.1	13.7	9.5	11.2	9.3	14.0	10.5
SRD H-4	-	10.5	12.4	-	10.1	9.6	12.8	9.6
CISH G-35	11.6	11.8	12.6	9.2	11.9	7.8	12.7	9.6
RCGH-1	11.4	-	12.2	11.7	11.9	9.5	12.5	-
RCGH-7	11.9	-	11.4	8.4	-	6.9	12.6	-
RCGH-11	11.9	-	9.9	10.4	-	9.6	11.8	-
CISH G-5	-	13.0	12.9	-	-	-	-	10.9
All. Safeda-Check	11.8	10.1	12.1	11.4	10.5	10.9	12.5	10.9
Red pulp var.								
Arka Kiran	11.6	11.5	12.4	9.5	11.4	8.9	12.2	10.0
SRD H-1	11.8	10.0	13.1	-	11.1	8.6	12.6	9.5
RCGH-4	11.8	-	11.7	9.1	-	9.2	12.1	-
CD at 5%	NS	0.7	0.8	0.3	NS	1.5	1.5	0.8

BLR: Bengaluru, LDH: Ludhiana, LKO: Lucknow, PNT: Pantnagar, RHR: Rahuri, REW: Rewa, UDP: Udaipur, SBR: Sabour, RNC: Ranchi, NER: Neri, RPR: Raipur
* At Ranchi & Neri centres plants are under juvenile stage.

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.

Anantharajupet: All the planting material were planted, except CISH-GS-14. Maximum plant height (1.49 m) and canopy volume (1.15 m^3) was recorded in Allahabad safeda.

Neri: All the planting material were planted. Maximum plant height (1.89 m) was recorded in Allahabad safeda while, higher canopy volume (2.62 m^3) was recorded in CISH-GS-14.

Periyakulam: All the planting material were planted, except CISH-GS-14. Highest plant height (1.12 m) and canopy volume (0.92 m^3) was recorded in Lalit.

Rahuri: Trial was initiated and all the planting material were planted. Maximum plant height (1.27m) and canopy volume (1.57 m^3) was recorded in Lalit.

Rewa: All the planting material were planted. The vegetative and yield parameters were non-significant among the hybrids.

Udaipur: All the planting material were planted. Highest plant height (0.61m) was recorded in Arka Rashmi.

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

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

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 the five treatments, drip irrigation at 90% ER has recorded maximum fruits per tree (40.2). whereas, 80% per cent ER has recorded maximum TSS (11.2°B) and shelf life (6.0 days). However, for other yield parameters no significant difference was recorded between the treatments.

Udaipur: Among five treatments, irrigation with 80% ER exhibited maximum yield (17.0 kg/tree & 28.4 t/ha). However, other parameters recorded no significant difference between the treatments (Table 97).

Table-97: Effect of irrigation treatments on fruit yield, number of fruits and fruit weight of guava at different centres during 2020

Treatments	Yield (kg/tree)		Yield (t/ha)		Fruits per tree		Fruits weight (g)	
	Rewa	Udaipur	Rewa	Udaipur	Rewa	Udaipur	Rewa	Udaipur
70% ER	6.8	10.2	11.3	17.1	28.4	52.4	238.8	195.3
80% ER	8.3	17.0	13.9	28.4	31.1	72.5	267.8	235.0
90% ER	6.8	15.1	11.3	25.1	40.2	66.0	168.5	228.5
100% ER	7.3	13.2	12.2	21.9	32.2	60.3	227.5	218.0
Local control (Calendar schedule)	7.1	13.4	11.9	22.3	34.2	65.2	208.0	204.8
CD at 5%	1.0	1.9	4.7	3.1	4.5	8.5	42.5	26.6

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: Application of vermicompost (30 kg/ plant) + *Azospirillum* culture+ PSB @ 250 g/tree has recorded the maximum canopy volume (130.29 m^3). There is no significant difference were recorded for yield parameters.

Rahuri: No significant difference were recorded for growth and yield parameters among the treatments.

Sabour: Maximum number of fruits per tree (295.03) was recorded in the treatment with vermicompost (30 kg/plant) + *Azospirillum* culture+ PSB (@ 250 g/ tree). Whereas, maximum canopy volume 135.74 m^3 and yield of 33.64 kg per tree was recorded in the plants supplied with Vermicompost (30 kg/plant) + *Azotobactor*+ PSB (@ 250 g/ tree).

Sangareddy: Application of vermicompost (30 kg/ plant) + *Azotobactor*+ PSB (@ 250 g/ tree) recorded maximum yield 49.66 kg/tree. However the growth and other yield parameters were non-significant (Table 98).

Vengurle: Significantly maximum number of fruits per tree (89.12) and yield (119.05 kg/tree), fruit weight (214) was recorded in the plants supplied with vermicompost (30 kg/plant) + *Azospirillum* culture+ PSB (@ 250 g/tree)

Table-98: Effect of organic source of nutrients on number of fruits/plants and yield of guava at different centres

Treatments	Fruits/plant					Yield (kg/tree)				
	LDH	RHR	SBR	SNG	VNG	LDH	RHR	SBR	SNG	VNG
T_1	278.0	324.3	211.7	330.0	66.5	54.60	47.04	30.56	38.36	11.08
T_2	322.3	373.1	182.3	331.7	59.87	65.62	53.20	27.05	40.33	10.51
T_3	299.0	343.2	159.3	328.3	80.22	54.84	51.44	21.62	41.00	12.98
T_4	351.0	368.4	295.0	355.0	89.12	61.78	55.66	27.03	46.56	19.05
T_5	309.3	356.3	273.3	350.0	68.55	54.13	55.19	33.64	49.66	11.66
T_6	345.0	390.7	173.3	310.0	65.17	69.21	64.84	21.65	41.26	11.17
T_7	308.0	381.0	205.0	288.3	69.20	57.35	61.15	30.19	37.66	12.02
CD at 5%	18.60	49.18	14.06	12.54	3.91	5.90	8.81	2.48	1.507	0.75

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

#T_1:FYM (30 kg/plant),T_2:FYM (30 kg/plant) + *Azospirillum* culture+ PSB (@ 250,T_3:Vermicompost (30 kg/plant) g/tree),T_4:Vermicompost (30 kg/plant) + *Azospirillum* culture+ PSB (@ 250 g/tree),T_5:Vermicompost (30 kg/plant) + Azotobactor+ PSB (@ 250 g/ tree),T_6:Vermicompost (30 kg/plant) + *Azospirillum* culture @ 250 g/tree + PSB @ 250 g/tree + vermiwash,T_7: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: Treatment involving 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%)] recorded maximum yield efficiency

(9.68 kg/m^3), ascorbic acid (174.62 mg/100 g) and B:C ratio (3.09) were recorded with the treatment of when compared to control (2.63 kg/$m^{3,}$ 160.85 and 2.08 respectively).

Mohanpur: The treatment of T_1 [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%)] has recorded maximum fruit weight (162.3 g) and B:C ratio (2.69) compared to control (120.40 g). However the quality and other yield parameters were non-significant.

Neri: The trial has been initiated in 2019 and the plants are in vegetative phase.

Pantnagar: The trees are in vegetative stage meanwhile, treatment involving 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%)] has recorded higher values for plant height (1.87 m).

Periyakulam: Significantly maximum fruit yield (50.22 kg/tree), fruits per tree (232.5), fruit weight (180.0 g) were recorded with the treatment of T_1 [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 (29.14 kg/tree, 180.00 fruits/tree, 110.94 g respectively).

Rewa: Maximum number of fruits per tree (181.50), fruit yield (30.86 kg/tree), TSS (11.03°B) and shelf life (5.75 days) was recorded in the treatment of T_1 [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 (90.60, 14.41 kg/tree, 9.70°B and 2.75 days respectively).Highest BC ratio (2.34) was also recorded in the treatment T_1 (Table 99)

Sabour: Plants are in vegetative stage and there was no significant variation recorded for vegetative growth.

Sangareddy: The treatment , 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%)] recorded higher fruit yield (17.10 kg/tree), TSS (11.50°B) and ascorbic acid (176.25 mg/100 g), when compared to control (8.12 kg/tree, 8.82°B and 138.00 mg/100 g respectively).

Udaipur: Significantly higher fruit yield (13.30 kg/tree), fruits per tree (60.20) and BC ratio (0.94) were registered with the treatment of T_1 [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 (5.70 kg/tree, 31.40 and BC ratio (0.17) fruits per tree respectively).

Table-99: Effect of different inputs on yield (kg/tree) in different cultivars of guava at various centres

Treatments	LKO	MHR	NER	PNT	PKM	REW	SBR	SNG	UDP
Name of variety	Lalit	Sardar	-	Pant Prabhat	Sardar (L-49)	Allahabad Safeda	Allahabad Safeda	Allahabad Safeda	Allahabad Safeda
T_1	27.84	10.60	*	*	50.22	30.86	-	17.10	13.3
T_2	24.72	9.93	*	*	44.13	20.16	-	12.60	10.5
T_3	19.94	8.58	*	*	36.05	18.12	-	10.50	9.0
T_4	9.69	8.35	*	*	33.50	18.50	-	9.42	7.2
T_5	7.82	7.55	*	*	29.14	14.41	-	8.12	5.7
CD at 5%	5.29	0.99	*	*	2.42	4.98	-	2.24	1.3

LKO: Lucknow, MHR: Mohanpur, NER: Neri, PNT: Pantnagar, PKM: Periyakulam, REW: Rewa, SBR: Sabour, SNG: Sangareddy and UDP: Udaipur

#T_1: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 %),T_2:Raised bed cultivation + Drip irrigation (80% ER at all stages) + Fertigation (75% RDF) + Mulching with 100 micron UV stabilize black polythene,T_3:Raised bed cultivation Drip irrigation (80% ER at all stages) + Fertigation (75% RDF) + Micro nutrients spray ($ZnSO_4$& Boric acid 60.2 %),T_4:Raised bed cultivation + Drip irrigation (80% ER at all stages) + Micro nutrients spray ($ZnSO_4$& Boric acid @0.2 %) (RDF as soil application),T_5:Control (soil application of RDF, basin irrigation and no mulching) * At Neri and Pantnagar centre plants are in vegetative stage

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 fruit yield (38.83 kg/tree & 15.53t/ha), fruits per tree (292.71), TSS (13.68°B), ascorbic acid (256.43 mg/100 g) and B:C ratio (2.90) were recorded with the treatment of T_3 [75% RDF + AMC soil application (12.5 kg/ha) twice a year along FYM] as compared to control (28.9 kg/tree, 241.43 fruits per tree, TSS- 11.68 °B, ascorbic acid 216.28 mg/100 g and B:C ratio-2.13 respectively).

Rahuri: The treatment T_1 [100% Recommended Dose of Fertilizers (RDF) as soil application] has recorded higher fruit weight (161.00). However, other yield parameters were found non-significant among the treatments.

Rewa: Significantly higher fruit yield (40.55 kg/tree & 16.22 t/ha) and fruits per tree (225.24) were recorded with the treatment T_3 [75% RDF + AMC soil application (12.5 kg/ha) twice a year along FYM] as compared to control (27.20 kg/tree and 180.24 fruits per tree respectively).

Sabour: Application of 75% RDF + AMC soil application (12.5 kg/ha) twice a year along FYM recorded higher fruit yield (19.06 kg/tree) with higher TSS (9.68 °B) as compared to control (13.13 kg/tree and TSS- 9.36 °B respectively).

Sangareddy: Application of 5% RDF + AMC soil application (12.5 kg/ha) twice a year along FYM recorded significantly higher fruits per tree (90.00), fruit weight (110.00 g), ascorbic acid (176.28 mg/100g) as compared to control (60.00 fruits per tree, 83.71 g, and 157.85 mg/100g respectively) (Fig 18).

Udaipur: Application of 75% RDF + AMC soil application (12.5 kg/ha) twice a year along FYM recorded significantly higher fruit yield (42.43 kg/tree and 11.79 t/ha), fruits per tree (235.00) with higher TSS (13.60°B) and BC ratio (2.05) as compared to control (31.16 kg/tree, 185.31 fruits per tree, TSS-12.59 °B and BC ratio 1.61) (Table 100).

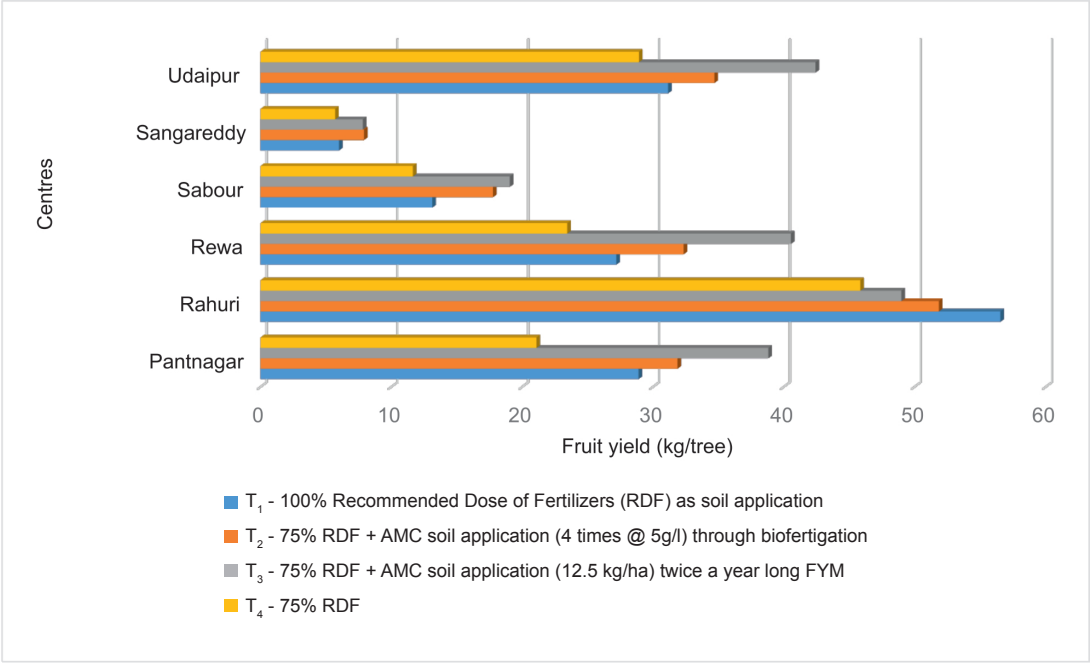


Fig. 18: Effect of different treatments on fruit yield (kg/tree) of guava at various centres

Table-100: Effect of different treatments on fruit yield (t/ha) of guava at various centres

Treatments#	Pantnagar	Rahuri	Rewa	Sabour	Sangareddy	Udaipur
T_1	11.6	15.66	10.88	-	9.60	8.66
T_2	12.75	14.36	12.94	-	12.66	9.61
T_3	15.53	13.57	16.22	-	12.51	11.79
T_4	8.4	12.70	9.38	-	9.14	8.06
CD at 5%	1.77	1.53	0.02	-	0.91	0.40
# T_1: 100% Recommended Dose of Fertilizers (RDF) as soil application, T_2: 75% RDF + AMC soil application (4 times @ 5g/l) through biofertigation, T_3: 75% RDF + AMC soil application (12.5 kg/ha) twice a year along FYM, T_4: 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.

Ludhiana: Incidence of Snail, *Succenea* sp. Blackfly, *Aleurocanthus husaini* Corbett were 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 of guava Very high incidence of *Conogethes punctiferalis* was observed in almost all the guava growing areas followed by fruit fly. No new insect pest was observed.

Pantnagar: Major insect pest were Fruit and shoot borer, *Conogethes punctiferalis* (>25% incidence) and fruit fly, *Bactrocera dorsalis* (>10% incidence). Beside, Mango mealy bug, *Drosicha mangiferae* (Green), Aphid, Myzuspersicae; Coccids, *Chloropulvinaria psidii*; Semilooper;Anar butterfly, *Deudorix (Virachola) isocrates*; Leaf cutter bee Mechachile sp., *Spodoptera litura* and defoliating beetles and various lapidopterans larvae were also observed on guava during the vegetative to fruiting stage.

Rahuri: Incidence of Mealy bug (*Ferrisia virgata*) was reported during July 2020. Anar caterpillars *Deudorix isocrates* was recorded in the month of November up to 2.50%. The incidence of caster capsule borer (*Conogethe spuntiferalis*) was recorded in the second week of June in high density guava plantation and it was increased to 3.50 % in the last week of July 2020. Whereas, fruit flies (*Bactrocera dorsalis*) were severe in second week of August 2020. The recently reported pest wax scales (Ceroplastes destructors Newstead) was observed in the month of Aug-2020 and the infestation level was up to 6.25 per cent in the month of October-2020. The mealy bug infestation was increased by 2.25 per cent during current year as compare to the past incidence.

Sangareddy: The dynamics of pest population in guava post monsoon period of 2019-20 revealed that spiralling whitefly and fruit flies recorded more incidence, whereas, coccids have recorded less incidence and also bark eating caterpillar damage was observed throughout the year (Table 101).

Table 101: Insect pest fauna associated with guava at different centers

Name of the insect pest	PNT	RHR	LDH	SNG	MHR
Fruit fly, Bactrocera dorsalis (Hendel)	High	High	High	High	High
Anar butterfly, *Deudorix (Virachola) isocrates* (Fabricius)	Low	High	Medium	High	High
Fruit and shoot borer, *Conogathes punctiferalis* (Guenée)	High	Medium	Medium	Medium	High
Bark eating caterpillar *Indarbela tetraonis* Moore	High	-	Low	Low	-
shoot borer (*Microcolona* technographa)	-	-	Low	-	High
Spiraling whitefly *Aleurodicus dispersus* Russel	-	-	-	High	-
Thrips, *Selenothrips rubrocinctus* Giard and and *Rhipiphorothrips cruentatus* Hood	Low	-	Low	-	-
Mealy bugs, *Ferresia* virgata Cockerell	-	Medium	Low	-	Low
Mango mealy bug *Drosicha mangiferae* (Green)	Medium	Low	Medium	Low	High
Aphid, Aphis *gossypii* Glover	Low	-	-	-	-
Coccids, *Chloropulvinaria psidii* (Maskell)	Low	Low	Low	Low	-
Wax Scale (*Ceroplastes destructors* Newstead)	-	Medium	Low	-	-
PNT-Pantnagar; RHR-Rahuri; LDH-Ludhiana; SNG- Sangareddy; MHR- Mohanpur					

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 (T_1 to T_3) and

chemical sprays (T_4) 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 (14.46 %), whereas the chemical insecticide lamda-cyhalothrin @ 0.05% recorded 11.96% and in control TMB damage recorded 50.67%. The TMB population ranged from 3.47 to 4.33 in different treatments as against 7.00 in control, minimum TMB population among the three different doses of bio-control agent *B. bassiana* in T_3 (*B. bassiana* W/P-12g/l) recorded (3.75). However chemical insecticide Lambda-cyhalothrin 0.05% recorded (3.47) TMB population. Similar trend has been observed for Yield (30.10kg/tree), number of TMB damaged fruits(33.90), weight of healthy (24.07) and damaged fruits (2.91) and BC ratio (1.58) in T_3 (*B. bassiana* W/P-12g/l) as over control (23.39 kg/tree, 109.12, 12.64, 10.75 &1 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* @ 10 g/lit (13.28%), which was closely followed by T_3 treatment *B. bassiana* @ 12 g/lit, which recorded 14.51 % as against 24.24 % in standard check (Lambda -cyhalothrin - 0.05%) and 39.75% in control. Similar trend has been observed for yield (17.08 kg/tree), number of TMB damaged fruits (17.00), weight of healthy (15.74 kg/tree) and BC ratio (1.86) in treatment *B. bassiana* W/P-10g/l over the standard check (Lambda-cyhalothrin - 0.05%) 11.34 kg tree yield, 24.00, 9.40 kg/tree & 1.55 respectively.

Periyakulum: Among the three bioagents no significant difference was recorded. However, minimum TMB damage (%) was recorded in *B.bassiana* @ 5g/lit (38.60%), followed the chemical insecticide lamda-cyhalothrin 0.05%, which recorded 37.18% as against 59.30% in control. TMB population ranged from 2.90 to 5.47 in different treatments as against 7.20 in control. Minimum of 2.90 was recorded in T_4 and T_1 (3.33). Similar trend has been observed for number and weight of healthy fruits, damaged fruits. Though the chemical check recorded maximum control for TMB, *B. bassiana* W/P-5 g/l recorded higher BC ratio of 1:3.67.

Tinsukia: Among the three bioagents no significant difference was recorded. However, minimum TMB damage (%) was recorded in *B. bassiana* @ 12 g/lit (7.50 %), whereas the chemical insecticide lamda-cyhalothrin @ 0.05% recorded 9.60% and in control TMB damage recorded 10.00%. TMB population ranged from 7.50 to 9.60 in different treatments as against 7.00 in control. Similar trend has been observed for number of TMB damaged fruits (22.00), weight of healthy (14.39 kg/tree) and BC ratio (1.86) in treatment *B. bassiana* W/P-12 g/l over the standard check (Lambda -cyhalothrin - 0.05%) 28.00, 11.65 kg/tree & 1.90 respectively (Table 102 & 103).

Table-102: Tea mosquito bug incidence at different centres

Treatments	TMB affected fruits/tree at maturity (%)				TMB nymphs before spray and after last spray							
	BLR	LEM	PKM	TNK	BLR		LEM		PKM		TNK	
	-	-	-	-	Before	After	Before	After	Before	After	Before	After
T_1	31.26 (33.99)	19.09 (25.91)	38.60 (38.38)	9.50 (17.95)	7.65 (2.76)	4.33 (2.08)	3.21 (1.93)	0.04 (0.73)	7.33 (2.87)	3.33 (2.04)	8.50 (2.91)	4.40 (2.09)
T_2	23.13 (28.74)	13.28 (21.37)	40.03 (39.80)	8.30 (16.74)	7.94 (2.81)	3.90 (1.97)	1.23 (1.32)	0 (0.71)	6.94 (2.0)	3.73 (2.14)	8.00 (2.80)	5.10 (2.25)
T_3	14.46 (22.34)	14.51 (22.39)	43.15 (41.03)	7.50 (15.89)	6.00 (2.44)	3.75 (1.93)	2.09 (1.61)	0 (0.71)	7.05 (2.82)	5.47 (2.52)	7.65 (2.76)	3.85 (1.96)
T_4	11.96 (20.23)	24.24 (29.49)	37.18 (34.55)	9.60 (18.05)	8.00 (2.82)	3.47 (1.86)	2.15 (1.63)	0 (0.71)	7.28 (2.86)	2.90 (1.93)	8.20 (2.86)	4.45 (2.10)
T_5	50.67 (45.38)	39.75 (39.09)	59.30 (50.34)	10.00 (18.43)	8.33 (2.88)	7.00 (2.64)	2.14 (1.62)	2.03 (1.59)	6.86 (2.79)	7.20 (2.85)	8.53 (2.92)	7.85 (2.80)
CD at 5%	7.54	9.85	2.92	2.17	NS	0.20	0.30	0.54	NS	0.095		2.10

#T_1: B. bassiana W/P-5g/l, T_2: B. bassiana W/P-10g/l, T_3: B. bassiana W/P-12g/l, T_4: Lambda -cyhalothrin - 0.05%, T_5: 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-103: Benefit cost ratio in biological control of TMB by Beauveria bassiana at different centres

Treatments	BC ratio			
	Bengaluru	Lembucherra	Periyakulam	Tinsukia
T_1	1.37	1.36	3.67	2.15
T_2	1.47	1.86	2.92	2.85
T_3	1.58	1.55	2.90	2.70
T_4	1.62	1.23	3.54	1.90
T_5	1.00	0.92	2.22	-

#T_1: *B. bassiana* W/P-5g/l, T_2: *B. bassiana* W/P-10g/l, T_3: *B. bassiana* W/P-12g/l, T_4: Lambda -cyhalothrin - 0.05% ,T_5: Unsprayed (control)

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 and monsoon period major disease was Algal rust (15.7-23.4%), Sooty mould (11-18.2%). However, *Phytophthora* rot (10.7%) was reported in pre-monsoon period and canker (18.2%) in monsoon period.

Ludhiana: During monsoon period highest incidence of anthracnose (20.33%) was observed whereas, low incidence of wilt (4-7%) was observed during monsoon and post-monsoon periods.

Rewa: During pre-monsoon and monsoon period, higher incidence of anthracnose (7.2 to 17.2% respectively), incidence of wilt (2.2 to 3.1%), *Phytophthora* rot (5.7 to 24.7%) was observed.

Rahuri: During pre-monsoon and monsoon period incidence of canker ranged from 4.12 to 15.23% and anthracnose (4.55 to 21.25 %) was reported.

Mohanpur: During pre-monsoon and monsoon period canker (5.50 to 17.00% respectively) and anthracnose (5.00 to 16.50%) incidence was reported. Monsoon period also recorded Wilt (10.00%) and algal rust (11.50%).

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

Sangareddy: During pre-monsoon and post-monsoon period anthracnose was reported ranging from 10.4 to 18.2 per cent. *Cercospora* fruit spot was also recorded during post monsoon (8.9%).

6.2.3. G. Integrated management of guava wilt

To manage the guava wilt disease through integration of resistant root stock, bio-agents and organic amendments, the grafted plants of local promising variety of the region on inter specific hybrid (*Psidium mole x Psidium guajava*) were planted and the grafts are being observed for the performance in terms of resistance to wilt disease.

Lucknow: No incidence of wilting was observed on grafted plant of Allahabad Safeda and Lalit (local promising and Susceptible Check). Application of *Trichoderma viride* enriched in FYM @ 5.0 kg in pit at the time of planting + application of 10 kg enriched FYM with in *Trichoderma viride* every year in June on local promising variety (Local Check) and treatment with grafted plants of Local promising variety of the region on inter specific *(Psidium mole X P. guajava)* + application of *Trichoderma viride* enriched in FYM @ 5.0 kg in pit at the time of planting + application of 10 kg enriched FYM with in *Trichoderma viride* every year in June on Allahabad Safeda has recorded maximum yield of 8.8 and 9 kg per tree kg per tree during winter season and 7.53 and 7.81 kg per tree during rainy season respectively.

Mohanpur: No wilting was observed in grafted plant of local promising variety of the region on Inter specific hybrid (*Psidium mole x Psidium guajava*) + application of *Aspergillus niger* enriched with FYM @5.0 kg in pit at the time of planting + application of 10 kg enriched FYM with *Aspergillus niger* every year in June on Allahabad Safeda. Whereas, 80 per cent mortality was observed in T_1(Grafted plant of Allahabad Safeda and Lalit (Local promising and susceptible check)and T_2 (Grafted plants of Local promising variety of the region on inter specific *(Psidium molle X P. guajava)* treatments. The treatment T_6 (Grafted plants of Local promising variety of the region on inter specific *(Psidium molle X P. guajava)* + Application of *Trichoderma viride* enriched in FYM at 5.00 kg in pit at the time of planting + application of 10 kg enriched FYM with in *Trichoderm viride* every year in June on Allahabad Safeda.) was also effective in controlling the wilt disease of guava and recorded yield of 30 kg per tree during rainy season.

Sangareddy: No wilt symptoms were observed so far.

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).

Jorhat: Exploration was carried out at three agro climatic zones of Assam *viz.,* Central Brahmaputra Valley Zone (CBVZ), Lower Brahmaputra Valley Zone (LBVZ) and North Bank Plains in four districts (Morigaon, Kamrup, Barpeta & Darang). A total of 10 accessions were evaluated during the reporting period. Among them MG 12 has recorded maximum number of fruits (270.33) and MG 11 has recorded maximum fruit weight (10.20 kg).

Kannara: Exploration for collection of new accession was carried out at Idukki, Palakkad, Thrissur and Ernakulam districts of Kerala resulted in identification of four accessions including a gumless type, off season type and small fruited type. Among the four, two accessions were dual purpose types (KJ 38/19, KJ 40/20) and two were table purpose types (KJ41/20, KJ (32/19). All the accessions planted in the field are in vegetative stage (Fig 19-21).

Kovvur: Explorations were carried out in tribal zone of East Godavari district and high altitude of north coastal belt. One new accession was collected which bears small and round shaped fruits. Among the conserved 29 accessions (Primary and secondary collections) in the field gene bank, twenty-five accessions are in bearing stage and 4 accessions are in pre bearing stage. Swarna Manohar has recorded maximum canopy volume (647.2 m^3). Palur-1 has recorded maximum number of fruits (43.0) and yield (352.3 kg/tree). Whereas, maximum fruit weight (12.4 kg) and number of flakes (340) was recorded in Boduluru 4.

Lembucherra: During the reporting period, explorations were carried out in West Tripura and Khowai districts. One new accession was identified and collected. Characterization and evaluation of 20 genotypes are in progress.

Mohanpur: During the reporting period, explorations were carried out in different parts of Nakashipara in Nadia district, Baharampore in Murshidabad district and Mogra in Hooghly district of West Bengal. A total of sixty accessions were identified, collected and conserved from different parts of West Bengal, Assam, Bihar, Tripura, Meghalaya and bordering areas of Jharkhand. 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 (80 & 84). BCJ-22 (15.1 kg) and BCJ-30 (15.5 kg) has recorded maximum fruit weight. BCJ- 27 is suitable for dessert purpose with spherical shaped fruits (2 kg). BCJ-16 has recorded complete red coloured flakes. Whereas, BCJ-34, BCJ-35, BCJ-36 and BCJ-37 produced fruits year-round (Table 104).

Periyakulam: Explorations were carried out in Theni District and three new accessions were collected. Out of total 44 accessions conserved in field gene bank, 2 accessions were evaluated which were table purpose type. Twenty nine accessions were characterized, among which eighteen accessions are in bearing stage and 9 accessions are in pre-bearing stage. The accession AH-2 has recorded maximum number of fruits (28) followed by AH 18 (20).

Table-104: Variation in fruit characteristics (quantitative) of jackfruit at different centres

Quantitative parameters	Lower (Minimum)	Higher (Maximum)
Fruit weight (kg)	2.08 (HRS17)	40 (KJ 40/20)
Flake:Fruit	0.19 (BCJ-15)	0.87 (BCJ-5)
Flake thickness (mm)	0.20 (KJ 32/19, Khajawa, & BCJ-20)	0.90 (Tanjavur)
Flakes/ kg fruit	1.79 (KJ 40/20)	44 (Khajawa)
TSS (°B)	14.4 (AH 7)	33.5 (Pechiparai)
Fruit rind thickness (cm)	0.56 (BCJ-21)	3.4 (KJ 40/20)
Flake length (cm)	3.2 (Kajawa)	11.14 (AH 5).
Flake width (cm)	1.7 (Khajawa & BCJ-27)	5.5 (BCJ-2)
Note; Mohanpur: BCJ-2, 5, 15, 20, 21, 27; Kannara: KJ 32/19, KJ 40/20 & Pechiparai; Periyakulam: AH 5, 7 and Tanjavur;		

Fig. 19: Features of accession KJ-38 /19

Fig. 20: Features of accession KJ-32 /19

Fig. 21: Features of accession KJ-41/20

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, Muttam Varrikka has recorded the maximum fruit weight (8.3 kg), fruits per tree (32.7) and yield (27.1 t/ha).

Kovvur: Among the evaluated varieties, maximum fruits per tree (43.3) and yield (27.2 t/ha) were recorded in Palur-1. Whereas, Singapore jackfruit (9.6 kg) has recorded maximum fruit weight (Table 105).

Kannara: Among the evaluated varieties, Singapore jackfruit has recorded maximum fruits per tree (186.0) with yield of 269.30 t/ha (Fig 22).

Mohanpur: Among the evaluated varieties, maximum number of fruits per tree (17.4) was recorded in Palur-1 and maximum yield (11.1t/ha) was recorded in Pechiperai which was at par with Muttam Varikka, Palur-1 and Burliar-1 (Table 105).

Periyakulam: Variety Palur-1 has recorded maximum number of fruits per tree (13.2) and yield (31.4 t/ha).

Table-105: Yield of jackfruit varieties at different centres

Varieties	Yield (t/ha)				
	Jorhat	Kannara	Kovvur	Mohanpur	Periyakulam
Muttam Varikka	27.1	12.4	9.4	11.0	10.8
Gum less jack	9.0	10.4	11.5	6.7	-
Palur-1	14.9	24.1	27.2	10.7	31.4
Pechiperai-1	16.8	157.5	14.7	11.1	4.8
Singapore jack	11.1	269.3	20.4	7.7	14.8
Velipala	13.7	17.2	2.7	8.7	2.3
Burliar-1	9.8	7.6	7.5	10.7	3.3

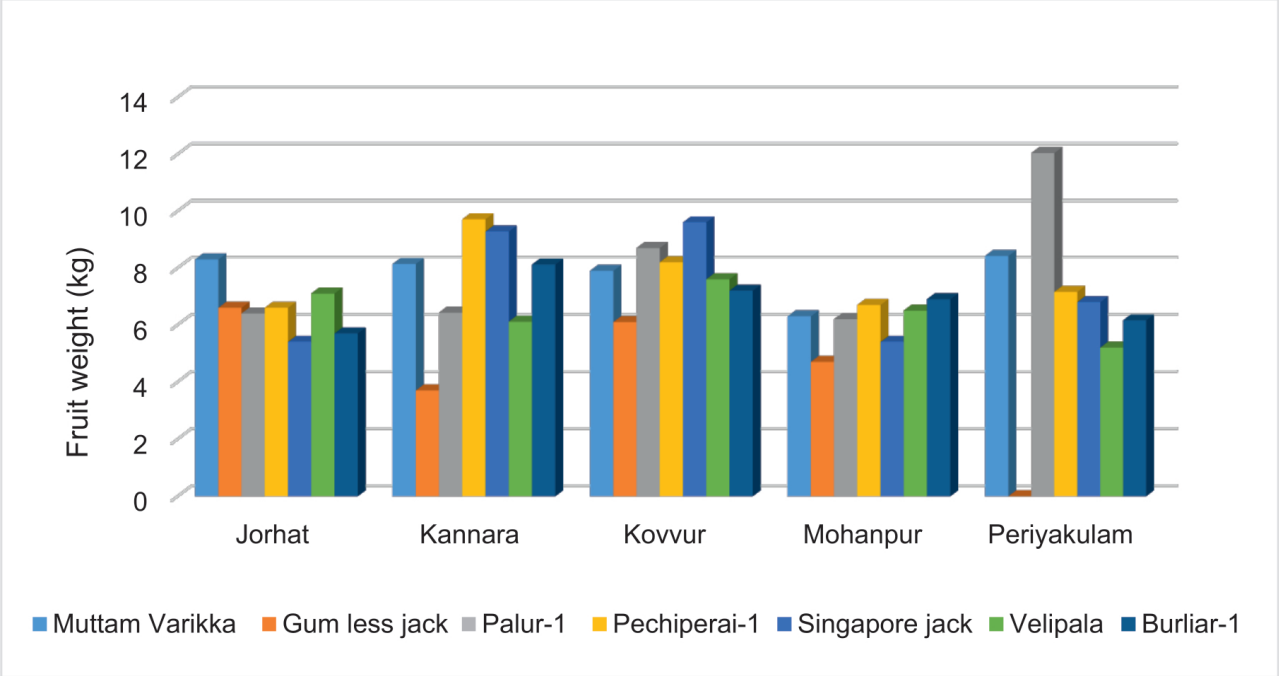


Fig. 22: Yield (kg/tree) of jackfruit varieties

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: During reporting period, fruit and shoot borer (*Glyphodes caesalis*) and aphid were recorded with an increased incidence (28-38 & 5-10% respectively) in jackfruit (Table 106).

Kannara: During the reporting period, both nymphs and adults of a regular pest spittle bug (*Clovia lineaticollis*), was recorded on growing young shoots. Sporadic occurrence with defoliation by Long horned Grasshoppers/Katydids and leaf caterpillars were recorded. Bud weevil (*Ochyromera artocarpi)* infestation was also sporadic which fed on young and tender jack fruits. Jack fruit aphid (*Greenidia artocarpii)* infestation was also recorded on young shoots. 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 which damage the young flushes and shoots. A defoliator (*Olenecamptus bilobus*) either alone or in group of 3-4 beetles which feeds on young shoots and leaves was observed across the surveyed areas during pre-monsoon and monsoon period with an incidence of 10.0-60.0 per cent (Table 106).

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 jack fruit. Among them, fruit borer was found to be the major pest of jackfruit (1.0 to 23.55%) as given in table 106.

Lembucherra: During the reporting period, infestations of mealy bug (1-15 %) and leaf webber (1-17 %) were recorded (Table 106).

Mohanpur: During the reporting period, incidence of fruit and shoot borer (*Glyphodes caesalis*) and mealy bug was observed to be increasing (18-30.5% & 2-6% respectively) in all the jackfruit growing areas. Incidence of Eriophyid mite (*Tegolophus indica)* with 1 to 2 percent infestation was also observed throughout the year (Table 106).

Periyakulam: Surveys were conducted in various parts of Tamil Nadu. Incidence of stem borer, mealy bug and aphids were found to increase during reporting period. Regular insect pest *viz.,* shoot and fruit borer incidence was maximum in Panruti (9.24%) followed by Thandikudi (8.71%). Stem borer incidence was maximum in Periyakulam, Sirumalai and Panruti (6.20 to 6.50%). Mealybug infestation (8.52%) was high in Vr iddhachalam followed by Panruti (7.12%). Aphids infestation (13.25% and 10.20%) was high in Periyakulam and Sirumalai (Table 106). Natural enemies *viz.,* spiders, praying mantids, green lacewings, Coccinellids, *Spalgis epius* and reduvid bugs were also observed in surveyed areas (2.5-8.3%).

Table-106: Status of different insect pests of jackfruit at different centres

Centres	Name of the Pest	Past incidence (%)	Current incidence (%)	Remarks
Jorhat	Fruit & shoot borer *(Glyphodes caesalis)*	28	28 – 38	Pest incidence increased
	Mealy bug	15	5-10.0	Pest incidence decreased
	Aphid *(Toxoptera aurantii)*	4	5.0 -10.0	Pest incidence increased and found at budding stage
Kovvur	Fruit borer	12.75	1.00 – 23.55	Pest infestation same
	Olenecamptus bilobus	-	1.0 – 29.40	-
	Mealy bug	1.80	0.0 – 2.50	Pest infestation same
Lembucherra	Mealy bug	-	1-15	Patchy infestation on fruit
	Leaf webber	-	1-17	Bind the leaves and cause damage
Periyakulam	Shoot and fruit borer (%)	6.50	6.57	Pest incidence slightly increased
	Stem borer (%)	3.84	5.12	Pest incidence increased
	Mealy bug (%)	4.47	5.28	Pest incidence increased
	Aphid infestation	5.08	5.98	Pest incidence increased
Kannara	Shoot and fruit borer *(Margaronia caesalis)*	0.75	0.5-1.0	Pest population insignificant.
	Batocera rufomaculata	15.0	10.0-15.0	The pest incidence increased
	Olenecamptus bilobus	35.0	10.0-60.0	Pest incidence same
	Glenea multiguttata	10.0	5.0-20.0	Pest incidence increased
	Oberea artocarpi	12.5	5.0-15.0	Pest incidence decreased
	Epepeotes uncinatus	10.0	5.0-20.0	Pest incidence increased
	Macrochenus isabellinus	22.5	10.0-35.0	Pest incidence same
	Leaf caterpillar *(Margaronia bivitralis)*	15.0	10.0 - 20.0	Pest incidence same
	Mealy bug	10	5-15.0	Pest incidence same
	Jack fruit aphid (Greenidia artocarpii)	7.5	5.0 -10.0	Pest incidence same
Mohanpur	Bark eating caterpillar *(Indarbela tetraonis)*	3.2	3.0-4.0	Bark eating caterpillar (Indarbela tetraonis)
	Aphid *(Toxoptera aurantii)*	3.8	3.0 -4.0	Aphid (Toxoptera aurantii)
	Fruit & shoot borer *(Glyphodes caesalis)*	16.6	18.0-30.5	Fruit & shoot borer (Glyphodes caesalis)
	Mealy bug	2.2	2.0-6.0	Mealy bug
	Eriophyid mite	-	1-2	Eriophyid mite

6.5.1.J. New and emerging diseases of 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: Surveys conducted at Goalpara, Jorhat, Kamrup Rural, Sonitpur districts has recorded that incidence of leaf spot (13.9%) and red rust (9.7%) was maximum (Table 107).

Kannara: During reporting period maximum incidence of leaf spot (20 %) was recorded. Seedling blight caused by *Colletotrichum* sp and *Rhizctonia* sp was observed as an emerging disease in the root stock of commercial nurseries in post south west monsoon period since last few years in Thrissur District with an incidence of 1-5 per cent (Table 107).

Kovvur: During reporting period decreased level of Rhizopus fruit rot (20.5%) and leaf spot (7.2%) incidence was recorded compared to past incidence (Table 107).

Mohanpur: Jack wilt/root rot complex by *Phytophthora* sp was recorded as emerging diseases. The disease was a complex with infestation of borer. Inflorescence rot/young fruit rot was recorded maximum (5.8-8.5%) during reporting period (Table 107).

Periyakulam: Survey conducted at Theni, Tirunelveli, Tenkasi Districts recorded that Algal red rust (*Cephaleuros* spp) and leaf spot was maximum (9.18% & 22.48% respectively) during reporting period (Table 107).

Table-107: Status of various disease(s) of jackfruit at different centres

Centres (District surveyed)	Name of the disease (causal organism)	Past incidence (%)	Current status (%)	Remarks
Jorhat (Goalpara, Jorhat, Kamrup Rural, Sonitpur district)	Fruit rot (Rhizopus sp.)	23.0	21.0	Decreased
	Leaf spot (*Phyllosticta* sp., *Colletotricum* sp.)	11.0	13.9	Increased
	Red rust (*Cephaleuros sp*)	7.3	9.7	Increased
Kannara (Thrissur District)	Leaf spot (*Colletotrichum sp*)	18 (PDS)	20 (PDS)	Increased
	Seedling blight (*Colletotrichum* sp. and *Rhizoctonia* sp.)	1 -5	1 - 5	No change, observed in seedlings (Root stock of commercial nurseries in post south west monsoon period)
	Algal rust (*Cephaleuros* sp.)	16	16	No change
	Pink disease (*Corticium salmonicolor*)	10	8	Decreased
	Fruit rot (*Rhizopus* sp.)	20	20	No change
	Fruit rot (*Botridiplodia* sp)	8	5	Decreased
Kovvur (West Godavari)	Fruit rot *Rhizopus sp.*	22.6	20.5	Decreased
	Leaf spot (*Colletotricum* spp)	7.69	7.2	Slightly decreased
	Jack wilt (Etiology not yet confirmed)	Traces	Traces	-
Mohanpur (Nadia District)	Inflorescence Rot/ Young fruit rot (Rhizopus spp.)	03.4 – 05.2	5.8-8.5	Increased
	Leaf spot (*Phyllosticta* sp., *Colletotrichum* sp)	10.7-17.5	12.46-15.98	No much change
	Post-harvest fruit rot/Storage rot (*Botrydiplodia* 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 (*Colletotrichum gloeosporioides*)	21.89	22.48	Increased
	Fruit rot (*Rhizopus* sp.)	10.51	10.29	Slightly Decreased
	Red rust (*Cephaleurus* sp)	8.79	9.18	Slightly 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, two fungal cultures and one bacterial culture was obtained from foot rot/ collar rot infected jackfruit plant. One of the fungal cultures was *Fusarium* sp. and another culture yet to be identified. In two-year-old nursery plants, *Fusarium* sp. showed drying up of the lower twigs and leaves, gummosis or reddish-brown area around the stem, less foliage and sick appearance with leaf spots in 15 days and further study is in progress.

Mohanpur: Two pathogens were isolated from infected roots and rhizospheric soil of foot rot/ collar rot infected jackfruit plants. *Fusarium* sp. and *Phytophthora* sp. were identified through microscopic studies. *Phytophthora* sp. after inoculation as soil drenching with minor root injury showed foot rot symptom and pathogen was reisolated from the roots of infected plants. However, pathogenicity of *Fusarium* sp is yet to be confirmed.

LITCHI

1.3.2. L. Creating variability in litchi

For strengthening genetic base of litchi, half-sib seedling population from potential and leading varieties of the region are raised and evaluated as per litchi descriptors. The progress made during the year 2020 is as follows:

Gangian: Seedling population of Dehradun were transplanted whose average plant height and stem girth was recorded to be 0.18 m and 0.45 cm respectively.

Medziphema: Seedlings of Shahi were planted and the average plant height and stem girth recorded were 0.59 m and 1.20 cm respectively.

Mohanpur: Seedlings of Bombai were established and the plant height ranged from 0.20 m to 0.60 m while stem girth was in the range of 0.20 cm to 0.60 cm.

Muzaffarpur: Shahi seedlings population were transplanted and observed for plant height and stem girth which ranged from 0.45 to 0.80 m and 0.52 to 1.26 cm respectively.

Pantnagar: A total of 1000 seedlings were raised in polybags and are to be transplanted after attaining the transplanting stage

Ranchi: In Bedana seedlings population, plant height ranged from 0.50 to 1.10 m whereas stem girth ranged from 0.11 to 0.18 cm.

Sabour: Five hundred seedlings of Mandraji have been raised and transplanted. The plant height and stem girth ranged from 0.40 to 0.70 m and 0.45 to 0.67 respectively.

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: New plantation have been established and initial soil parameters like organic carbon, EC, pH, available soil P_2O_5 and soil K_2O (0.25%, 0.07 dS/m, 7.4, 5.6 kg/ha and 27.00 kg/ha respectively) was recorded.

Mohanpur: Flowering has been initiated and significant yield was observed. Plant height, trunk crossectional area, canopy volume, yield, fruit weight and TSS were recorded maximum at 6x6 m which was *at par* with 5x5 m (Table 108) whereas it was minimum in 2 x 2 m. Initial soil chemical parameters was analyzed and observed no significant differences in soil EC, pH, and available soil P_2O_5 and K_2O except for soil organic carbon and available soil N.

Neri: Significantly, plant height, trunk cross-sectional area and canopy volume was found maximum at 6x6 m (Table 108). Soil chemical parameters did not differ significantly among treatments.

Pantnagar: Significant variation in plant height, trunk cross-sectional area and canopy volume was noted (Table 108). However, soil characteristic with respect to soil organic carbon, EC and pH did not differ significantly among treatments.

Sabour: Canopy volume was found significantly higher at 6x6 m spacing. There was no significant differences in plant height, trunk cross-sectional area and soil parameters among treatments (Table 108).

Table-108: Effect of planting density on plant height and trunk cross section area at different centres

Treatments (Spacing)	Plant height (cm)				Trunk cross section area (cm^2)			
	MHR	NER	PNT	SBR	MHR	NER	PNT	SBR
2x2 m	1.78	0.81	1.56	2.63	3.16	1.61	26.98	29.72
3x3 m	3.70	0.58	1.86	2.35	3.42	1.44	31.04	29.43
4x4 m	3.05	0.65	2.44	2.41	3.08	1.64	35.69	33.10
5x5 m	3.73	0.57	2.32	2.17	3.50	1.37	37.17	24.56
6x6 m	3.63	0.85	3.14	2.19	3.61	1.80	41.63	22.70
SEm ±	0.38	0.23	0.054	0.13	-	0.03	2.118	4.15
CD at 5%	1.11	0.11	0.179	NS	-	0.12	7.015	NS
MHR: Mohanpur, NER: Neri, PNT: Pantnagar and SBR: Sabour								

2.3.7.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: The maximum plant height (0.79 m), canopy volume (0.051 m^3) and trunk cross sectional area (21.52 cm^2) was recorded in T_4. Soil parameters did not differ significantly among treatments (Table 109).

Mohanpur: Maximum plant height (1.72 m) was observed in T_1 while trunk cross sectional area was noted maximum in T_3 (37.13 cm^2).

Muzaffapur: The maximum plant height (3.25 m), canopy volume (20.60 m^3) and trunk cross sectional area (182 cm^2) was observed in T_7, T_3 and T_5 respectively. Soil organic carbon, EC and pH did not differ significantly among treatments (Table 109).

Pantnagar: The maximum plant height (2.74 m), trunk cross sectional area (54.73 cm^2) and canopy volume (14.47 m^3) was recorded in T_9. There was no significant difference among treatments for soil organic carbon and EC except for soil pH (Table 109).

Ranchi: Plant height was recorded maximum (21.48 m) in T_3 whereas canopy volume (2.99 m^3) and trunk cross sectional area was note maximum (83.96 cm^2) under T_{10} (Control). There was no significant effect of treatments on soil parameters (Table 109).

Sabour: Plant height was found maximum(1.99 m) in T_9 whereas, trunk cross sectional area was recorded maximum (51.02 cm^2) in T_7. The effect of treatments on soil organic carbon, EC and soil pH did not differ significantly (Table 109).

Table-109: Effect of treatments on plant height (m) and trunk crossectional area of litchi at different centres

Treatments	Plant height (m)						Trunk cross sectional area (cm^2)					
	GNG	MFR	MHR	PNT	RNC	SBR	GNG	MFR	MHR	PNT	RNC	SBR
T_1 (P_2S_2)	0.76	2.97	1.72	2.31	1.17	1.58	17.4	157	34.6	25.7	59.7	39.9
T_2 (P_2S_3)	0.70	3.20	1.43	2.50	1.16	1.68	17.1	167	30.4	30.5	61.2	43.6
T_3 (P_2S_4)	0.79	3.22	1.64	2.36	1.48	1.74	12.5	179	37.1	28.4	73.7	23.1
T_4 (P_3S_2)	0.79	2.87	1.45	2.43	1.14	1.56	21.5	169	35.1	44.9	52.4	34.4
T_5 (P_3S_3)	0.60	3.25	1.48	2.47	1.26	1.55	11.6	157	22.5	27.6	58.1	37.3
T_6 (P_3S_4)	0.71	3.20	1.06	2.52	1.26	1.70	16.2	167	23.4	44.5	74.5	38.5
T_7 (P_4S_2)	0.67	3.03	1.25	2.71	1.21	1.96	18.6	182	13.7	37.7	59.5	51.0
T_8 (P_4S_3)	0.58	2.93	1.49	2.64	1.27	1.68	14.4	153	29.2	44.7	67.6	36.2
T_9 (P_4S_4)	0.61	3.03	1.05	2.74	1.17	1.99	13.0	160	26.8	54.7	78.4	50.9
T_{10} (control)	0.74	3.10	1.60	2.54	2.06	1.63	14.2	164	25.5	41.5	83.9	24.7
CD at 5%	-	0.35	0.44	4.41	0.24	NS	-	26.4	13.2	10.1	4.08	NS
*P_2 - 2 primary branches; P_3 – 3 primary branches; P_4 – 4 primary branches; S_2 – 2 secondary branches; S_3 – 3 secondary branches; S_4 – 4 secondary branches; T_{10} – Control GNG: Gangian, MFR: Muzaffarpur, MHR: Mohanpur, PNT: Pantnagar, RNC: Ranchi & SBR: Sabour												

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

Unproductive senile litchi trees were headed back at 1.5 m above ground and number of effective shoots per tree will be determine so as to assess the effect of rejuvenation on fruit yield and quality of litchi.

Pantnagar, Ranchi, Mohanpur, Neri (Hamirpur), Sabour and Gangian: At all centres, old plantation showing low productivity were rejuvenated and the plants are under non-bearing stage. The initial observations on number of flushes and flush emergence pattern and light intensity were recorded (Table 110).

Table-110: Rejuvenation of old and low productive litchi plantations at different centres

Centre	Gangian	Mohanpur	Neri	Pantnagar	Ranchi	Sabour
Cultivar	Dehradun	Bombai	Dehradun	Rose scented	Purbi	Purbi
Age of trees	40	25	20	>30	30	37
Year of rejuvenation	2018 - 19					
Reason(s) for rejuvenation	Intermingling of branches and low yield (40-50 kg/plant)	Low yield (20-25 kg/plant) and highly irregular bearing	Low yield (12-15 kg/ plant) and inferior fruit quality	Low yield (15-20 kg/plant)	Low yield (22-25 kg/plant) and difficulties in orchard management	Low yield (20-25 kg/plant)

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

Litchi cv. Shahi (Ranchi and Raipur), Bombai (Mohanpur), Rose Scented (Pantnagar), Purbi (Sabour) and Calcuttia (Gangian) were planted in single hedgerow system namely, 6x4, 8x4 and 10x4 m and trained to open centre system with two primary branches. Fruit yield and quality under different hedgerow system will be evaluated.

Ranchi, Mohanpur, Pantnagar, Sabour, Gangian and Raipur (Ambikapur): This experiment was approved during 7th Group Discussion of ICAR-AICRP on Fruits and all centres have established fresh plantation in litchi. The initial soil parameters on organic carbon, EC and pH have been recorded and did not differ significantly at Gangian centre.

3.3.3.L. Irrigation (Drip) 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. A spacing of 8×8 m (Muzaffarpur- Shahi), 5×5 m (Ranchi- Shahi) and 10×10 m (Mohanpur-Bombai and Pantnagar-Rose scented) were followed as per the standard practice of the region.

Pantnagar: Significantly highest yield was recorded in treatment irrigation at 100% ER along with mulching (T_4). However, maximum fruit weight and TSS (18.94°B) and lowest acidity (0.42%) was noted under T_3 (75% ER with Plastic Mulching) and lowest in control. Plant height and canopy volume differ significantly among treatments (Table 111).

Mohanpur: Yield was recorded significantly highest in T_3. Owing to university lockdown under the grip of Amphan cyclone, fruit quality parameters cannot be assessed (Table 111).

Ranchi: Irrigation at 100 per cent ER along with mulching (T_4) was found to be *at par* with irrigation at 75 per cent ER (T_4) in registering maximum yield and superior fruit quality parameters. Vegetative growth parameters did not exhibit significant variations (Table 111).

Muzaffarpur: Plants are in vegetative phase. Vegetative growth parameters exhibit significant variations. However, soil parameters with regard to EC and pH did not differ significantly.

Sabour: Plants are in juvenile phase. Significant variations in plant height, organic carbon per cent and pH were observed. However, soil EC did not differ significantly.

Table-111: Effect of different treatments on yield and fruit quality of litchi at different centres

Treatment	Yield (kg/tree)			Fruit weight (g)			TSS (°B)		
	MHR	PNT	RNC	MHR	PNT	RNC	MHR	PNT	RNC
T_1 (Control)	64.5	17.89	23.83	21.9	21.18	18.36	18.0	18.20	19.36
T_2 (50% ER + M)	67.0	18.15	28.41	22.5	23.55	20.90	17.4	18.53	21.47
T_3 (75% ER + M)	68.6	31.31	32.03	20.4	24.11	21.76	18.2	18.94	21.80
T_4 (100% ER + M)	65.3	32.22	35.62	21.3	22.75	21.91	18.2	18.40	21.52
T_5 (50% ER - M)	65.0	14.19	27.72	22.0	20.80	19.46	17.6	18.23	20.53
T_6 (75% ER - M)	62.0	26.32	27.97	20.5	21.95	19.55	18.0	18.48	20.40
T_7 (100% ER - M)	60.0	27.47	30.09	22.6	22.69	20.55	17.5	18.43	20.89
CD at 5%	3.12	1.23	4.57	2.32	1.22	1.06	1.24	0.39	1.08

*+M: With mulching; -M: Without mulching
MHR- Mohanpur, PNT- Pantnagar & RNC-Ranchi

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

The effect of girdling on improving flowering in litchi cv. Calcuttia at Gangian, Dehradun at Neri and Shahi at Chettali on 25 and 50 per cent of the primary branches were investigated. Whereas, in cv. Shahi at Medziphema and Raipur and Dehradun at Neri girdling was carried out on 75 per cent of the primary branches (PB) with different girdling size (2 mm, 4 mm and 6 mm width). Treatments were imposed at 5 to 6 months (August–September) before the anticipated flowering.

Chettalli: The earliest healing of girdled section was noted in trees girdled at 2mm width in 25% PB (128 days) as compared to 6mm width in 50 per cent PB (152 days). Significant variation of girdling treatments on yield was observed and was found highest in 2 mm girdling in 50 per cent PB. The same treatment also resulted in maximum fruit weight and highest flowering per cent. However, 6 mm girdling width in 50 per cent PB gave maximum pulp recovery (59.3%).

Gangian: The maximum yield was noted in 4 mm girdling width in 50%primary branches (PB) while maximum fruit weight was observed in 2 mm girdling in 50% PB. The number of fruits set per panicle varies significantly among treatments and was highest in 2 mm girdling in 25% PB (29.65 fruits). The highest flowering per cent was noted in 4 mm girdling in 50% PB whereas pulp recovery and TSS:acid was highest in trees girdled with 6 mm girdling width in 50 per cent PB (Table 112).

Medziphema: The maximum yield was noted in 4 mm girdling width in 50 per cent primary branches (PB). Fruit weight was found maximum in 6mm girdling in 50% and 25% PB respectively while TSS:acid was highest in 4 mm girdling width in 75% PB. All girdled branches showed cent per cent flowering. Significant variation in pulp recovery was recorded and was highest (59.4%) in 6 mm girdling width in 50 per cent PB (Table 112).

Neri: Yield varied significantly among treatments and was highest in 6mm girdling in 50% PB. Maximum fruit weight was also noted in 6mm girdling in 50% and 25% PB respectively whereas pulp recovery and TSS:acid ratio was recorded highest in 4 mm girdling width in 50 per cent PB (Table 112).

Raipur: The required girdling treatments have been imposed.

Table-112: Effect of girdling on number of shoot showing panicle emergence and TSS-acid ratio at different centres

Treatment	Flowering%				TSS-acid ratio			
	CHL	GNG	MDI	NER	CHL	GNG	MDI	NER
2mm 25% PB	41.3	50.8	100	-	21.3	60.9	40.2	20.8
4mm 25% PB	48.1	61.2	100	-	23.6	68.2	40.5	34.2
6mm 25% PB	44.3	55.2	100	-	19.8	64.4	36.4	45.5
2mm 50% PB	58.4	64.3	100	-	31.3	53.0	37.5	33.0
4mm 50% PB	35.2	74.3	100	-	23.6	57.6	34.7	42.2
6mm 50% PB	32.8	54.1	100	-	29.1	78.5	34.1	29.1
2mm 75% PB	-	-	100	-	-	-	35.7	19.4
4mm 75% PB	-	-	100	-	-	-	42.1	26.2
6mm 75% PB	-	-	100	-	-	-	34.8	32.1
Control	36.3	44.0	-	-	26.3	66.3	-	-
CD at 5%	2.78	0.54	-	-	2.19	1.05	NS	4.01

CHL: Chettalli, GNG: Gangian, MDI: Medziphema, NER: Neri, RPR: Raipur
PB: Primary branches

4.3.5. L. Evaluation of PGR and promising chemicals for early flowering in litchi

The effect of foliar sprays at monthly interval from September to December, to regulate flowering and fruiting in litchi was investigated in cv. Mandraji at Sabour, Rose Scented at Pantnagar and Shahi at Ranchi.

Mohanpur: The earliest flowering and maximum flowering intensity was noted in K_2HPO_4 (1%) + KNO_3 (1%) followed by K_2HPO_4 (2%) and Ethrel (400ppm). Owing to COVID-19 pandemic, observations on fruit quality parameters could not be recorded.

Ranchi: Foliar application of KNO_3 (1%), K_2HPO_4 (1%) + KNO_3 (1%) and KH_2PO_4 (1%) + KNO_3 (1%) resulted in early flowering and harvesting by 6 and 7 days respectively over control. The treatments KNO_3 (1%), K_2HPO_4 (1%) + KNO_3 (1%) and KH_2PO_4 (1%) + KNO_3 (1%) also resulted in significantly higher flowering intensity and yield compared to control. The fruit quality parameters were found non-significant with respect to different treatments (Table 113).

Table-113: Effect of chemicals and PGRs on harvest advancement (days) and yield of litchi at Ranchi

Treatment	Advancement of flowering (Days)	Flowering intensity (%)	Harvest advancement (days)	Fruit weight (g)	Yield (kg/ tree)	TSS (°B)
T_1: KNO_3 (1%)	6	72.09	7	20.62	71.00	18.95
T_2: K_2HPO_4 (1%)	3	65.61	3	21.09	61.24	18.19
T_3: KH_2PO_4 (1%)	3	67.04	3	19.51	64.40	18.21
T_4: K_2HPO_4 (2%)	3	70.01	3	20.74	65.05	18.16
T_5: KH_2PO_4 (2%)	3	68.01	3	20.50	66.77	18.23
T_6: K_2HPO_4 (1%) + KNO_3 (1%)	6	74.58	7	20.25	72.83	19.30
T_7: KH_2PO_4 (1%) + KNO_3 (1%)	6	75.81	7	20.49	72.97	19.06
T_8: Ethrel (400ppm)	3	66.75	3	20.19	64.32	18.69
T_9: Control	-	64.42	-	19.29	58.86	19.21
CD at 5%	-	4.16	-	NS	3.75	NS

4.3.6. L. Bagging of litchi bunches for quality fruits

To study the effect of bagging on fruit quality in litchi, fruit bunches of Shahi (Muzaffarpur, Medziphema and Ranchi), Rose Scented (Pantnagar), Purbi (Sabour), Bombai (Mohanpur) and Dehradun (Gangian and Neri) were bagged at 15, 25 and 30 days after fruit set, using polypropylene pink and white coloured bags.

Gangian: Maximum fruit weight was noted in bagging with polypropylene white coloured bags at 30 days after fruit set (DAFS). Fruit bagged with white coloured bags at 15 DAFS depicted the maximum yield and pericarp anthocyanin content and lowest hue angle value followed by bagging at 30 DAFS, indicating better fruit colour compared to unbagged fruits. Bagging did not exert a significant effect on fruit TSS (Table 114-115).

Medziphema: Fruit weight, fruit size and TSS were recorded maximum in bagging with pink coloured bags at 25 DAFS while maximum pericarp anthocyanin content was noted in bagging with white coloured bags at 25 DAFS. Fruit yield varies among treatment and maximum yield was noted in trees bagged with pink coloured bags at 15 DAFS. Fruit cracking mildly occurs in bagged and unbagged fruits. Interestingly, bagging reduces the incidence of fruit borer to the tune of 95.0 per cent over control (Table 114-115).

Mohanpur: Data presented in table 114-115 showed that maximum fruit weight, fruit diameter, yield and pericarp anthocyanin content was recorded in bagging with pink coloured bags at 25 DAFS. However, TSS did not differ significantly among treatments. There was mild incidence of fruit cracking, however, bagged bunches recorded least infestation (3.41%) of fruit borer as compared to unbagged fruits (7.47%).

Neri: Bunches bagged with pink coloured bags at 25 DAFS recorded maximum fruit weight, fruit size and TSS. There was no incidence of fruit cracking and fruit borer in bagged fruits. Fruit yield varies significantly among treatment and maximum yield was noted in trees bagged with white coloured bags at 25 DAFS followed by bagging at 30 DAFS (Table 114).

Raipur: Bagging with polypropylene white coloured bags at 30 days after fruit set (DAFS) gave maximum fruit weight. In unbagged fruits, the infestation of fruit borer was 30.5 per cent which were reduced to 15.47 per cent in bagged fruits. TSS was unaffected by different bagging treatments. Irrespective of the type of bags fruit colour significantly improves in bagged bunches as compared to control (Table 114-115).

Table-114: Effect of bunch bagging on fruit cracking (%) and fruit borer infestation (%) in litchi at different centres

Treatments	Fruit cracking (%)					Fruit borer infestation (%)				
	MHR	GNG	MDI	NER	RPR	MHR	GNG	MDI	NER	RPR
T_1 (PPW + 15 DAFS)	1.56	6.80	1.70	0.00	2.7	4.08	0.03	0.52	0.00	19.63
T_2 (PPW + 25 DAFS)	1.36	4.40	1.86	0.00	1.79	3.98	0.71	0.89	0.00	17.63
T_3 (PPW + 30 DAFS)	1.49	10.78	2.50	0.00	1.09	4.05	0.00	1.23	0.00	15.47
T_4 (PPP + 15 DAFS)	1.40	4.15	1.66	0.00	3.14	4.28	0.00	0.32	0.00	19.4
T_5 (PPP + 25 DAFS)	1.29	9.47	1.69	0.00	2.55	3.41	0.00	0.82	0.00	20.22
T_6 (PPP + 30 DAFS)	1.46	9.07	2.04	0.00	1.3	4.06	0.00	1.10	0.00	16.43
T_7 (Control)	2.47	6.07	2.66	0.00	20.54	7.47	5.85	26.33	0.00	30.5
CD at 5%	0.34	0.27	0.72	-	2.18	4.87	0.18	1.75	-	-
MHR: Mohanpur, GNG:Gangian, MDI: Medziphema, NER: Neri & RPR: Raipur										

Table-115: Effect of bunch bagging on pericarp anthocyanin content (mg/100 g) and yield (kg/tree) in litchi

Treatments	Pericarp anthocyanin content (mg/100 g)					Yield (kg/tree)				
	MHR	GNG	MDI	NER	RPR	MHR	GNG	MDI	NER	RPR
T1 (PPW + 15 DAFS)	22.1	36.2	13.0	-	-	71.5	71.7	16.0	27.7	-
T2 (PPW + 25 DAFS)	22.3	29.5	17.4	-	-	78.1	53.6	16.3	29.5	-
T3 (PPW + 30 DAFS)	22.2	34.0	16.3	-	-	68.3	67.5	16.2	26.8	-
T4 (PPP + 15 DAFS)	22.5	22.6	11.9	-	-	73.1	55.9	19.0	25.8	-
T5 (PPP + 25 DAFS)	23.3	31.8	12.3	-	-	78.5	49.8	16.0	31.5	-
T6 (PPP + 30 DAFS)	23.3	26.3	10.3	-	-	69.7	62.0	18.0	29.1	-
T7 (Control)	21.4	18.9	10.5	-	-	59.2	54.2	14.2	20.5	-
CD at 5%	4.12	-	1.92	-	-	14.8	3.40	0.86	-	-
MHR: Mohanpur, GNG:Gangian, MDI: Medziphema, NER: Neri & RPR: Raipur										

5.3.1.L. Survey and surveillance of pest complex and their natural enemies

Systematic surveys were conducted in litchi orchards to study the diversity and intensity of insect pests and their natural enemies with critical observations on the new emerging pest.

Ambikapur: Survey was not conducted owing to covid-19 pandemic lockdown.

Gangian: Fruit borer, *Anarsia* sp. (Lepidoptera: Gelechiidae) has been reported as new insect pest while Litchi fruit borer, Litchi nut borer (*Blastobasis spp.*) and Litchi borer (*Gatesclarkeana erotias*) were recorded as regular pests in litchi. The diverse natural enemies recorded in litchi have been provided.

Mohanpur: Survey was conducted twice in different parts of the state and no new insect pest observed. However, Grey weevil *(Mylloceros* sp.) has been recorded as emerging insect pest. Leaf miner (*Acrocercops cramerella* Snellen), Semilooper (*Trichoplusia spp.*), Litchi looper (*Perixera illepidaria* Guenée), Bark eating caterpillar (*Indarbela quardinotata* Walker), Grey Weevils (*Mylloceros spp.*), and Litchi white rust mite (*Notacaphylla chinensiae*) as minor pest during vegetative stage and Litchi nut borer [*Blastobasis sp.* (Lepidoptera: Blastobasidae)] as minor pest during reproductive stages were recorded. The major pest recorded were Litchi fruit & shoot borer (*Conopomorpha sinensis* Bradley) and Litchi Fruit borer (*Conopomorpha cramerella* Snellen) during fruiting stages and Leaf curl mite (Eriophyes litchi Keifer) and Litchi mid-rib borer (*Conopomorpha litchiella* Bradley) during vegetative stages. Leaf curl mite and Litchi mid-rib borer were also observed as regular pest specific to vegetative stages at Nadia and Hoogly respectively. The diverse natural enemies recorded in litchi have been provided.

Pantnagar: Two pest surveys in the different regions of the state were conducted. Leaf roller (*Tortrix epicyrta* Meyrick; Platypeplus *aprobola* Meyer) and leaf miner (*Acrocercops cramerella* Snellen) were major pest with high activity during vegetative stages whereas Litchi fruit & shoot borer (*Conopomorpha sinensis* Bradley) and Litchi bug (*Tessaratoma javanica* Thun.) were the active pests during reproductive stages. Pests which occurs actively during vegetative - reproductive stages includes Leaf curl mite (*Eriophyes litchi* Keifer), Semilooper (*Trichoplusia spp.*) and Bark eating caterpillar (*Indarbela quardinotata* Walker). No new insect pest has been recorded. However, incidence of litchi bug, *Tessaratoma javanica* (Thun.) was observed as emerging insect pest. Leaf curl mite as major pest and Litchi mid-rib borer as minor pest were also observed as regular pest specific to vegetative stages at Ramnagar and Khatima respectively. The diverse natural enemies recorded in litchi have been provided.

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 20 accessions were collected, (26 accessions have been added to field gene bank) characterized 114 accessions, evaluated 206 accessions for various horticultural traits and 24 genotypes are being used in the breeding mango programme at 5 different centres across India (Table 116).

Table-116: Collection, characterization, conservation and utilization of mango germplasm

Category	Prior to reporting period	Reporting period	Total
1	2	3	4 (2+3)
Centres	Number of explorations/ surveys (Number of Accession)	Number of explorations/surveys (Accession number)	Number*
A. Collection			
Bengaluru	0	0	0
Imphal	1 (15)	1(3)	18
Lucknow	1 (25)	0	25
Lembucherra	1(10)	1(2)	12
Mohanpur	0	0	0
New Delhi	1(7)	1 (5)	12
Pantnagar	1(12)	0	12
Paria	0	8	8
Port Blair	10	0	10
Rahuri	0	0	0
Rewa	0	0	0
Sabour	0 (Secondary collections-52)	0	0
Sangareddy	0	0	0
Udaipur	0	1(2)	
Vengurle	0	0	0
Grand Total (A)	5(79)	4(20)	99
B. Characterization			
Bengaluru	0	41	41
Imphal	0	0	
Lucknow	0	0	
Lembucherra	10	0	10
Mohanpur	24	0	24
New Delhi	30	0	30
Pantnagar	15	9	24
Paria	0	11	11
Port Blair	10	10	20
Rahuri	0	0	0
Rewa	0	0	0
Sabour	48	8	56
Sangareddy	435	10	445
Udaipur	18	0	18
Vengurle	17	25	17
Grand Total (B)	597	114	676
C. Conservation			
Bengaluru	767	0	767
Imphal	98	0	98
Lucknow	0	0	0

Category	Prior to reporting period	Reporting period	Total
1	2	3	4 (2+3)
Centres	Number of explorations/ surveys (Number of Accession)	Number of explorations/surveys (Accession number)	Number*
Lembucherra	22	0	22
Mohanpur	109	0	109
New Delhi	0	0	0
Pantnagar	232	0	232
Paria	163	8	171
Port Blair	10	10	20
Rahuri	52	0	52
Rewa	235	2	237
Sabour	48	6	54
Sangareddy	477	0	477
Udaipur	69	0	69
Vengurle	266	0	266
Grand Total (C)	2548	36	2574
D. Evaluation			
Bengaluru	0	0	0
Imphal	15	0	15
Lucknow	322	0	322
Lembucherra	10	0	10
Mohanpur	24	7	31
New Delhi	30	20	50
Pantnagar	15	15	30
Paria	0	11	11
Port Blair	0	0	0
Rahuri	0	0	0
Rewa	52	32	84
Sabour	48	54	102
Sangareddy	12	0	12
Udaipur	41	42	83
Vengurle	119	25	144
Grand Total (D)	688	206	894
E. Utilization			
Bengaluru	2	2	4
Imphal	0	0	0
Lucknow	0	0	0
Lembucherra	0	0	0
Mohanpur	0	0	0
New Delhi	0	0	0
Pantnagar	9	0	9
Paria	2	0	2
Port Blair	0	0	0
Rahuri	0	0	0
Rewa	8	0	8
Sabour	0	0	0
Sangareddy	1	0	1
Udaipur	0	0	0
Vengurle	0	0	0
Grand total (E)	22	2	24

*In evaluation data, there might be repetition of number of varieties for the last two years
Areas explored: Manipur, Tripura, Goa, Bihar, Uttar Pradesh, Maharashtra, Karnataka and West Bengal

1.1.7.M. Varietal trial in mango

Udaipur: The mango varietal trial has been laid out in RBD with a square planting system of 10m x 10m at all the centres except at Udaipur which was planted at the spacing of 8 m X 8 m. The trial was replicated three or four times with two plants per unit (5 plants/variety in Udaipur) comprising of varieties from four different regions of the country *viz*., North (Dashehari, Langara, Fazli, S.B. Chousa, Mallika); West (Alphonso, Kesar, Mankurad, Fernandin, Vanraj), South (Banganapalli, Banglora, Mulgoa, Neelum, Suvarnarekha), Central and East (Zardalu, Bombai, Bombay Green, Himsagar, Kishan Bhog).

During the reporting period, regional variety Dashehari proved significantly best with the highest fruit yield (58.71 kg/tree) and maximum number of fruits/tree (295) over the second best performing south region variety Neelum (261 fruits/tree and 45.68 kg fruit yield/tree). While, Chausa was recorded with good content of TSS (23.08˚B) and lower acidity content (0.21%). Whereas, maximum fruit weight (395 g) was found in Baneshan. The maximum pulp content was found in Langra (73.70%) followed by Fazli (71.00%) while, minimum peel percent in Vanraj (12.3%) and stone weight was found in Bangalora (10.1%).

Among all varieties, the highest plant height was found in Langra (4.97 m) followed by Kishen Bhog (4.74 m) while, minimum in Fernandin (3.13 m). The plant stem diameter was observed maximum in Chousa (18.55 cm) followed by Langra (18.45 cm) and lowest in Zardalu (12.30 cm). Meanwhile, the maximum canopy volume was noted in Langra (90.88 m3) and minimum in Fernandin (20.06 m^3).

The best performing varieties "Dashehari" is traditionally associated with the Udaipur zone might be due to its better adaptability, precocity in bearing and yield performances. Further, no severe pest and disease was reported during the reporting period.

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: Planting will be taken up during the year 2020-21.

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) (Table 117 & 118)

Neri: The centre produces the first-year data and observed that the plant height ranges from 0.45 to 0.65 m, tree circumference ranges from 0.01 to 0.04 cm.

Pantnagar: Significant results were obtained for the morphological characters viz., the highest canopy volume (37.19 m^3), tree circumference (48.00 cm) and plant height (3.60 m) was recorded in H-1-1. The yield contributing parameters were observed with the highest fruit yield (27.11 kg/tree & 10.84 t/ha), fruits per tree (158.33) in H-1-1 followed by H-1739 (25.46 kg/tree, 84.33 fruits/tree) (Table 117). The hybrid H-311 observed the highest TSS content (20.00°B), low acidity (0.12%). However, the caroteniod content (5.19 mg/100 g pulp) maximum in H-1-6. The highest shelf life (days) of mango F_1 hybrids at Pantnagar (H-1739– 14.33 days) (Table 118).

Paria: Significant results were obtained in the morphological characters pertaining to plant height (1.93 m) and canopy volume (4.60 m^3) in the hybrid H-311. The yield and quality parameters will be recorded during the year 2021-22.

Periyakulam: The hybrid H-12 exhibited the maximum canopy volume (19.80 m^3) and tree circumference (37.55 cm). However, the plant height recorded 3.90 m in the variety H-2-6. Arka Udaya (H-12) recorded the maximum fruit yield of 4.00 kg/tree, 1.61 t/ha and 15.34 fruits per tree followed by H-2-6 which recorded the yield of 2.86 kg per tree and 12.42 fruits per tree. Among the mango hybrids evaluated H-12 registered highest TSS content (16.88 °B) followed by H-2-6 (16.00°B) and the shelf life in H-35 was 10.56 days (Table 117 & 118).

Ranchi: The morphological parameters, viz., plant height (1.98 m), trunk circumference (1.49 cm) and the canopy volume (1.07 m^3) registered with highest value in the variety H-1-16.

Sabour: The morphological parameters among the mango hybrids analyzed and the result reported that H-314 exhibited the highest plant height 3.57 m, trunk circumference 40.67 cm and canopy volume 50.28 m^3. The highest fruit weight recorded in H-360 (488.00 g) followed by H-316 (423.61 g) and the variety, H-2-6 registered 21.99°B (Table-118).

Vengurle: The mango hybrid H-360 recorded the highest value of canopy volume (19.86 m^3), tree circumference (31.00 cm). However, the variety H-1-1 recorded the maximum plant height of 2.95 m.

Table-117: Yield characters of mango hybrids planted at different centres

Mango hybrids	Yield (kg/tree)			Yield (t/ha)		Yield efficiency (kg/m^3)		Fruits/tree		
	PNT	SBR	PKM	PNT	PKM	PNT	PKM	PNT	SBR	PKM
V1 (H- 949)	18.88	1.42	-	7.55	-	1.36	-	62.00	4.67	-
V2 (H-1084)	19.94	5.94	-	7.98	-	1.59	-	75.33	22.00	-
V3 (H-1739)	25.46	1.01	-	10.19	-	0.99	-	84.33	4.00	-
V4 (H- 1 -1)	27.11	1.75	-	10.84	-	0.73	-	158.33	4.67	-
V5 (H- 1 - 6)	19.44	12.24	-	7.76	-	1.30	-	72.00	28.67	-
V6 (H- 2 -6)	21.76	9.17	2.86	8.70	1.44	1.23	1.40	77.00	25.33	12.42
V7 (H-12)	9.24	0.00	4.00	3.70	1.61	1.52	1.22	33.33	0.00	15.34
V8 (H-311)	12.17	3.63	-	4.87	-	1.38	-	39.00	12.00	-
V9 (H-314)	15.40	3.46	-	6.16	-	1.10	-	81.67	15.33	-
V10 (H-360)	9.82	1.12	2.77	3.93	1.10	1.12	1.45	10.33	2.33	9.09
V11 (GMH - 1)	21.96	1.66	-	8.78	-	1.01	-	63.67	4.67	-
V12 (Local check)	33.13	2.34	20.18	13.25	8.07	0.82	0.71	170.00	9.33	72.10
V13 (Local Check)	38.33	1.43	27.60	15.33	11.04	0.77	0.64	112.33	5.00	81.88
CD at 5%	6.83	5.80	4.98	2.73	2.12	NS	NS	17.32	10.50	9.88
PNT: Pantnagar, PKM: Periyakulam & SBR: Sabour										

Table-118: Quality character of mango hybrids planted at different centres

Mango Hybrids	TSS (°B)				Acidity (%)			Shelf life (days)	
	MHR	PNT	PKM	SBR	PNT	PKM	SBR	PNT	PKM
V1 (H- 949)	16.33	18.73	-	19.89	0.14	-	0.22	9.67	-
V2 (H-1084)	16.0	14.0	-	18.24	0.41	-	0.25	8.33	-
V3 (H-1739)	-	19.0	-	19.23	0.46	-	0.33	14.33	-
V4 (H- 1 -1)	-	19.0	-	19.51	0.21	-	0.28	8.67	-
V5 (H- 1 - 6)	-	19.5	-	18.35	0.18	-	0.22	10.33	-
V6 (H- 2 -6)	-	18.2	16.00	21.99	0.12	0.23	0.27	10.33	9.11
V7 (H-12)	-	16.6	16.88	0.00	0.39	0.26	0.00	11.67	10.56
V8 (H-311)	-	20.0	-	20.13	0.12	-	0.20	10.0	-
V9 (H-314)	-	18.50	-	20.93	0.14	-	0.25	10.33	-
V10 (H-360)	-	16.47	15.50	18.76	0.12	0.21	0.25	12.33	8.32
V11 (GMH - 1)	-	17.50	-	20.11	0.20	-	0.26	9.67	-
V12 (Local check)	17.0	20.01	18.61	20.13	0.10	0.16	0.27	10.0	9.51
V13 (Local Check)	17.0	18.80	17.05	18.94	0.16	0.18	0.26	7.67	8.00
CD at 5%	0.80	0.72	1.21	1.78	0.03	0.38	NS	1.15	2.18
MHR: Mohanpur, PNT: Pantnagar, PKM: Periyakulam & SBR: Sabour									

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.

Mohanpur: Five hundred seedlings of Amrapali have been established in field. During the season near about 25 per cent plants were in flowering stage of which 11 per cent produced fruit. However, due to cyclone Amphan all the fruits have been dropped prematurely with damage to branches also.

New Delhi: Four hundred seedlings of Amrapali are established in field out of which 78 plants showed flowering and fruits from only 31 plants were harvested.

Paria: Five hundred seedlings of Sonpari are established in field and all are in vegetative phase.

Sangareddy: One hundred and fifty seedlings of KMH1 are established and all are in vegetative phase.

Vengurle: Thirty-six seedlings are established in 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 F_1 progenies.

Bengaluru: A total of 32 F1 progenies of Amrapali x Vanraj are being maintained in the nursery.

New Delhi: A total of 64 panicles having 410 flowers have been crossed during March 2020. Total 10

hybrids stones obtained from crosses. Besides, 12 progenies forwarded from 2019.

Vengurle: During the period no crossing work was carried out. However, twenty F_1 progenies forwarded from 2019.

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 1957 bisexual flowers of Vellaikolumban were crossed with Olour and raised 8 F_1 progenies. Similarly, 328 bisexual flowers were crossed with Turpentine and raised two progenies. In addition, F_1 46 progenies forwarded from 2019 and all those progenies will be field planted in ensuing season.

New Delhi: A total of 26 progenies have been raised from Olour × Karukkan and OlourX Bappakai.

Vengurle: Trees were not flowered.

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: Problematic soil site was selected at HRS, Anantharajupet which has pH of 8.67. Grafting was completed to the seedlings; the trail will be planted with the grafted plants.

Imphal: The trial is yet to be initiated.

Paria: The rootstocks were grafted with scion of variety Kesar and the grafts were planted in the field. The plants are in vegetative stage. The data on growth and other parameters will be recorded when the grafts will be four years old.

Periyakulam: The treatment has been imposed as per the technical programme at HC&RIW, Trichy, where saline soil is predominant. The crop is in vegetative stage and morphological parameters observations in progress.

Sangareddy: The site with problematic soils has been identified at Ibrahimpatnam. Planting will be taken up in the ensuing season.

Udaipur: The trial is laid out with four rootstocks *viz.* Kurkan, Bappakai, Terpentine, open pollinated own seedling rootstock (check) and scion of variety Amrapali has been used for grafting. The plants are in vegetative stage.

3.1.1.a.M. Evaluation of substrate dynamics for IPNM in mango

To study the influence of various substrates (fertilizers, organic manure and bio fertilizers) on the fruit yield and quality of mango, the trial was laid out with 10 treatments in RBD replicated three times.

Mohanpur: Application of 250 g of Azotobacter along with 50 kg FYM and half dose of RDF resulted in higher fruit yield at Mohanpur (660 fruits per tree and 185 kg/tree). The same treatment had also given highest shelf life of 12.00 days.

Rewa: Application of half of the RDF along with 50kg FYM and 250g *Trichoderma* has resulted in higher yield (65.80 kg/tree and fruit weight 312.52 g) (Fig 23).

Sabour: Application of half of the RDF along with 50kg FYM and 250g *Azospirillum* has resulted in higher yield (332 kg/tree).

Sangareddy: Application of 250g of *Azotobacter* along with 50kg FYM and half dose of RDF resulted in higher fruit yield at sangareddy (194 fruits per tree and 75.77 kg/tree). The same treatment had also given highest shelf life of 14.50 days (Table 119).

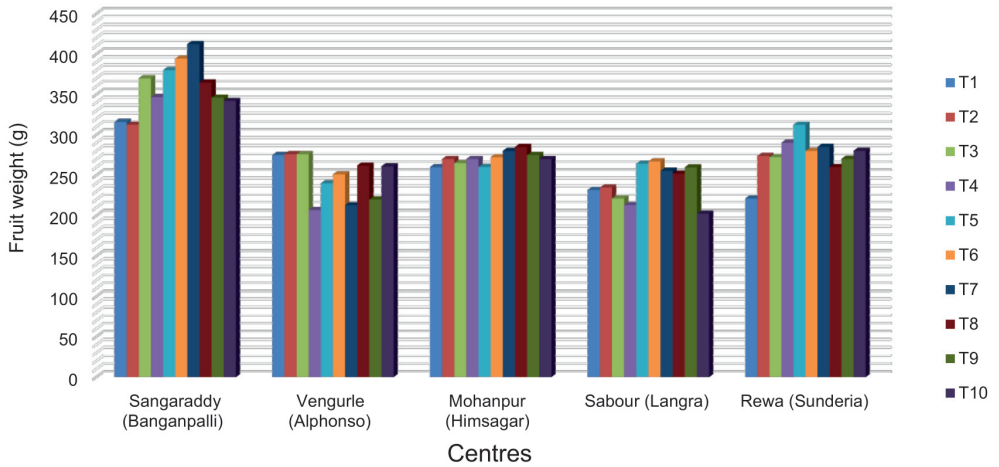
Vengurle: The treatment with 1000:1000:1000 g of N, P_2O_5, K_2O per tree + Zn (0.5%) + B (0.2%) + Mn (1 %) + Ca (0.6%) as 2 foliar applications in August and in October + organic mulching 10cm thick resulted in getting higher yield (14.21 kg/tree).

Table-119: Effect of various substrate dynamics treatments on yield (kg/tree) of mango

Treatments	Sangareddy (Banganpallli)	Vengurle (Alphonso)	Mohanpur (Himsagar)	Sabour (Langra)	Rewa (Sunderja)
T_1	41.48	13.18	170.00	225	29.92
T_2	43.10	13.32	165.30	209	46.64
T_3	44.15	10.95	180.30	178	57.86
T_4	53.45	14.21	160.00	213	49.66
T_5	48.02	9.04	165.00	242	65.80
T_6	56.02	8.03	185.30	332	58.95

Treatments	Sangareddy (Banganpallli)	Vengurle (Alphonso)	Mohanpur (Himsagar)	Sabour (Langra)	Rewa (Sunderja)
T_7	75.77	5.39	185.00	296	50.05
T_8	54.25	7.59	180.00	223	48.18
T_9	47.25	6.09	170.00	232	46.16
T_{10}	46.45	9.56	160.00	251	52.08
CD at 5%	1.40	5.19	6.19	7.79	17.21

T_1: 1000:1000:1000 g of N, P_2O_5, K_2O per tree (control); T_2:T_1 + Zn (0.5%) + B (0.2%) + Mn (1 %) + Ca (0.6%) as 2 foliar applications in August and in October; T_3:T_1 + Organic mulching 10 cm thick; T_4:T_2 + Organic mulching 10cm thick; T_5: ½ RDF + 50kg FYM + 250g Trichoderma ; T_6:½ RDF + 50kg FYM + 250g Azospirillum; T_7: ½ RDF + 50kg FYM +250g Azotobacter ; T_8 : ½ RDF + 50kg FYM + 5kg vermicompost; T_9: ½ RDF + 50kg FYM + 250g Psuedomonas florescence; T_{10}: ½ RDF + 50kg FYM + 250g Trichoderma + 250g Pseudomonas florescence



T_1: 1000:1000:1000 g of N, P_2O_5, K_2O per tree (control); T_2:T_1+ Zn (0.5%) + B (0.2%) + Mn (1 %) + Ca (0.6%) as 2 foliar applications in August and in October; T_3:T_1 + Organic mulching 10 cm thick; T_4:T_2 + Organic mulching 10cm thick; T_5: ½ RDF + 50kg FYM + 250g Trichoderma ; T_6:½ RDF + 50kg FYM + 250g Azospirillum; T_7: ½ RDF + 50kg FYM +250g Azotobacter ; T_8 : ½ RDF + 50kg FYM + 5kg vermicompost; T_9: ½ RDF + 50kg FYM + 250g Psuedomonas florescence; T_{10}: ½ RDF + 50kg FYM + 250g Trichoderma + 250g Pseudomonas florescence

Fig. 23: Effect of various substrate dynamics treatments on fruit weight (g) of mango

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.

Ananthrajupet: The yield potential of high yielding orchards was 7.8 t/ha when compared to 1.70 t/ha in low yielding orchards cv Banganpalli. Further, high yielding orchards have highest soil N (353.20 kg/ha) and K_2O (260.30 kg/ha) compared to low yielding orchards.

Imphal: The yield potential of high yielding orchards was 10.10 t/ha when compared to 7.20 t/ha in low yielding orchards. Further, high yielding orchards have highest leaf N (1.50%) and K (1.20%) and other micro nutrient Fe (94.20ppm), Mn (34.20ppm), Zn (16.60ppm) and Cu (14.30ppm) compared to low yielding orchards.

Lembucherra: The yield potential of high yielding orchards was 52.13 kg/tree when compared to 18.71 kg/tree in low yielding orchards. Further, high yielding orchards have highest soil N (231.98 kg/ha) and K_2O (183.31 kg/ha) compared to low yielding orchards.

Mohanpur: The yield potential of high yielding orchards was 77.38 kg/tree when compared to 20.22 kg/tree in low yielding orchards.

Periyakulam: The yield potential of high yielding orchards was 7.80 t/ha when compared to 3.85 t/ha in low yielding orchards. Further, high yielding

orchards have highest leaf N (2.18%) and K (1.12%) and other micro nutrient Fe (111.00 ppm), Mn (67.71 ppm), Zn (41.42 ppm) and Cu (23.15 ppm) compared to low yielding orchards.

Rewa: The yield potential of high yielding orchards was 71.61 kg/tree when compared to 25.20 kg/tree 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 25 t/ha when compared to 3 t/ha in low yielding orchards.

Sangareddy: The mean yield of high yielding orchard of cv Banganpalli was recorded 14.68 t/ha when compared with low yielding orchard of 4.16 t/ha. Further, high yielding orchards have highest leaf N (2.16%) and K (1.12%) and other micro nutrient Fe (110.20 ppm), Mn (80.60 ppm), Zn (40.42 ppm) and Cu (40.15ppm) compared to low yielding orchards.

Vengurle: High yielding orchard of cv Alphonso recorded 4.70 t/ha yield compared to low yielding orchard of 2.67 t/ha. In general, the soil pH 6.05 was the major constraint in low yielding orchard. Further, high yielding orchards have highest soil N (310 kg/ha) and sail K_2O (365 kg/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. Alphonsi in Vengurle in RBD comprising five treatments and five replications with various treatments and yield and yield parameters were recorded.

Paria: Treatment with 40:60:20, 40:40:20 and 20:0:60 $N:P_2O_5:K_2O$ respectively at after harvest, during fruit set and marble size stage recorded significantly higher yield (58.21 kg/tree) followed by treatment T_3 (52.85 kg/tree). Whereas, control treatment recorded lowest yield (38.05 kg/tree).

Rewa: No yield was recorded during current season.

Sabour: Treatment with 20:30:10, 20:20:10 and 10:0:30 $N:P_2O_5:K_2O$ respectively at after harvest, during fruit set and marble size stage recorded significantly higher yield (202 kg/tree) and it was at par with treatment T_1, T_3 and T_5.

Sangareddy: Treatment T_2 (40:60:20, 40:40:20 and 20:0:60 $N:P_2O_5:K_2O$ respectively at after harvest, during fruit set and marble size stage) recorded significantly higher yield (40.16 kg/tree) followed treatment T_3 (35.0 kg/tree) and was at par with T_2 (40:60:20, 40:40:20 and 20:0:60 $N:P_2O_5:K_2O$ respectively at after harvest, during fruit set and marble size stage). Whereas, control (T_1) recorded lowest yield i.e., 27.08 kg per tree.

Vengurle: No flowering was observed during the reporting period.

3.1.4.M. Development of organic package of practice for mango

To study the influence of various organic package of practices in mango on fruit yield and its quality the trial was laid out with seven treatments in RBD replicated three times.

Rahuri: Application of vermicompost (50 kg/tree) + *Azospirillum* culture @ 250 g/tree + PSB @250 g/tree + vermiwash (T_7) had recorded significantly higher yield (619.51 fruits/tree and 143.66 kg/tree).

Sabour: Application of Vermicompost (50 kg/tree) + *Azospirillum* culture @ 250 g/ tree + PSB @250 g/tree + vermiwash (T_7) had recorded significantly higher yield (683.33 fruits/tree and 228.51 kg/tree)

Sangareddy: Application of vermicompost (50 kg/tree) + *Azospirillum* culture @ 250 g/tree + PSB @250 g/tree, (treatment T_5) had significantly increased the yield at Sangareddy (175 fruits/tree & 143.66 kg/tree).

Vengurle: Application of vermicompost (50 kg/tree) + *Azospirillum* culture @ 250 g/tree + PSB @ 250 g/tree, (T_5) had significantly increased the yield (5.29 kg/tree) (Table 120).

Table-120: Effect of various organic package of practices on yield (kg/tree) of mango at different centres

Treatments	Yield (kg/tree)				Fruit weight (g)			
	SNG (Banganpalli)	VNG (Alphonso)	SBR (Langra)	RHR (Kesar)	SNG (Banganpalli)	VNG (Alphonso)	SBR (Langra)	RHR (Kesar)
T_1	42.50	2.03	182.70	96.30	318.60	244	346.64	183.61
T_2	57.50	4.57	167.35	100.06	341.80	250	366.68	183.72
T_3	56.89	3.64	145.54	106.53	335.66	223	309.77	192.27
T_4	41.42	2.78	197.94	99.51	356.33	215	350.07	187.14

Treatments	Yield (kg/tree)				Fruit weight (g)			
	SNG (Banganpalli)	VNG (Alphonso)	SBR (Langra)	RHR (Kesar)	SNG (Banganpalli)	VNG (Alphonso)	SBR (Langra)	RHR (Kesar)
T_5	68.35	5.29	220.07	120.90	386.33	250	370.73	205.38
T_6	62.70	5.07	185.26	130.02	363.92	238	300.62	215.23
T_7	44.82	4.24	228.51	143.66	347.42	236	339.97	231.95
T_8	-	-	107.95	-	-	-	253.33	-
CD at 5%	2.90	0.24	41.66	19.23	2.82	1.41	99.49	25.91

SNG: Sangareddy, VNG: Vengurle, SBR: Sabour, RHR: Rahuri & LKO: Lucknow
Treatment details: T_1: FYM (50 kg/tree); T_2: FYM (50 kg/tree) + Azospirillum culture @ 250 g/tree + PSB @ 250 g/tree; T_3: FYM (50 kg/tree) + Azotobacter @ 250 g/tree + PSB @ 250 g/tree; T_4: Vermicompost (50 kg/tree); T_5: Vermicompost (50 kg/tree) + Azospirillum culture @ 250 g/tree + PSB @250 g/tree; T_6: Vermicompost (50 kg/tree) + Azotobacter @ 250 g/tree + PSB @ 250 g/tree; T_7: Vermicompost (50 kg/tree) + Azospirillum culture @ 250 g/tree + PSB @ 50 g/tree + vermiwash, T_8: Control

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:P_2O_5:K_2O 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: The highest tree height (2.68 m) in F_2 (90% of RDF through fertigation), whereas, the highest canopy volume was observed with value of 6.28 m^3 in the treatment 70 per cent of RDF through fertigation (F_4). At Lucknow (mango variety Dashehari), the treatment 100% of RDF through fertigation (F_1) recorded the highest yield/tree (13.95 kg/tree), yield (5.56 t/ha), fruits/tree (49.25) and pulp content (77.60%) followed by F_3 (80% of RDF through fertigation). Similarly, registered the highest TSS content (21.75°B) in the treatment 100% of RDF through fertigation (F_1) and low acidity content (0.20%) followed by F_2 (90% of RDF through fertigation). The soil parameters viz., soil pH ranges between to 6.97 - 7.36, soil OC (0.42 – 0.49 %), soil EC (0.33-0.41 dS/m), Nitrogen (141.37-163.33 kg/ha), Phosphorus (19.13-22.24 kg/ha) and Potassium (198.27-220.72 kg/ha) were recorded. The leaf nutrient contents of N, P, K and micronutrient were analyzed.

Mohanpur: The treatment F_5 (60% of RDF through fertigation) recorded the maximum plant height of 4.15 m.

Neri: The experiment has been initiated during the year 2020-21 and the data will be produced during 2021-22.

Pantnagar: The treatment F_2 (90% of RDF through fertigation) registered the highest canopy volume (14.62 m^3) and tree height (2.85 m) in variety Dashehari. The yield parameters will be recorded during 2021-22. The soil parameters soil pH ranges between to 6.97 to 7.36, soil OC (0.54 – 0.75 %), soil EC (0.11-0.14 dS/m), Nitrogen (206.97-238.33 kg/ha), Phosphorus (51.21-56.81 kg/ha) and Potassium (124.69-136.89 kg/ha) were recorded. The leaf nutrient contents of N, P, K and micronutrient also analyzed and report revealed that leaf nitrogen content range between (1.54-1.82 %) Potassium (0.40-0.50%).

Paria: Recorded the highest canopy volume (14.77 m^3) and tree height (2.43 m) in the treatment F_2 (90% of RDF through fertigation). The soil parameters and leaf nutrient were analyzed.

Periyakulam: Recorded the highest canopy volume (2.84 m^3) and tree height (2.11 m) in the treatment F_2 (90% of RDF through fertigation) in the variety Imam Pasand. The soil parameters soil pH ranges between (7.05-7.68), soil OC (0.50-0.53%), soil EC (0.12-0.14 dS/m), Nitrogen (150.00-162.81 Kg/ha), Phosphorus (30.38-32.02 kg/ha) and Potassium (278.75-288.31 kg/ha) were recorded. The leaf nutrient contents of N, P, K and micronutrient also analyzed and report revealed that leaf nitrogen content range between 1.32-1.48 %, Phosphorous (0.172-0.17) and Potassium (0.60-0.68%).

Rewa: The experiment has been initiated. However, the soil fertility parameters were analysed and recorded. The soil nitrogen status is ranging from 112.47-113.26 kg/ha, phosphorous 37.50-38.01 kg/ha and potassium 361.63-382.57 kg/ha.

Sabour: The treatment F_1 (100% of RDF through fertigation) registered the maximum plant height of 4.10 m. The soil parameters soil pH ranges between (76.96-7.45), OC (0.31-0.46 %), EC (0.06-0.07 dS/m), Nitrogen (165.67-198.63 kg/ha), phosphorus (34.34-48.45 kg/ha) and potassium (80.78-89.76 kg/ha) were recorded.

Sangareddy: The treatment F_1 (100% of RDF through fertigation) registered the 3.44 m plant height and F_4

(70% of RDF through fertigation) registered the highest yield/tree (11.20 kg/tree), yield (4.48 t/ha), fruit weight (250.00 g) and fruits/tree (45.00) in Dashehari and while in Banganapalli the same treatment F_4 (70 % of RDF through fertigation) reported the highest value of Yield/tree (9.50 kg/tree) and Number of fruits/ tree (380.00). The soil, physical and leaf nutrients are analyzed as per the treatments

Udaipur: Recorded the highest canopy volume (6.57 m^3) and tree height (2.36 m) in the treatment F_2 (90% of RDF through fertigation).

Vengurle: Recorded the highest canopy volume (0.26 m^3) and tree height (0.72 m) in the treatment F_2 (90% of RDF through fertigation).

3.1.6.M. Effect of micronutrients on yield and quality of mango

The trial was conducted during the year 2018 (in Southern and Western part) 2019 (in Northern part) 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 Banganpalli, 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 (6.31 t/ha) as well as the flowering intensity (57.55%) were found higher with the treatment of T_7 [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 Anantharajupet.

Lucknow: The fruit yield on per hectare basis (12.70 t/ ha) was found significantly higher with the treatment of T_6 (RDF + 100 g $ZnSO_4$ + 50 g $CuSO_4$ + 50 g H_3BO_3 (Soil application) in basin after harvest + Foliar spray of 0.2 % $ZnSO_4$ + 0.1% H_3BO_3 (2 sprays at just before flowering and marble stage) at Luchnow. However, the flowering intensity (44.19%) was observed higher with T_7 at Lucknow.

Mohanpur: The fruit yield on per hectare basis (25.50 t/ha) was found significantly higher with the treatment of T_5 (RDF + Foliar spray of 0.2% $ZnSO_4$ + $CuSO_4$ (0.1%) + H_3BO_3 (0.1%) [2 sprays at just before flowering and marble stage]) at Mohanpur (Table 121).

Sabour: The fruit yield on per hectare basis (21.45 t/ha) as well as the flowering intensity (71.67%) were found higher with the treatment of T_7 [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 (14.25 t/ha) was found significantly higher with the treatment of T_8 (RDF + Mango special (IIHR) @ 5g/l (2 sprays at 2 months before flowering & fruits of 2-4 cm diameter stage) at Sangareddy (Table 121). However, the flowering intensity (65.20%) registered higher with the treatment T_5 (RDF + Foliar spray of 0.2% $ZnSO_4$ + $CuSO_4$ (0.1%) + H_3BO_3 (0.1%) [2 sprays at just before flowering and marble stage]).

Table-121: Effect of micronutrients on yield (t/ha) in different cultivars of mango at various centres (2020)

Treatments	Anantharajupet (Baneshan)	Lucknow (Dashehari)	Mohanpur (Himsagar)	Sabour (Langra)	Sangareddy (Banganpalli)
T_1	4.52	9.22	24.50	9.81	10.35
T_2	4.98	9.59	22.50	11.96	10.82
T_3	5.09	10.39	20.00	15.57	11.14
T_4	5.63	11.94	24.50	17.08	11.30
T_5	6.09	11.98	25.50	17.59	13.03
T_6	6.22	12.70	24.50	19.19	13.63
T_7	6.31	12.49	25.00	21.45	13.70
T_8	6.01	10.90	24.50	20.81	14.25
CD at 5%	0.42	2.12	1.17	2.99	0.18

#Treatment details: T_1 - Control as per RDF (Region specific) in basin after harvest; T_2 - RDF + 200 g $ZnSO_4$ + 100 g Borax (Soil application) in basin after harvest; T_3 - RDF + 200 g $ZnSO_4$ + 100 g $CuSO_4$ + 100 g H_3BO_3 (Soil application) in basin after harvest; T_4 - RDF + Foliar spray of 0.2% $ZnSO_4$ + H_3BO_3 (0.1%) [2 sprays at just before flowering and marble stage]; T_5 - RDF + Foliar spray of 0.2% $ZnSO_4$ + $CuSO_4$ (0.1%) + H_3BO_3 (0.1%) [2 sprays at just before flowering and marble stage]; T_6 - RDF + 100 g $ZnSO_4$ + 50 g $CuSO_4$ + 50 g H_3BO_3 (soil application) in basin after harvest + Foliar spray of 0.2 % $ZnSO_4$ + 0.1% H_3BO_3 (2 sprays at just before flowering and marble stage), T_7 - RDF + 100 g $ZnSO_4$ + 50 g $CuSO_4$ + 50 g H_3BO_3 (Soil application) in basin after harvest + Foliar spray of 0.2% $ZnSO_4$ + 0.1% $CuSO_4$ + 0.1% H_3BO_3 (2 sprays at just before flowering and marble stage); T_8 - 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	Baneshan, Bengalora, Neelum, Pulihara
Bengaluru	Alphonso, Benganpalli, Totapuri, Amrapali
Bhubaneswar	Amrapali and Dashehari
Lucknow	Dashehari and Mallika
Mohanpur	Bombai, Fazli, Himsagar and Langra
New Delhi	Amrapali, Bombay green, Dashehari, Mallika and Langra
Paria	Alphonso, Kesar, Mallika and Totapari
Periyakulam	Bengalora, Benganpalli, Neelum
Rahuri	Alphonso, Kesar, Mallika, Totapuri, Vanraj
Rewa	Langra, Mallika, Sundreja and Totapari
Sabour	Bombay, Jardalu, Langra and Totapari
Sangareddy	Benganpalli, Mallika, Suvarnarekha and Totapari
Udaipur	Amrapali, Dashehari, Kesar, Langra and Mallika
Vengurle	Alphonso, Kesar, Pairi, Ratna and Totapari

Anantharajupet: Among all the varieties evaluated for climatic variability Neelum recorded lowest number of days (19.34days) for 50 per cent flowering, while Pulihora recorded on par values. Lowest sex ratio was recorded in Neelum (3.33), while highest number of fruits set per panicle (8.92 fruits) were recorded on Neelum variety. Highest fruit weight (288.72 g) was recorded in baneshan cultivar, but highest fruit per tree (250.62) was recorded in Neelum while the lowest yield was recorded in Baneshan (4.88 t/ha). However, Baneshan recorded highest TSS content (18.5°B) when compared to the other cultivar.

Bengaluru: The first appearance of flower bud ranged from mid (Alphonso) to end (Totapuri) January. The duration of flowering varied from 46 days in Totapuri to 0 days in Amrapali that did not flower at all. Days to 50 percent flowering was lowest in Totapuri and highest in Alphonso. Least sex ratio of male/hermaphrodite flowers was recorded in Totapuri (4.46) whereas Alphonso showed maximum sex ratio of 16.27. Highest fruit set at marble stage and maximum number of fruits per panicle at harvest was recorded in Banganapalli while these were least in Alphonso. Banganapalli gave maximum fruit yield followed by Totapuri during the current year.

Lucknow: The vegetative and reproductive shoot growth pattern in relation to weather changes was monitored in Dashehari (20 years) and Mallika (20 years) cultivars. The flowering intensity 31.8 per cent was observed in Dashehari and 55.2 per cent in Mallika.

Mohanpur: It was observed that cv. Himsagar took maximum days (14.78 days) from first flowering to 50 per cent flowering but it was minimum (10.71 days) in cv. Langra. The flowering percentage was observed maximum in cv. Himsagar (85.20%) and it was found minimum in cv. Fazli (48.50%) in 2020. The maximum number of fruits was noted in cv. Himsagar (102.22) in 2020 and minimum was recorded in cv. Fazli (39.35). The highest fruit yield was recorded in Himsagar (23.29 kg/plant) while it was found lowest in cv. Langra (14.52 kg/plant).

Paria: From the five varieties under study, only Kesar and Mallika initiated flowers and bear fruits,

whereas varieties Langra and Dashehari neither initiated flowers nor vegetative flush. In case of variety Amrapali, the terminal shoots produced vegetative flush instead of flowers. The possible reasons for such behavior may be changes in soil moisture and air humidity due to rain in the month of December and its impact on physiological activities of these varieties during flowering period. Kesar and Mallika variety took 13.20 and 12.80 days, respectively to reach 50 per cent flowering. The duration of flowering was 35.40 and 39.00 days in Kesar and Mallika, respectively. Flowering intensity was 71.00 and 55.75 per cent, in Kesar and Mallika respectively. Male to female sex ratio of 17.23 and 15.37 was recorded in Kesar and Mallika varieties, respectively. The average number of fruit set (per panicle) at marble stage was 3.71 and 2.95 in cv. Kesar and Mallika, respectively. Fruit retention at maturity from fruit set (13.86% and 15.35%) was recorded with cv. Kesar and Mallika, respectively. However, on the average basis, higher yield in terms of number of fruits per tree and yield (160.80 and 54.55 kg/tree, respectively) was noted in cv. Kesar as compared with Mallika. The TSS (18.77°B and 18.30°B), acidity (0.22% and 0.23%) and ascorbic acid (23.12 mg/100g and 24.76 mg/100) was observed with Kesar and Mallika cultivars respectively.

Periyakulam: Climatic variability during the reporting period favoured for mango flowering, fruit set and yield. The yield performance and quality attributes of mango varieties viz., Neelum, Bangalora and Banganapalli were recorded. The average temperature (29.32°C), relative humidity (68.00%) and total rainfall (955.88 mm) were recorded. The flowering and fruiting behaviour have been registered for three varieties and observed that variety Neelum exhibited late in 50% flowering and harvesting stage (36.05). The variety Bangalora harvest period was observed upto May 2020 and for Neelum June 2020. However, the early flowering, fruiting and harvest period were recorded in the variety Banganapalli 28.66 days (50% flowering). In variety Neelum, recorded the highest number of fruits (618.51). However, the yield per tree recorded with the highest value in variety Bangalora (222.10 kg/tree). The biochemical parameters were also recorded, the highest TSS (20.22°B) and lowest acidity content of (0.21%) registered in the variety Banganapalli. Whereas Bengalora recorded the TSS content of 16.00°B.

Rahuri: Earliest flowering initiation was observed in cultivar Alphonso while days for 50% flowering was lowest (37.00) in Totapuri and highest in Vanraj (44.00). Flowering intensity was highest in Totapuri (62.32%) and lowest in cultivar Mallika (40.32%). The duration of flowering was lowest in Keshar (60) and highest in Mallika (81). The sex ratio was highest in Keshar (0.13) and lowest in Mallika (0.05). The fruit set at Marble stage was maximum in cv. Totapuri (7.65/panicle) while it was minimum in cv Alphonso (3.12/panicle). The fruit retention percentage based on fruit set at marble stage was highest in Alphonso (26.32%) and lowest in Vanraj (16.35%). The average fruit weight was maximum in cv. Vanraj (501.85 g) while it was minimum in cv Alphonso (225.25 g). The number of fruits per tree was maximum in Totapuri (473.21) and minimum in Alphonso (311.32). The highest per plant and per hectare yield was observed in Totapuri (141.55 kg/tree, 14.20 t/ha) and lowest in Alphonso (70.15kg/tree, 7.08 t/ha). Quality parameters: As regards to quality parameters, the TSS was highest in Alphonso (19.32°B) and lowest in Totapuri (15.32°B). However, the acidity was lowest in Totapuri (0.15%) and highest in Vanraj (0.20%).

Rewa: Maximum yield was recorded in Totapari (68.02 kg/plant) followed by Mallika (64.78 kg/plant). Maximum fruit weight in Totapari (242.95 g). The Maximum TSS were noted in Sunderja (22.13°B) and minimum in Totapari (17.25°B).

Sabour: High amount of flowering intensity (83%) was observed in Bombay with minimum fruit drop percentage (90.80%) in Totapuri. Zardalu was harvested early on 26.05.2020.

Sangareddy: The experiment was initiated in the concluded varietal trial at Fruit Research Station, Sangareddy during 2016-17. During 2019-20, the flower initiation was 2 days earlier in Banganapalli (15-12-19) when compared to Mallika (7-1-20). The early fruit set (27-2-20) in Banganapalli was recorded when compared to Suvarnarekha (15-3-20). Significantly maximum yield of 76.03 kg per tree was obtained in mango cv Mallika due to maximum number of fruits/tree (165) when compared with 135 in Suvaranarekha. Mango cv Mallika is giving consistently higher yield during the past two years.

Udaipur: Early panicle emergence was recorded in variety Amrapali while, late panicle emergence during January, was observed in Langra and as well as in Dashehari with the highest flowering intensity of 67 per cent. Variety Mallika and Dashehari took maximum of 36 and 35 days respectively to 50 per cent flowering while; variety Langra took minimum of 29 days to 50 per cent flowering. Dashehari proved best as compared to other varieties with highest number of fruits per tree (567) and yield per tree (119.4 kg) but, in Mallika maximum average fruit weight (272 g) and in Amrapali yield (31.7 t/ha) was recorded.

Hopper population during flowering was observed maximum in Amrapali whereas, malformation was observed maximum in Kesar. In case of powdery mildew low to moderate infection was observed in all five varieties.

Vengurle: Total rainfall received during 2020 was (5018.6 mm) as it was above the mean annual rainfall (3000 mm) of the region. Rainy days were also more (119 days) as compared to previous years (109 days). As far as maximum and minimum temperature is concerned no any extreme variation was observed. Photo period received during June to September, 2020 for the mango was also low (0.26 to 1.56 hours.) which may delay flowering during current season. Relative humidity during morning and evening was also at normal. No extreme deviation was observed.

4.1.7.M. Validation of Arka Saka Nivarak for prevention of spongy tissue in Alphonso mango

The experiment was laid out in RBD comprising six replications with the following four treatments *viz*., T_1 Spraying on the fruits with Arka Saka Nivarak @ 100 ml/l; T_2 - Dipping the fruits with Arka Saka Nivarak @ 100 ml/l; T_3 - Water spray (standard check) and T_4 - Unsprayed control.

Paria: As the experiment site is at farmer's field, experiment was not conducted due to Lockdown.

Sangareddy: Experiment was not conducted due to insufficient trees for conducting replicated trial.

Vengurle: The results indicated that the extent of spongy tissue was lowest (18.66%) in treatment T_2 (Dipping of fruits with Arka Saka Nivarak @100 ml/l), however, it was at par with T_1 (Spray of fruits with Arka Saka Nivarak @100 ml/l) and significantly superior over all other treatments.

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 2020.

Ludhiana: A total of 44 insect pests as emerging pests were recorded at Ludhiana centre, among them major ones are *viz.,* mango stem borer, *Aeolesthes holosericea* (Fabricius), beetle, *Bandar pascoei* Lansberge, jewel beetle, *Belionota prasina* (Thunberg), timber worm weevil, *Arrhenodes* sp., Click beetle, *Alaus* sp. Borer, *Gatesclarkeana* sp., leaf webber, *Nephopteryx* sp., leaf folder, *Dudua aprobola* (Meyrick) bark bug, *Hylus dentatus* Fabricius. mango shoot borer, *Penicillaria jocosatrix* Guenee, leaf beetle, *Cryptocephalus* sp. Armoured scale, *Octaspidiotus tripurensis* Takagi. leaf weevil, *Peltotrachelus cognatus* Marshall *Syntomoides imaon* Cramer, geometrid moth, *Thalassodes falsaria* Prout.

Malda: There are 16 insect pests were recorded. Among them mango hoppers, mealy bugs and mango fruit fly were observed as major insect pest. An undefined species of semi-looper was reported as new insect pest on mango leaves. Besides, natural enemies viz. Coccinelid beetles, spiders and predatory bugs were also found on mango.

Mohanpur: Mango hoppers and mango red banded caterpillar or fruit borer *Deanolis sublimbalis* are the most destructive pest in different places of West Bengal. Incidence of thrips from panicle initiation to fruiting or fruit developing stages is becoming an emerging threat to mango production. Mango leaf cutting beetle was also observed in new vegetative flush. The mango fruit fly incidence was also recorded higher in all the mango growing parts during May-June and Sept.-Oct. in parts of Hoogly district where mango is harvested in two seasons. No new pest was observed during the survey.

Pantnagar: Among the diversified pest fauna associated with mango crops mango hoppers, mealy bugs, mango fruit fly, shoot gall psylla were observed as major insect pest with significant damage. Besides, stem borer, bark eating caterpillar, termite, leaf gall midge, leaf cutting weevil, coccids, defoliator larvae, green stink bug, gundhi bug, citrus black fly, jewel bug and red cotton bug were recorded as minor insect pests. While some other insects like crane flies, short horned grasshopper, tussock moth, and tiger moth were found as plant visitors only and caused negligible damage to mango.

Among the natural enemies, spiders were seen feeding on mango hoppers, ladybird beetle species *viz*., *Chilocorus nigritus* (Leach) was seen attacking on coccids whereas, both grub and adult of *Rodolia fumida* (Mulsant) was seen feeding voraciously on mango mealy bug. Besides these, green lace wings, predatory stink bugs, dragon fly and damsel fly were also seen occasionally feeding on the insect pests. There was no new insect was recorded as new pest during the year 2020. However, incidence of fruit borer was found higher (20-22%) as compared to previous year.

Paria: Major insect pests of mango recorded at Paria centre are hopper, thrips and fruit fly whereas; other pests of either minor/sporadic importance. Beneficial insects viz; spiders, coccinellids, praying mantis, green lacewings bug and dragon fly were observed in mango. No new pest was recorded during the study periods. 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 plants at different surveyed areas. Fruit fly infestation was also recorded higher as compared to past incidence (5-20%).

Periyakulam: Mango hoppers and fruit flies are observed as regular major pest at Periyakulam. Fruit borer, *Citripestis eutraphera* and *Deanolis albizonalis* were recorded as emerging pest.

Sangareddy: The pest fauna recoded at Sangareddy were *viz.*, hoppers, fruit flies, fruit borer, mealy bug, stem borer, thrips and webber. Heavy infestation of leaf webber was also observed during this year, while hopper population was very low compared to last year. Presence of red cotton bug on leaves and flowers of mango was also recorded. Fruit borer, *Citripestis eutraphera* and *Deanolis albizonalis* were recorded as emerging pest.

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 eutraphera* and *Deanolis albizonalis* were recorded as emerging pest.

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.

Bengaluru: Among the different treatments of biocontrol agent *M. anisopliae* oil-based formulation @ 1ml/l was found most effective treatment for management of mango hopper and thrips (5.12 & 9.69 per panicle) 9th day after spray, apart from the chemical-based treatment, However, standard check (Imidacloprid @0.3ml/l) recorded minimum hopper and thrips population (2.14 & 3.21/panicle) respectively.

Mohanpur: Among the different treatments of biocontrol agent *M. anisopliae* oil-based formulation @ 1ml/l was found most effective treatment for management of mango hopper and thrips (5.58 & 0.99per panicle) 9th day after spray, However, standard check (Imidacloprid @0.3ml/l) recorded minimum hopper population (4.09 per panicle).

Pantnagar: Among the different treatments of biocontrol agent *M. anisopliae* oil-based formulation @ 1ml/l was found most effective treatment for management of mango hopper (5.19 per panicle) 9th day after spray, However, standard check (Imidacloprid @ 0.3ml/l) recorded minimum hopper population (2.73 per panicle).

Paria: Among the different treatments of biocontrol agent *M. anisopliae* oil-based formulation @ 1ml/l was found most effective treatment for management of mango hopper and thrips (5.40 & 4.40per panicle) 9th day after spray, However, standard check (Imidacloprid @ 0.3ml/l) recorded minimum hopper and thrips population (2.08 & 1.68 per panicle).

Periyakulam: Among the different treatments of biocontrol agent *M. anisopliae* oil-based formulation @ 1ml/l was found most effective treatment for management of mango hopper (8.32 per panicle) 9th day after spray, However, standard check (Imidacloprid @0.3 ml/l) recorded minimum hopper population (6.24 per panicle).

Vengurle: Among the different treatments of biocontrol agent *M. anisopliae* oil-based formulation @ 1ml/l was found most effective treatment for management of mango hopper and thrips (3.68 & 2.98 per panicle) 9th day after spray, However, standard check (Imidacloprid @ 0.3ml/l) recorded minimum hopper and thrips population 1.03 & 1.80 per panicle).

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.

Rahuri: Among the two modules, module I as per the clusters of chemicals (Imidacloprid + thiamethoxam +NSKE 5%+Dichlorvos /chlorpyriphos injection along with methyl eugenol trap +crop sanitation measures) has recorded significantly minimum population of hoppers (0.93/panicle) and thrips (1.15/panicle) as compared to the module II (1.17 & 2.33/panicle respectively).Similarly the fruit fly infestation was significantly lower (2.45 %) in module I as compared to the (5.20%) Module II (University recommendation).

Pantnagar: The trial is under progress.

Periyakulam: The trial is under progress.

Paria: Among the two modules, module I as per the clusters of chemicals (Imidacloprid + thiamethoxam

+NSKE 5%+Dichlorvos /chlorpyriphos injection along with methyl eugenol trap +crop sanitation measures) has recorded significantly minimum population of hoppers (1.69/panicle) and thrips (2.15/panicle) as compared to the module II (3.02 & 3.38/panicle respectively).

Vengurle: Among the two modules, module I as per the clusters of chemicals (Imidacloprid + thiamethoxam + NSKE 5% + Dichlorvos /chlorpyriphos injection along with methyl eugenol trap + crop sanitation measures) has recorded significantly minimum population of thrips (2.81/panicle) as compared to the module II (3.29/panicle respectively). However, for hoppers and fruit fly infestation no significant difference was recorded between the two modules (Table 122 & 123).

Table-122: Incidence of different pests of mango in different modules at Rahuri

Treatments	Incidence of different foliage pests			Per cent trees recovered	Yield (kg/tree)
	Hopper (Number/ panicle)	Thrips (Number/panicle)	Fruit fly (% fruits infested)	Stem borer (% Recovery)	
T_1 (As per cluster)	0.93 (1.38)#	1.15 (1.45)#	2.45 (8.21)*	79.44 (63.15)*	33.19
T_2 (POP)	1.17 (1.47)	2.33 (1.81)	5.20 (13.14)	77.22 (61.90)	32.15
T_3 (control)	11.02 (3.46)	13.23 (3.76)	15.51 (23.09)	5.45 (12.57)	27.76
CD at 5%	0.22	0.23	2.35	7.15	4.08
Module -I Spraying ofimidacloprid 17.8 SL (0.008%) @ 0.3ml/l of water at panicle initiation followed by thiamethoxam @ 0.32 g/l of water and third need based spraywith NSKE 5% @ 5ml/l of water.1.Installation of methyl eugenol trap @ 10 traps/hectare withhanging of wooden block (5x5x1 cm) in plastic bottle soaked in solution in ratio of 6:4:1 (alcohol: Methyl Eugenol: DDVP) 2.Recommended crop sanitation measures Module II University recommendation					

Table-123: Incidence of different pests of mango in different modules at Vengurle

Treatment	Hopper incidence (No./Panicle)		Thrips incidence No./panicle		% incidence of fruit fly	Yield (kg/tree)
	Precount	7 days after last spray	Precount	7 days after last spray		
T_1	9.13 (3.17)*	0.71 (1.31)*	6.54 (2.74)*	2.81 (1.95)*	0.43 (3.76)**	23.29
T_2	10.07 (3.32)	0.80 (1.34)	6.46 (2.72)	3.29 (2.07)	0.14 (2.14)	22.77
T_3	9.17 (3.18)	7.43 (2.90)	6.44 (2.72)	9.10 (3.18)	11.86 (20.18)	16.26
CD at 5%	NS	0.12	NS	0.18	2.90	1.94
*Indicate square root transformed values. **Indicate arcsine transformed values. *Refer previous table for treatment details						

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: Among the different botanical formulations the treatment T_1 (Azadirachtin 10,000 ppm @ 3 ml/l of water) and Neem soap (IIHR product) @ 10g/l of water were on par for effective management of mango hopper (1.05 & 1.18 /panicle) thrips (3.32 & 3.45/panicle) respectively. However, standard check (chemical spray) has recorded minimum hopper and thrips population (0.68 & 2.45/panicle).

Mohanpur: Among the different botanical formulations the treatment T_5 (Azadirachtin 10,000 ppm @ 3 ml/l of water+Neem soap (IIHR product) @ 10g/l of water + Pongamia soap (IIHR product) @ 10g/l of water) was effective for management of thrips (1.07/panicle) that was on par with standard check (chemical spray) 0.91/panicle. However, for mango hoppers no significant difference was recorded among the botanical formulations.

Pantanagar: Among the different botanical formulations the treatment T_5 (Azadirachtin 10,000 ppm @ 3 ml/l of water + Neem soap (IIHR product) @ 10g/l of water+Pongamia soap (IIHR product) @ 10 g/l of water) was effective for management of mango hoppers (3.00/panicle) that was on par with standard check (chemical spray) 2.75/panicle.

Paria: Among the different botanical formulations the treatment T_1 (Azadirachtin 10,000 ppm @ 3 ml/l of water) was effective for management of mango hoppers and thrips (5.18 & 4.20/panicle). However, standard check (chemical spray) has recorded

minimum hopper and thrips population (4.95 & 3.43/panicle).

Rahuri: Among the different botanical formulations the treatment T_5 (Azadirachtin 10,000 ppm @ 3 ml/l of water + Neem soap (IIHR product) @ 10 g/l of water + Pongamia soap (IIHR product) @ 10g/l of water) was effective for management of mango hopper and thrips (2.84 & 2.96/panicle). However, standard check (chemical spray) has recorded minimum hopper and thrips population (0.96 & 1.03/panicle).

Vengurle: Among the different botanical formulations the treatment T_1 (Azadirachtin 10,000 ppm @ 3 ml/l of water) was effective for management of mango hopper and thrips (0.60 & 3.53/panicle). However, standard check (chemical spray) has recorded minimum hopper and thrips population (0.00 & 0.03/panicle).

5.1.9.M. Management of mango stem borer (*Batocera rufomaculata*) using 'Arka Borer Control'

Anantharajupet: The trial was initiated in the month of January 2021. COC+ monocrotophos was applied as treatment T_2 (standard check). The trial is in initial stage.

Gangian: The trial was commenced in the month of August 2020. The initial results showed infestation of mango stem borer at zero per cent in T_1 (Arka Borer Control) as compared to 1.5 per cent in standard check T_2 (Swabbing of cotton dipped in kerosene and killing grubs with iron wire) and 9.1 per cent in untreated control T_3.

Imphal: Trial was initiated in September 2020. Emamectin benzoate was used at 5 g/litre of water used as standard check in T_2.

Lembucherra: The trial had been initiated in August 2020. The initial results showed T_1 (ABC) was found most effective for management of mango stem borer (3.48 % infestation) as compared to 8.24% in standard check T_2 (Local practice i.e. petrol @4-5ml/l and plastered the whole with mud) and untreated control (15.27%).

Ludhiana: The Trial was initiated in August 2020. The initial results showed zero per cent infestation of mango stem borer in T_1 (ABC) as against 1.3% in standard check T_2 (Swabbing of cotton dipped in kerosene and killing grubs with iron wire) and 8.5% in untreated control T_3.

Malda: The trial was initiated in October 2020. The trial is in initial stage.

Medziphema: The trial was initiated in September 2020. The trial is in initial stage.

Mohanpur: The trial was initiated in July 2020. The initial results showed zero per cent infestation of mango stem borer in T_1 (ABC) as against 1.0% in untreated control T_3.

Neri: The trial was initiated in August 2020. Methyl Parathion, 50EC @ 0.2% was used as standard check in T_2. The initial results showed infestation of mango stem borer as 56.17 per cent in T_1 (ABC) as against 22.47 per cent in standard check and 67.41 per cent in untreated control.

Pantnagar: The trial was initiated in July 2020. Paste of Chloryriphos @1ml + Neem oil @10 ml+ Copper oxy chloride @4 g in 1 litre of water was used as standard check in T_2. The initial results showed treatment T_2 most effective (14.2 % infestation)

Paria: The trial was initiated in June 2020. The trial is in initial stage.

Periyakulam: The trial was initiated in September 2020. Application of carbofuran 3G, 5 g per hole and plug with mud is the practice followed in standard check (T_2). The trial is in progress.

Rahuri: The trial was initiated in August 2020. The infestation level of mango stem borer was zero per cent in the treatment T_1, whereas the infestation was 2.50 and 3.80 per cent in standard check and untreated control, respectively.

Rewa: The trial was initiated in July 2020. The initial results showed minimum infestation 2.03 per cent of mango stem borer in treatment T_1 whereas the infestation was 4.07 per cent in standard check and 7.13 per cent in untreated control after 3 months of ABC application.

Sabour: The trial was initiated in 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. The initial results showed minimum infestation 1.2% of mango stem borer in treatment T_1 whereas the infestation was 1.4 per cent in standard check and 4.3 % in untreated control after 3 months of ABC application.

Sangareddy: The trial was initiated in August 2020. The experiment is in progress.

Udaipur: The trial was initiated in August 2020. The experiment is in progress.

Vengurle: The trial was initiated in August 2020. However, the result was non-significant.

The experiment was not started at Bhubaneswar, Lucknow, New Delhi, Raipur and Yachuli 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, blossom blight (45%), leaf anthracnose (12-18%) sooty mould (23%) and gummosis (16.5%) was recorded during flowering and fruiting season. Whereas, at fruit maturity season 12-15 per cent of powdery mildew was observed.

Bhubaneswar: During flowering and fruiting season powdery mildew (32.5%) and Red rust (22%) disease severity was recorded. In fruit maturity and ripening season malformation severity was upto 12.20 per cent.

Lucknow: Among the major diseases Blossom blight (32.5%), sooty mould (18.5%) was recorded during flowering and fruiting season. However, during fruit maturity shoulder browning (64.0%) and leaf anthracnose (19.2%) was severe.

Malda: Blossom blight (20%), sooty mould (25%), bacterial blight (21.6%) was severe during flowering and fruiting season. However, during fruit maturity sooty mould increased to 31.67%, shoulder browning was 56.67% and stem end rot was 13.3%.

Mohanpur: Among the major diseases, incidence of sooty mould (19.0) was severe during flowering and fruiting season.

Periyakulam: Powdery mildew disease severity was observed to the tune of 27.16 per cent during flowering and fruiting season. However, Sooty mould reached to a severity of 19% during fruit maturity.

Rahuri: Powdery mildew (18.6%) disease severity was recorded during flowering and fruiting season.

Rewa: Among the major disease, malformation disease incidence was 26.6 and sooty mould incidence was 21.7 during flowering and fruiting season. However, during fruit maturity season incidence of anthracnose was recorded upto 33.3.

Sangareddy: Powdery mildew (17.6) incidence was recorded during flowering and fruiting season. Whereas, disease incidence of gummosis (19.2) was recorded in fruit maturity period.

Sabour: Among the major diseases red rust was recorded during flowering and fruiting season with a disease incidence of 18.5

Vengurle: Powdery mildew (26.2%) and blossom blight (16.2%) was recorded during flowering and fruiting season.

6.1.11. M. Integrated management of post-harvest diseases (anthracnose, shoulder browning, stem end rot and Aspergillus rot) of mango fruits

Anantharajupet: Trial is in initial stage.

Bengaluru: Among the different treatments for integrated management of post-harvest diseases, T4 (Difenoconazole+ hot water treatment) recorded minimum PDI for Anthracnose at 10th day (8.5%) as compared to control (untreated) as well as with standard check (Difenoconazole) 42 and 19.1% respectively. However, stem end rot and aspergillus rot showed non-siginificant results.

Lucknow: Among the different treatments for integrated management of post-harvest diseases, T4 (Difenoconazole+ hot water treatment) recorded minimum PDI for Anthracnose at 10th day (8.0%) as compared to control (untreated) as well as with standard check (Difenoconazole) 64 and 16.0% respectively. However, for stem end rot T4 (Difenoconazole+ hot water treatment) and standard check (Difenoconazole) both recorded no post harvest loss. For aspergillus rot no siginificant results were recorded.

Mohanpur: Trial is in initial stage.

Pantnagar: Trial is in initial stage.

Paria: Trial is in initial stage.

Rahuri: Trial is in initial stage.

Rewa: Trial is in initial stage.

Sabour: Trial is in initial stage.

Sangareddy: Among the different treatments for integrated management of post-harvest diseases, T4 (Difenoconazole+ hot water treatment) recorded minimum PDI for Anthracnose and stem end rot at 10th day (8.4 & 2.5%) as compared to control (untreated) as well as with (Difenoconazole) standard check (32.7,18.7 & 8.30,4.98% respectively). However, for *aspergillus* rot T_4 (Difenoconazole+ hot water treatment) and (T_2) hot water control both recorded no post harvest loss.

Vengurle: The results were non-significant for all the three post harvest diseases.

PAPAYA

1.3.4.P. Multilocation testing of new papaya selection (MLT-I)

Anantharajupet: Maximum fruit weight (1.10 kg), fruit yield (28.54 kg/plant & 88.07 t/ha), pulp thickness (3.12 cm) and lowest acidity (0.32%) with medium level PRSV infestation (38.33%) were recorded in Pune selection-1. However, maximum

TSS (12.01° B) with lowest fruit bearing height (78.88 cm) was recorded in cv. Red Lady. 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 (Table 124-130).

Ranchi: Maximum fruit yield (50.40 t/ha) was recorded in Pune Selection-3 with minimum PRSV infection (38.67%) at fruit setting stage. Whereas, maximum TSS was recorded in Red Lady (9.77 °B). Based on overall acceptability the Red Lady was found best due to its red pulp colour.

Coimbatore: The initial observations revealed that the Pune Selection 1 exhibited comparatively high field tolerance to PRSV among the varieties evaluated. However, maximum plant height (1.99 m) and fruits per tree (32.80) was recorded in Pune Selection 3.

Gandevi: Significantly maximum fruit weight (1.28 kg), yield (37.28 kg/pla`nt & 84.51 t/ha), pulp thickness (3.22 cm) and minimum acidity (0.32%) as well as lowest PRSV infestation (33.33%) with medium level were recorded in cv. Pune selection-1. However maximum TSS (9.87°B) was recorded in Red Lady and significantly higher plant height (0.85 m), cavity index (33.75%) as well as lowest fruit bearing height (88.88 cm) was recorded in cv. Madhu Bindu (Local Check).

Malda: The performance of three varieties i.e. PS-1, PS-3 and Pusa Dwarf (Local Check) was evaluated and could not assess the performance of Red Lady cultivar due to less germination of seeds and subsequent mortality after transplanting. Among the three cultivars tested highest number of fruits per tree (40.11), fruit weight (1.09 kg) and yield (95.11 t/ha) was recorded in Pune Selection 1.

Table-124: Fruit yield (kg/plant & t/ha) of papaya selections at different centres

Varieties	Yield (kg/plant)				Yield (t/ha)			
	ANP	Gandevi	Malda	Ranchi	ANP	Gandevi	Malda	Ranchi
Pune Selection-1	28.54	37.28	41.95	22.14	88.07	84.51	95.11	49.82
Pune Selection-3	25.12	34.35	24.87	22.40	77.54	77.88	56.38	50.40
National Check (Red Lady)	27.76	35.45	-	7.18	85.67	80.37	-	16.15
Local Check (Pusa Nanha)	23.81	31.50	31.02	21.05	73.50	71.40	70.31	47.35
CD at 5%	3.12	3.08	N/A	2.92	9.89	7.21	N/A	6.57
ANP:Anantharajupet								

Table-125: Fruit/plant and fruit weight of papaya selections at different centres

Varieties	Fruits/plant				Fruit weight (kg)			
	ANP	Gandevi	Malda	Ranchi	ANP	Gandevi	Malda	Ranchi
Pune Selection-1	25.94	29.78	40.11	21.13	1.10	1.28	1.09	1.35
Pune Selection-3	27.30	36.81	37.78	21.63	0.92	0.95	0.64	1.22
National Check (Red Lady)	31.55	35.11	-	11.43	0.88	1.01	-	0.79
PusaNanha - Local Check	34.01	36.50	38.56	18.04	0.71	0.90	0.91	1.47
CD at 5%	5.83	4.65	N/A	2.30	0.20	0.08	N/A	0.06
ANP:Anantharajupet								

Table-126: Cavity (%) and pulp thickness (cm) of papaya selections at different centres

Varieties	Cavity index (%)				Pulp thickness (cm)			
	ANP	Gandevi	Malda	Ranchi	ANP	Gandevi	Malda	Ranchi
Pune Selection-1	27.54	26.70	33.60	31.86	3.12	3.22	3.18	2.19
Pune Selection-3	29.38	29.45	30.05	32.83	2.82	2.88	2.67	2.30
National Check (Red Lady)	30.26	33.61	-	27.85	3.00	3.00	-	2.01
PusaNanha - Local Check	32.54	33.75	38.42	35.89	2.69	2.74	2.95	2.50
CD at 5%	2.94	2.15	N/A	3.06	0.27	0.14	N/A	0.13
ANP: Anantharajupet								

Table-127: Pulp colour (Red/Yellow/Orange/Pink) and TSS (˚B) of papaya selections at different centres

Varieties	Pulp colour				TSS (˚B)			
	ANP	Gandevi	Malda	Ranchi	ANP	Gandevi	Malda	Ranchi
Pune Selection-1	Yellow	Yellow	Yellow	Yellow	9.72	9.67	10.38	7.89
Pune Selection-3	Yellow	Yellow	Yellow	Yellow	8.14	8.52	10.28	7.94
National Check (Red Lady)	Orange	Red	-	Red	12.01	9.87	-	9.77
Pusa Nanha - Local Check	Yellow	Yellow	Yellow	Yellow	8.54	8.55	10.73	8.96
CD at 5%	-	-	-	-	3.24	0.08	N/A	0.54
ANP: Anantharajupet								

Table-128: Acidity (%) and fruit bearing height (cm) of papaya selections at different centres

Varieties	Acidity (%)				Fruit bearing height (cm)				
	ANP	Gandevi	Malda	Ranchi	ANP	COB	Gandevi	Malda	Ranchi
Pune Selection-1	0.32	0.32	0.38	0.30	110.52	87.93	113.28	57.33	70.88
Pune Selection-3	0.36	0.34	0.41	0.32	106.85	93.18	109.40	68.66	75.57
National Check (Red Lady)	0.32	0.37	-	0.34	78.88	79.31	96.40	-	67.70
Pusa Nanha - Local Check	0.34	0.35	0.32	0.30	89.54	97.24	88.88	44.67	81.80
CD at 5%	NS	0.012	N/A	0.02	13.78	4.79	6.58	9.42	5.44
ANP: Anantharajupet, COB: Coimbatore									

Table-129: Field tolerance to PRSV (High/medium/low/Nil) and PRSV-P infection at fruit setting (%) of papaya selections at different centres

Varieties	Field tolerance to PRSV (High/medium/low/Nil)					PRSV-P infection at fruit setting (%)				
	ANP	COB	GND	Malda	Ranchi	ANP	COB	GND	Malda	Ranchi
Pune Selection-1	Medium	Medium	Medium	Medium	Medium	38.33	30.00	33.33	45.27	41.33
Pune Selection-3	Medium	Medium	Medium	Medium	Medium	39.66	36.67	36.00	52.31	38.67
National Check (Red Lady)	Low	High	High	-	Low	78.56	83.33	82.66	-	76.30
Pusa Nanha - Local Check	High	High	High	Medium	Medium	75.45	64.00	73.33	51.32	57.33
CD at 5%	-	-	-	-	-	35.73	-	-	N/A	4.29
ANP: Anantharajupet, COB: Coimbatore, GND: Gandevi										

Table-130: Sensory evaluation of papaya selections at different centres

Sensory parameters	Varieties	Anantharajupet	Gandevi	Ranchi
Pulp Colour	Pune Selection-1	6.9	5.83	6.4
	Pune Selection-3	6.8	7.00	6.4
	National Check (Red Lady)	9.0	8.67	8.6
	Local Check (Pusa Nanha / TNAU Papaya CO 8)	7.1	6.17	7.2
Flavour	Pune Selection-1	6.8	6.50	6.8
	Pune Selection-3	6.5	7.17	7.0
	National Check (Red Lady)	9.0	8.17	8.2
	Local Check (Pusa Nanha / TNAU Papaya CO 8)	7.4	5.92	7.6
Texture	Pune Selection-1	7.3	7.00	7.4
	Pune Selection-3	7.5	7.33	7.6
	National Check (Red Lady)	8.5	7.83	7.8
	Local Check (Pusa Nanha / TNAU Papaya CO 8)	7.2	6.33	7.4

Sensory parameters	Varieties	Anantharajupet	Gandevi	Ranchi
Taste	Pune Selection-1	6.9	7.00	6.8
	Pune Selection-3	6.8	7.17	6.8
	National Check (Red Lady)	8.8	8.00	8.4
	Local Check (Pusa Nanha / TNAU Papaya CO 8)	7.3	5.50	7.4
Overall acceptability	Pune Selection-1	6.9	6.54	6.85
	Pune Selection-3	6.8	7.17	6.95
	National Check (Red Lady)	9.0	8.13	8.25
	Local Check (Pusa Nanha / TNAU Papaya CO 8)	7.2	5.71	7.40

Note: 9point 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 Ananthrajupet, 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 5thset (March 2020, after 13months 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 and 38.76 per cent was recorded in Module I as against lowest germination of 33.54. 9.53, 9.14 and 6.38 per cent respectively after 13,16,19 and 22 months of storage. The seedling vigour index also followed the same trend of germination.

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 5th set (March 2020, after 13 months of storage) onwards. Module I recorded the highest germination percentage and seedling vigour index compared to Module II from 16 months of storage. The highest germination of 76.57, 80.29, 70.00 and 78.57 per cent was recorded in Module I as against lowest germination of 25.14,23.43,6.57 and 0.00 per cent respectively after 13,16,19 and 22 months of storage. The seedling vigour index also followed the same trend of germination. Significantly highest seedling vigour index of 1164, 1338, 1089 and 1630.43 was recorded during V, VI, VII and VIII set respectively in Module I compared to Module II (1185, 1164, 1246 and 1064) and local practice (343, 252, 97 and 0.00).

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. The module I recorded the highest germination percentage (70.00, 71.43,68.85 and 42.27 respectively after 13,16,19 and 22 months of storage) and vigour index (609.00, 709.05, 565.44 and 532.60) compared to other two modules where the seeds failed to germinate after 16 months of storage in Module III.

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. Seed germination and vigour index were significantly higher in Module II than the Module I and III from 5thset (March, 2020 after 13 months of storage). For all the four sets Module-II recorded highest germination (69.14, 70.29, 71.43 and 60.29) and seedling vigour index (1162,1158,1166 and 800.40) as compared to Module-I and Module-III, which have failed to germinate.

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. Seed germination and vigour index were significantly higher in Module II than the Module I and III from 5thset (March, 2020 after 13 months of storage). For all the four sets Module-II recorded highest germination 65.43, 67.43, 61.71 and 45.14) and seedling vigour index (1144, 551,409 and 64) as compared to Module-I and Module-III except for the 7th set of treatment (Sep., 2020 after 19 months of storage) where the module I was on par with module II.

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: The trial with revised technical programme will be initiated during January – February, 2021.

Coimbatore: The new trial as per revised technical programme has been initiated with the variety, TNAU papaya CO 8 during August, 2020 and the crop is in flowering phase.

Ranchi: The trial with revised technical programme will be initiated during January – February, 2021.

Pune: No significant difference among various treatment combinations for plant height, fruit bearing height, stem girth, fruit length, fruit circumference, cavity index, number of fruits per tree, fruit weight, fruit yield (kg/plant) and TSS except for pulp thickness. Among the treatments, application of 75% of RDF along with AM fungi (50 g/plant) + PSB (25 g/plant) + *Azospirillum* (50 g/plant) + *Trichoderma harzianum* (50g/plant) recorded maximum pulp thickness of 2.80cm in Pune selection 3.

Gandevi: The trial with revised technical programme will be initiated during January – February, 2021.

3.3.3. P. Enhancing the input use efficiency in papaya

The trial was carried out to identify efficient input use technology for improving yield and quality using different components *viz.,* drip system of irrigation, fertigation and mulching in papaya by following five treatments with four replications using RBD design.

Anantharajupet: The third trial was taken up with the variety Red Lady. Raised bed cultivation + drip irrigation (80% ER) + fertigation (75% RDF) + micro nutrient spray $ZnSO_4$ 0.5% + boric acid (0.2%) at alternate months was found to be superior for fruit weight (1.16 kg), number of fruits (52.64), fruit length (17.03 cm), yield (44.45 kg/plant; 135.95 t/ha), TSS (12.43°B) and pulp thickness (3.18 cm) and maximum BC ratio (2.30) compare to control (0.84 kg, 50.91, 14.36 cm, 33.19 kg/plant, 101.44 t/ha 11.74 °B, 2.13 cm and 1.62 respectively).

Coimbatore: The trial was taken up with the variety TNAU papaya CO.8. Among the treatments, fruit yield (68.81 kg/plant & 182.65 t/ha), number of fruits per tree (35.43), pulp thickness (2.85 cm) and TSS (14.38ºB) was maximum in raised bed cultivation + drip irrigation (80% ER) + fertigation (75% RDF) + micro nutrient spray $ZnSO_4$ 0.5% + boric acid (0.2%) at alternate months compare to control (40.23 kg/plant, 107.11 t/ha, 30.70, 2.13 cm, 12.52 ºB respectively).

Pusa: The trial was taken up with the variety Red Lady. Among the treatments imposed, maximum yield (56.78 kg/plant ;155.63 t/ha), number of fruits per plant (30.21), pulp thickness (2.55 cm) and TSS (17.62 ºB) in raised bed cultivation + drip irrigation (80% ER at all stages) + fertigation (75% RDF) + mulching with 100-micron UV stabilized black polyethylene + micronutrient spray (ZnSO4 (0.5%) + boric acid (0.2%) alternate months from second month. Whereas, the treatment T_3 (raised bed cultivation + drip irrigation (80% ER) + fertigation (75% RDF) + micro nutrient spray $ZnSO_4$ 0.5% + boric acid (0.2%) at alternate months recorded minimum cavity index (44.37%) and BC ratio (2.13).

Three trials on enhancing the input use efficiency in papaya have been completed at all the three centres. The results at Anantharajupet and Coimbatore indicated that Raised bed cultivation + Drip irrigation (80% ER) + Fertigation (75% RDF) + micro nutrient spray $ZnSO_4$ 0.5% + boric acid (0.2%) at alternated months (T_3) is the best treatment with highest fruit yield 73.45 kg/plant (190.94 t/ha) and BC ratio (2.97), whereas at Pusa, the treatment T_1 (Raised Bed cultivation + Drip irrigation (80% ER at all stages) + Fertigation (75% RDF) + Mulching with 100-micron UV stabilized black polyethylene + Micronutrient spray {($ZnSO_4$ (0.5%) + Boric acid (0.2%)} alternate months from second month) recorded highest fruit yield 56.78 kg/plant (155.63 t/ha) with BC ratio of 1.85 (Table 131-133).

Table-131: Effect of input treatments on yield parameters of papaya at different centres

Treatments	Yield (kg/plant)			Yield (t/ha)			Fruits/plant			Fruit weight (kg)		
	ANP	COB	Pusa	ANP	COB	Pusa	ANP	COB	Pusa	ANP	COB	Pusa
T_1	42.67	60.47	56.78	130.54	160.67	155.63	52.10	32.22	30.21	1.02	1.91	1.93
T_2	40.91	46.94	46.66	125.15	125.18	139.36	51.72	31.14	27.04	1.00	1.51	1.84
T_3	44.45	68.81	48.69	135.95	182.65	148.76	52.64	35.43	28.83	1.16	2.01	1.88
T_4	37.20	48.18	30.71	113.77	127.93	104.40	51.85	28.58	23.15	1.03	1.71	1.47
T_5	33.19	40.23	26.18	101.44	107.11	100.21	50.91	30.70	18.21	0.84	1.31	1.16
CD at 5%	0.79	10.22	2.38	1.76	26.08	7.14	0.71	3.28	2.26	0.12	0.48	0.18

ANP: Anantharajupet, COB: Coimbatore, Treatment details: T_1: Raised Bed cultivation (RBC) + Drip irrigation (80% ER at all stages) + Fertigation (75% RDF) + Mulching with 100micron UV stabilized black polyethylene + Micronutrient spray {($ZnSO_4$ (0.5%) + Boric acid (0.2%)} alternate months from second month. Prepare separately and mix the micro nutrient solution (MN Spray); T_2: Raised Bed cultivation (RBC) + Drip irrigation (80% ER at all stages) + Fertigation (75% RDF) + Mulching with 100-micron UV stabilized black polyethylene; T_3: Raised Bed cultivation (RBC) + Drip irrigation (80% ER at all stages) + Fertigation (75% RDF) + Micronutrient spray {($ZnSO_4$ (0.5%) + Boric acid (0.2%)} alternate months from second month. Prepare separately and mix the micro nutrient solution (MN Spray); T_4: Raised Bed cultivation (RBC) + Drip irrigation (80% ER at all stages) + Micronutrient spray {($ZnSO_4$ (0.5%) + Boric acid (0.2%)} alternate months from second month. Prepare separately and mix the micro nutrient solution (MN Spray); T_5: Control

Table-132: Effect of input treatments on fruit quality attributes of papaya at different centres

Treatments	Cavity index (%)			Fruit length (cm)			Fruit circumference (cm)			TSS (°B)		
	ANP	COB	Pusa	ANP	COB	Pusa	ANP	COB	Pusa	ANP	COB	Pusa
T_1	28.05	49.07	51.93	16.51	36.25	32.54	45.19	49.09	41.80	12.18	13.77	17.62
T_2	28.68	52.93	54.34	16.03	33.14	31.29	44.53	45.35	40.24	11.98	13.45	15.28
T_3	26.10	41.30	44.37	17.03	37.96	36.43	45.09	51.38	43.62	12.43	14.38	16.09
T_4	29.03	52.10	52.84	14.88	35.37	30.76	43.18	43.65	40.61	11.66	13.12	14.67
T_5	28.96	47.58	53.30	14.36	31.55	31.73	40.71	42.05	40.44	11.74	12.52	14.88
CD at 5%	1.11	7.51	1.27	0.86	2.63	3.75	1.10	1.50	0.26	0.33	0.77	0.14

ANP: Anantharajupet, COB: Coimbatore

For treatment details refer previous table

Table-133: Effect of input treatments on growth and quality attributes of papaya at different centres

Treatments	Pulp thickness (cm)			Plant height (cm)			BC ratio			Days to flowering		
	ANP	COB	Pusa	ANP	COB	Pusa	ANP	COB	Pusa	ANP	COB	Pusa
T_1	3.12	2.28	2.55	239.0	177.8	151.6	1.99	2.32	1.85	142.6	121.9	119.0
T_2	3.01	2.11	2.21	234.9	163.6	143.4	1.93	1.57	1.50	143.4	128.1	121.0
T_3	3.18	2.85	2.22	242.3	179.4	163.3	2.30	2.97	2.13	141.6	123.7	118.0
T_4	2.48	2.29	2.17	218.7	178.2	146.5	1.78	1.80	1.52	145.9	122.9	110.0
T_5	2.10	2.13	2.10	210.9	170.3	137.8	1.62	1.64	1.37	146.9	136.6	125.0
CD at 5%	0.13	0.38	1.29	2.65	3.88	3.72	-	-	-	1.85	NS	3.65

ANP: Anantharajupet, COB: Coimbatore

For treatment details refer previous table

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 *viz.,* temperature (minimum and maximum), rainfall, evapo-transpiration and sunshine hours and analysis of the data on phenology and productivity in relation to weather patterns recorded at different centres are presented herewith. Impact on pest incidence has been furnished under survey results.

Coimbatore: No extreme variation for the weather parameters was observed during the reporting period. 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 74-80 per cent in the existing trials-

Pune: Total precipitation of Pune 1134 mm was much higher than the average rainfall of Pune (763 mm). Large portion (70%) of which (795 mm) was received during the monsoon months (June-September 2020, highlighted figures). Maximum temperature crossed 35°B in April and May 2020 while minimum temperature dropped below 15°C during January and February 2020. Relative humidity (RH) at 08.30 AM was less than 80 per cent from February to May 2020. RH at 05.30 PM was more than 80 per cent during August 2020 and less than 30 per cent during April 2020. Evaporation was more at 17.30 than at 08.30. Average sunshine hours were less than four in July and August 2020. PRSV intensity was the lowest in the line Pune Selection-1 (52%). Among gynodioecious lines, PRSV intensity was the lowest in the line PS-3-1 (47%). Other dioecious and gynodioecious lines also had lower PRSV intensity than that of Red Lady (98%). Highest TSS was recorded in PS-2-1 (9.9°B) and the lowest in PS-2 (7.5°B). Highest keeping quality and the lowest pulp thickness was observed in Red Lady. Keeping quality and the pulp thickness of dioecious lines was lower than that of gynodioecious lines.

Pusa: Though there was no notable deviation from the 30 years average for the current reporting year, the rainfall was 1655 mm when compared to the average of 30 years (564 mm). There was excess of 1090 mm to the average normal.

4.3.2.P. Net house cultivation of papaya

The present study was carried out to compare the performance of papaya as well as PRSV incidence under net house cultivation and open field conditions by using t-test with 5 replications. The data of pooled analysis of the trials (three at Anantharajupet and Gandevi; two at Coimbatore) is presented. At all three locations, plants grown inside the net house are taller along with higher fruiting height and performed better for yield characters than open field cultivation. In addition, it was observed that net house was able to significantly protect the plants from PRSV incidence.

Anantharajupet: Cultivar Red Lady grown under net house condition performed better for yield and quality characters *viz*., number of fruits (62.73), yield (46.11 kg/plant & 140.97 t/ha), fruit weight (1.17 kg), cavity index (26.54%), pulp thickness (3.12 cm) and TSS (12.54^{0}B) when compared to open condition (58.09, 32.26kg/plant, 98.61 t/ha, 0.95kg, 29.72%, 2.94 cm and 11.44^{0}B). The PRSV incidence was observed null in net house condition from early growth stage to till maturity of papaya, while 94.36% incidence was recorded in open field condition (210 days after planting).

Coimbatore: The trial was taken with the variety TNAU Papaya CO 8. The plants grown under net house condition performed better for yield and quality parameters *viz*., number of fruits (80.12), fruit weight (1.44 kg), fruit yield (115.21 kg & 276.64 t/ha), cavity index (23.60%), pulp thickness (2.70 cm) and TSS (13.56^{0}B) when compared to open condition (51.55, 1.21 kg, 62.31 kg/plant, 170.58 t/ha, 20.64%, 2.52 cm and 12.35^{0}B). The PRSV incidence of 95.00% was observed in open condition (210 days after planting) whereas net house cultivation recorded null incidence.

Gandevi: The trial was taken up with the cv. Red Lady. The plants grown under net house recorded maximum number of fruits (46.74), fruit yield (38.78 kg & 87.88 t/ha), cavity index (30.70%), pulp thickness (2.85 cm) and TSS (12.28^{0}B) when compared to open condition (36.27, 38.78 kg/ha, 66.03 t/ha, 2.79 cm and 11.37^{0}B). The PRSV incidence was observed null in net house condition from early growth stage to till maturity of papaya, while 69.67 per cent infestation was reported in open field condition (210 days after planting).

The PRSV incidence could be prevented under net house condition. There was a significant increase in plant height under net house as compared to open conditions and net house condition improved yield and quality parameters in papaya (Table 134-140).

Table-134: Incidence of PRSV (%) under net house and open conditions

Stage of the crop	Coimbatore (CO 8)		Gandevi (Red Lady)		Anantharajupet (Red Lady)	
	Net house (T_1)	Open field (T_2)	Net house (T_1)	Open field (T_2)	Net house (T_1)	Open field (T_2)
30 DAP	0.00	4.73	0.00	0.00	0.00	5.50
60 DAP	0.00	27.40	0.00	1.33	0.00	18.00
90 DAP	0.00	41.62	0.00	11.00	0.00	41.33
120 DAP	0.00	55.55	0.00	21.67	0.00	55.66
150 DAP	0.00	66.66	0.00	34.67	0.00	72.33

180 DAP	0.00	80.34	0.00	51.67	0.00	85.03
210 DAP	0.00	94.36	0.00	69.67	0.00	95.00
t-test value	-	-	-	-	-	-

Table-135: Performance of papaya on yield attributes at different centres

Treatments	Yield (kg/plant)			Yield (t/ha)			Fruits/plant		
	ANP	COB	GND	ANP	COB	GND	ANP	COB	GND
T_1: Net house	46.11	115.21	38.78	140.97	276.64	87.88	62.73	80.12	46.74
T_2: Open field	32.26	62.31	29.12	98.61	170.58	66.03	58.09	51.55	36.27
t-test value	18.06	15.55	9.34	18.43	2.23	9.35	7.40	3.29	9.23
ANP: Anantharajupet, COB: Coimbatore, GND: Gandevi									

Table-136: Performance of papaya on yield attributes at different centres

Treatments	Fruit weight (kg)			Total number of marketable fruits			Total number of unmarketable fruits		
	ANP	COB	GND	ANP	COB	GND	ANP	COB	GND
T_1: Net house	1.17	1.44	0.84	39.35	77.12	42.74	22.67	3.00	4.00
T_2: Open field	0.95	1.21	0.81	33.60	42.92	29.27	25.09	8.63	7.00
t-test value	7.88	1.45	1.26	10.74	38.40	-	6.16	-6.20	-
ANP: Anantharajupet, COB: Coimbatore, GND: Gandevi									

Table-137: Performance of papaya on quality attributes at different centres

Treatments	Cavity index (%)			Pulp thickness (cm)			Pulp colour (Red/Yellow/Orange/ Pink)		
	ANP	COB	GND	ANP	COB	GND	ANP	COB	GND
T_1: Net house	26.54	23.60	30.70	3.12	2.70	2.85	Orange	Red	Red
T_2: Open field	29.72	20.64	30.98	2.94	2.52	2.79	Orange	Red	Red
t-test value	-3.21	11.28	0.311	0.98	0.88	1.46	-	-	-
ANP: Anantharajupet, COB: Coimbatore, GND: Gandevi									

Table-138: Performance of papaya on quality attributes at different centres

Treatments	Ascorbic acid (mg/g)			TSS (°B)			Acidity (%)		
	ANP	COB	GND	ANP	COB	GND	ANP	COB	GND
T_1: Net house	-	0.55	-	12.54	13.56	12.28	0.28	0.25	0.30
T_2: Open field	-	0.51	-	11.44	12.35	11.37	0.39	0.37	0.37
t-test value	-	2.30	-	9.37	1.84	2.48	-6.31	-11.33	5.84
ANP: Anantharajupet, COB: Coimbatore, GND: Gandevi									

Table-139: Performance of papaya on growth attributes at different centres

Treatments	Fruit bearing height (cm)			Plant height (m)			Stem girth (cm)		
	ANP	COB	GND	ANP	COB	GND	ANP	COB	GND
T_1: Net house	72.61	138.70	101.88	2.27	2.42	1.53	37.12	32.59	36.41
T_2: Open field	71.05	88.20	75.49	1.96	1.34	1.18	33.25	28.94	34.94
t-test value	2.09	6.40	6.90	8.30	9.64	3.61	4.14	20.01	0.72
ANP: Anantharajupet, COB: Coimbatore, GND: Gandevi									

Table-140: Status of pest population and economics at different centres

Treatments	Average aphid population			B:C		
	ANP	COB	GND	ANP	COB	GND
T_1: Net house	Nil	Nil	-	1.36	1.85	1.69
T_2: Open field	6.12	6.11	-	1.78	2.45	3.38
t-test value	-	-	-	-	-	-
ANP: Anantharajupet, COB: Coimbatore, GND: Gandevi						

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, no new disease was recorded. Among fungal diseases collar rot (5-15%) and fruit rot (10-15%) were recorded. Powdery mildew disease was also observed but incidence was very low (1%). Among viral diseases, PRSV incidence ranged between 45-100 per cent in cv Read lady. Papaya leaf curl virus incidence varied from 1-20%.

Coimbatore: Incidence of papaya ring spot virus, *Phytophthora* rot, *Cercospora* leaf spot and bacterial crown rot incidence was observed in Coimbatore and Erode districts, which were already reported. In all the places irrespective of variety, PRSV incidence ranged from 20 to 90 per cent. Papaya leaf curl incidence varied between 5 and 10 per cent in cv Red lady in Karapadji of Erode district. *Cercospora* leaf spot intensity ranged from 5 to 26 PDI and it was observed in cv CO 8 and Red Lady during October to December. *Phytophthora* rot (5-10%), Bacterial crown rot (5-10%) and Black leaf spot (5-20%) were also recorded in CO 8. Black leaf spot of Papaya was observed in Coimbatore district with 5 to 10 per cent incidence and 5 per cent incidence in Erode district. Isolation of causal agent was carried out. Pathogenicity test was confirmed.

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. Highest incidence was observed in case of root rot (20-85%) while fruit rot and collar rot showed 2-10 per cent and 10-18 per cent incidence respectively in area under survey. The black leaf spot disease was first time observed in the agro-ecological condition of Bihar because of frequent rain and high humidity in the month of August and September 2020. Bacterial crown rot was also recorded in Gorakhpur, UP with a 2 per cent incidence. The incidence of PRSV was found between 60 to 100 per cent, while leaf curl showed less than 1-2 per cent incidence only. Fruit rot, root rot, PRSV and leaf curl showed no change trend whereas collar rot showed an increasing trend in comparison to previous year (Table 141 & 142).

Table-141: 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	5-15 (10-15)	0-5 (1.0)	4-6 (5-6)	2-8 (2-5)
Fruit rot	10-15 (10-15)	-	6-9 (6-9)	10-15 (2-10)
Root rot	-	-	-	30-85 (20-85)
Cercospora leaf spot (PDI)	-	10-26 (20-23)	-	-
Bacterial crown rot (PDI)	-	5/2-5	-	
Powdery mildew	1 (2-5)	-	-	
PRSV	45-100 (100)	20-90 (60-90)	85-90 (91-100)	70-100 (80-100)
Leaf curl	1-20 (10-20)	5-10 (1.0)	-	1-2 (0-1)

Table-142: Changing scenario of different papaya diseases at national level during reporting period over previous year

Name of disease	Number of centre(s)	Increase	Decrease	No change
Collar rot	4	Coimbatore	Anantharajupet	Gandevi and Pusa
Fruit rot	3	Pusa		Anantharajupet and Gandevi
Root rot	1	Pusa	-	-
Cercospora leaf spot	1	Coimbatore	-	-
PRSV	4		Anantharajupet, Gandevi Coimbatore and Pusa	-
Leaf curl	3	Coimbatore	-	Anantharajupet and Pusa

SAPOTA

3.4.3.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.

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, IIHRS-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 planting was done during August to September, 2017. The plants are in vegetative stage Maximum plant height was recorded in DHS 2/1 (1.57 m).

Kovvur: The plants are in vegetative stage.

Gandevi: New hybrid grafts were prepared and planted during June-July, 2017. The plants are in vegetative stage. Maximum canopy volume was recorded in IIHR-63 (4.94 m^3).

Periyakulam: All the four varieties were planted in the main field during September, 2017. The plants are in vegetative stage.

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 6m 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. Pruning treatments are imposed on trees at 6 X 6 m. Maximum yield (10.9 t/ha) was recorded in treatment T_{12} (6 X 6 m) with 2.0 m gap which is at par with treatment T_{11}(6 X 6 m) with 1.5 m gap and T_{10} (6 X 6 m) with 1.0 m gap (Table 143).

Gandevi: The variety used for the trial is Kalipatti. Trees are in pre bearing stage. Maximum yield of 2.4 t/ha was recorded in treatment T_{12} (6 X 6 m) with 2.0 m which is at par with T_{10} (6 X 6 m) with1.0 m gap.

Kovvur: The variety used for the trial is Kalipatti. Maximum fruit yield (6.0 t/ha) and number of fruits (329.8) were observed in treatment T_{10} (6 X 6 m) with 1.0 m gap (Table 143). Pruning treatments were imposed in 6 X 6 m spaced trees. Based on the number of trees per hectare maximum yield was observed in 6 X 6m spaced trees pruned to a gap of 1m between the tree canopy.

Periyakulam: The variety PKM-1 spaced at 6 X 6 m with 1.0 m gap recorded maximum yield of 16.9 t/ha which is at par with treatment T_{11} (6 X 6) with 1.5 m gap (15.5 t/ha).

Table-143: 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	733.3	55.4	276.7	1046.5	6.4	0.4	2.0	8.9
T_2 (10 X10m) 1.5m	713.0	70.7	313.3	956.4	6.0	0.5	2.4	8.3
T_3 (10 X10m) 2.0 m	774.7	53.0	248.4	915.1	6.8	0.4	1.7	8.0
T_4 (8 X 8m) 1.0 m	667.3	79.8	253.3	855.1	8.4	0.8	2.8	11.2
T_5 (8 X 8m)1.5 m	617.3	80.5	255.4	835.1	7.6	0.8	2.8	10.9
T_6 (8 X 8m) 2.0 m	653.3	87.7	246.7	859.1	8.1	0.9	2.8	11.3
T_7 (8 X 6 m) 1.0 m	464.7	128.7	285.5	874.6	7.3	1.9	4.1	15.2
T_8 (8 X 6 m) 1.5 m	469.7	146.7	313.0	788.2	7.4	2.2	4.4	13.5
T_9 (8 X 6 m) 2.0 m	512.0	76.7	286.0	706.1	8.3	1.0	4.3	12.1
T_{10} (6 X 6 m) 1.0 m	462.7	130.3	329.8	756.1	9.9	2.4	6.0	16.9
T_{11} (6 X 6 m) 1.5 m	506.3	87.7	282.8	696.1	10.5	1.8	5.1	15.5
T_{12} (6 X 6 m) 2.0 m	505.0	113.8	228.6	644.1	10.9	2.4	4.8	14.4
CD at 5%	80.1	26.1	68.9	2.0	1.5	0.3	1.1	1.4

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: Center opening along with cutting of cross branches in 10 x 10 m spaced trees have recorded (Table 144) maximum yield (67.09 kg/tree with 896 fruits/tree having 76.20 g fruit weight) on 43 years old sapota cv. Cricket ball over control (48.65 kg yield /tree with 690 fruits/tree having 72.30 g fruit weight).

Gandevi: Topping terminal growth of 1.0m has recorded maximum light penetration beneath the canopy (1030 lux), yield/tree (170 kg/tree with 2040 fruits/tree having 83.00 g fruit weight) on 45 years old sapota cv. Kalipatti (10 x 10 m spacing) over control (115 kg yield/tree with 1555 fruits/tree having 74.00 g fruit weight) (Table 144).

Periyakulam: Center opening along with cutting of cross branches at 10x10 m spacing has recorded maximum light penetration beneath the canopy (1052 lux), yield (274.94 kg/tree with 3355 fruits/tree having 82.16 g fruit weight) on 38 years old sapota cv. PKM-1 over topping terminal growth of 1.0 m (194.5 kg yield/tree with 2501 fruits/tree having 77.50 g fruit weight) (Table 144).

Table-144: 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_1	-	769	825	857.6	1807	2530	61.51	150.1	203.3	73.08	83.00	80.20
T_2	-	1030	943	851.6	2040	2501	60.56	170.0	194.5	72.48	83.00	77.50
T_3	-	967	1052	896.0	1812	3355	67.09	138.3	274.9	76.20	76.00	82.15
T_4	-	541	961	690.6	1555	2553	48.65	115.0	203.6	72.30	74.00	79.60
CD at 5%	-	107	109	27	127	76	2.34	11.84	10.26	1.41	3.12	2.280

Arabhavi (Cricket Ball), Gandevi (Kalipatti), Periyakulam (PKM-1)

*T_1: Topping Terminal Growth of 0.5 m; T_2: Topping Terminal Growth of 1.0 m; T_3: Center opening along with cutting of cross branches; T_4: Control.

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 (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 *viz.*, (i) application of 1/12th RDF for 12 years (A_1), (ii) application of 1/10th RDF for 10 years (A_2) and (iii) application of 1/8th RDF for 8 years (A_3) as well as three age wise doses of nutrients *viz.*, 100% RDF after 12 years (B_1), 80% RDF after 10 years (B_2) and 60% RDF after 8 years (B_3) in factorial randomized block design with three replications having 4 plants in each treatments.

Arabhavi: The experiment was initiated in 2008 with cv. Kalipatti. Maximum yield (79.87 kg/tree), number of fruits (993.7) and fruit weight of 82.67 g was recorded with 1/8th RDF with 100 per cent application to 12 years old trees (Table 145 & 146).

Gandevi: The experiment was initiated in 2011 with cv. Kalipatti. Maximum yield (9.72 kg/tree) and number of fruits (159.2) was recorded with application of 1/10th RDF for 10 years (Table 145 & 146).

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. Higher yield (102.0 kg/tree) and number of fruits (1194) with fruit weight of 88.39 g were recorded with application of 1/8th RDF for 8 years with 100% application to 14 years old trees (Table 145 & 146).

Table-145: Effect of residual and cumulative nutrient on yield parameters of sapota

Treatment	Fruits/ tree				Yield (kg/tree)			
	ARB	GND	KVR	PKM	ARB	GND	KVR	PKM
T_1 : A_1B_1	865.3	99.33	160.7	1084	60.71	7.05	11.63	89.97
T_2 : A_1B_2	858.0	66.50	501.3	913.7	61.39	4.84	25.40	74.58
T_3 : A_1B_3	872.3	94.67	333.0	815.0	62.93	6.64	25.13	65.00
T_4 : A_2B_1	954.3	134.8	227.7	1042	69.32	9.09	14.90	84.99
T_5 : A_2B_2	945.3	159.2	136.3	989.6	69.58	9.72	10.26	78.62
T_6 : A_2B_3	962.7	95.33	103.5	875.6	71.29	6.11	9.26	69.98
T_7 : A_3B_1	993.7	107.8	188.3	1194	79.87	8.09	10.63	102.0
T_8 : A_3B_2	956.3	87.67	148.0	946.2	73.08	6.11	8.90	76.91
T_9 : A_3B_3	895.7	134.8	117.6	865.2	63.73	8.71	9.60	65.28
CD at 5%	42.73	16.42	NS	35.92	4.41	1.28	NS	3.26
# ARB: Arabhavi (Kalipatti – 10x10 m), GND: Gandevi (Kalipatti – 10x10 m), KVR: Kovvur (Kalipatti – 10x10 m) and PKM: Periyakulam (PKM1- 8x8 m)								

Table-146: Effect of residual and cumulative nutrient on yield parameters of sapota

Treatment	Fruit weight (g)			
	Arabhavi	Gandevi	Kovvur	Periyakulam
T_1 : A_1B_1	72.67	70.84	72.31	85.68
T_2 : A_1B_2	74.00	73.00	51.26	83.92
T_3 : A_1B_3	74.67	70.85	79.63	82.79
T_4 : A_2B_1	75.00	67.02	91.78	83.97
T_5 : A_2B_2	76.00	61.18	90.59	81.12
T_6 : A_2B_3	76.33	64.13	90.45	83.39
T_7 : A_3B_1	82.67	74.55	59.40	88.39
T_8 : A_3B_2	78.67	69.89	64.00	83.86
T_9 : A_3B_3	73.67	64.44	77.91	77.43
CD at 5%	2.33	4.02	NS	2.74
# ARB: Arabhavi (Kalipatti – 10 x 10 m), GND: Gandevi (Kalipatti – 10 x 10 m), KVR: Kovvur (Kalipatti – 10 x 10 m) and PKM: Periyakulam (PKM1- 8 x 8 m)				

3.4.4.S. Standardization of stage wise requirement of nutrients in sapota

The trial was laid out in RBD replicated three times with five treatments. In all treatments 80% of RDF given through fertigation and the rest of the 20% is compensated through vermicompost, micronutrient sprays and biofertilizers. The trial was implemented from 2015-16 and to be concluded by 2019-20.

Per cent nutrients of RDF					Common dose
Treatments	Stages of crop growth				
	I Vegetative flush (July)	II Fruit set (September)	III Fruit growth (November)	IV Fruit growth (February)	*15 kg vermicompost per tree in July+Micronutrient spray in October (Zn-0.6%, Fe-0.4%, Mn-0.2%, Cu-0.2%, B-0.2%) +Azotobacter 100g and PSB 100g per tree (10^8cfu/g)
	N-P-K	N-P-K	N-P-K	N-P-K	
T_1	32-40-20	16-0-20	16-40-20	16-0-20	
T_2	20-40-32	20-0-16	20-40-16	20-0-16	
T_3	20-80-20	20-0-20	20-0-20	20-0-20	
T_4	20-40-20	20-0-20	20-40-20	20-0-20	
T_5 (Control)	50-100-50	25-0-25	25-0-25	0-0-0	
For Kovvur centre (RDF= 400:150:450g N: P: K per plant per year) For Gandevi: 1000:500:500 g N: P_2O_5: K_2O per tree per year Variety: Kovvur, Arabhavi, Gandevi (Kalipatti), and Periyakulam (PKM-1)					

Arabhavi: Application of 80% RDF through drip in proportioned NPK ratio of 20-80-20, 20:00:20, 20:00:20 and 20:00:20 with 15 kg vermicompost, micronutrient spray and biofertilizer during the months of July, September, November and February (T_3) recorded significantly higher yield (126.8 kg/tree), fruits per tree (1556.25), TSS (24.5°B) and BC ratio (3.42) and the same treatment recorded maximum fruit yield (8.79 t/ha) and fruits per tree (1076.75) during winter crop.

Gandevi: Significantly maximum fruit yield (199.4 kg/tree & 19.94 t/ha), fruits per tree (2500), TSS (22.44 °B) and BC ratio (4.78) was recorded when sapota trees were applied with 80 per cent RDF with NPK in the ratio of 32-40-20, 16-0-20, 16-40-20 and 16-0-20 during July, September, November and February respectively (T_1). The same treatment recorded maximum fruit yield (16.67 t/ha) and fruits per tree (2107) during winter crop (Fig 24).

Kovvur: Application of 80 per cent RDF with NPK in the ratio of 32-40-20, 16-0-20, 16-40-20 and 16-0-20 during July, September, November and February respectively along with 15 kg of vermicompost, micronutrient spray and biofertilizer application (T_1) recorded significant maximum fruit yield (203.65 kg/tree and 20.36 t/ha), fruits/tree (2315) and BC ratio of 3.39 (Table 147-151).

Periyakulam: Application of N-P_2O_5-K_2O in the ratio of 32-40-20, 16-0-20, 16-40-20 and 16-0-20 of 80% RDF during July, Sept, November and February respectively along with 15 kg vermicompost, micronutrient spray and biofertilizer application (T_1) recorded significant maximum fruit yield (181.32 kg/tree and 28.3 t/ha), fruits/tree (2188), higher TSS (22.56 °B) and shelf life (7.72 days) along with BC ratio of 3.86 (Table 147-151).

Table-147: Effect of stage wise nutrient application on growth and yield parameters of sapota at different centres

Treatment	Canopy volume (m^3)				Yield (kg/tree)			
	Arabhavi (Kalipatti)	Kovvur (Kalipatti)	PKM (PKM-1)	Gandevi (Kalipatti)	Arabhavi (Kalipatti)	Kovvur (Kalipatti)	PKM (PKM-1)	Gandevi (Kalipatti)
T_1	127.96	573.16	391.86	367.75	111.84	203.65	181.32	199.4
T_2	149.81	544.57	380.86	337.25	117.48	171.17	172.08	170.4
T_3	151.58	572.30	291.76	324.75	126.80	166.02	154.38	185.5
T_4	137.88	653.45	352.98	338.5	123.84	193.82	165.46	168.5
T_5	131.80	540.21	303.76	335	106.64	162.65	158.67	156.4
CD at 5%	13.34	NS	1.78	18.27	8.88	26.85	6.96	13.11
*Refer methodology for treatment details, PKM: Periyakulam								

Table-148: Effect of stage wise nutrient application on yield parameters of sapota at different centres

Treatment	Yield (t/ha)				Fruits/tree			
	Arabhavi (Kalipatti)	Kovvur (Kalipatti)	PKM (PKM-1)	Gandevi (Kalipatti)	Arabhavi (Kalipatti)	Kovvur (Kalipatti)	PKM (PKM-1)	Gandevi (Kalipatti)
T_1	11.18	20.36	28.30	19.94	1464.50	2315	2188	2500
T_2	11.75	17.11	26.88	17.04	1496.00	1838	2133	2391
T_3	12.68	16.60	24.12	18.55	1556.25	1620	1958	2437
T_4	12.38	19.38	25.83	16.85	1543.50	2026	2067	2276
T_5	10.66	16.26	24.46	15.64	1402.75	1629	2031	2207
CD at 5%	0.89	2.68	1.78	1.31	49.61	221.55	87.7	125.5
*Refer methodology for treatment details, PKM: Periyakulam								

Table-149: Effect of stage wise nutrient application on yield and quality parameters of sapota at different centres

Treatment	Fruit weight (g)				TSS (°B)			
	Arabhavi (Kalipatti)	Kovvur (Kalipatti)	Periyakulam (PKM-1)	Gandevi (Kalipatti)	Arabhavi (Kalipatti)	Kovvur (Kalipatti)	Periyakulam (PKM-1)	Gandevi (Kalipatti)
T_1	74.26	89.17	85.35	79.75	24.08	16.85	22.56	22.44
T_2	76.73	93.45	83.06	71.23	23.63	17.82	22.26	21.58
T_3	80.45	101.40	81.20	76.11	24.50	22.02	20.45	20.72
T_4	79.03	96.35	82.46	74.07	23.85	21.35	22.00	22.04
T_5	73.55	98.82	79.51	70.85	22.78	19.72	21.02	21.10
CD at 5%	3.83	NS	3.29	4.48	0.72	2.55	1.06	NS
*Refer methodology for treatment details								

Table-150: Effect of stage wise nutrient application on yield and yield parameters of summer crop in Sapota at different centres

Treatment	Yield (t/ha)				Fruits/tree			
	Arabhavi (Kalipatti)	Kovvur (Kalipatti)	PKM (PKM-1)	Gandevi (Kalipatti)	Arabhavi (Kalipatti)	Kovvur (Kalipatti)	PKM (PKM-1)	Gandevi (Kalipatti)
T_1	3.72	14.72	21.32	3.266	486.75	1685	1564	391.6
T_2	4.04	11.37	19.72	3.660	515.25	1223	1437	459.6
T_3	3.89	9.95	15.67	3.386	479.50	982	1267	407.8
T_4	3.83	12.23	16.14	3.271	478.75	1292	1260	403.2
T_5	3.63	10	14.76	3.795	476.25	949	1203	463.6
CD at 5%	0.07	1.19	1.63	0.2	27.23	162.04	182.97	23.15
*Refer methodology for treatment details, PKM: Periyakulam								

Table-151: Effect of stage wise nutrient application on yield and yield parameters of winter crop in sapota at different centres

Treatment	Yield (t/ha)				Fruits/tree			
	Arabhavi (Kalipatti)	Kovvur (Kalipatti)	PKM (PKM-1)	Gandevi (Kalipatti)	Arabhavi (Kalipatti)	Kovvur (Kalipatti)	PKM (PKM-1)	Gandevi (Kalipatti)
T_1	7.46	5.64	6.97	16.67	977.75	630	623.58	2109
T_2	7.71	5.74	7.15	13.38	980.75	615	695.78	1932
T_3	8.79	6.64	8.44	15.16	1076.75	637	690.19	2029
T_4	8.55	7.14	9.68	13.58	1064.75	734	806.13	1873
T_5	7.03	6.26	9.69	11.99	926.50	680	827.63	1744
CD at 5%	0.12	NS	7.03	1.471	26.81	NS	7.2	105.45
*Refer methodology for treatment details, PKM: Periyakulam								

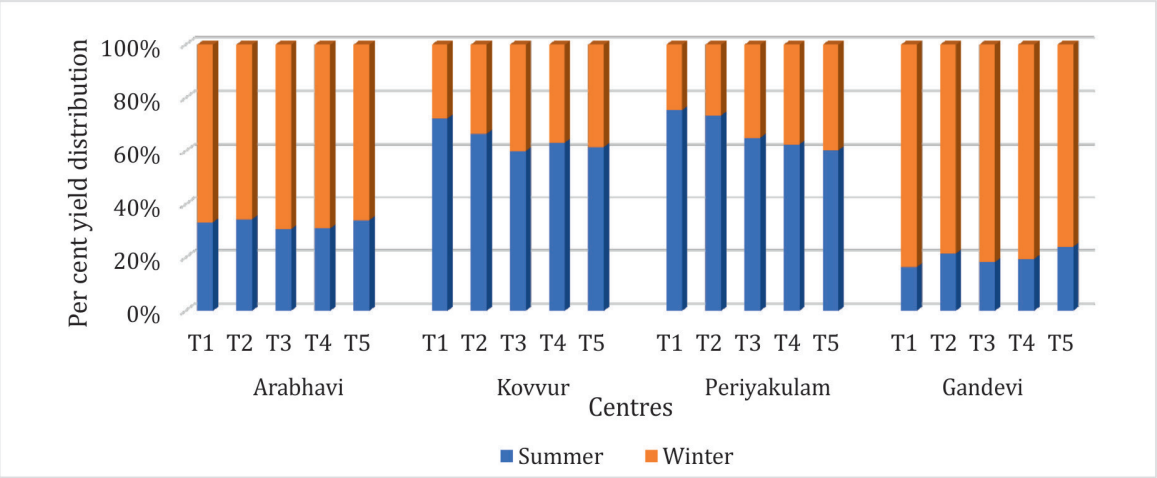


Fig. 24: Effect of stage wise nutrient application on per cent yield distribution of summer and winter crop in sapota at different centres

4.4.1.S. Assessment of phenology, productivity and incidence of insect pests and diseases in sapota grown under varying climatic conditions

The trial has been started with collection and analysis of the past weather data, mainly temperature (minimum& maximum), rainfall, evapo-transpiration and sunshine hours, and analysis of the data on phenology and productivity in relation to the recorded weather patterns and long-term data source.

Arabhavi: Three main vegetative flush and flowering was observed during Feb-Mar, Oct-Nov and Dec-Jan 2020 in the sapota crop which was planted during 1995-96 and started yielding since 1999-2000. It was observed that the emergence of new flush and flowering was affected compared to normal situation. The maximum temperature was 42.88°C in May, 2020 and the minimum temperature is 11.95°C in June, 2020. Regarding pest incidence, the leaf webber was maximum (3.00%) during September, 2020. The least incidence of 1.00 % was observed during

December in 2019 and May, 2020. The budworm incidence was maximum (3.50%) in April, 2020. The maximum incidence of bark eating caterpillar was 2.10%, during August, 2020. The occurrence of ash weevil was also noticed which was maximum (2.00%) during August, 2020. The fruit fly incidence was maximum (4.00%) during August, 2020. The incidence of bud worm and fruit fly was observed maximum compared to other pests during the reporting period. With regard to diseases, *Phaeophleospora* leaf spot PDI was maximum in October 2019 (25.50). The least incidence was noticed in May, 2020 (2.33).

Gandevi: The maximum new flush emergence and flowering (59.44%) was found during December, 2019 and later during March, 2020 (61.11%). No flowering was observed during August month. There was no extreme weather conditions occurred during flowering and fruiting stages of the tree. Average max. temp. range was noted between 26.2 to 33.8°C during reporting period, while min. temp. ranged between 16.0 to 26.8°C during Oct. 2019 to September, 2020. The peak rainfall was counted October, 2019 and June to September months during 2020 and total 2270 mm rainfall noted during the cropping period. The incidence of insect pests and diseases were observed similar as normal weather conditions. During flowering, bud borer and chiku moth incidence showed increasing trend from March to June, 2020 (>10%) as well as chiku moth also caused more damage during December, 2019 and April-May, 2020 (>10%). Similarly, midrib folder incidence was found moderate between November-December, 2019 and low (<10%) in remaining months. The seed borer fruit damage was found high in the month of Dec., 2019 at early fruiting stage and during the period of Feb.-April, 2020 at advance fruiting stage. Among diseases, leaf spot incidence was found low on sapota. No new insect pest or diseases and outbreak were reported on sapota crop.

Kovvur: The highest new flush emergence and flowering (55% was recorded during July 2020 followed by in November 2019 (50%). No new emergence and flowering were recorded in April, May and September 2020. also, there was no extreme weather conditions occurred during flowering and fruiting stages of the tree. Average max. temp. range was recorded from 30.6 (January, 2020) to 39.3°C (May, 2020) while min. temp. ranged from 22.2 (January, 2020) to 27.9°C (June 2020). The peak rainfall was received during July 2020 and total of 1765.5 mm rainfall recorded during the reporting period. during summer crop that is harvested from March to July, the TSS recorded was 22.4°B and during winter it was 19.8°B. Similarly, shelf life was 4-6 days during summer and 5-7 days during winter crop kept at room temperature. However, the acidity was 0.138 % and 0.184 % during winter and summer crop respectively. The incidence of insect pests and diseases observed were below the threshold levels except rugose whitefly which is 5-10 per cent during October 2019 to December 2019. Later the rugose whitefly was subsided to zero. Fruit borer to the tent of 5 per cent and leaf folder 5-10 per cent was recorded during the March-April, 2020 and August–September, 2020 respectively.

Periyakulam: Maximum flowering percentage was observed during April (49.54%) followed by May (35.23%) and the emergence of new flushes was in February (66.95%) followed by January (47.66%). The insect pest incidence showed that the sapota leaf midrib borer damage was noticed to the extent of 1.38 per cent. The bud borer damage was observed up to 10.56 per cent. The sapota leaf spot was noticed up to 3.51 per cent and shooty mould damage was observed up to 8.23 per cent. During the year 2020, the sapota chiku moth damage was observed with 9.24 per cent and it was higher during the months of April and September 2020.

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 was 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 (Table 152-154).

Gandevi: Fixed plot survey results indicated that major pests were reported on sapota throughout the year in more or less intensity. The bud borer caused peak bud damage during main flowering stage in March to June (11.90-18.67%) and then declined towards monsoon from July onwards (<10%). The chiku moth showed moderate bud infestation in December 2019 (12.44%) at new foliage ad fruiting stage as well as in May, 2020 (20.51%) at peak flowering flush. The midrib folder peak infestation was observed in December 2019 (11.85%) as well as in May, 2020 (11.77%) at new foliage flush and in other months recorded <10% leaf damage. During initial fruiting phase from October onwards, seed borer showed infestation up to 9.00-11.00% fruit

damage in December 2019 and retrieved again up to 12.00-16.00% between Feb.-April, 2020 at advanced stage of fruiting and then declined. The fruit damage due to fruit borer and fruit fly was recorded to be slightly increasing (5-8%) during April to May, 2020. The damage due to leaf miner, mite and mealy bug was recorded at low level (<3%) and infrequently during 2019-20. Among natural predators, dragonfly, damselfly and lady bird beetles were observed in sapota.

The overall succession of major insect pests of sapota indicated that there were two main phases of pest infestation in orchard. First phase comprising initiation of foliage and fruiting stage during October onwards was vulnerable for seed borer, chiku moth and midrib folder. During flowering season from March onwards, second phase started with increased invasion of bud borer, chiku moth and seed borer damage.

Periyakulam: The major sapota growing areas in Tamil Nadu was surveyed for the identification of emerging pest and natural enemies in sapota ecosystem. This was done once in each season viz., October - December, January – March, April - June and July - September. The sapota leaf webber damage was noticed to the extent of 17.24%; bud borer damage was observed up to 10.56% whereas seed borer incidence was low (7.86%). Once in 15 days, observation was recorded on the infestation of major insect pests of sapota on 20 randomly selected trees. During the year 2020, the sapota chiku moth damage ranged from 14.72 to 23.58%. More than 20% damage was recorded from June II fortnight to September II fortnight. Bud borer damage was severe (11.05 to 13.26%) during May to August. Fruit infestation by seed borer was high (8.24%) during July 2020. Leaf twisting, mealy bug and fruit borer damage were very low.

Table-152: Status of sapota insect pest incidence at different centres under roving survey

Insect pest	Infestation (%)			
	Gandevi		Periyakulam	
	Past incidence reported	Current status	Past incidence reported	Current status
New and Emerging pest	Nil	-	Nil	-
Bud borer [*Anarsia achrasella* Bradley] (bud damage)	18-22	18-22	11.20	10.56
Chiku moth [*Nephopteryz eugraphella* (Ragonot)] (bud damage)	15-18	20-23	17.55	17.24
Seed borer [*Trymalitis margarias* Meyrick] (fruit damage)	15-18	14-16	8.17	7.86
Fruit fly [*Bactrocera dorsalis, B. zonata* and *B. correcta*] (fruit damage)	4-7	5-10	1.65	2.05
Midrib folder [*Banisia myrsusales elearalis* (Walker)] (leaf damage)	15-18	16-20	1.75	1.38

Table-153: Peak activity of various insect pests of sapota at different centres

Common and Scientific name of insect pest	Level of insect pest's infestation (%)	
	Gandevi	Periyakulam
Bud borer [*Anarsia achrasella* Bradley]	Higher during March to May (11.90-18.67% in main flowering stage)	Severe during May to August (11.05 -13.26%)
Chiku moth [*Nephopteryz eugraphella* (Ragonot)]	Higher bud damage in December (12.44% during new flowering) and May (20.51% in at new flowering and foliage flush)	High infestation during April – Sept. (14.72 to 23.72%)
Seed borer [*Trymalitis margarias* Meyrick]	Higher fruit damage in December (0-11.00%) and Feb.-April (12.00-16.00% at fruiting stage)	High fruit infestation during July 2020 (8.24%).
Fruit fly [*Bactrocera dorsalis, B. zonata and B. correcta*]	Fruit damage of 5-8% during April-May.	-
Midrib folder [*Banisia myrsusales elearalis* (Walker)]	Peak leaf infestation in December. (11.85%) and May (11.77%) at new foliage flush	Peak infestation during March to June 2020 (1.15 to 1.78%)
Leaf miner [*Acrocerops gemoniella* Stainton]	<3% leaf damage	-
Fruit mite [*Tuckerella* sp.]	<2% leaf damage	-
Leaf twisting weevil [*Apoderus* sp.]	--	Trace/low

Common and Scientific name of insect pest	Level of insect pest's infestation (%)	
	Gandevi	Periyakulam
Mealy bug [*Ferrisia* virgata) & Mango mealybug, Drosicha sp.]	<2% fruit and leaf damage	Low during May to July 2020
Fruit borer [*Phycita erythrolophia* Hampson & *Conogethes* spp.]	Fruit damage of 2-4% during March-April.	Low
Red ant Oecophylla smaragdina (Fabricius)	-	Traces

Table-154: Status of natural enemies of sapota orchard at different centres

Common and Scientific name of natural enemies	Natural enemies population	
	Gandevi	Periyakulam
Predators		
Dragonfly	+	1.25/tree
Damselfly	+	2/tree
Coccinellids – *Menocheilus sexmaculatus*	-	Grubs (0.4/twig), adult (054/twig)
Parasitoids		
Elasmus sp. from leafminer larvae	-	-
Sympiesis sp. from leafminer larvae	-	-

* * * * * * *

Transfer of technology

A. Seminars/Symposium/Workshop/Group meeting attended

Akola

- Paithankar DH and Ingle YV participated in 7th Group Discussion Meeting of ICAR-AICRP on Fruits organized at PAU, Ludhiana during (16th -19th January 2020).
- Paithankar DH and Ingle YV participated in State Level Seminar on "*Frontier Technologies for Climate Resilient Agriculture*" at Dr. PDKV, Akola (17-18th February 2020).
- Paithankar DH participated in Research Planning Meeting on Zoom App platform organized by ICAR-IIHR, Bengaluru (18th June 2020).
- Paithankar DH participated in Online Zoom App Meeting on ''Weather based Fruit Crop Insurance'' organized by Commissionerate of Agriculture, Pune (26th June 2020).
- Ingle YV participated in National Webinar on "Advances in disease and pest management for sustainable banana management" organized by AAU, Jorhat and ICAR-IIHR, Bengaluru (4th July 2020).
- Ingle YV participated in "Current Status, Challenges & Future Prospects of Plant Diseases" organized by College of Agriculture, SKRAU, Bikaner (29th July 2020).
- Ingle YV participated in virtual National Webinar *on* "Integrated Disease Management in Horticultural Crops" organized by College of Horticulture, Sardar krushinagar Dantiwada Agril. University, Gujarat (22nd October 2020).
- Ingle YV participated in two days National online Workshop on "Fungal systematics and technological advances" organized by Shri Shivaji Science College, Amravati (29th & 30th November 2020).
- Paithankar DH participated in Fruit Crops Insurance Meeting organized by Commissionerate of Agriculture, Pune (5th December 2020).

Anantharajupet

- Naga Lakshmi T participated in the International E-Conference on "Multidisciplinary approaches for plant disease management for achieving sustainability in agriculture" organised by Department of Plant Pathology, UHS, Bagalkot. (6th to 9th October 2020).

Arabhavi

- Kantharaju V, Suhasini Jalawadi and Siddanna Thoke participated in 7th Group Discussion of ICAR-AICRP on Fruits organized at PAU, Ludhiana during (16th -19th January 2020).
- Suhasini Jalawadi participated in Annual Technical Meet, Department of Fruit Science, organised by COH, Mysore (11th September 2020).

Bhubaneswar

- Saudamini Swain and Bipin Kumar Pradhan participated 7th Group discussion of AICRP on Fruits organized at PAU, Ludhiana during (16th -19th January 2020).
- Saudamini Swain and Bipin Kumar Pradhan attended VC's review meeting (28th April 2020).
- Saudamini Swain and Bipin Kumar Pradhan attended ZREAC meeting organized by OUAT (30th May 2020).

Gandevi

- Modi PK participated in National Web Conference on "Vegetable Farmers Forum-2020" organized by Division of Entomology, IARI, New Delhi (25th and 26th June 2020).
- Modi PK participated in National webinar on "Quality production of pomegranate in arid region during Covid 19" organized by AICRP on Arid zone fruits, Agril. Res. Station, SKRAU, Bikaner (2nd and 3rd July 2020).
- Patel AP, Naik BM and Bisane KD participated in National Webinar on "Advances in disease and pest management for sustainable banana industry" organized by AAU, Jorhat (Assam) and ICAR-AICRP, ICAR-IIHR, Bengaluru (4th July 2020).
- Patel AP and Modi PK participated in ICAR-NRCB Webinar Series–2020 on "Value addition and entrepreneurs development in banana" organized by ICAR-National Research Centre for Banana, Tiruchirapalli (22nd July 2020).
- Patel AP, Modi PK and Bisane KD participated in ICAR-NRCB Webinar Series–2020 on "Precision farming in banana" organized by ICAR-National Research Centre for Banana, Tiruchirapalli (25th July 2020).
- Patel AP, Modi PK, Bisane KD and Naik BM

participated in ICAR-NRCB Webinar Series–2020 on "Integrated Disease Management in Banana" organized by ICAR-National Research Centre for Banana, Tiruchirapalli (29th July 2020).

- Patel AP, Modi PK and Bisane KD participated in ICAR-NRCB Webinar Series–2020 on "Integrated Insect Pests and Nematodes Management in Banana"organized by ICAR-National Research Centre for Banana, Tiruchirapalli (4th August 2020).
- Patel AP and Modi PK participated in ICAR-NRCB Webinar Series–2020 on "Planting Material in Banana: Present and Next Generation Technologies" organized by ICAR-National Research Centre for Banana, Tiruchirapalli (7th August 2020).
- Bisane KD participated in Webinar on "Biopesticide: Green Technology in Sustainable Agriculture" organized by College of Agriculture, NAU, Bharuch (18th August 2020).
- Patel AP, Modi PK, Bisane KD and Naik BM participated in ICAR-NRCB Webinar Series–2020 on "ICAR NRCB Foundation Day Celebrations and Webinar on Approaches and Strategies for Augmenting Export of Bananas from India" organized by ICAR-National Research Centre for Banana, Tiruchirapalli (21st August 2020).
- Bisane KD participated in National E-Workshop on "Microbial Intervention in Plant Health and Nutrition" organized by College of Agriculture, NAU, Bharuch (26th August 2020).
- Bisane KD participated in National Webinar on "Beekeeping Techniques" organized by Anand Niketan College of Agriculture, Warora, Maharashtra (20th September 2020).
- Bisane KD participated in Online lecture on "Regulatory environment for safe use of Agro-chemicals in India" organized by NAHEP-CAAST, NAU, Navsari, Gujarat (7th October 2020).
- Modi PK and Naik BM participated in National Webinar on "Management of Root rot Disease of Horticultural crops" organized by Dr. RPCAU, Pusa (24th November 2020).
- Bisane KD participated in in International Training Programme on "Organic Farming: Field to Fashion" organized Dr. PDKV, Akola (14th to 19th December 2020).
- Bisane KD participated in Online Seminar on "Protected cultivation for enhancing resource use efficiency and productivity of horticultural crops" organized by NAHEP-CAAST, AAU, Anand (22nd December 2020).

Jalgaon

- Shaikh NB, Mendhe AR and Pawar KB participated in the 7th Group Discussion meeting organised at PAU Ludhiana (16th to 19th January 2020).
- Chaure JS, Attar AV, Jadhav RJ and Mane SB participated in the "Indian Horticulture Summit 2020" organised at Chitrakoot, Madhya Pradesh (14th to 16th February 2020).
- Mendhe AR participated in state level seminar on "Frontier technologies for climate resilient Agriculture" at Dr.PDKV, Akola, Maharashtra (17th to 18th February 2020).
- Shaikh NB, Mendhe AR, Chaure JS and Attar AV participated in International conference on Banana– 2020 "Innovations in sustainable production and value chain management in Banana" organised at Tiruchirappalli, Tamil Nadu (22nd to 25th February 2020).
- Pawar KB and Mane SB attended ICAR – NRCB webinar series–2020 on "Integrated insect pests and nematodes management in Banana" (4th July 2020).
- Shaikh NB, Pawar KB and Mendhe AR attended ICAR–NRCB webinar series – 2020 "Value addition and Entrepreneurship Development in Banana" organized virtually (22nd July 2020).
- Shaikh NB, Pawar KB, Mendhe AR and Chaure JS attended ICAR – NRCB webinar series–2020 "Planting material in Banana present and Next generation technologies" (7th August 2020).

Jorhat

- Popy Bora and Inee Gogoi participated in the 7th Group Discussion meeting organised at PAU Ludhiana (16th to 19th January 2020).
- Popy Bora participated in Indian Horticulture Summit organised by Chitrakoot, MP (14th to 16th February 2020).
- Bhabesh Deka and Inee Gogoi participated in National Webinar on "Advances on Disease and Pest Management for Sustainable Banana Industry", conducted by ICAR-AICRP on Fruits, Department of Horticulture, AAU, Jorhat (4th July 2020).
- Bhabesh Deka participated in Webinar on "Organic banana production and certification –the status and way forward" conducted by ICAR-NRC Banana (18th July 2020).

- Bhabesh Deka participated in Webinar on "Value addition and entrepreneurship development in banana" conducted by ICAR-NRC Banana (22nd July 2020).
- Bhabesh Deka participated in Webinar on "Value addition and entrepreneurship development in banana" conducted by ICAR-NRC Banana (22nd July 2020).
- Popy Bora participated in Webinar on "Integrated Disease Management in Banana" organized by NRCB, Trichy (29thJuly 2020).
- Bhabesh Deka and Inee Gogoi participated in International Webinar on "Horticulture Industry under Covid-19 Pandemic" conducted by Dept. of Horticulture, Assam Agricultural University, Jorhat. (27th to 28thAugust, 2020).

Kannara

- Pushpalatha PB organized webinar on "Foc Race – 4 - An invasive threat for banana cultivation" at BRS, Kannara (30th June 2020).
- Manju PR attended ICAR-NRCB webinar on "Precision farming in Banana (25th July 2020) and Planting Material in Banana "Present and Next Generation technologies" (7th August 2020).
- Gavas Ragesh and Manju PR attended ICAR-NRCB Webinar on "Integrated Insect Pests and Nematodes Management in Banana" (4th August 2020).
- Pushpalatha PB and Manju PR attended ICAR-NRCB Webinar on "Approaches and Strategies for Augmenting Export of Bananas from India" (21st August 2020).
- Pushpalatha PB organized and participated in webinar on "Postharvest management and nutritional security" in collaboration with Post-harvest Technology departments KAU (16th October 2020).
- Pushpalatha PB, Vimi Louis, Manju PR and Gavas Ragesh attended the 42nd Pre ZREAC-meeting organized by RARS, Pattambi (19th and 20th November 2020).

Kovvur

- Ramanandam G participated in the 7th Group Discussions of AICRP on Fruits organised at PAU, Ludhiana (16th to 19th January 2020).
- Ramanandam G participated in International banana conference – 2020 and banana expo held at Trichy (22nd to 25th February 2020).
- Snehalatha Rani A participated in "International training on epidemiology and management of FocTR4" at Trichy, Tamil Nadu (24th February 2020).
- Ramanandam G, Naga Lakshmi R and Snehalatha Rani A attended Virtua National Webinar on "Advances on Disease and Pest Management for Sustainable Banana Industry" organized by Assam Agricultural University, Jorhat (4th June 2020).
- Ramanandam G and Snehalatha Rani A attended the pre ZREAC meeting at HRS, Ambajipeta, Kovvur (11th June 2020).
- Ramanandam G, Naga Lakshmi R and Snehalatha Rani A participated in the webinar on "Post covid banana cultivation" organized by HRS, Anantarajupeta (11th July 2020).
- Ramanandam G, Naga Lakshmi R and Snehalatha Rani A participated in the national webinar on "Organic banana production and certification –The status and way forward" organised by NRC banana (18th July 2020).
- Ramanandam G, Naga Lakshmi R and Snehalatha Rani A participated in the national webinar on "Value addition and entrepreneurship development in banana"organised by NRC banana (22nd July 2020).
- Ramanandam G, Naga Lakshmi R and Snehalatha Rani A participated in the national webinar on "Status and management of *Fusarium* wilt race 4 in banana" and "Precision farming in banana" organised by NRC banana (25th July 2020).
- Ramanandam G, Naga Lakshmi R and Snehalatha Rani A participated in the national webinar on "Registration of germplasm at ICAR-NBPGR-Procedures and guidelines" organized by Dr.YSRHU. (31st July 2020).
- Naga Lakshmi R and Snehalatha Rani A participated in the webinar "Banana - Fruit for Nutritional and Livelihood security" conducted by Annamalai University (2nd August 2020).
- Ramanandam G, Ravindra Kumar K and Snehalatha Rani A participated in the ICAR-NRCB Webinar on Planting Material in Banana: Present and Next Generation Technologies (7th August 2020).
- Ramanandam G, Naga Lakshmi R and Snehalatha Rani A participated in the national webinar on "Integrated Insect Pests and Nematodes Management in Banana" organised by NRC banana (8th August 2020).

- Ramanandam G and Naga Lakshmi R participated in mid-term review meeting on banana trial 1.2.3 B (Evaluation of new introductions of Banana (MLT-2) organised by NRC banana (8th August 2020).
- Ashok P participated in webinar on "Genetic Improvement of Peppers for fruit Quality Traits" organized by Annamalai University, Tamilnadu (27th August 2020).
- Ravindra Kumar R participated in Virtual Crop Seminar on banana and coconut to FPOs Farmers of East and West Godavari Dt, organized by Coramandal (12th September 2020).
- Ashok P and Ramesh Babu B participated in webinar on "Application of Statistical concepts in Horticultural Research: Basics and way ahead" organized by Dr.YSRHU VR.Gudem (14th September 2020).
- Naga Lakshmi R participated in the webinar entitled "Mechanization in value addition of banana and generation of wealth from banana pseudostem waste" organized by ICAR- CIAE, Coimbatore, Tamil Nadu (18th September 2020).
- Ramesh Babu B participated in webinar on "Intellectual property and Technology commercialization pivotal for successful business" conducted by Horti- Business Incubator, Dr. YSRHU (12th October 2020).
- Ashok P participated in webinar on "Imaging sensor-based phenol typing of crops" organized by ICAR – IISR (14th October 2020).
- Ramanandam G, Naga Lakshmi R, Ravindra Kumar K and Snehalatha Rani A attended "Webinar on amelioration measures for different Horticultural Crops due to heavy rains /floods" (20th October 2020).
- Ramanandam G, Naga Lakshmi R, Ravindra Kumar K and Snehalatha Rani A attended the "National Webinar on Soil Borne Plant Pathogens (Management with emphasis on Bio-control agents)" being organized by Dr.YSRHU (5th November 2020).
- Ramanandam G and Naga Lakshmi R attended the "Webinar on Prospects of Horticulture in South India" organized by Dr.YSRHU (7th November 2020).
- Ramanandam G, Naga Lakshmi R, Ravindra Kumar K and Snehalatha Rani A attended the "Webinar on Nematodes in Horticultural Crops and its management" being organized by Dr.YSRHU (9th November 2020).

Lembucherra (ICAR RC)

- Satyapriya Singh participated in the 7th Group Discussion of ICAR-AICRP on Fruits at PAU, Ludhiana (16th –19th January 2020).
- Lembisana Devi H participated in the National Webinar on "Management of Root-rot disease of Horticultural Crops" organized virtually by RPCAU, Pusa, Bihar (24th November 2020).
- Lembisana Devi H participated in the "National Webinar on Urban and Periurban Horticulture for Health and Nutrition" virtually organized by ICAR – CIARI, Port Blair (25th November 2020).

Lucknow (CISH)

- Ram RA participated in National webinar on "Nutrient management options for Boosting Organic Agriculture" organized by Mata Gujri College, Fatehgarh Sahib, Punjab (28th to 30th May 2020).
- Ram RA participated in National webinar on "organic farming: An enticing alternative for health hazards and happy India" organized by MGCGV, Chitrakoot (31st May 2020).
- Ram RA participated in National webinar on "Prospect of Cosmic and organic in India" organized by Om sterling Global University, Hisar (18th June 2020).
- Ram RA participated in Bio-enhancers for organic production: National webinar on "Post pandemic management of fruit crops" organized by Confederation of Horticulture Association of India, Pusa, Bihar (3rd September 2020).

Ludhiana

- Sandeep Singh, Rattanpal HS, Krishan Kumar and Anita Arora organized and participated in 7th Group Discussion of ICAR-AICRP on Fruits at PAU, Ludhiana (16th to 19th January 2020).
- Sandeep Singh, Krishan Kumar and Anita Arora participated in "Research & Extension Specialist Workshop for Horticultural Crops (Winter)" held at PAU, Ludhiana (23rd & 24th January 2020).
- Anita Arora participated in Citrus show-cum-seminar organized by Citrus Estate, Abohar (28th January 2020).
- Anita Arora participated in Seminar on "Bagbani faslan sambandi kisan goshti" held at MS Randhawa FRS, Gangian, Hoshiarpur (20th February 2020).
- Sandeep Singh participated in webinar on "Desert Locust: Current Situation & Future

Perspectives" organized by Department of Entomology, PAU Ludhiana (30th May 2020).

- Sandeep Singh participated in "Mango Workers E-Conference" organised by IIHR, Bengaluru (12th June 2020).
- Sandeep Singh participated in "National Webinar on Advances in Pest Management for Sustainable Banana Industry" organized by AAU, Jorhat (4th July 2020).
- Sandeep Singh participated in webinar on "Sub-Tropical Fruits organized by Centre for Subtropical Fruits" Haryana (18th to 22th July 2020).
- Sandeep Singh participated in webinar on "Pests of Banana and their Managemen", organized by ICAR-NRC Banana (7th August 2020).
- Sandeep Singh, Rattanpal HS, Krishan Kumar and Anita Arora participated in "Webinar on Guava Cultivation" organized by PAU, Ludhiana (26th August 2020).
- Sandeep Singh, Rattanpal HS, Krishan Kumar and Anita Arora participated in "Webinar on Citrus Cultivation" organized by PAU, Ludhiana (30th September 2020).
- Anita Arora participated in national webinar on "Integrated Disease Management in Horticultural Crops" organized by Department of Plant Protection, College of Horticulture, S.D. Agricultural University, Jagudan (22nd October 2020).
- Anita Arora participated in virtual symposium on "Modern Trends in Systematics and Bio-prospecting of fungi" organized by Indian Phytopathological Society, New Delhi (16th December 2020).

Mandsaur

- Nitin Soni participated in 7th Group Discussion of ICAR-AICRP on Fruits organised at PAU, Ludhiana (16th to 19th January 2020).

Paria

- Patel CR, Solanki PD and Bana JK participated in 7th Group Discussion of the ICAR-AICRP on Fruits organized by IIHR, Bengaluru at PAU, Ludhiana (16th to 19th January 2020).
- Patel CR and Solanki PD participated in 2-days training on "Use of social media skills for extension" (online mode) organized by Extension Education Institute, AAU, Anand, Gujarat (9th to 10th July 2020).
- Patel CR participated in Research Advisory Committee meeting of KVK, Ambheti, District Valsad (15th October 2020).
- Chavan SM participated in 5-days on 'Fruit Fly: Surveillance and Management' (online mode) organized by National Institute of Plant Health Management, Hyderabad (7th to 11th December 2020).

Pantnagar

- Singh AK, Poonam Srivastava, Satish Chand and Rajesh Shukla participated in 7th Group Discussion of AICRP on Fruits at PAU, Ludhiana (16th to 19th January 2020).

Port Blair (CIARI)

- Abirami K participated in the "International conference on Banana 2020-Innovations in sustainable production and value chain management in Banana" organised at Tiruchirapalli, Tamil Nadu (22th to 25th February 2020).

Pune (IARI RS)

- Sunil Kumar Sharma participated in 7th Group Discussion of AICRP on Fruits at PAU, Ludhiana (16th to 19th January 2020).

Pune (NRCG)

- Somkuwar RG, Sharma AK, Sujoy Saha, Deependra Yadav and Roshni Samarth participated in 7th Group Discussion of AICRP on Fruits at PAU, Ludhiana (16th to 19th January 2020).

Rahuri

- Garange VK, Jadhav SB, Pawar PS, Palande AL, Shete MH and Bhalerao VK attended the 8th Group Discussion of ICAR-AICRP on Fruits organised at PAU, Ludhiana (3rd to 6th March, 2020).
- Shete MH attended International e-Symposium on Diversification of Indian Agriculture: Ancient to Modern (17th to 18th June 2020).
- Jadhav SB participated in national webinar on "Intellectual Property Right in Agriculture Sector"organized by SKRAU, Bikaner (17th July 2020).

Rajendranagar

- Vijaya D, Jagdev Sharma AK, Upadhyay and Ram Reddy participated in National Conference on Geospatial Technologies in Agriculture, NAARM (20th to 21st February 2020).

Sriganganagar

- Ravi Kumar Meena attended 7th Group Discussion of ICAR-AICRP on Fruits held at PAU, Ludhiana Punjab (16th to19th January 2020).
- Ravi Kumar Meena attended national webinar on "Technological advances in Crop Production during COVID-19" on virtual mode, organized by DOR, SKRAU, Rajasthan (16th June 2020).
- Ravi Kumar Meena participated in national webinar on "Strategy for Strengthening Agriculture Education under Changing Scenario of COVID-19" virtually, organized by SKRAU, Rajasthan (26th to 27th June 2020).
- Ravi Kumar Meena participated national webinar on "Quality production of pomegranate in the arid region during COVID-19" on virtual mode, organized by SKRAU, Rajasthan (23rd July 2020).
- Ravi Kumar Meena attended ZREAC meeting Rabi – 2020 (Zone 1B of Rajasthan) held at Agricultural Research Station (SKRAU), Sriganganagar (5th & 6th September 2020).
- Ravi Kumar Meena attended national webinar on "Management of root rot diseases of horticultural crops" virtually, organized by Dr. Rajendra Prasad Central Agricultural University, Pusa and ICAR-AICRP on Fruits (24th November 2020).

Tinsukia

- Kakoti RK, Dutta JP and Sikha Deka attended the national conference on "Natural Resource Management and Sustainable Agriculture with reference to North East India"organised by Arunachal University of Studies, Namsai (28th to 29th January 2020).
- Kakoti RK, Dutta JP and Sikha Deka participated in the 7th Group Discussion of ICAR, AICRP on Fruits organised at PAU, Ludhiana (16th to 19th February 2020).
- Kakoti RK, Dutta JP and Sikha Deka attended the Annual Technical Committee Meeting at AAU, Jorhat on (10th to 12th November 2020).

Udaipur

- Lakhawat SS participated in the 7th Group Discussion of ICAR, AICRP on Fruits organized at PAU, Ludhiana (16th to 19th February 2020).
- Lakhawat SS participated in online Pre-GD Meeting of AICRP on Fruits during organised by PC Cell, IIHR, Bengaluru (August -September 2020).

Vengurle

- Dheware RM, Munj AY, Raut RA participated in 7th Group Discussion of ICAR, AICRP on Fruits organised at PAU, Ludhiana (16th to 19th February 2020).

B. AIR-Dodarshan Programme

Akola

The following advisories were furnished to AIR and the same was broadcasted by them.

- Delivered advisory for Cold wave affected tree management and guidelines of operations for the month of January in 'Kisanwani' programme held on Aakashwani (January 2020).
- Given advisory for harvesting of *Mrigbahar* and mite management and guidelines of operations for the month of February in 'Kisanwani' programme held on Aakashwani (February 2020).
- Given advisory for harvesting of *Mrigbahar* and Thrips management and guidelines of operations for the month of March in 'Kisanwani' programme held on Aakashwani (March 2020).
- Given advisory for *Bahar* management for Nagpur mandarin, Black fly management and guidelines of operations for the month of April in 'Kisanwani' programme held on Aakashwani (April 2020).
- Given advisory for migratory locust, Water management for Nagpur mandarin/acid lime/ sweet lime and guidelines of operations for the month of May in 'Kisanwani' programme held on Aakashwani (May 2020).
- Given advisory for establishment of new orchard suitability, nursery practices and guidelines of operations for the month of June in 'Kisanwani' programme held on Aakashwani (June 2020).
- Given advisory for planting of new orchard, avoidance of water stagnation, *Ambiabahar* fruit drop and guidelines of operations for the month of July in 'Kisanwani' programme held on Aakashwani (July 2020).
- Given advisory for Brown rot and fruit drop management, fertilizer management, avoidance of water stagnation, *Ambia bahar* fruit drop, citrus canker management, leaf eating caterpillar management and guidelines of operations for the month of August in 'Kisanwani' programme held on Aakashwani (August 2020).
- Ingle YV has delivered radio talk (AIR) on Acid

lime citrus canker management (9th August 2020).

- Ingle YV has delivered radio talk (AIR) on Fungal fruit drop management (24th September 2020).
- Given advisory for fruit sucking moth management, check of fruit dropping in *Ambiabahar*, nursery practices and guidelines of operations for the month of September in 'Kisanwani' programme held on Aakashwani (September 2020).
- Given advisory for citrus mite management, *Phytophthora* infected trees management and guidelines of operations for the month of October in 'Kisanwani' programme held on Aakashwani (October 2020).
- Given advisory for *Mrigbahar* management, *Phytophthora* infected trees management and guidelines of operations for the month of October in 'Kisanwani' programme held on Aakashwani (November 2020).
- Given advisory for harvesting of *Ambia bahar*, citrus leaf minor management and guidelines of operations for the month of December in 'Kisanwani' programme held on Aakashwani (December 2020).
- Ingle YV has delivered radio talk (AIR) on witches broom and gummosis of acid lime crop management (28th December 2020).
- Ingle YV has delivered radio talk (AIR) on acid lime disease management on (8th December 2020).

Anantharajupet

- Naga Lakshmi T has given TV programme (E TV Annadata) on "B*oppai lo virus tegulla yajamanym* (Viral disease management in papaya).

Bhubaneswar

- Saudamini Swain has delivered radio talk (AIR, Akashbani, Puri) on Improved cultivation practices of culinary banana (16th September 2020).

Jalgaon

- Shaikh NB has given radio talk on winter care for banana.
- Shaikh NB has given TV programme (SAM TV) on management of cucumber mosaic virus in banana.

Kannara

- Manju PR has given radio talk on nutrient deficiencies in banana and their management (19th and 20th May 2020).
- Vimi Louis has given radio talk (AIR) on integrated disease management in banana (9th June 2020).
- Gavas Ragesh has given radio talk on integrated pest management in banana (7th June 2020).

Kovvur

- Ravindra Kumar K has given TV programme (Vijayawada) on Vesavi kalam lo aratithotalalo chepatta valasina yajamanya padhatulu (Cultural practices to be taken up during summer in banana) (6th January 2020).
- Ramanandam has given TV programme (ETV Annadata) on Improved Varieties of banana for commercial cultivation (7th January 2020).
- Snehalatha Rani has given TV programme (ETV Annadata) on Rhizome rot disease of banana and its management and Basal stem rot disease of coconut and its management (7th January 2020).
- Ravindra Kumar has given TV programme (ETV Annadata) on tissue culture banana production and nutrient management in banana (7th January 2020).
- Ramesh Babu has given TV programme (Doordarshan, Saptagiri) on Management of fruit crops in summer (2nd March 2020).
- Ramanadam has given TV programme (DD Saptagiri, Vijayawada) on Tissue culture Aratilo Samagra Poshaka Yajamanyam (Integrated nutrient management in banana) (6th July 2020).
- Ravindra Kumar has given TV programme on *Pandla totalalo adhika varshala prabhavam – Teesukovalasina charyalu"* (Cultural practices to be followed during monsoon season/ heavy rains in fruit orchards) and suggested necessary ameliorative measures over phone (27th October 2020).
- Ramanandam has given TV programme (DD Sapthagiri) on integrated nutrient management for tissue culture banana cultivation (11th November 2020).

Pantnagar

- Singh AK delivered radio talks (Janvani Radio) on "Scientific suggestion for new orchard management in hilly areas" (20th January 2020), "Management of fertilizers in fruit crops" (21st January 2020), "Essential work in management of fruit orchard" (14th February 2020), "Protection of fruit orchard from frost" (13th October 2020).

- Poonam Srivastava delivered radio talks (Janvani Radio) on "Control of insect–Pest in mango orchard" (21st January 2020) and "Insect-pest management in fruit crops" (14th February 2020).

Rahuri

- Pawar PS delivered radio talk on Limbuvargiya falbaug lagwad (Cultivation of citrus fruits). Akashwani-Ahmednagar (7th July 2020).
- Pawar PS delivered radio talk (Akashwani-Pune) on Mosambi bageche *ambia bahar* vyavasthapan (Management practices for *Ambia bahar* Sweet orange) (23rd October 2020).
- Pawar PS delivered radio talk (Akashwani-Ahmednagar) on Mosambi bageche *ambia bahar* vyavasthapan (Management practices for *Ambia bahar* Sweet orange) (11th December 2020).
- Shete MH delivered radio talk (Akashwani-Ahmednagar) on *Limbu Pikache Rog Vyavasthapan* (Disease management in acid lime) (September 2020).

Rajendranagar

- Vijaya D delivered TV talks (Raithunestham, Dooradarshan) on *Drakshalo rasam rakalu* (Juicy varieties in grapes) (10th March 2020) and *Drakshalo eruvulu mariyu neeti yajamanayam* (Fertilizer and water management in Grapes) (22nd June 2020).
- Baby Rani T delivered radio talk on *Endu draksha tayari vidhanam mariyu upayogalu* (Raisin making and its uses) (January 2020).

Vengurle

- Munj AY has delivered radio talk on management of mango cashew stem borer (17th November 2020).

C. Extension and other activities

Akola

- Paithankar DH and Ingle YV organized "Teleconference for citrus growers" organized with cooperation of Reliance Foundation (30thApril 2020).
- Paithankar DH and Ingle YV acted as recourse person for State Level Webinar on "Orange Orchards Management" at Dr. PDKV, Akola campus online (5th June 2020).
- Paithankar DH and Ingle YV organised training on "Acid lime production and protection technology" at Babhulgaon Tq. Dist. Akola (1st July 2020).
- Paithankar DH and Ingle YV organised training on "Mandarin Mrig bahar, Pest and Disease management" at Mungla Tq. Malegaon Dist. Washim (7th July 2020).
- Paithankar DH and Ingle YV organized You Tube Live Stream Programme jointly organized by Reliance Foundation and AICRP'F on 'Aambia bahar Management' (15th August 2020).
- Paithankar DH and Ingle YV organized You Tube Live Stream Programme jointly organized by Reliance Foundation and AICRP'F on 'Fruit Drop Management' (19thSeptember 2020).
- Paithankar DH and Ingle YV acted as recourse person in google meet online webinar on "Aambia/ Mrig bahar and disease management" organized by VANAMATI, Nagpur (25thSeptember2020).

Anantharajupet

- Naga Lakshmi T conducted method demonstration on "Preparation of low-cost methyl eugenol fruit fly trap for the management of fruit flies in fruit crops and IDM in Papaya".

Arabhavi

- Kantharaju V provided Farm advisory for about 115 farmers on their field disease problems by examining diseased specimen and suggested the suitable remedies for the management of diseases.
- Kantharaju V has visited 10 farmer fields and suggested the suitable remedies for the management of diseases.
- Kantharaju V organized three on campus training, and five method demonstrations on disease management of fruit crops.
- Suhasini Jalawadi visited three farmer fields and suggested the suitable remedies for the management of diseases.
- Suhasini Jalawadi has conducted three on campus training and one method demonstration on disease management of fruit crops
- Siddanna Thoke has visited 12 farmers field and suggested the suitable remedies for the management of diseases.
- Siddanna Thoke has conducted three on campus training, two off campus training and 3 method demonstrations

Gandevi

- Patel AP, Bisane KD, Modi PK and Naik BM organized "Farmers Scientist Interaction

Meeting" under ICAR-AICRP (Fruits) at Navagam village of Navsari district along with exhibition of sapota varieties (3rd January 2020).

- Patel AP, Bisane KD, Modi PK and Naik BM organized "Farmers' Meet" under SCSP scheme of ICAR-AICRP (Fruits) at Siyod Village of Surat district along with exhibition of banana varieties (9th January 2020).
- Patel AP, Bisane KD, Modi PK and Naik BM organized one "Farmers' Meet" for banana growers under TSP programme of ICAR-AICRP (Fruits) at FLD tribal village Khutli in dist.-Valsad with about 196 farmers including male and females (9th January 2020).
- Patel AP, Modi PK, Bisane KD and Naik BM organized "On Campus Training Programme and Technology Demonstration" under TSP scheme of ICAR-AICRP (Fruits) at FRS, NAU, Gandevi with 30 farmers (6th July 2020).
- Patel AP and Modi PK organized "Farmers meet" under Tribal sub plan Scheme (TSP) ICAR-AICRP (Fruits) at Bhenskatri village of the Dang district with 30 farmers (18th December 2020).

Jorhat

- Conducted front line demonstration on "Improved Production Technology of Banana" under SCSP programme at three locations Dohutia, Jorhat district, Radhika nagar, Bhatiapar, Gaurisagar, Sibsagar district and Vill-Sensua, Bhotiapar, Jajimukh, Sibsagar district.
- Conducted front line demonstration on "Integrated Disease Management in Banana" under SCSP programme at Goalpara
- Conducted front line demonstration on "Integrated Pest Management in Banana" under SCSP programme at Golaghat
- Conducted farmer training on "Integrated management of insect pest of banana" under SCSP programme at Golaghat
- Conducted farmer training on "Integrated management of diseases of banana" under SCSP programme at Goalpara
- Conducted awareness programme on "fusariul wilt (Race-4):A loomimng threat to banana cultivation" at Goalpara

Kannara

- Pushpalatha PB, Manju PR, Vimi Louis Gavas Ragesh took classes for SCST farmers from Mala block at BRS, Kannara (29th February 2020).

Kovvur

- Naga Lakshmi R and Snehalatha Rani A conducted surveys in banana fields at Ambajipeta, Kothapeta, Savaram, Devarapalli and Kadiyapulanka villages of East Godavari district on Incidence of *Eumusae* leaf spot and banana bract mosaic virus was observed in K.C. Keli and Red banana cultivars (3rd January 2020).
- Ravindra Kumar K Conducted a diagnostic visit in banana field and recommended to spray 13:0:45 and/or 0:0:50 @ 5 g/l at least 3 to 4 times for recovery of banana cv. Grand Naine TC plants at Tadikalapudi, West Godavari district (8th January 2020).
- Kishore Kumar S, Malludora S and Prasad KVSK conducted exposure visit for 32 tribal farmers of West Godavari district to banana Expo at NRCB, Thiruchirapalli to create awareness on banana improved cultural operations under AICRP (fruits) tribal Sub-plan programme (20th to 26th Febuary 2020).
- Ramesh Babu attended the training programme as a resource person on plant protection measures on mango plantation conducted by Department of Horticulture at Errampalli (V), Chintalapudi (M) (4th March 2020).
- Ramanandam G and Snehalatha Rani A conducted diagnostic survey for diseases of banana. Observed rhizome rot disease and suggested control measures to the farmers at Chagallu and Pasivedala villages of West Godavari District (29th May 2020).
- Ravindra Kumar K, Yesubabu AO and Sreenivas HO has visited Grand Naine banana fields and observed heavy incidence of Erwinia rhizome rot in Mr. Garapati Ramarao field. Recommended application of 8-10 grams bleaching powder per plant followed by drenching with copper hydroxyl chloride @ 2 grams/lit to control the disease along with proper drainage infield at Chagallu (29th September 2020).
- Ramanandam G and Snehalatha Rani organised a farmers meet at Pandirimamidi and distributed plant material of acid lime mango grafts and other inputs to the tribal farmers under TSP programme (9th December 2020).
- Ramanandam G, Naga Lakshmi R, Ravindra Kumar and Snehalatha A conducted a diagnostic survey for diseases of banana in Chidipi village and observed 18.75% rhizome rot incidence in Tellachekkerakeli. Also observed potassium

and micro nutrient deficiencies and suggested control measures for rhizome rot, leaf spot and nutrient deficiencies (15th December 2020).

Lembucherra (ICAR RC)

- Plant health camps were organized during the lockdown period for necessary technical interventions and critical inputs distribution to resource poor farmers at different locations of Tripura (8th, 11th, 20th, 22nd, 26th May 2020 and 23rd June 2020)
- Organised one day training programme on "Biotic stress management in improved mango production technology for higher income generation" (28th October, 2020).

Ludhiana

- Krishan Kumar delivered lecture on "Training and pruning of Citrus plants" to farmers during Citrus seminar organized by Citrus estate, Abohar (21st January 2020).
- Anita Arora delivered lecture on "Innovations in fruit disease management" to HDOs during research and extension specialist's workshop for horticultural crops (Winter), held at PAU, Ludhiana (24th January 2020).
- Rattanpal HS delivered lecture on "Innovations in Citrus cultivation" to HDOs during research and extension specialist's workshop for horticultural crops (Winter), held at PAU, Ludhiana (24th January 2020).
- Sandeep Singh delivered lecture on "Innovations in pest management in fruit crops" to HDOs during research and extension specialist's workshop for horticultural crops (Winter), held at PAU, Ludhiana (24th January 2020).
- Krishan Kumar acted as resource person during research and extension specialist's workshop for horticultural crops (Winter), held at PAU, Ludhiana (24th January 2020).
- Anita Arora delivered lecture on "Management of Citrus diseases" to farmers during Citrus show-cum-seminar organized by Citrus Estate, Abohar (28th January 2020).
- Anita Arora delivered lecture on "Citrus, mango, grapes, ber and guava fruit plants diseases and their control measures" in three months training course on integrated crop production for young farmers of Punjab" held at skill development centre, PAU, Ludhiana (30th January 2020).
- Anita Arora delivered lecture on "Post-harvest disease management of fruit crops during pack house operations" to farmers and farmwomen in training course on pack house worker held at skill development centre, PAU, Ludhiana (11th February 2020).
- Anita Arora delivered lecture on diseases of Citrus, mango and their management to farmers in "Bagbani faslan sambandi kisan goshti" held at MS Randhawa FRS, Gangian, Hoshiarpur (20th February 2020).
- Krishan Kumar delivered lecture on "Management of citrus plants" during cotton and horticulture awareness camp at Usmankhera, Abohar (7th March 2020).
- Anita Arora delivered lecture on "Management of citrus, grape and guava diseases" to SC/ST candidates in training course on "Phaldar bootyan di sambh-sambhal ate nursery paida karan bare sikhlai course" held at Fruit Research Farm, PAU, Ludhiana (13th March 2020).
- Sandeep Singh delivered lecture on on "Importance of PAU fruit fly traps in fruit crops" during E-awareness camp on PAU fruit fly traps, with KVK Tarn Taran (Webinar) (11th July 2020).
- Sandeep Singh delivered lecture on "Pests of fruit crops and their management" during Sub-Tropical Fruit Expo-2020 at Centre for Subtropical Fruits, Ladwa, Haryana (Webinar) (19th July 2020).
- Anita Arora delivered lecture on "Disease management in guava" during webinar on guava cultivation (26th August 2020).
- Sandeep Singh delivered lecture on "IPM in guava" during webinar on guava cultivation (26th August 2020).
- 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 (25th September 2020).
- Sandeep Singh delivered lecture on management of insect-pests of fruit crops in "Online Three months skill development integrated crop production training course for young farmers of Punjab" organized by Skill Development Centre, PAU, Ludhiana (25th September 2020).

Mandsaur

- Organized field day in chairman ship of Director NRC, Grapes and Director research services, RVSKVV, Gwalior at Ratlam (17th February 2020).

Pantnagar

- 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 held at HRC, Pattharchatta and Kisan Goshthi at Pantnagar to the farmers of Uttarakhand and adjoining states (2020).
- Sushila Mishra with 45 farmers visited different trials running under AICRP on fruits at Balrampur, UP (31st January 2020)
- Shree Sant Ram Sharma with 20 farmers visited different trials running under AICRP on fruits at Sirmor, HP (5th February 2020)
- Shree Nawal Kishor with 31 farmers visited different trials running under AICRP on fruits at Jashpur, Chhattisgarh (7th February 2020)
- Shree Rajesh Pathak with 21 farmers visited different trials running under AICRP on fruits at Mirjapur, UP (10th February 2020)
- Shree Vinod Kumar Awasti with 32 farmers visited different trials running under AICRP on fruits at Behraich, UP (16th March 2020)
- Laxmikant with 28 farmers visited different trials running under AICRP on fruits at KVK Ujjivani (17th March 2020)
- Vijaypal Singh with 25 farmers visited different trials running under AICRP on fruits at Meerut, UP (18th March 2020)

Paria

- Patel CR delivered lecture in the farmers training on nursery management in mango at FTC, Pardi, District Valsad (29th January 2020).
- Solanki PD delivered lecture in the farmers training on "Scientific cultination of fruit crops" at FTC, Pardi, District Valsad (2nd January and 10th February 2020).
- Solanki PD delivered lecture in the farmers training on "Rejuvenation in mango at FTC, Pardi, District Valsad (17th February 2020).
- Bana JK delivered lecture in the farmers training on "IPM in mango" at FTC, Pardi, District Valsad (2nd January, 10th, 19th February and 4th March 2020).

Pune (ARI)

- Sujata Tetali disseminated information on grape varieties developed at ARI, Pune to Farmers in Kisan Mela organized at Songaon. Tal. Baramati (28th February 2020)
- Sujata Tetali and. Phalake SV visited farmer's field nearby Solapur areas and guided farmers regarding cultivation and processing of grape variety ARI-516 (18th February 2002).

Pune (NRCG)

- Facilitated the submission of grape variety MACS516 (developed by Agharkar Research Institute, Pune) to Central Variety Release Committee which was approved in the meeting (28th October 2020).

Rahuri

- Garange VK, Jadhav SB, Palande A and, Shete MH participated in formation of Farmer- Scientist forum on Cultivation practices, pest and disease management of citrus crop (14th February 2020).

Rajendranagar

- Surveyed of grape growing areas and interacted with grape growers and gave timely advice on plant protection measures, in establishment of new vineyards and other management practices.

Vengurle

- Raut RA delivered a lecture on "Mango rejuvenation and mango blossom protection" at Kushewad, Bhendmala, Vengurle (6th and 28th October 2020).
- Munj AY delivered a lecture on "Mango plant protection" at Kalvi Bandar, Tendoli, Vengurle (8th and 15th October 2020).
- Munj Ay delivered a lecture on "Mango blossom protection at various places of Vengurle" (3rd November and 11th,16th, 23rd December 2020).

D. Special Programmes

D1. Achievements under SCSP Programme

The Schedule Caste Sub Plan is being undertaken at various centres under the ICAR-AICRP on Fruits. During the year 2020, the centres had conducted about 8 trainings to the 130 farmers of schedule caste community farmers and had 59 demonstrations & field visits to their orchards. The, Gandevi centre had organised training on how to reduce the cost of cultivation and increase net income. The Akola centre had organised training on orchard management and also on management of soil bore diseases through bio fertilisers and bio pesticides. The Mohanpur centre had developed two mango orchard within

the umphun affected villages of 'Sundarvan' area of district North 24 parganas. A total of 7200 planting materials, 45 bags of fertilizers and 20 farm implements were distributed to the 222 beneficiaries under this plan.

Distribution of different agricultural inputs by Mohanpur centre

Training on management of diseases in banana by Jalgaon centre

D2. Achievements under STC Programme

The Scheduled Tribe Component progamme is under Bhubaneswar, Gandevi, Jalgaon Kovvur, Medziphema, Ranchi and Udaipur centres of ICAR-AICRP on Fruits. During the year 2020, Seven each demonstrations and trainings were conducted by the centres to the 60 farmers. Field inputs like vegetable seeds, planting materials, bio-pesticides, bio-fertilizers and small farm implements were distributed to 110 beneficiary farmers. Ranchi centre had conducted training on '*Improved Papaya Nursery Raising' for the* farmers from the Gumla and Lohardaga Districts which resulted in the production of more than 28,000 papaya seedlings and earning of average profit of Rs. 12,000/-.

Tribal farmers meet (Gandevi Centre)

Farmers training under STC (Udaipur Centre)

General Information

A. Monitoring of the project

A1. Monitoring of Project by Project Coordinator and Review Meeting

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. Besides these monthly meetings, the following meetings were held to review the progress of work.

Pre-Group-Discussion meeting: All the 136 experiments being conducted across 50 centres were individually reviewed virtually during September-October 2020. The work done was presented by the experiment in-charge, following which mid-term corrections, suggestions, modifications if any were deliberated. This online mid-term review aided everyone in gaining experience for the virtual Group discussion also.

Mango Researchers Meeting: An exclusive virtual meeting was conducted on 12 June, 2020 to review the work done on mango.

Litchi Researchers Meeting: An exclusive virtual meeting was conducted on 16 June, 2020 to review the work done on litchi.

Review meeting for SCSP/TSP programmes: An online meeting was held on 17 July 2020 to review the work done in centres pertaining to SCSP and TSP programmes.

Crop Coordinators' meeting: A virtual meeting was conducted with the crop coordinators on 18 Dec 2020. Compilation of GAP (good agricultural practices) for all the crops zone-wise was discussed.

A2. Monitoring of banana research activities at different centres under ICAR-AICRP (Fruits) by Crop Coordinator for banana

Jalgaon (5th March, 2020): Dr. R. Selvarajan, PS, ICAR-NRCB visited Jalgaon and suggested modifications in the implementation of the technical programme.

Coimbatore (25th November, 2020): Dr. P. Durai, Asst. CTO, ICAR - NRCB visited germplasm block of Coimbatore centre for identification and morphotaxonomic characterization.

A3. Monitoring of Citrus research activities at different centres under ICAR-AICRP (Fruits) by Crop Coordinator for Citrus

Nagpur (15th September, 2020): Dr. A. A. Murkute, Principal Scientist (Horticulture) conducted a virtual meeting on "Midterm review of AICRP project on Citrus germplasm".

Nagpur (23rd September, 2020): Dr. A. K. Das, Principal Scientist (Plant Pathology) conducted a virtual review meeting on "Screening of Citrus rootstocks for *Phytophthora* tolerance".

Nagpur (29th September, 2020): Dr. A. K. Das attended a virtual meeting on "Citrus greening management" presented by Dr. M. Shete, MPKV, Rahuri Centre.

B. Research papers

Akola

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Bhubaneswar

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Gangian

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  Singh H, Arora A, Kaur S, Kaur K (2020). Evaluation of germplasm, fungicides and biocontrol agents against anthracnose (*Colletotrichum gloeosporioides*) in mango (*Mangifera indica*) nursery. *Indian J Agri. Sci.,* **90**(6)1125-9.

Jalgaon

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Kannara

- Gavas Ragesh and Sanju Balan (2020) The first report on Fall Armyworm, *Spodoptera frugiperda* (J. E. Smith) (Lepidoptera: Noctuidae) as an invasive pest in banana from Kerala, South India and notes on its behaviour. *Insect Environ.* **23**:19-23.

Ludhiana

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Pantnagar

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Pune (ARI)

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Pune (IARI RS)

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Rahuri

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Rajendranagar

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Sriganganagar

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Tinsukia

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Vengurle

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C. Group Discussion of ICAR-AICRP on Fruits

The seventh Group Discussion of the ICAR-All India Coordinated Research Project on Fruits was organised at Punjab Agricultural University (PAU), Ludhiana from 16th to 19th January 2020. More than 200 delegates from 50 various centres across the country participated in the deliberation.

The Chief Guest Dr. W.S. Dhillon, Assistant Director General (Hort. Sci.-II) ICAR, New Delhi in his inaugural address emphasised on the development of indigenous rootstocks rather than importing the same which leads to increases in cost of cultivation and also insisted on production of quality planting material. He also stressed on the need to enhance the income from horticultural crops by adopting High Density Planting systems for all the suitable fruit crops and to minimize the post-harvest losses from retailer to consumer as well.

Padma Shri Dr. B.S. Dhillon, Honourable Vice Chancellor, Punjab Agricultural University, Ludhiana in his Presidential address complimented the work being carried out under the All India Coordinated Research Projects. He suggested that, the fruit

scientists, plant breeders and mechanical engineers should work together as a multi-disciplinary team for the improvement of quality of horticultural produce, nursery production and mechanization in fruit crop production system. He also emphasised that during the process of testing, development and recommendation of the technologies, the science generated should be published in high impact journals.

Dr. Prakash Patil, Project Coordinator (Acting), ICAR-AICRP on Fruits, presented the progress of work done at the participating centres across the country on nine fruit crops (mango, Citrus, banana, guava, litchi, grapes, papaya, sapota and jackfruit).

During the inaugural function a monograph on Litchi insect pests and smart management options and two CD-ROMs – one on key characters of varieties/ hybrids under MLTs and another is monograph on mango pollinators were released beside the release of a postal stamp of 7th Group Discussion of ICAR-AICRP on Fruits.

During the event, Kannara centre was awarded the Best Centre Award for the year 2019. Ludhiana centre bagged the Award of Excellence for linking technology development and transfer. To encourage the leadership, two best lead presenters award for 2019 was also conferred.

Directors of ICAR Institutes and officials from ICAR Headquarters attended the Group Discussion and participated in the deliberations.

The research achievements made during 2018 to 2019 in relation to crop improvement, crop production and crop protection were reviewed in detail and the research programme on the mandate fruit crops for the year 2020–21 was finalized in addition to the recommendation of the technologies.

During the deliberations, many technologies were recommended, which include a juice variety in grape, package for Macro-propagation for banana, Stage-wise nutrient doses in Nagpur mandarin and acid lime. Enhancing input use efficiency in banana, Organic source of nutrition in mandarin and sweet orange, use of micronutrients in mango for quality productivity, bagging of litchi bunches for quality fruits, Girdling technology for assured flowering and fruiting in litchi, Management of banana scarring beetle and Management of seed borer in sapota. A total of six new entries (4 in mango and 2 in banana) have been included for MLT besides one each in agro-techniques and crop protection.

Dr. N.S. Bains, Director of Research, PAU welcomed the delegates and the inaugural event was concluded with a vote of thanks by Dr. Harminder Singh, Head, Dept. of Fruit Science, PAU.

D. Planting material produced

Table-1: Planting material produced during 2020

Crops	Centres	Quantity (Numbers)	Total
Banana	Arabhavi	854	72832
	Bhubaneswar	3402	
	Gandevi	1106	
	Jorhat	500	
	Kannara	38030	
	Kovvur	28640	
	Port blair	300	
Citrus	Akola	88550	25192
	Ludhiana	2000	
	Rahuri	10457	
	Sriganganagar	5587	
	Pune (ARI)	6558	
	Rajendranagar	590	
Guava	Sangareddy	22000	23500
	Udaipur	1500	
Jackfruit	Kannara	505	3105
	Kovvur	2020	
	Jorhat	580	
Litchi	Medziphema	3050	3050
Mango	Kannara	10	128108
	Kovvur	14398	
	Medziphema	650	
	Sangareddy	100000	
	Udaipur	50	
	Vengurle	13000	
Sapota	Arabhavi	162	5088
	Gandevi	1500	
	Kovvur	3426	
Papaya	Coimbatore	18.30 kg	18.30 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	Arabhavi	Bhubaneswar	Coimbatore	Gandevi	Imphal	Jalgaon	Jorhat	Kannara	Ludhiana
I Physical properties												
1	Soil type		Medium	Silty clay	Loam	Sandy clay loam	Clay loam	-	Clay	Sandy loam	Clay loam	Sandy loam
2	Clay content	%	47.92	45	-	21.8	36	71.68	48.42	18.35	0.17	15
3	Bulk density	g/cc	1.30	1.3	-	1.7	1.2	-	1.17	1.53	1.5	1.4
4	Moisture holding capacity	%	28.00	58	-	41.0	60.55	-	-	60.45	20	50
5	Moisture at field capacity	%	30.15	28	-	27.0	33	-	36	32	18	30
6	Moisture at wilting	%	12.17	12	-	15	15	-	19	15	11	6.2
II Chemical properties												
7	pH (1:2.5)	--	7.6	8.15	4.99	7.67	6.80	5.60	8.21	4.62	4.37	8.0-8.2
8	Conductivity	dS/m	0.31	0.9	0.010	0.26	0.13	-	0.33	0.4	0.46	0.15-0.8
9	Available N	kg/ha	202	2816	299.0	199 (Low)	261.3	410.6	191	254.53	-	-
10	Available P	kg/ha	44.65	17.80	16.0	12.0 (Medium)	59.43	38.62	19.6	50.8	35	25.27
11	Available K	kg/ha	578	852	110.0	199 (Medium)	279.0	261.8	710	95.22	253	78-135
12	Available Ca	µg/g	38.00	53.113	-		-	-	6.10	1.5-2.0	447	-
13	Available Mg	µg/g	10.00	15.78	-		-	-	-	0.5-1.2	63	-
14	Available Zn	µg/g	6.10	0.23	-	1.43 (Sufficient)	-	-	0.67	8-12	1.13	2.08-2.68
15	Available Mn	µg/g	-	-	-	1.83 (Deficient)	-	-	9.40	-	-	-
16	Available Cu	µg/g	-	-	-	3.97 (Sufficient)	-	-	2.60	-	-	7.78-10.30
17	Available Fe	µ/g	-	-	-	0.09 (Deficient)	-	-	3.20	-	-	4.40-7.62
18	Organic carbon	%	-	-	-	0.43 (Low)	0.34	1.12	0.42	-	0.84	0.72-0.90

Sl. No.	Properties	Units	Centres								
			Mandsaur	Pantnagar	Paria	Pasighat	Lembu cherra	Pune (ARI)	Pune (NRCG)	Pusa	Rahuri
I Physical properties											
1	Soil type		Medium Black	Sandy loam	Clayey	Loamy Sand	Red loam or sandy loam	Sandy loam	Clay	Medium deep	Medium deep
2	Clay content	%	28	10.4	More than 65%	17	29.9	6.86	42.65	44.3	44.3
3	Bulk density	g/cc	1.3	1.52	1.4-1.5	2.77	1.40 – 1.56	1.32	1.38	1.10	1.10
4	Moisture holding capacity	%	18	26-28	44-49	33	38.02 – 52.46	53.50	19.66	62.3	62.3
5	Moisture at field capacity	%	35	20-22	-	40	23.94 – 29.09	53.50	38	32.3	32.3
6	Moisture at wilting	%	15	8-10	-	-	-	-	18	16.1	16.1
II Chemical properties											
7	pH (1:2.5)	-	7.30-7.80	7.39	6.6-7.5	5.5	4.23 – 6.18	7.86	7.24	8.10	8.10
8	Conductivity	dS/m	-	0.35d	0.16-0.55	0.033	0.1 – 0.2	0.18	1.19	0.31d	0.31
9	Available N	kg/ha	218.02	142.90	282-470	290	107.00 – 322.87	253.0	78.21	138	138
10	Available P	kg/ha	18.75	44.16	20.17-62.16	18	24 – 50	29.51	37.83	12.30	12.30
11	Available K	kg/ha	422	158.43	379-550	120	150 – 340	462	490.1	290	290
12	Available Ca	µg/g	10	-	146-210	48	1.16 – 2.48	11.96	8.37	2502	2502
13	Available Mg	µg/g	7.25	-	97-161	26.7	-	0.60	-	418	418
14	Available Zn	µg/g	0.62	45	2.3-4.5	98	0.86- 4.36	0.58	11.90	0.32	0.32
15	Available Mn	µg/g	-	15.33	-	-	-	-	32.66	-	-
16	Available Cu	µg/g	-	1.26	-	-	-	-	12.4	-	-
17	Available Fe	µg/g	-	9.26	-	-	-	-	23.55	-	-
18	Organic carbon	%	-	0.85	-	-	-	-	0.91	-	-

Sl. No.	Properties	Units	Centres					
			Rajendra nagar	Sriganga nagar	Tinsukia	Tiruchirapalli	Udaipur	Vengurle
I Physical properties								
1	Soil type		Sandy clay loam	Sandy loam	Sandy clay loam	Silty clay loam	Sandy clay loam	Sandy clay loam
2	Clay content	%	30	10.5	25	35	23.50	31.64
3	Bulk density	g/cc	1.35	1.55	1.42	1.31	1.45	2.67
4	Moisture holding capacity	%	-	-	42.10	38	54.25	48.92
5	Moisture at field capacity	%	-	16.3	23.45	29	23.25	-
6	Moisture at wilting	%	-	6.3	11.18	12	11.40	-
II Chemical properties								
7	pH (1:2.5)	-	5.8 - 6.8	8.3	4.69	8.2	8.25	5.52
8	Conductivity	dS/m	0.04 -0.14	0.18	0.025	0.18	0.55	0.094
9	Available N	kg/ha	289 – 364	112.0	223.24	192	335	372.94
10	Available P	kg/ha	6 -18	36.0	3.95	7.2	27.5	13.77
11	Available K	kg/ha	168 - 215	340.0	168.80	178	385	452.86
12	Available Ca	µg/g	-	-	500.00	980	210	-
13	Available Mg	µg/g	-	-	2.50	450	136	-
14	Available Zn	µg/g	3.1- 4.3	0.58	0.85	5.2	3.65	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	%	-	0.24	-	-	-	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 & Papaya
22.	Rajendranagar	Grape Research Station (SKLTSHU), Rajendranagar, Hyderabad-500030, Telangana	Grapes
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

Sl. No.	Centre name	Location of the centre	Mandate crops
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, Bhubaneshwar-751019, Odisha	Mango
33.	Chettalli	IIHR-Central Horticultural Experiment Station, Chettalli, Kodagu-571248, Karnataka	Citrus & Litchi
34.	Lucknow	ICAR-Central Institute for Subtropical Horticulture (CISH), Rehmankhera, 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), Mushahari, Muzaffarpur-842002, Bihar	Litchi
37.	Nagpur	ICAR- Central Citrus Research Institute (CCRI), Nagpur-400033, 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), Thayanur post, 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
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

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	2	1	1	4	4	9	9
2.	Anantharajupet	2	2	2	2	1	-	2	-	7	4
3 .	Arabhavi	4	3	4	4	1	1	4	3	13	11
4.	Bhubaneswar	2	2	2	2	1	1	2	-	7	5
5.	Coimbatore	4	4	4	4	1	1	4	4	13	13
6.	Gandevi	4	3	4	4	1	-	4	-	13	7
7.	Jalgaon	3	2	3	1	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	2	1	1	4	4	13	11
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	3	1	1	2	-	10	7
16 .	Pasighat	1	1	2	2	1	1	1	1	5	5
17 .	Periyakulam	5	5	6	3	1	1	5	5	17	14
18 .	Pune (ARI)	1	1	1	1	-	-	1	1	3	3
19 .	Rahuri	7	7	7	6	1	1	6	6	21	20
20 .	Rajendranagar	3	3	3	1	1	1	2	1	9	6
21 .	Rewa	3	3	3	3	1	1	2	2	9	9
22 .	Sabour	3	3	3	3	1	1	3	3	10	10
23 .	Sangareddy	4	4	5	3	1	-	2	-	12	7
24 .	Sriganganagar	1	-	1	1	1	1	2	1	5	3
25 .	Tinsukia	3	3	3	3	1	1	3	1	10	8
26 .	Tirupati	4	4	4	4	1	-	4	2	13	10
27 .	Udaipur	2	1	2	1	1	-	2	2	7	4
28 .	Vengurle	4	4	4	4	1	1	3	3	12	12
	Total	**92**	**87**	**97**	**78**	**25**	**20**	**90**	**66**	**304**	**251**

S = Sanctioned, F = Filled, 304 posts sanctioned (Conveying the approval of 3 posts pending)

Annexure-III

The budget allocation for ICAR-AICRP on Fruits (ICAR and State shares) during 2020

I. SAU/CAU/ DBT Institute based centre

(Amount in Rupees- ICAR+State share)

Sl. No.	Centre	Grant in aid Salary	Grant in aid General	Grants in aid Capital	Grand Total
1.	Akola	37,33,225	16,59,500	55,000	54,47,725
2.	Anantharajupet	40,49,975	10,06,500	1,30,250	51,86,725
3.	Arabhavi	92,49,750	23,78,750	9,05,000	1,25,33,500
4.	Bhubaneswar	33,83,000	11,33,000	4,25,000	49,41,000
5.	Coimbatore	94,00,000	17,16,250	5,12,500	1,16,28,750
6.	Gandevi	49,32,850	11,87,250	5,00,750	66,20,850
7.	Gangian	-	3,00,000	-	3,00,000
8.	Imphal (CAU)	-	12,62,750	1,93,750	14,56,500
9.	Jalgaon	50,33,500	11,89,750	22,250	62,45,500
10.	Jorhat	86,33,725	26,88,750	6,88,250	1,20,10,725
11.	Kalimpong	-	1,10,250	-	1,10,250
12.	Kannara	1,36,66,750	23,07,250	-	1,59,74,000
13.	Kovvur	91,66,750	16,94,250	37,500	1,08,98,500
14.	Ludhiana	1,36,99,750	18,72,500	-	1,55,72,250
15.	Mandsaur	7,67,000	5,85,500	50,000	14,02,500
16.	Medziphema (NU)	-	15,23,500	4,87,500	20,11,000
17.	Mohanpur	1,46,00,250	25,32,000	1,37,500	1,72,69,750
18.	Neri	-	5,49,750	-	5,49,750
19.	Pantnagar	1,00,00,500	9,19,250	3,23,750	1,12,43,500
20.	Paria	51,00,250	11,46,000	6,00,000	68,46,250
21.	Pasighat (CAU)	22,75,000	16,13,250	5,87,500	44,75,750
22.	Periyakulam	1,52,67,250	24,57,125	5,90,625	1,83,15,000
23.	Pune (ARI)	25,50,000	3,95,000	20,000	29,65,000
24.	Pusa (CAU)	-	6,59,750	1,75,000	8,34,750
25.	Rahuri	1,93,16,250	24,61,750	62,500	2,18,40,500
26.	Raipur	-	5,00,250	-	5,00,250
27.	Rajendranagar	61,66,500	8,01,500	-	69,68,000
28.	Rewa	50,33,000	11,39,500	61,250	62,33,750
29.	Sabour	98,00,250	9,98,250	1,74,750	1,09,73,250
30.	Sangareddy	68,66,500	9,85,250	81,500	79,33,250
31.	Sriganganagar	17,66,750	4,22,000	12,500	22,01,250
32.	Tinsukia	99,66,250	25,50,750	7,78,500	1,32,95,500
33.	Tirupati	1,08,33,750	18,93,750	2,62,500	1,29,90,000
34.	Udaipur	65,33,000	5,74,250	-	71,07,250
35.	Vengurle	85,99,750	17,79,000	50,000	1,04,28,750
36.	Yachuli (KVK)	-	3,38,250	50,000	3,88,250

II. ICAR based centre

(Amount in Rupees- ICAR share)

Sl.No.	Centre	Grant in aid General	Grants in aid Capital	Grand Total
1.	Bengaluru (PC Unit)	47,17,250	54,34,000	1,01,51,250
2.	Bengaluru (IIHR)	9,72,500	-	9,72,500
3.	Bhubaneswar (CHES)	2,62,500	-	2,62,500
4.	Chettalli (CHES)	2,91,000	-	2,91,000
5.	Lucknow (CISH)	4,16,250	-	4,16,250
6.	Malda (CISH-RS)	1,23,750	-	1,23,750
7.	Muzaffarpur (NRCL)	5,93,750	-	5,93,750
8.	Nagpur (CCRI)	6,44,000	-	6,44,000
9.	New Delhi (IARI)	2,03,750	-	2,03,750
10.	Port Blair (CIARI)	2,16,250	-	2,16,250
11.	Pune (IARI RS)	1,30,000	-	1,30,000
12.	Pune (NRCG)	5,34,250	-	5,34,250
13.	Ranchi (RCER RC)	7,09,250	-	7,09,250
14.	Tiruchirapalli (NRCB)	10,42,500	-	10,42,500
15.	Lembucherra (ICAR RC)	13,57,750	1,81,250	15,39,000

III. TSP programme

(Amount in Rupees- ICAR share)

Sl.No.	Centre	Grant in aid General	Grants in aid Capital	Grand Total
1.	Bhubaneswar	7,12,500	50,000	7,62,500
2.	Gandevi	10,25,000	62,500	10,87,500
3.	Jalgaon	8,87,500	25,000	9,12,500
4.	Kovvur	9,87,500	2,00,000	11,87,500
5.	Medziphema	10,37,500	2,00,000	12,37,500
6.	Ranchi	10,37,500	2,37,500	12,75,000
7.	Udaipur	9,37,500	50,000	9,87,500

IV. SCSP programme

(Amount in Rupees- ICAR share)

Sl.No.	IV SCSP	Grant in aid General	Grants in aid Capital	Grand Total
1.	Akola	6,42,500	81,250	7,23,750
2.	Anantharajupet	4,50,000	1,37,500	5,87,500
3.	Arabhavi	6,30,000	1,37,500	7,67,500
4.	Coimbatore	5,52,500	1,25,000	6,77,500
5.	Gandevi	5,50,000	75,000	6,25,000
6.	Jalgaon	4,03,750	83,750	4,87,500
7.	Jorhat	5,08,750	1,93,750	7,02,500
8.	Kannara	4,62,500	1,37,500	6,00,000
9.	Ludhiana	4,62,500	50,000	5,12,500
10.	Mandsaur	3,17,500	1,00,000	4,17,500
11.	Mohanpur	5,87,500	1,47,250	7,34,750
12.	Paria	5,37,500	50,000	5,87,500
13.	Periyakulam	6,00,000	1,37,500	7,37,500
14.	Ranchi	5,37,500	87,500	6,25,000
15.	Tirupati	6,62,500	1,25,000	7,87,500
16.	Tinsukia	5,95,000	81,500	6,76,500

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 20	0.00	0	27.10	14.30	82.00	46.00	3.80
February	0.00	0	30.80	15.00	68.00	30.00	5.20
March	19.30	0	34.60	19.60	62.00	27.00	8.30
April	4.10	1	40.50	24.90	44.00	16.00	11.30
May	4.10	0	42.90	28.00	41.00	16.00	15.30
June	165.20	10	35.20	24.60	77.00	46.00	8.80
July	264.90	16	32.70	23.70	85.00	61.00	5.00
August	212.80	15	29.60	22.70	88.00	74.00	4.30
September	90.70	8	32.80	22.00	87.00	59.00	4.70
October	32.00	3	33.20	19.60	86.00	49.00	4.20
November	5.50	1	32.00	12.50	83.00	31.00	4.80
December	0.50	0	30.00	12.60	81.00	30.00	3.90

Anantharajupet

Month	Rainfall (mm)	Rainy days	Temperature (°C)		Relative Humidity (%)		Evaporation (mm/day)
			Max.	Min.	Morn.	Even.	
January 20	15.20	2	32.80	13.60	85.10	50.50	-
February	-	-	33.30	12.90	79.20	41.50	-
March	-	-	37.60	18.20	81.50	40.30	-
April	140.00	1	42.10	26.40	57.70	33.90	-
May	-	-	44.10	26.20	69.40	36.20	-
June	15.70	3	36.90	26.20	85.20	35.70	-
July	64.00	8	33.20	23.50	80.60	34.50	-
August	124.70	9	34.70	22.00	80.40	42.00	-
September	152.00	12	34.10	22.20	83.10	50.30	-
October	85.50	11	32.10	22.10	75.40	39.50	-
November	289.10	18	24.40	20.10	78.50	42.20	-
December	155.60	08	30.60	17.20	82.50	46.60	-

Arabhavi

Month	Rainfall (mm)	Rainy days	Temperature (°C)		Relative Humidity (%)		Evaporation (mm/day)
			Max.	Min.	Morn.	Even.	
January 20	0.00	-	36.20	13.10	79.40	36.10	3.50
February	0.00	-	34.10	14.40	69.50	35.90	2.50
March	0.00	-	38.30	14.20	66.90	28.10	1.50
April	12.40	-	38.40	15.89	74.38	37.10	2.95
May	83.80	-	42.88	14.45	91.20	48.10	3.85
June	102.80	-	36.90	11.95	83.90	58.70	2.85
July	100.80	-	31.85	13.90	79.38	75.40	1.15
August	151.10	-	31.75	12.95	89.10	79.80	1.55
September	193.40	-	33.80	14.45	85.89	79.80	1.85
October	131.40	-	34.00	15.50	87.50	77.80	1.20
November	0.00	-	32.40	15.40	86.80	71.40	2.90
December	0.00	-	32.70	15.90	84.20	68.10	3.00

Bhubaneswar

Month	Rainfall (mm)	Rainy days	Temperature (°C)		Relative Humidity (%)		Evaporation (mm/day)
			Max.	Min.	Morn.	Even.	
January 20	12.71	4	27.93	16.10	94.03	50.74	3.49
February	94.25	8	28.54	16.17	91.24	48.17	3.49
March	56.42	6	34.21	22.10	95.19	49.52	5.10
April	108.00	10	36.94	24.66	93.03	50.43	6.37
May	157.17	12	35.96	25.90	89.18	59.87	6.59
June	95.40	6	34.86	26.65	92.70	68.13	5.62
July	159.03	21	34.36	26.53	93.39	68.03	3.73
August	585.28	23	32.70	26.03	94.84	75.48	2.89
September	211.80	17	34.08	26.23	94.80	70.20	3.33
October	247.60	13	31.89	24.35	95.00	76.00	3.10
November	5.60	1	31.43	19.62	90.00	53.00	3.50
December	0.00	0	29.78	14.26	94.00	41.00	3.60

Coimbatore

Month	Rainfall (mm)	Rainy days	Temperature (°C)		Relative Humidity (%)		Evaporation (mm/day)
			Max.	Min.	Morn.	Even.	
January 20	0.00	0	29.90	17.90	88.00	42.00	5.20
February	0.00	0	33.10	21.40	85.00	44.00	6.70
March	0.00	0	35.70	23.50	82.00	41.00	7.60
April	57.00	3	35.80	24.20	82.00	42.00	7.20
May	67.50	4	34.90	25.00	84.00	49.00	6.20
June	22.50	2	32.40	23.20	81.00	54.00	6.90
July	83.50	7	31.60	24.10	84.00	59.00	5.90
August	49.50	7	31.10	23.40	83.00	57.00	5.80
September	140.50	10	30.30	22.70	84.00	53.00	5.30
October	82.50	4.0	31.80	22.70	5.50	6.40	52.80
November	85.70	6.0	30.50	22.10	5.20	5.60	57.00
December	85.20	3.0	28.20	21.00	4.60	4.40	58.50

Gandevi

Month	Rainfall (mm)	Rainy days	Temperature (°C)		Relative Humidity (%)		Evaporation (mm/day)
			Max.	Min.	Morn.	Even.	
January 20	0.00	0	26.20	16.00	84.30	73.60	2.60
February	0.00	0	30.40	17.40	80.00	63.60	4.10
March	11.00	1	30.80	19.10	78.40	72.00	4.20
April	0.00	0	34.60	23.30	81.40	70.40	6.30
May	0.00	0	33.80	26.80	85.50	68.40	7.40
June	76.00	9	31.50	25.50	86.00	79.10	3.50
July	577.00	17	30.80	24.50	90.20	83.70	2.40
August	1231.00	24	29.70	25.80	89.10	86.50	0.40
September	199.00	12	30.50	25.10	89.10	84.90	1.10
October	0.00	0	33.70	23.30	83.30	81.60	3.30
November	0.00	0	29.70	19.20	80.00	69.20	2.90
December	54.50	3	25.20	17.70	83.80	71.10	1.80

Imphal

Month	Rainfall (mm)	Rainy days	Temperature (°C)		Relative Humidity (%)		Evaporation (mm/day)
			Max.	Min.	Morn.	Even.	
January 20	65.80	-	21.20	7.50	91.40	50.00	-
February	13.30	-	23.40	8.20	92.80	40.80	-
March	12.10	-	27.60	12.10	83.00	37.50	-
April	102.80	-	28.40	15.20	78.00	44.10	-
May	148.60	-	29.10	18.90	83.50	57.10	-
June	307.40	-	30.00	22.50	89.00	69.50	-
July	270.80	-	29.70	22.90	90.60	72.80	-
August	205.70	-	30.00	23.00	87.50	71.20	-
September	229.90	-	30.30	22.30	90.90	67.30	-
October	165.80	-	37.10	20.90	93.00	67.00	-
November	104.90	-	26.30	12.80	94.00	50.50	-
December	0.00	-	23.00	6.50	96.40	48.20	-

Jalgaon

Month	Rainfall (mm)	Rainy days	Temperature (°C)		Relative Humidity (%)		Evaporation (mm/day)
			Max.	Min.	Morn.	Even.	
January 20	0.00	0	28.30	13.30	75.00	46.00	6.10
February	0.00	0	31.80	14.30	70.00	34.00	8.30
March	5.50	1	34.80	18.40	66.00	31.00	8.00
April	0.00	0	41.00	24.00	56.00	27.00	10.10
May	0.00	0	43.50	28.50	62.10	27.60	12.70
June	212.50	7	35.30	25.50	85.60	54.80	6.80
July	228.70	8	34.10	25.50	88.10	62.20	6.50
August	290.00	9	30.70	24.50	90.50	77.80	5.20
September	83.80	7	33.00	24.30	87.80	67.30	7.80
October	40.00	3	34.90	22.60	81.80	48.60	8.70
November	0.00	0	33.20	16.60	70.90	44.70	8.80
December	6.50	1	31.10	14.50	73.00	62.00	6.60

Jorhat

Month	Rainfall (mm)	Rainy days	Temperature (°C)		Relative Humidity (%)		Evaporation (mm/day)
			Max.	Min.	Morn.	Even.	
January 20	29.60	3	22.65	9.82	99.39	63.48	1.13
February	11.10	2	24.88	12.02	97.14	59.34	1.44
March	6.40	1	28.81	15.87	93.13	61.00	2.77
April	107.20	8	29.07	17.56	93.10	66.00	3.14
May	236.40	13	29.78	21.02	92.03	72.10	2.46
June	410.30	19	31.52	24.29	95.13	78.13	2.65
July	370.10	20	31.54	25.02	96.55	80.94	2.00
August	325.70	14	33.56	25.60	93.42	75.26	3.06
September	210.30	17	32.39	24.83	95.13	76.77	2.02
October	180.80	11	31.74	23.31	95.97	73.29	1.91
November	19.30	3	28.15	15.79	97.30	61.73	1.60
December	4.00	1	24.92	10.54	98.71	60.65	1.13

Kannara

Month	Rainfall (mm)	Rainy days	Temperature (°C)		Relative Humidity (%)		Evaporation (mm/day)
			Max.	Min.	Morn.	Even.	
January 20	0.00	0	34.10	22.40	78.00	43.00	4.90
February	0.00	0	35.50	23.20	71.00	37.00	5.90
March	33.40	2	36.40	24.40	85.00	46.00	4.80
April	44.70	4	36.40	24.70	86.00	55.00	4.60
May	59.60	5	35.00	25.20	90.00	63.00	3.70
June	427.20	20	31.10	23.70	94.00	75.00	2.30
July	563.00	21	30.50	23.20	96.00	78.00	2.50
August	607.70	17	30.20	23.10	96.00	77.00	2.50
September	587.60	21	30.00	22.40	96.00	80.00	2.10
October	310.30	12	31.00	21.50	95.00	69.00	2.40
November	56.10	2	33.00	22.00	84.00	57.00	3.60
December	7.70	1	32.00	21.90	75.00	55.00	4.40

Kovvur

Month	Rainfall (mm)	Rainy days	Temperature (°C)		Relative Humidity (%)		Evaporation (mm/day)
			Max.	Min.	Morn.	Even.	
January 20	10.10	-	30.60	22.50	89.00	60.80	3.14
February	0.80	-	31.80	22.70	87.80	56.00	3.50
March	0.20	-	33.90	22.80	95.40	53.30	3.35
April	85.70	-	36.40	24.20	99.60	47.90	4.20
May	19.70	-	39.30	27.80	88.50	39.40	3.91
June	139.60	-	36.00	27.90	88.30	56.30	2.91
July	567.10	-	32.90	26.60	91.60	74.00	2.93
August	194.30	-	31.80	26.70	89.00	74.50	2.12
September	269.10	-	34.70	27.40	89.60	67.30	3.76
October	462.40	-	33.92	26.70	88.75	66.12	-
November	117.20	-	34.06	24.54	79.66	43.72	-
December	0.00	-	31.92	20.47	85.52	42.35	-

Lembucherra

Month	Rainfall (mm)	Rainy days	Temperature (°C)		Relative Humidity (%)		Evaporation (mm/day)
			Max.	Min.	Morn.	Even.	
January 20	22.80	4	24.10	10.50	98.90	62.20	1.40
February	0.00	0	27.00	11.30	95.30	43.00	2.20
March	16.90	3	32.10	16.00	90.60	40.00	3.90
April	97.60	9	33.80	19.40	91.00	58.10	3.90
May	373.50	14	32.90	21.80	94.30	71.80	3.30
June	427.30	17	32.60	23.60	94.70	79.70	3.00
July	370.80	15	32.30	23.90	94.20	82.10	2.50
August	233.90	14	33.20	23.90	93.20	73.60	3.20
September	375.30	17	32.80	23.70	96.00	80.50	2.80
October	184.00	10	32.90	22.70	96.10	77.00	2.40
November	20.20	3	30.20	16.00	95.90	60.30	2.00
December	0.00	0	26.10	10.80	98.00	59.40	1.50

Lucknow

Month	Rainfall (mm)	Rainy days	Temperature (°C)		Relative Humidity (%)		Evaporation (mm/day)
			Max.	Min.	Morn.	Even.	
January 20	60.00	-	19.60	6.90	90.10	70.20	2.80
February	0.00	-	24.40	7.10	88.90	71.80	4.030
March	41.40	-	29.10	13.60	93.90	64.20	4.80
April	10.00	-	35.50	19.40	92.40	57.20	7.20
May	38.80	-	37.40	21.70	92.80	52.70	7.30
June	59.00	-	34.50	25.50	94.70	61.60	7.00
July	241.80	-	33.80	26.20	95.60	72.50	5.50
August	311.40	-	33.60	25.90	94.90	72.50	6.10
September	0.00	-	34.70	25.20	95.20	65.50	6.70
October	0.00	-	33.80	17.50	93.50	69.40	6.40
November	35.00	-	27.70	9.10	90.80	74.40	4.60
December	0.00	-	23.30	5.60	89.40	62.50	4.10

Ludhiana (PAU)

Month	Rainfall (mm)	Rainy days	Temperature (°C)		Relative Humidity (%)		Evaporation (mm/day)
			Max.	Min.	Morn.	Even.	
January 20	39.80	6	16.60	6.70	93.20	63.60	-
February	15.00	2	21.30	8.60	91.40	51.40	-
March	69.00	5	24.50	12.90	89.40	53.90	-
April	13.20	3	32.80	17.70	73.00	34.00	4.46
May	49.60	7	36.90	22.30	58.00	28.00	6.87
June	9.60	5	37.60	26.50	65.00	39.00	7.11
July	232.00	14	34.40	26.90	81.00	60.00	5.08
August	145.60	13	33.50	26.80	83.00	67.00	4.38
September	13.60	2	34.50	24.90	87.00	54.00	3.98
October	0.00	0	32.60	15.90	88.00	25.00	3.53
November	15.60	2	25.30	9.80	90.00	34.00	1.70
December	6.00	2	19.40	7.10	92.00	52.00	1.23

Ludhiana (Abohar)

Month	Rainfall (mm)	Rainy days	Temperature (°C)		Relative Humidity (%)		Evaporation (mm/day)
			Max.	Min.	Morn.	Even.	
January 20	39.20	3	16.30	5.20	98.70	53.90	-
February	-	-	22.60	7.40	97.60	40.00	-
March	80.40	4	24.80	12.40	98.80	47.90	-
April	8.40	1	33.20	16.80	89.50	26.60	-
May	28.20	5	38.70	21.30	79.50	19.60	-
June	54.40	3	39.10	25.90	80.90	31.80	-
July	197.60	5	35.50	20.80	71.10	56.20	-
August	237.60	8	34.70	22.00	73.10	60.80	-
September	69.70	3	33.70	20.90	71.90	51.40	-
October	0.00	-	29.40	13.60	73.70	38.10	-
November	75.00	1	22.10	6.90	79.40	44.40	-
December	9.00	1	17.00	4.00	80.20	53.70	-

Mandsaur

Month	Rainfall (mm)	Rainy days	Temperature (°C)		Relative Humidity (%)		Evaporation (mm/day)
			Min.	Max.	Morn.	Even.	
January 20	0.00	-	9.61	23.16	74.84	-	-
February	0.00	-	12.41	27.91	71.29	-	-
March	0.00	-	17.32	31.61	61.68	-	-
April	0.00	-	22.62	38.60	44.99	-	-
May	0.00	-	25.26	42.42	44.94	-	-
June	166.00	-	24.49	36.40	66.29	-	-
July	81.00	-	24.55	34.06	78.87	-	-
August	245.50	-	24.10	29.74	88.10	-	-
September	71.50	-	23.68	33.54	82.20	-	-
October	0.00	-	18.45	33.22	58.85	-	-
November	0.00	-	15.71	30.81	60.10	-	-
December	0.00	-	14.46	28.60	60.45	-	-

Pantnagar

Month	Rainfall (mm)	Rainy days	Temperature (°C)		Relative Humidity (%)		Evaporation (mm/day)
			Max.	Min.	Morn.	Even.	
January 20	118.20	7	17.60	8.10	94.00	72.00	1.80
February	23.20	2	22.10	8.10	95.00	56.00	2.70
March	46.10	4	26.90	17.90	88.00	47.00	3.90
April	70.80	1	33.60	17.20	68.00	33.00	6.30
May	61.10	4	35.20	20.80	69.00	40.00	7.10
June	222.40	10	33.50	25.20	80.00	59.00	6.00
July	402.70	14	32.40	25.80	89.00	72.00	5.60
August	249.50	13	32.20	26.20	89.00	73.00	4.90
September	56.30	4	33.70	24.70	90.00	63.00	5.10
October	0.00	0	33.10	17.30	87.00	46.00	3.90
November	0.00	0	27.20	10.50	92.00	39.00	3.00
December	2.50	1	21.10	7.00	95.00	58.00	1.80

Paria

Month	Rainfall (mm)	Rainy days	Temperature (°C)		Relative Humidity (%)		Evaporation (mm/day)
			Max.	Min.	Morn.	Even.	
January 20	0.00	0	30.78	13.58	79.29	54.53	3.55
February	0.00	0	34.32	16.61	68.89	42.33	4.87
March	0.50	0	33.87	19.38	77.92	56.39	5.50
April	0.00	0	37.86	22.18	73.33	71.41	6.05
May	0.00	0	37.51	26.92	76.62	83.82	7.05
June	69.40	8	35.56	27.24	94.23	95.50	4.97
July	477.50	22	32.79	15.71	89.68	85.24	4.80
August	993.00	27	30.22	-	91.58	90.35	5.95
September	160.60	10	32.31	-	92.63	90.20	2.88
October	1.70	0	34.73	-	85.96	63.60	1.49
November	0.00	0	35.01	-	79.87	48.52	2.04
December	61.60	3	31.58	12.64	85.78	59.45	2.35

Pasighat (CAU)

Month	Rainfall (mm)	Rainy days	Temperature (°C)		Relative Humidity (%)		Evaporation (mm/day)
			Min.	Max.	Morn.	Even.	
January 20	24.50	6	20.85	22.60	84.40	77.90	3.10
February	71.00	11	21.10	22.70	86.10	56.20	3.80
March	203.50	10	22.80	24.80	81.60	72.70	3.80
April	182.50	10	26.60	29.10	83.80	71.60	3.90
May	391.50	13	25.50	29.10	87.40	82.60	3.90
June	560.00	18	29.40	31.80	88.30	86.30	4.50
July	734.00	16	27.90	31.10	84.50	82.10	4.00
August	261.00	9	-	-	84.10	79.90	4.60
September	660.00	16	28.40	30.20	91.80	90.00	3.60
October	95.00	7	26.20	29.10	82.90	76.20	3.70
November	169.00	7	25.30	25.30	78.80	78.80	3.60
December	17.00	2	20.50	24.60	85.90	73.20	3.80

Port Blair

Month	Rainfall (mm)	Rainy days	Temperature (°C)		Relative Humidity (%)		Evaporation (mm/day)
			Max.	Min.	Morn.	Even.	
January 20	2.60	0	30.20	24.20	66.00	-	-
February	0.00	0	30.70	23.60	70.00	-	-
March	0.00	0	31.50	24.10	66.00	-	-
April	4.50	1	32.90	26.40	68.00	-	-
May	25.00	3	32.30	25.90	76.00	-	-
June	657.10	20	30.30	25.10	84.00	-	-
July	382.50	18	30.20	24.8	83.00	-	-
August	351.70	16	30.50	25.30	84.00	-	-
September	403.90	22	30.10	24.70	85.00	-	-
October	461.80	23	29.80	24.30	88.00	-	-
November	192.90	13	30.80	33.40	74.00	-	-
December	163.30	10	29.80	32.50	77.00	-	-

Pune (ARI)

Month	Rainfall (mm)	Rainy days	Temperature (°C)		Relative Humidity (%)		Evaporation (mm/day)
			Max.	Min.	Morn.	Even.	
January 20	-	-	29.39	13.20	94.82	52.09	-
February	-	-	31.68	14.76	89.50	45.18	-
March	10.60	1	34.45	16.67	80.14	39.64	-
April	4.20	1	38.44	20.90	75.78	31.65	-
May	32.70	3	38.73	23.25	73.34	28.79	-
June	109.00	10	32.09	22.70	85.78	61.31	-
July	129.50	11	30.56	22.76	87.76	70.05	-
August	94.90	9	29.05	22.03	91.01	72.57	-
September	334.50	8	31.43	22.64	89.10	62.80	-
October	311.30	11	31.02	21.32	90.21	62.37	-
November	-	-	30.85	17.12	83.57	47.01	-
December	-	-	38.70	14.16	89.10	45.79	-

Pune (IARI)

Month	Rainfall (mm)	Rainy days	Temperature (°C)		Relative Humidity (%)		Evaporation (mm/day)
			Max.	Min.	Morn.	Even.	
January 20	0.00	-	29.20	13.30	91.00	46.00	-
February	0.00	-	31.80	14.80	79.00	35.00	-
March	9.00	-	34.00	16.80	62.00	35.00	-
April	0.00	-	38.50	20.60	53.00	26.00	-
May	0.00	-	38.70	23.10	58.00	38.00	-
June	222.00	-	31.40	22.30	80.00	70.00	-
July	120.00	-	30.40	22.40	83.00	74.00	-
August	255.00	-	27.90	21.70	89.00	86.00	-
September	198.00	-	30.80	21.90	86.00	77.00	-
October	312.00	-	31.40	20.40	89.00	76.00	-
November	0.00	-	31.00	16.10	85.00	56.00	-
December	4.50	-	29.80	13.60	98.00	52.00	-

Pune (NRCG)

Month	Rainfall (mm)	Rainy days	Temperature (°C)		Relative Humidity (%)		Evaporation (mm/day)
			Min.	Max.	Morn.	Even.	
January 20	4.00	0	12.50	30.20	47.80	97.90	110.50
February	1.00	0	14.39	32.55	38.69	89.17	147.40
March	57.00	4	17.08	33.33	36.39	88.13	175.30
April	4.00	0	20.28	34.17	28.53	84.73	243.10
May	1.50	0	23.62	34.97	34.29	80.86	223.70
June	157.40	9	23.03	31.13	66.62	95.90	90.70
July	82.40	9	23.05	30.99	71.48	95.87	60.90
August	126.90	15	22.20	27.90	83.50	97.80	29.90
September	203.30	9	22.10	31.10	66.30	98.50	61.20
October	251.30	10	20.80	31.60	59.00	99.20	51.70
November	1.20	0	12.10	24.70	34.50	79.00	106.90
December	2.30	0	12.60	30.50	48.20	99.10	105.20

Rahuri

Month	Rainfall (mm)	Rainy days	Temperature (°C)		Relative Humidity (%)		Evaporation (mm/day)
			Max.	Min.	Morn.	Even.	
January 20	0.00	0	27.07	13.25	82.50	43.00	4.63
February	0.00	0	29.82	14.80	78.50	35.50	5.15
March	0.00	0	32.87	15.22	73.00	26.25	6.40
April	13.70	2	37.10	20.60	73.00	22.25	8.85
May	0.00	0	39.22	24.85	62.25	20.50	12.40
June	54.00	8	35.20	24.55	77.75	39.50	9.25
July	60.10	10	32.32	24.52	85.50	54.00	4.90
August	59.65	13	30.07	23.90	87.75	64.75	4.40
September	24.05	8	29.30	23.30	88.25	64.75	4.45
October	92.60	14	30.02	23.32	90.00	57.50	3.92
November	48.86	7	30.55	21.57	89.50	52.25	4.42
December	4.20	1	29.45	17.20	84.50	40.50	5.15

Sangareddy

Month	Rainfall (mm)	Rainy days	Temperature (°C)		Relative Humidity (%)		Evaporation (mm/day)
			Min.	Max.	Morn.	Even.	
January 20	3.00	-	16.40	30.70	68.00	73.00	-
February	30.00	-	16.30	32.60	62.00	66.00	-
March	55.00	-	18.30	33.60	65.00	65.00	-
April	28.00	-	20.50	38.60	66.00	58.00	-
May	76.00	-	23.00	42.80	65.00	46.00	-
June	169.00	-	22.50	34.00	71.00	61.00	-
July	372.00	-	30.90	31.60	76.00	69.00	-
August	307.00	-	21.00	30.40	77.00	72.00	-
September	332.00	-	22.10	32.00	77.00	71.00	-
October	253.90	-	18.55	30.88	83.22	76.90	-
November	1.30	-	17.44	30.68	78.20	69.33	-
December	0.00	-	15.02	30.02	72.23	73.96	-

Sriganganagar

Month	Rainfall (mm)	Rainy days	Temperature (°C)		Relative Humidity (%)		Evaporation (mm/day)
			Max.	Min.	Morn.	Even.	
January 20	21.90	-	16.99	6.63	92.81	71.26	0.86
February	0.00	-	23.51	6.53	88.90	54.52	2.05
March	54.50	-	26.54	13.04	87.55	56.00	2.63
April	6.60	-	35.73	20.03	64.03	36.20	4.65
May	16.50	-	39.87	22.10	56.29	32.23	6.95
June	26.80	-	41.28	27.11	62.17	43.07	8.17
July	131.20	-	38.71	26.50	75.94	57.87	7.47
August	127.40	-	36.12	26.88	82.03	70.48	5.03
September	20.40	-	37.41	24.34	81.13	51.70	4.87
October	0.00	-	35.23	14.25	80.55	36.97	3.82
November	1.00	-	27.37	8.64	81.03	50.17	1.59
December	2.80	-	21.46	4.75	87.90	64.97	1.33

Tinsukia

Month	Rainfall (mm)	Rainy days	Temperature (°C)		Relative Humidity (%)		Evaporation (mm/day)
			Max.	Min.	Morn.	Even.	
January 20	26.00	4	23.00	9.60	99.00	64.00	-
February	27.00	4	25.10	11.40	97.00	50.00	-
March	52.00	7	29.20	16.40	96.00	60.00	-
April	131.00	12	27.70	17.00	95.00	65.00	-
May	432.00	16	29.60	20.70	84.00	65.00	-
June	706.00	25	29.60	23.50	93.00	76.00	-
July	441.00	21	30.20	24.60	93.00	78.00	-
August	302.00	19	32.00	24.70	89.00	71.00	-
September	86.00	8	30.90	24.30	88.00	76.00	-
October	113.00	6	30.60	24.00	86.00	70.00	-
November	3.00	1	24.20	14.70	97.00	79.00	-
December	0.00	1	24.50	10.40	97.00	57.00	-

Tiruchirapalli

Month	Rainfall (mm)	Rainy days	Temperature (°C)		Relative Humidity (%)		Evaporation (mm/day)
			Max.	Min.	Morn.	Even.	
January 20	21.80	-	31.64	22.22	74.64	-	-
February	-	-	33.89	22.41	68.82	-	-
March	-	-	36.64	25.00	65.19	-	-
April	13.40	-	38.46	27.06	62.20	-	-
May	25.00	-	39.22	28.09	60.90	-	-
June	62.90	-	37.96	27.46	58.33	-	-
July	205.40	-	35.64	26.09	66.22	-	-
August	191.40	-	35.70	26.19	63.29	-	-
September	128.80	-	34.16	25.33	71.43	-	-
October	79.00	-	34.41	25.58	68.41	-	-
November	195.10	-	31.70	24.33	80.16	-	-
December	-	-	28.83	22.22	-	-	-

Udaipur

Month	Rainfall (mm)	Rainy days	Temperature (°C)		Relative Humidity (%)		Evaporation (mm/day)
			Max.	Min.	Morn.	Even.	
January 20	0.00	-	22.19	6.50	84.61	41.71	-
February	0.00	-	26.51	7.10	77.93	27.93	-
March	34.60	-	29.35	13.37	67.23	26.26	-
April	8.00	-	36.50	18.17	53.07	19.80	-
May	20.00	-	39.43	23.41	43.94	20.97	-
June	30.60	-	35.63	23.23	69.07	43.63	-
July	150.20	-	33.06	22.69	81.61	65.35	-
August	422.90	-	30.35	21.92	90.52	76.52	-
September	265.20	-	30.72	20.00	107.97	62.65	-
October	21.40	-	32.56	16.40	70.52	31.13	-
November	0.00	-	28.67	10.06	72.20	31.50	-
December	0.00	-	23.30	7.05	85.19	37.39	-

Vengurle

Month	Rainfall (mm)	Rainy days	Temperature (°C)		Relative Humidity (%)		Evaporation (mm/day)
			Max.	Min.	Morn.	Even.	
January 20	0.00	0	33.27	17.98	90.72	64.40	-
February	0.00	0	35.00	18.39	88.25	54.72	-
March	0.00	0	35.00	23.02	76.11	66.69	-
April	0.00	0	35.67	23.71	80.20	67.57	-
May	25.00	1	36.40	25.91	77.58	70.35	-
June	1218.40	22	32.41	23.81	92.47	83.40	-
July	1395.80	25	31.15	23.69	93.77	86.97	-
August	973.60	28	31.35	23.61	93.58	84.35	-
September	867.00	23	31.90	23.33	94.37	79.90	-
October	389.00	12	33.10	23.42	92.81	78.71	4.48
November	0.00	0	35.34	20.65	86.40	69.93	4.88
December	4.00	1	34.67	18.62	91.48	66.58	4.12

Max=Maximum, Min=Minimum
Morn. = Morning, Even. = Evening

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