

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

**ICAR-All India Coordinated
Research Project on Fruits**

वार्षिक प्रतिवेदन
**Annual Report
2019**



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



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वार्षिक प्रतिवेदन २०१९
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Preface



I have great pleasure in presenting the progress of the All India Coordinated Research Project on Fruits for the period January to December 2019. The highlights of the report are drawn from the results of the experiments conducted at different centres. During the period under report, a total of 26 accessions in banana, 11 in Citrus, 19 in guava, 56 in jackfruit and 69 in mango have been added to the existing germplasm collections. Evaluation of promising clones of banana has revealed that BRS Selection *Popoulu sp.* under the plantain group (AAB) and NRCB selection-10 under ABB group (Pisang Awak/ Karpurvalli group) have recorded higher bunch weight, productivity and profitability compared with their respective checks. In grapes, MACS 516 was found superior with respect to yield and quality parameters (juice recovery, TSS & acidity), hence released for cultivation in four states. Superiority of macro propagated banana plants have been noticed with increased yield ranging from 26 to 70 percent over the sucker raised banana plants at different centres and has been the farmer friendly propagation technology to multiply regional varieties. The papaya grown under net house performed better in recording higher marketable fruits (82-85%) and quality attributes besides the protection of papaya plants from PRSV incidence at three locations (Anantharajupet, Gandevi and Coimbatore). Survey results indicated that fruit rot of jackfruit is the common disease at all the centres. In grapes, with the advisory support of 'online interactive weather information-based diseases and insect pest assessment', there has been saving in the cost of cultivation to the tune of around Rs. 50,000/- across different centres besides reduction in the usage of pesticides.

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. 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. W.S. Dhillon, 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 place on record my sincere thanks to Dr. S.K.Singh, Pusa for the hindi translation of executive summary.

I thank the staff of Project Coordinator (Fruits) Unit, ICAR-IIHR, Bengaluru and Dr. Sridhar Gutam for his efforts in bringing out this report timely and with high quality. Assistance of Mrs. Jeevitha S, Ms. Shweta Maruti Sutagatti, Ms. Pooja N U, Ms. Shwetha H K, Mr. Manjunatha C, Ms. Divya R, Mr. Nagaraja M R, Mrs. Sheela, 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 July 2020

(Prakash Patil)

Project Coordinator (Fruits) Acting

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Acronyms and Abbreviations

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

विशिष्ट सारांश

भा.कृ.अनु.प.-अखिल भारतीय समन्वित फल अनुसंधान परियोजना का उद्देश्य बहुस्थानीय परीक्षण के माध्यम से किस्मों एवं संकरों की पहचान एवं विमोचन, राष्ट्रीय सक्रीय जननद्रव्य साइट (एनएजीएस) के साथ जननद्रव्यों के मूल्यांकन और वृद्धि के अतिरिक्त सुरक्षित आवृत्तियों का अनुरक्षण, उत्पादक-सामग्रियों की उपयोग-दक्ष तकनीकियों और विभिन्न कृषि-जलवायु क्षेत्रों में पौध-स्वास्थ्य-प्रबंधन तकनीकियों का मूल्यांकन इस परियोजना का उद्देश्य है। प्रमुख क्षेत्रों में केला एवं आम की सस्योत्तर हानि का मूल्यांकन इस परियोजना का अधिदेश है। वर्तमान में अखिल भारतीय समन्वित फल अनुसंधान परियोजना के तहत 50 केन्द्र हैं, जिनमें राज्य कृषि विश्वविद्यालय के अधीन 30, भारतीय कृषि अनुसंधान परिषद के संस्थानों के अधीन 14, केन्द्रीय कृषि विश्वविद्यालय के अधीन 4, केन्द्र और निजी क्षेत्र में एक केन्द्र एवं अरुणाचल प्रदेश सरकार के तहत एक केंद्र शामिल हैं। इनमें से 23 केन्द्र आम पर, 16 केन्द्र अमरूद पर, 13 केन्द्र केले पर, 12 नींबूवर्गीय फलों पर, 09 पपीता पर, आठ आठ केन्द्र लीची एवं अंगूर पर, 05 केन्द्र कटहल पर और 04 केन्द्र चीकू पर अनुसंधान कार्य कर रहे हैं। वर्ष 2019-2020 में बजट भारतीय कृषि अनुसंधान परिषद के हिस्से के अधीन रु. 26.88 करोड़ था। इस परियोजना के तहत की गई प्रगति का संक्षिप्त विवरण विभिन्न उप-शीर्षकों के माध्यम से प्रस्तुत किया गया है:

फसल आनुवंशिक संसाधन

उक्त अवधि के दौरान मौजूदा जननद्रव्य संग्रहों में केले के 26, नींबूवर्गीय फलों के 11, अमरूद के 19, कटहल के 56 और आम के 69 एक्सेशनों को जोड़ा गया। आम में विभिन्न केन्द्रों के जननद्रव्य खण्डों के कुल 415 एक्सेशनों की प्रतिलिपियों को निकालने के लिए पहचान की गई।

फसल-सुधार

केले के उन्नत क्लोनों के मूल्यांकन से पता चला कि प्लेन्टेन समूह (एएबी) के अधीन बीआरएस चयन, पोपुलस स्पीशीज़ और एबीबी समूह (पिसंग अवाक/कर्पूरवल्ली समूह) के अधीन एनआरसीबी चयन-10 में उनके चेक किस्मों की तुलना में अधिक गुच्छ-वजन, उत्पादकता

और लाभकारिता दर्ज किया गया।

एसिड लाइम के उन्नत क्लोनों का मूल्यांकन किया गया, परिणामों के अनुसार सर्वाधिक संख्या में फल अकोला में क्लोन पीडीकेवी में 125.20 फल / वृक्ष दर्ज किया गया, राहुरी में टीएल-94/14 में 748.01 फल / पेड़ एवं एनआरसीसी नींबू-3 में नागपुर, तिरुपति और पेरियाकुलम में क्रमशः 887.67, 236.50 और 436 फल / वृक्ष दर्ज किया गया।

अंगूर की ताजा उपयोग किए जाने की रंगीन किस्मों का मूल्यांकन किया गया, जिसमें मंजरी श्यामा (ए-18 / 3) की उच्चतम उपज एवं गुणवत्ता मानकों में श्रेष्ठता पेरियाकुलम (थेनी) में देखा गया।

किशमिश के लिए अंगूर की विभिन्न किस्मों का मूल्यांकन पेरियाकुलम में किया गया जिसमें, थॉम्पसन सीडलेस ने उपज और गुणवत्ता मानकों (टीएसएस और किशमिश रिकवरी) के संबंध में श्रेष्ठ पाया गया इसके बाद 2 ए-क्लोन, उपज और गुणवत्ता मानकों (टीएसएस और किशमिश रिकवरी) बेहतर पाया गया।

अंगूर की विभिन्न किस्मों का रस के मूल्यांकन किया गया जिसमें, एमएसीएस 516 को मंजरी मेडिका से उपज और गुणवत्ता मानकों (रस वसूली, टीएसएस और अम्लता) के संबंध में बेहतर पाया गया।

फसल-उत्पादन

विभिन्न केंद्रों (अराभावी, गंडवी और जोरहाट) पर किये गए अनुसंधान के अनुसार मैक्रो प्रोपागेशन विधि से तैयार केले के पौधे में प्रकंद विधि से तैयार केले के पौधों की तुलना में 26 से 70 प्रतिशत अधिक उपज के साथ-साथ, 3 से 90 दिन कम पौधों की फसल अवधि दर्ज किया गया।

नींबू में पोषक तत्वों के जैविक स्रोतों के मानकीकरण परीक्षण ने संकेत दिया कि केंचुआ खाद के माध्यम से नत्रजन की अनुशंसित मात्रा के 75 प्रतिशत के साथ में ट्राइकोडर्मा हरजियानम (30-40 मि.ली./पौधा), एजाडिरेक्टिन (1% छिड़काव के रूप में 3-4 मि.ली./ली.) और स्यूडोमोनास फ्लूरसेंस (30-40 मि.ली./पौधा) के प्रयोग से अधिक उपज अकोला, तिनसुकिया दर्ज की

गई और संतरा में राहुरी में। यह उपचार मंदारिन(मंडारिन) में 34% और 88% अधिक उपज क्रमशः अकोला एवं तिनसुकिया में दर्ज किया गया, जिसकी तुलना 100% अकार्बनिक उर्वरकों की संस्तुति मात्र से किया जा सकता है। राहुरी में मीठे नारंगी(स्वीट ऑरेंज) में भी इसी तरह के परिणाम सामने आए थे, जिसमें 35 प्रतिशत की बढ़ी हुई उपज दर्ज की गई थी।

अमरूद में पोषक तत्वों के उपयुक्त जैविक स्रोत को मानकीकृत करने के लिए परीक्षण में पाया गया कि, वर्मीकम्पोस्ट (30 किग्रा / पौधा) + एज़ोस्फिरिलम कल्चर + पीएसबी @ 250 ग्राम / वृक्ष) के प्रयोग से लुधियाना में प्रति पौधे अधिकतम संख्या में फल एवं उपज(किग्रा) दर्ज किया गया (379.7 और 67.60 किग्रा / पेड़), संगारेड्डी (350 एवं 45.50 किग्रा / पेड़) और वेंगुर्ले में (78.67 और 16.36 किग्रा / पेड़)। यह उपचार उच्च TSS युक्त फलों के उत्पादन में प्रभावी था, संगारेड्डी में 12°B और वेंगुर्ले 10.20°B टीएसएस दर्ज किया गया। इसके अलावा अधिकतम एज़ोस्फिरिलम की गणना, वेन्गुरले और लुधियाना में क्रमशः 44 और 40.08 CFU / ग्राम $\times 10^5$ इसी उपचार में दर्ज किया गया।

अमरूद में सघन खेती के तहत उत्पादक-सामग्री की उपयोग-दक्षता को बढ़ाने के लिए ऊँची क्यारी खेती + टपक सिंचाई + फर्टिगेशन(75% अनुशंसित उर्वरक) + यूवी स्थिरीकृत काली पॉलिथीन (100 माइक्रान का) से पलवार + सूक्ष्म पोषक तत्वों का छिड़काव (ज़िंक सल्फेट एवं बोरिक अम्ल @ 0.2%) के संयोजित उपचार से 1.7 से लेकर 2.6 गुणा अधिक उपज, चेक की तुलना में सभी केन्द्रों(लखनऊ, मोहनपुर, पंतनगर, पेरियाकुलम, रीवा और उदयपुर)पर दर्ज किया गया।

अमरूद में अरका माइक्रोबियल कंसोर्टियम (एएमसी) के प्रभाव के प्रारंभिक परिणामों ने संकेत दिया है कि 75 % नत्रजन एवं फॉस्फोरस की संस्तुति मात्रा + एएमसी का मिट्टी के प्रयोग @ 12.5 किलोग्राम / हेक्टेयर का वर्ष में दो बार सड़े गोबर की खाद के प्रयोग के परिणामस्वरूप फल के उपज, टीएसएस और एस्कॉर्बिक एसिड की मात्रा में क्रमशः, पंतनगर में (73.15 किग्रा / पेड़, 13.21° B एवं 245.72 मिलीग्राम / 100 ग्राम) और उदयपुर (38.50 किग्रा / पेड़, 13.80 ° B & 186 मिलीग्राम / 100 ग्राम) दर्ज किया गया।

मेडज़िपेमा में 50 प्रतिशत प्राथमिक शाखाओं में 4 मिमी के साथ शाखाओं की गर्डलिंग करने से फूल उत्पन्न करने वाली शाखाओं में चेक के मुकाबले 7 प्रतिशत की वृद्धि और अधिकतम फल फल का लगना (150 फल / टहनी) दर्ज किया गया, जो चेक से दो गुना ज्यादा है। गर्डलिंग करने से सभी स्थानों पर बिना गर्डलिंग करने की तुलना में फल की उपज में भारी वृद्धि दर्ज किया गया।

सिंचाई और मल्लिंग का निर्धारण 19 वर्षीय लीची प्रजाति रेड सेंटेट पर किया गया। पंतनगर में लीची प्रजाति रेड सेंटेट पर किये गए प्रयोग में प्लास्टिक मल्ल के साथ 100 प्रतिशत ईआर के साथ सिंचाई उपचार पिछले दो वर्षों में न्यूनतम फल गिरावट (60.75%) और उपज (27.08 किग्रा / वृक्ष) के साथ लगातार परिणाम दर्ज किया है। इसी तरह, 15 वर्षीय लीची प्रजाति शाही पर रांची में पिछले दो वर्षों से किये गए प्रयोग से उपरोक्त उपचार में अधिकतम उपज (36.03 किलोग्राम / पेड़) दर्ज किया गया। जबकि, मोहनपुर में बॉम्बे ने 50 प्रतिशत ER + मल्ल के साथ अधिकतम टीएसएस (24.40°B), फलों का वजन (24.50 ग्राम) और उपज (91.00 किलोग्राम / पेड़) दर्ज किया है।

सड़ी गोबर की खाद (एफवाईएम) 50 किलो के साथ 250 ग्राम एज़ोटोबैक्टर के प्रयोग से आम में संगारेड्डी में निरंतर फल की उपज वृद्धि के साथ उर्वरकों की संस्तुति मात्रा (आरडीएफ) में 50 प्रतिशत की कमी दर्ज किया गया है। पिछले चार वर्षों से इसी तरह के परिणाम स्थिरता देखी गई है। जबकि वेंगुर्ले में, जिंक सल्फेट (0.5%) + बोरिक अम्ल (0.2%) + मैग्नीशियम सल्फेट (1%) + कैल्शियम (0.6%) का दो पर्णिय छिड़काव (अगस्त और अक्टूबर) एवं 10 सेंटीमीटर मोटी जैविक पलवार करने से, उर्वरकों की संस्तुति मात्रा को 50 प्रतिशत कम करने में एवं उपज में 32.4 प्रतिशत की वृद्धि चेक की तुलना में दर्ज किया गया। जबकि वेंगुरले में, सड़ी गोबर की खाद (एफवाईएम) (50 किग्रा / वृक्ष) + एज़ोस्फिरिलम कल्चर का प्रयोग @ 250 ग्राम / पेड़ + पीएसबी @ 250 ग्राम प्रति पेड़ करने से फल / वृक्ष एवं उपज/ वृक्ष (26 फल / वृक्ष और 8.05 किग्रा / वृक्ष) में वृद्धि दर्ज किया गया है। पिछले तीन वर्षों से परिणामों में स्थिरता देखी गई है।

आम में सूक्ष्म पोषक तत्वों के प्रभाव का मूल्यांकन हेतु

किये गए परीक्षण से पता चला है कि कटाई के बाद उर्वरकों की सस्तुति मात्रा (आरडीएफ) + 100 ग्राम जिंक सल्फेट + 50 ग्राम कॉपर सल्फेट + 50 ग्राम बोरिक अम्ल का मिट्टी में प्रयोग फूलों आने से पहले और फल में गुठली बनने से पूर्व करने से विभिन्न स्थानों यथा पंतनगर, पारिया, लखनऊ, पेरियाकुलम, मोहनपुर, अनंतराजुपेट और उदयपुर पर नियंत्रण की तुलना में काफी अधिक फलों की उपज में वृद्धि दर्ज किया गया है। जबकि, पंतनगर और वेंगुरले में, उर्वरकों की सस्तुति मात्रा (आरडीएफ) + 0.2% जिंक सल्फेट + कॉपर सल्फेट (0.1%) + बोरिक एसिड (0.1%) का आम में फूल आने से पहले और फल में गुठली बनने से पूर्व दो छिड़काव करने से उपज में भारी वृद्धि एवं काफी अच्छे गुणवत्तायुक्त फल प्राप्त हुए ।

नेट हाउस में उगाए गए पपीते में 82-85% तक बिक्री योग्य, उच्च गुणवत्ता के फल के साथ साथ पपाया रिंग स्पॉट वायरस में भी भारी कमी तीनों स्थानों (अनंतराजुपेट, गांडेवी और कोयंबटूर) में दर्ज किया गया ।

पपीते में उत्पादक-सामग्री के उपयोग की दक्षता को बढ़ाने के परीक्षण से पता चला कि अनंतराजुपेट एवं कोयंबटूर में ऊँची क्यारी खेती + टपक सिंचाई (80% वाष्पन पुनःपूर्ति) + फर्टिगेशन (75% अनुशंसित उर्वरक) + सूक्ष्मपोषक तत्वों का छिड़काव (एकांतर महीनों में 0.5 % जिंक सल्फेट एवं 0.2% बोरिक अम्ल) का संयोजित उपचार करने से) में उपज में 1.2 से 2.3 गुना तक वृद्धि विभिन्न स्थानों यथा, अनंतराजुपेट, कोयंबटूर और पूसा में दर्ज दिया गया।

पुराने चीकू (सपोटा) के बागों की (10x10 मीटर की दुरी) की उत्पादकता में सुधार करने के प्रयोगों से पता चला है कि, आर-पार की शाखाओं (क्रॉस) को काटने के साथ-साथ मध्य भाग को खोलने से सभी स्थानों यथा अराभवी में, गाँदेवी पेरियाकुलम में उपज में 33 से 64 प्रतिशत की वृद्धि दर्ज किया गया ।

चीकू (सपोटा) बीज छेदक के इन्फेक्शन के कारण क्षेत्र की स्थिति के तहत बाजार में आने वाले फलों के नुकसान का आकलन किया गया जिसमें किर्थीर्थी, डीएचएस -1 और डीएचएस -2 ज्यादा आक्रांत थे जबकि सीओ -1 और सीओ -3 में कम आक्रांत थे लगातार चार साल से गाँदेवी और पेरियाकुलम दोनों स्थानों यही स्थिति है ।

फसल-संरक्षण

सर्वेक्षण से संकेत मिलता है कि आभासी तना भेदक कीट (ओदोइपोरुस लॉगिकोल्लिस) का आसाम में सक्रमण 20% तक देखा गया, जबकि यही कीट मोहनपुर में जनसंख्या 0.22 - 5.64 / पौधा पाया गया । रूगोसे स्पिरालिंग सफ़ेद मक्खी का मोहनपुर में सक्रमण 3-5% देखा गया। केले की तितली को जुलाई-सितंबर 2019 के दौरान 2 प्रतिशत से भी कम सक्रमण वेंगुरले में पाया गया था, जबकि कन्नारा में इस कीट का सक्रमण 0-10% दर्ज किया गया । गन्देवी के बालों वाले कैटरपिलर का सक्रमण 1-2% दर्ज किया गया ।

केले के स्कारिंग बीटल को प्रभावी तरीके से प्रबंधित करने के लिए क्लोरपायरीफॉस 20EC @ 4 मिली/लीटर से मृदा शोधन + गुच्छा पर ऐसीफेट(0.1125%) का गुच्छा (बंच) में पहला हत्था निकलने के समय छिड़काव करने के बाद में गुच्छा को पॉलीप्रोपाइलीन बैग से ढक देते हैं, बिना किसी पहचाने जाने वाले कीटनाशक अवशेषों के ।

रूगोसे स्पिरालिंग सफ़ेद मक्खी के प्रबंधन में उनकी प्रभावकारिता के मूल्यांकन हेतु विभिन्न जैव-गहन उपचारों में अज़िरेक्टिन 10000 पीपीएम @ 3 मिली / लीटर का पर्णिय छिड़काव, एक एक महीने के अंतराल पर तीन बार छिड़काव करने से इस कीट को प्रभावी ढंग से नियंत्रित किया गया, जिससे क्षति में 68 से 75 प्रतिशत की कमी दर्ज की गई (कन्नारा और पेरियाकुलम में) ।

फ्यूजेरियम विल्ट रोग के प्रबंधन के लिए बेहतर सर्वोत्तम उपचारों की पुष्टि हेतु किये गए एक परीक्षण में पाया गया की रोग मुक्त क्षेत्र से लिए गए प्रकंद को 30 मिनट के लिए कार्बेन्डाजिम 0.2% के घोल में डूबने के बाद, नीम केक @ 250 ग्राम / पौधा के हिसाब से पौधे लगाने के बाद कार्बेन्डाजिम 0.2% का घोल रोपाई के बाद 2^{वें}, 4^{वें} और 6^{वें} महीने और कार्बेन्डाजिम @ 3 मिली , 2% के घोल से इंजेक्शन, रोपाई के 3^{वें} , 5^{वें} और 7^{वें} महीने) में देने से फ्यूजेरियम विल्ट रोग को कन्नारा केंद्र पर प्रभावी तरीके से प्रबंधित किया गया पाया गया ।

केले के यूमुसे पर्ण धब्बे के प्रबंधन के लिए रसायनों (प्रोपिकोनाज़ोल / कार्बेन्डाजिम / मेन्कोज़ेब / ट्राईफ्लोक्सेरोबोन/ टेबुकोनाज़ोल/ डायफेनोकोनाज़ोल)

और खनिज तेलों के छिड़काव के संयोजित उपचार से मानक चेक की तुलना में रोग-तीव्रता सूचक में 17-74 पीडीआई की कमी अराभावी, कन्नारा, कोव्वुर और मोहनपुर में दर्ज किया गया।

केले के पूवन प्रजाति के एपिसोमल टिशू कल्चर (बीएसवी मुक्त पौधे) का मूल्यांकन किया गया एवं अराभावी, भुवनेश्वर, कोयम्बटूर, जलगांव और मोहनपुर में केला स्ट्रीक वायरस (बीएसवी) का संक्रमण नहीं पाया गया, जबकि कन्नारा में 72 में से मात्र दो टिशू कल्चर पौधे में (रटून) बीएसवी के लक्षण देखे गए।

फलों के चूसने वाले कीटों के नियंत्रण के लिए, पेट्रोलियम तेल के 2% का छिड़काव प्रभावी रहा है और सभी परीक्षण केंद्रों पर 8.10 से 24.40% तक कम फल झाड़ना दर्ज किया गया। जबकि, नीम के तेल के 1% के छिड़काव ने भी फलों की गिरावट को 8.74 से घटाकर 30.80 प्रतिशत कर दिया है। चेक (नियंत्रण) में फल गिरने की सीमा 48.75 से 54.7 प्रतिशत थी।

पेरियाकुलम और तिनसुकिया में प्रोपरगाइट 57 उड़ @ (0.057%) और राहुरी और तिरुपति में सिट्रस माइट्स के खिलाफ स्पिरोमिसेफेन 240 एससी (0.009%) की श्रेष्ठता देखी गई है, इसलिए इसकी सिफारिश की किया गया है।

मैंडरिन में फाइटोफथोरा जड़ गलन रोग के एकीकृत प्रबंधन के लिए किये गए प्रयोगों के तहत, अकोला, लुधियाना और तिनसुकिया में पोटेशियम फॉस्फेट @ 3 ग्राम / लीटर के प्रयोग को अत्यधिक प्रभावी माना गया है, जिससे ट्रंक के घाव के आकार में 37 से 67% की कमी दर्ज किया गया।

सिट्रस हरीतन के समेकित प्रबंधन के लिए फास्फोरस (अनुशंसित मात्रा से 50% अधिक) के साथ में टेट्रासाइक्लिन हाइड्रोक्लोराइड (600 पीपीएम), जिंक सल्फेट एवं फेरस सल्फेट (प्रत्येक 200 ग्रा. / पौधा) का प्रयोग इस रोग की उग्रता को कम करने में प्रभावी रहा है। अकोला, लुधियाना, पेरियाकुलम, राहुरी, तिनसुकिया और तिरुपति में सिट्रस हरीतन रोग की उग्रता में 11 से 34 प्रतिशत की कमी चेक की तुलना में दर्ज किया गया।

अंगूर में आनलाईन इंटरैक्टिव मौसम सूचना-आधारित रोग एवं कीट मूल्यांकन की परामर्श - सहायता की

वजह से खेती की लागत में विभिन्न केंद्रों पर लगभग रु 50,000 / हेक्टेयर की बचत हुई है, जो कि छिड़काव की संख्या में कमी (डाउनी मिल्ड्यू के लिए 8 छिड़काव की कमी और पाउडरी मिल्ड्यू के लिए 6 छिड़काव की कमी) के कारण हुआ है।

सपोटा में बीज छेदक कीट के प्रभावी प्रबंधन के लिए, डेल्टामेथिन और बीटी के चार एकांतर प्रयोग गंदेवी और पेरियाकुलम केंद्रों पर प्रभावी रहे, जिसमें चेक की तुलना में फलों के नुकसान में 65 से 85 प्रतिशत की कमी दर्ज किया गया।

फसल कटाई के बाद का आकलन

भारत में विभिन्न स्थानों पर केले में कटाई के बाद के नुकसान के आकलन पर पायलट पैमाने के अध्ययन ने शुरुआत में क्षेत्र स्तर पर 1.21 से 6.8 प्रतिशत के नुकसान का संकेत दिया। हालांकि, जब यह रिटेलर के पास पहुंचा, तो घाटा 3.6-16.7 फीसदी हो गया। अंगूर में पायलट पैमाने पर फसल के बाद के नुकसान के आकलन ने संकेत दिया है कि पुणे में 14.1 प्रतिशत (ICAR-NRCG) और राहुरी में 21.0 प्रतिशत नुकसान हुआ है।

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. This project has also been mandated for assessment of post-harvest losses of banana and mango in major production. 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, 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 2019-20 was INR 26.88 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 26 accessions in banana, 11 in sCitrus, 19 in guava, 56 in jackfruit and 69 in mango have been added to the existing germplasm collections. In mango, a total of 415 duplicate accessions in the germplasm block of different centres have been identified to be eliminated.

Crop improvement

Evaluation of promising clones of banana has revealed that BRS Selection *Popoulu sp.* under the plantain group (AAB) and NRCB selection-10 under ABB group (Pisang Awak/ Karpurvalli group) have recorded higher bunch weight, productivity and profitability compared with their respective checks.

Among the different promising clones of acid lime evaluated, maximum number of fruits were recorded in clone PDKV lime at Akola (125.20 fruits/tree), TAL-94/14 at Rahuri (748.01 fruits/tree), NRCC Nimboo-3 at Nagpur, Tirupati and Periyakulam (887.67, 236.50 & 436 fruits/tree respectively).

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 at Periyakulam (Theni).

Evaluation of raisin varieties indicated that at Periyakulam, Thompson seedless has recorded superior values followed by 2A-clone with respect to yield and quality parameters (TSS & raisin recovery).

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.

Crop production

Superiority of macro propagated banana plants have been noticed with increased yield ranging from 26 to 70 percent over the sucker raised banana plants at different centres. Further, the crop duration of these plants was also reduced from 3 to 90 days over the sucker raised plants at different locations (Arabhavi, Gandevi and Jorhat).

Results on standardising the organic source of nutrients in Citrus indicated that application of 75 per cent recommended dose of N through vermicompost along with addition of *Trichoderma harzianum* (30-40 ml/plant) *Azadirachtin* (1% at 3-4 ml/l as spray) and *Pseudomonas fluorescens* (30-40 ml/plant) has been productive for mandarin at Akola and Tinsukia and sweet orange at Rahuri. This treatment in mandarin enhanced fruit yield to the tune of 34 per cent and 88 per cent at Akola and Tinsukia respectively which is comparable to application of 100% RDF through inorganic source. Similar results were also reported in sweet orange at Rahuri which recorded enhanced yield of 35 per cent.

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 and yield at Ludhiana (379.7 & 67.60 kg/tree), Sangareddy (350 & 45.50 kg/tree) & Vengurle (78.67 & 16.36 kg/tree). The treatment was also effective in producing the fruits of higher TSS at Sangareddy (12°B) and Vengurle (10.20°B). In addition, maximum *Azospirillum* population count was recorded in the same treatment at Vengurle and Ludhiana (44 & 40.08 CFU/g x10⁵ respectively).

Under HDP in guava, treatment combination of raised bed cultivation + drip irrigation + fertigation (75% RDF) + mulching with 100-micron UV stabilized black polythene + micro nutrients spray (ZnSO₄ & H₃BO₃ @ 0.2%) proved to be input efficient and recorded higher yield to the tune of 1.7-2.6 folds

increase over check across all the centres (Lucknow, Mohanpur, Pantnagar, Periyakulam, Rewa and Udaipur respectively).

Initial results on the effect 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, TSS and ascorbic acid content at Pantnagar (73.15 kg/tree, 13.21°B & 245.72 mg/100 g respectively) and Udaipur (38.50 kg/tree, 13.80°B & 186 mg/100g).

The trial to improve the productivity in litchi, the treatment involving girdling of branches with 4 mm in 50 per cent primary branches at Medziphema, gave maximum flowered shoots to the tune of 7 per cent increase over check. Similarly, maximum fruit set (150 fruits/panicle) was obtained by the same treatment to the tune of two-fold increase over check. Irrespective of locations, girdling treatments markedly improved fruit yield as compared to un-girdled plants.

Scheduling of irrigation and mulching on 19-year-old litchi cv. Rose Scented at Pantnagar revealed that the irrigation treatment with 100 per cent ER along with plastic mulch has recorded consistent results from past two years with minimum fruit drop (60.75%) and yield (27.08 kg/tree). Similarly, 15-year-old cv. Shahi at Ranchi has also recorded maximum yield (36.03 kg/tree) by the same treatment from last two years. Whereas, at Mohanpur, cv. Bombai has recorded maximum TSS (24.40 °B), fruit weight (24.50 g) and yield (91.00 kg/tree) in 50% ER with mulch.

Application of 250 g of *Azotobacter* along with 50 kg FYM has reduced the RDF by 50 per cent in sustained fruit yield in mango at Sangareddy. The consistency in results has been observed for the past four years. Whereas, at Vengurle application of RDF + $ZnSO_4$ (0.5%) + H_3BO_3 (0.2%) + $MnSO_2$ (1%) + $CaCl_2$ (0.6%) as 2 foliar application (August and October) + organic mulching 10 cm thick has reduced the RDF by 50 per cent in getting higher yield of 32.4 per cent compared to control.

Result on the use of organic source of nutrient in mango has revealed that application of vermicompost (50 kg/tree) + *Azospirillum* culture @250 g/ tree + PSB @ 50 g/tree + *vermiwash* has significantly increased the yield at Paria (190.11 fruits /tree & 54.51 kg/tree), Lucknow (493 fruits/tree & 146.22 kg/tree) and Sabour (236.59 kg/tree) whereas at Vengurle, application of FYM (50 kg/tree) + *Azospirillum* culture @250 g/tree + PSB @250 g

per tree has increased the yield (26 fruit/tree and 8.05 kg/tree). The consistency in results has been observed for the past three years.

Trial for evaluating the effect of micronutrients in mango has revealed that application RDF + 100 g $ZnSO_4$ + 50 g $CuSO_4$ + 50 g H_3BO_3 (soil application) basins after harvest followed by foliar spray of 0.2% $ZnSO_4$ + 0.1% $CuSO_4$ + 0.1% H_3BO_3 (2 sprays at just before flowering and at marble stage) has recorded significantly higher fruit yield as compared to control across different locations (Pantnagar, Paria, Lucknow, Periyakulam, Mohanpur, Anantharajupet and Udaipur). Whereas, at Pantnagar and Vengurle, application of RDF + Foliar spray of 0.2% Zinc sulphate + Copper sulphate (0.1%) + Boric acid (0.1%) [2 spray at just before flowering and marble stage] has recorded higher fruit yield with good fruit quality compare to control.

The papaya grown under net house performed better in recording higher marketable fruits (82-85%) and quality attributes besides the protection of papaya plants from PRSV incidence at three locations (Anantharajupet, Gandevi and Coimbatore).

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% at alternate months) has enhanced the yield to the tune of 1.2 to 2.3 times compared to check at different location (Anantharajupet, Coimbatore and Pusa).

Pruning methods to improve the productivity of old sapota orchard revealed that at Arabhavi, Gandevi Periyakulam, centre opening along with cutting of cross branches at 10x10 m spacing has recorded 33 to 64 per cent increase in yield over the check at different locations (Arabhavi, Gandevi and Periyakulam).

Trial on assessment of losses due to seed borer in different varieties of sapota revealed that the loss of marketable fruits under field condition due to sapota seed borer infestation was higher in Kirthibarthi and DHS-1 and DHS-2 and was low in CO-1 and CO-3 consistently for four years at both Gandevi and Periyakulam conditions.

Crop protection

Surveys indicated the incidence of pseudostem weevil/ borer *Odoiporus longicollis* has been noticed in Jorhat with 20% infestation whereas at Mohanpur population of *Odoiporus longicollis* ranged from 0.22 – 5.64/plant. The infestation of fruit scarring beetle (*Basilepta subcostata*) (38%) and 2.26 to 16.90/

terminal leaf whorl was recorded in Jorhat and Mohanpur Respectively. Rugose spiraling whitefly infestation has been observed in Mohanpur with infestation level of 3-5%. Banana skipper butterfly was recorded in Vengurle, during July- September 2019 with less than 2 percent incidence, whereas at Kannara 0-10% incidence was recorded. At Gandevi hairy caterpillar (1 to 2) infestation was recorded.

Banana scarring beetle was effectively managed by soil application of chlorpyrifos 20EC @ 2% (4ml/l) + bunch spraying with acephate (0.1125%) just after first-hand opening followed by bunch cover with polypropylene bag with no detectable pesticide residue recorded.

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 68 to 75 per cent reduction in damage over control at Kannara and Periyakulam.

A trial on validation of superior best treatments for the management of *Fusarium* wilt disease revealed that treatment of planting 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 months after planting) and carbendazim injection @ 3ml of 2% solution (3rd, 5th and 7th months after planting) was effective at Kannara.

For *Eumusae* leaf spot management of banana, alteration of spray of chemicals (propiconazole /carbendazim/mancozeb/trifloxystrobin/tebuconazole/difconazole) with mineral oil has recorded least disease severity and has resulted in reduction in the use of chemicals. The percent reduction in disease severity ranged from 17 to 74 percent across the centres (Arabhavi, Kannara, Kovvur and Mohanpur) over control.

Evaluation of episomal tissue cultured plants (BSV free plants) of banana cv. Poovan have clearly indicated the freeness from BSV incidence at Arabhavi, Bhubaneswar, Coimbatore, Jalgaon and Mohanpur. However, at Kannara, two out of 72 tissue culture plants (ratoon) were infected with BSV.

For the control of fruit sucking moths, petroleum spray oil (2%) has been effective and showed minimum fruit drop at all the tested centres (8.10 to 24.40%). However, neem oil (1%) has also reduced the fruit drop to the tune of 8.74 to 30.80 per cent. The extent of fruit drop in control was 48.75 to 54.7 per cent.

Superiority of propargite 57EC @ (0.057%) at Periyakulam and Tinsukia and spiromesifen 240 SC (0.009%) at Rahuri and Tirupati against Citrus mites has been observed, hence has been recommended.

For integrated management of *Phytophthora* root rot in mandarin, application of potassium phosphonate @ 3 g/l as foliar spray has been highly effective in recovery of trunk lesion size (37 to 67 %) at Akola, Ludhiana and Tinsukia.

Trials on integrated management of Citrus greening indicated that application of higher dose of phosphorus (50% more than the recommended dose) along with tetracycline hydrochloride (600 ppm), ZnSO₄ and FeSO₄ (each at 200 g/plant) has been effective in reducing the disease severity to the tune of 11 to 34 per cent in Akola, Ludhiana, Periyakulam, Rahuri, Tinsukia and Tirupati over control.

With the advisory support of 'online interactive weather information-based diseases and insect pest assessment' in grapes, there has been saving in the cost of cultivation to the tune of around Rs. 50,000/- per ha across different centres, which has been due to reduction the number of sprays (reduction of 8 sprays for downy mildew and 6 sprays for powdery mildew).

For the effective management of seed borer in sapota, four-alternate application of deltamethrin and *Bt* has been effective for seed borer fruit damage with 65 to 85 percent reduction in the fruit damage over the control at different centres (Gandevi and Periyakulam).

Post-harvest loss assessment

Pilot scale studies on post-harvest loss assessment in banana at various places in India indicated the loss of 1.21 to 6.8 per cent initially at the field level. However, when it reached the retailer, the losses amounted to 3.6-16.7 per cent.

Pilot scale post-harvest loss assessment in grapes has indicated that the total loss of 14.1 per cent at Pune (ICAR-NRCG) and 21.0 per cent at Rahuri has been reported.

Experimental Results

BANANA

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

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

Arabhavi: A total of 61 accessions are being maintained. Among which four accessions namely Banglaseh Malbhog (AAB), Malaikali (AAB), Namarai (AA) and Popoulu (ABB) were characterized as per the minimum descriptor. A total of 22 accessions (AA-2, AB-3, AAA-2, AB-8 and ABB-7) were evaluated for agronomic traits under ratoon crop I and found that Sakkarebale (AAB-22.78 kg/plant), BCB-1 (ABB-22.50 kg/plant), Kothia (19.77 kg/plant) and NRCB-10 (ABB-19.57 kg/plant) were recorded maximum bunch weight and varieties like Sakkarebale, Ney poovan and Malaikali performed well for quality parameters.

Bhubaneswar: The germplasm field was severely affected by the occurrence of super cyclone Fani hence could not take any observation during the period under report. The side suckers were allowed to grow and now the suckers are in vegetative stage.

Coimbatore: A total of 206 accessions are being maintained. Exploration has added four new accessions namely Yethan, Kozhikode, Thozhuvan and Peyan Chakkai in germplasm. Evaluation of ten accessions of ABB genome revealed that Monthan, Ashy Batheesa and Alshy were superior for bunch yield (>20 kg). The highest number of fingers was registered in Bargner (162 fingers/bunch). The accessions, Malbhog and Valliya Kunnan recorded low natural incidence (10.0 PDI) of *Eumusae* leaf spot. Banana bunchy top incidence was observed in the accessions viz., Lacatan, Rasthali and Kothiah.

Gandevi: A total of 90 accessions are being maintained. Evaluation of 63 germplasm revealed that Narmine (ABB) recorded the higher bunch weight (20 kg). The maximum number of hands (11.00) and the higher finger per bunch (202.33) was recorded in Parakuni (ABB) and Yangambi (AAA) respectively. The accession Ambala kadali (AA) recorded in higher TSS (25.2°B).

Jalgaon: Exploration was made in Jalgaon and Nandurbar districts which resulted in collection of two new accessions. A total of 23 accessions are being maintained. Four accessions have been deposited to

NAGS centre, ICAR-NRCB, Trichy to confirm their uniqueness and to get IC number.

Jorhat: Eight new germplasm accessions were added to the collection viz., Garu Malbhog, Padma Kol, Bhatta Kol, Baja Athia, Wild Banana, Tezkol, Suti Kachkol and Sahab Kol. Among the 10 accessions evaluated to assess the performance under moisture stress, cv. Barjahaji (AAA) recorded higher yielder followed by Bogimonohar and Agnisagar.

Kannara: Three primary collections were made from Wayanad district and included in the germplasm. A total of six accessions were evaluated and found that among the ABBB genomic group progeny No. 5 recorded maximum bunch weight and progeny No. 95 recorded more number of fingers and progeny No. 6 recorded maximum finger weight (70g).

Kovvur: A total of 122 accessions are being maintained in the field. In evaluation of plant crop, among the different genomic groups Pisang Linin (AA) (155.33 days), Tatilla Kunnan (AB) (173.75 days), Jahaji (AAA) (175.50 days), Pisang Seribu (AAB) (167.50 days), Srisailam collection (ABB) (216.75 days), FHIA-17 (AAAA) (250.75 days) and PV-03-44 (AAAB) (180.75 days) recorded earlier shooting than other genotypes in the same genome group. Whereas, Pisang Jaribuya (AA) (221.25 days), Kappukadali (AB) (272.50 days), Valery (AAA) (281.25 days), KBS-1 (AAB) (278.66 days), Bluggoe (ABB) (289 days) and PA-03-44 (AAAB) (293 days) were found to be short duration type among their respective genomic recorded earlier harvesting than other genotypes in the same genome group.

Mohanpur: Among the ratoon yield analysis for two AAA accessions Tella Chakrakelli, Karim Kadali and four AAB accessions, Ladan, Kellar Ladan, Chennai and Virupaskhi, of which Chennai showed the highest bunch weight (12.20 kg), yield (30.50 t/ha). Highest TSS (22.40°B) was found in Kellar Ladan. The main crop analysis of two accessions revealed that Martaman showed better performance than Champa. Both are tolerant to Fusarium wilt and Sigatoka leaf spot.

Port Blair: A total of four wild banana accessions have been collected from Nicobar Islands.

Pusa: Three new local germplasms have been collected and included in the germplasm adding the total to 77 that are conserved and evaluated.

Tiruchirapalli: Morphotaxonomic characterization of 90 germplasm accessions of Gandevi centre has been

done. Of which 27 were found to be duplicates and for the remaining 63 accessions IC number have been given. Similarly, 116 germplasm accessions of Kovvur centre were subjected to morphotaxonomic characterization. Of which 28 accessions were duplicates and IC number given to 74 accessions. Seven accessions which are found to be unique were collected for further evaluation at NAGS centre to get the IC number.

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 *viz.*, high yield, good finger size, tolerance to pest and disease, tolerance to abiotic stresses, tolerance to nematode and organoleptic evaluation were taken up in various centres.

Arabhavi: Five superior clones of regional variety Rajapuri were collected on the basis of higher yield (15-18 kg bunch weight per plant) compared to commercial cultivar having bunch weight ranging. These clones were planted for further assessment.

Bhubaneswar: Two clones of Patkapura, two clones of Bantal and three clones of Champa are selected from the germplasm trial and the suckers are planted separately. On account of occurrence of 'Fani' cyclone in Bhubaneswar all the mother plants were toppled down. Side sword suckers were allowed to grow. The suckers are now in vegetative stage.

Coimbatore: No new clones were identified at Erode, Theni and Tirunelveli districts. The selected Quintal Nendran selection (2014-CBE-1QN-PC-2018) registered higher yield (24.28 kg/bunch) as compared to Nendran (11.03 kg/bunch), but the selection has a long duration (453 days) as compared to the check (325 days).

Gandevi: Among 20 clones collected during 2014, the Clone No. 7 (P_3) performed better. Clone No. 3 collected during 2015 (P_2) showed better performance among the collected 5 clones. While, among the collected 5 clones during 2016 (P_1) clone No. 4 showed better performance.

Jalgaon: During the reporting period a new selection from 'Shravani' village, Tehsil Navapur, Dist. Nandurbar on account of free from Sigatoka leaf under higher PDI conditions in adjoining areas has been collected and planted as 2018-SH-PC-2019 and is under vegetative growth stage.

Jorhat: Surveys were carried out in two agro climatic zones i.e. Upper Brahmaputra Valley Zone, and Central zone for selection of local superior clone of commercial importance, no improved clones could be located during reporting year.

Kannara: During the reporting period, eleven Nendran (AAB) clones, eight clones of Rasthali (Poovan, AAB) and three clones of Pisang Lilin (AA) collected from different parts of Kerala during the reporting period has been established in the field and evaluation is being carried out. The plants are in vegetative stage.

Kovvur: A clone of Tella Chakkerakeli was identified at Nutakki village of Guntur district from Shri Sivaramireddy field has recorded 160 fingers with eight hands per bunch. However, the clone was not performing well for yield and yield attributing characters after planting on the field.

Mohanpur: Two clones *viz.*, Kanthali and Champa were selected. Clones performed well with regards to bunch weight (23.4 and 19.7 kg /plant), TSS (25.8°, 24.4°B) and BC ratio (3.73 and 3.14). The clones of Kanthali, Martaman and Grand Naine clone recorded 44%, 29% and 30% more yield as compared to check Thonte, Martaman and Grand Naine respectively. The selected clones have been showing superiority over the commercial cultivars.

Pusa: Four promising clones *viz.*, Nepali Chinia (ABB), Martman Tepri (AAB), Martman Nemopur (AAB) and Martman Simara (AAB) along with Karpooravalli (ABB) and Malbhog (AAB) as check were planted. Presently, the clones are in vegetative stage.

1.2.3 B. Evaluation of new introductions of banana (MLT-2)

The trail has been initiated to study the performance of BRS selection Popoulu (AAB - Plantain group) and NRCB selction-10 (ABB-Pisang Awak group) compared to its check varieties and results of 2nd crop cycle (RC-I or PC-2) are presented below.

Arabhavi: First ratoon crop (RC-1), Popoulu recorded higher yield (55.20 t/ha) and bunch weight (17.89 kg) over the check variety Nendran (yield 36.69 t/ha and bunch weight 11.89 kg). In Pisang Awak group (ABB), NRCB-10 recorded higher yield (59.00 t/ha) and bunch weight (19.12 kg) over check variety Budubale (yield 40.36 t/ha and bunch weight 13.08 kg). The incidence of *Eumusae* (Sigatoka) leaf spot was less in Popoulu whreas, NRCB-10 was supposed to be suitable for wind prone areas (Fig 1-3).

Bhubaneswar: Trial plot was damaged due to occurrence of cyclone "Fani" and evaluation results could not be presented for the reporting period.

Coimbatore: The second plant crop (PC2) recorded higher yield in Popoulu (13.87 kg/bunch) as compared to Nendran (12.46 kg/bunch), while the performance of Manjeri Nendran was not satisfactory.

The yield of Karpooravalli was higher (16.39 kg/bunch) as compared to NRCB 10 (12.55 kg/bunch). Incidence of pseudostem borer in Popoulu, Manjeri Nendran, Nendran, fruit fly incidence in 'Popoulu' and *Fusarium* wilt in Karpooravalli and NRCB 10 were observed (Fig. 1-3).

Jorhat: The second plant crop (PC-2) at early vegetative growth stage.

Kannara: In second plant crop (PC2), Popoulu recorded higher bunch weight (16.10 kg), yield (40.25 t/ha) and B:C ratio (2.68) compared to Manjeri Nendran (12.66 kg) and Nendran (11.10 kg). Crop duration of Nendran was on par with Popoulu. Popoulu showed more tolerance to *Eumusae* leaf spot. The NRCB sel.-10 recorded significantly higher bunch weight (23.46 kg/plant) compared with the check variety Karpooravalli (19.93 kg bunch/plant). The incidence of *Eumusae* (Sigatoka) leaf spot was less in Popoulu (PDI 12.01) and NRCB-10(15.92) as compared to check Nendran and Karpooravalli (22.87 & 17.08 PDI respectively) (Fig. 1-4).

Kovvur: Among plantain group (ABB), Popoulu recorded higher bunch weight (19.51kg/plant) compared with check variety Nendran (5.75 kg/

plant). Whereas in Pisang Awak/ Karpuravalli group (ABB), NRCB-10 recorded significantly higher bunch weight (19.41 kg/plant) over check variety Nukala Bontha (9.75 kg/plant). Fruit quality of Nendran and Manjeri Nendran recorded better than Popoulu, while NRCB-10 recorded superior fruit quality with respect to TSS content. The incidence of *Eumusae* (Sigatoka) leaf spot was very less in Popoulu (PDI 0.00) and NRCB-10(1.16) as compared to check Nendran and Karpooravalli (13.04 & 7.54 PDI respectively) (Fig. 1-4).

Mohanpur: Ratoon crop-1 (RC-1) showed that Popoulu recorded higher bunch weight (12.60 kg), productivity (31.40 t/ha) and production economics (B:C ratio of 2.46) compared to check variety Nendran (10.95 kg, 27.25 t/ha & 2.10, respectively). While the local check variety Kanthali recorded better performance over the clone NRCB Selection-10 with respect to bunch weight (18.30 and 13.65 kg), productivity (45.61 and 33.98 t/ha) and B:C ratio (3.10 and 2.74) respectively. The dwarf clone NRCB-10 (1.95 m) escaped the damage of high wind) at early bearing. (Fig. 1-4).

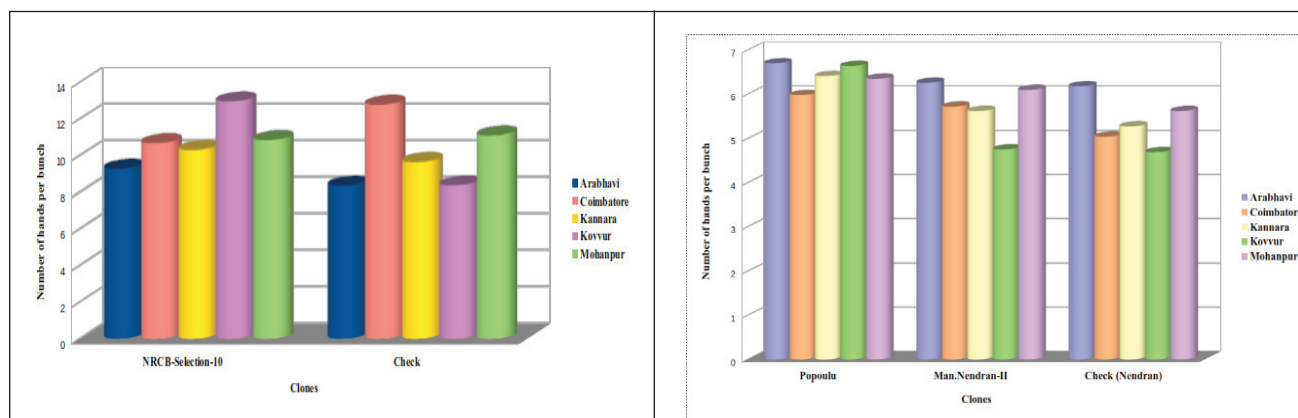


Fig.1 Performance of new clones of banana for hands per bunch

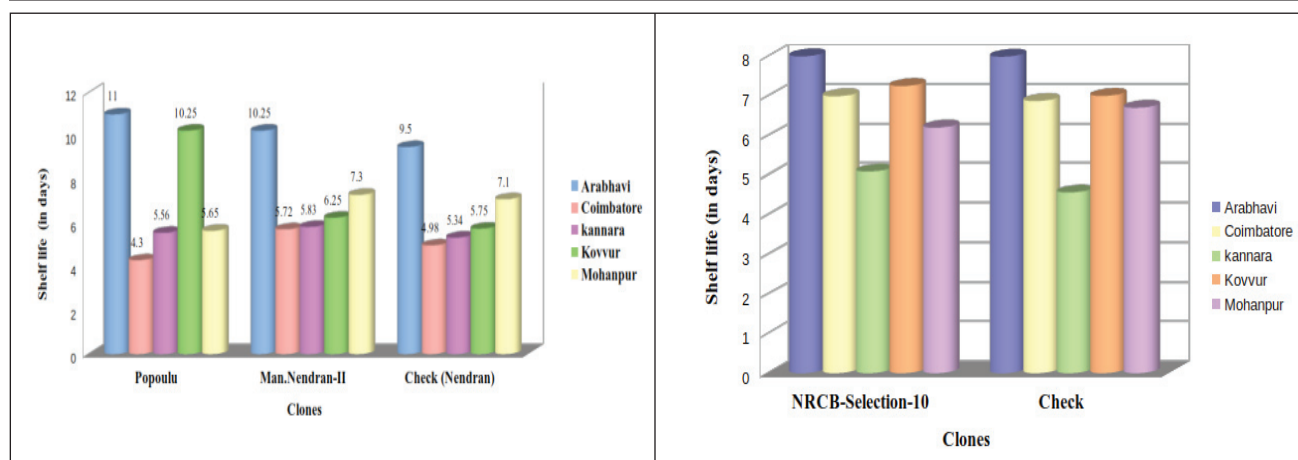


Fig.2 Performance of new clones of banana for shelf life

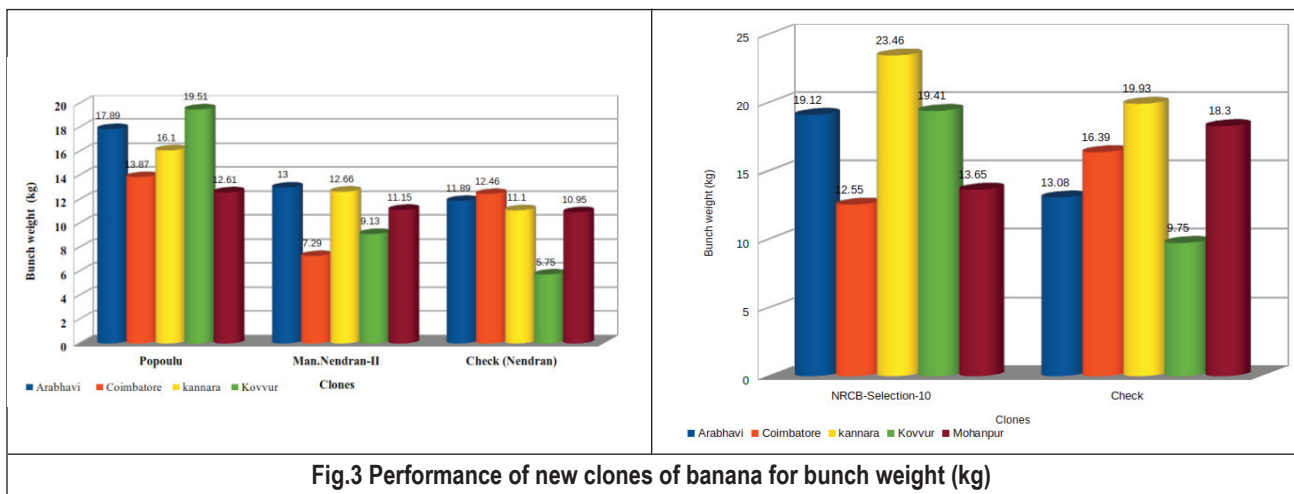


Fig.3 Performance of new clones of banana for bunch weight (kg)

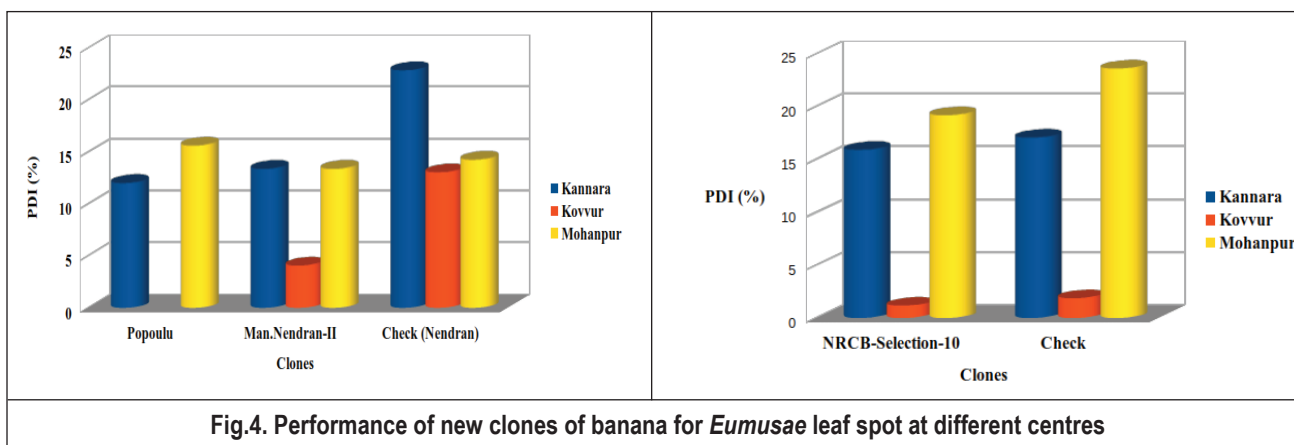


Fig.4. Performance of new clones of banana for *Eumusae* leaf spot at different centres

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

The trial was laid out in FRBD with three seasons of planting viz., S_1 =Feb-Mar; S_2 =June-July; S_3 =Oct-Nov and five varieties Grand Naine, Poovan, Ney Poovan, Red Banana and Monthan replicated twice in a spacing of 2x2 m. Suckers of the varieties were used as the planting material.

Port Blair: Early shooting (309 days) with minimum number of days from shooting to harvest (114.5 days), maximum TSS (22.6°B) was recorded in the variety Ney Poovan. The hands per bunch was maximum in Poovan (8.3) with maximum number of fingers per bunch in Grand Naine (101.3). Maximum bunch weight (12.3 kg) and yield per hectare (30 t/ha) was observed in Monthan.

Pantnagar: Monthan recorded maximum bunch weight (14.05 kg), yield (35.12 t/ha), shelf life (8 days) and minimum shooting to harvest duration (101 days), whereas the maximum number of hands/bunch (8 nos) was recorded in Poovan and Ney Poovan. The higher number of fingers/bunch (117 nos) was recorded in Poovan and the maximum TSS (22.31°B) was observed in Ney Poovan. From

suckers planted in July, 2018, fruits were harvested in all the four varieties Poovan, Ney Poovan, Monthan and Grand Naine maximum number of fingers/bunch (134) mbunch weight (19.91 kg), yield (49.78 t/ha) and the minimum shooting to harvest duration (66 days) was recorded in Grand Naine.

Ludhiana: All the cultivars of banana were planted in field. The suckers of all the five varieties are well established in the field and the crop is at vegetative stage. Few sporadic bunches were noted that were affected with choke and did not yield any viable fruits except Grande Naine.

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

Virus free tissue culture bananas were evaluated for the occurrence of streak disease at all growth stages and confirmed through molecular analysis like RCA and RE analysis done at NRCB.

Arabhavi: The tissue culture plants have recorded significantly higher bunch weight (17 kg/ plant) and yield (52.46 t/ha) for TC ratoon (T_1) compared to sucker ratoon (T_2). An additional yield of 5.5 t/ha was obtained on ratooning TC poovan compared to suckers. Hands per bunch, fingers per bunch, finger

length, and finger girth and finger weight were also significantly higher for TC ratoon than suckers. Better fruit quality in terms of higher TSS (20.55 °B) and lower fruit acidity (0.44%) was recorded in TC Poovan than suckers (19.00°B and 0.53% respectively). Earliness in shooting and harvest was also observed in TC ratoon.

Bhubaneswar: Ratoon plants of TC and sucker Poovan are in vegetative stage. There was no significant difference in growth characters.

Coimbatore: No symptoms of occurrence of BSV were noticed in the tissue culture plants of Poovan.

Kannara: Bunch weight and yield recorded for TC ratoon were 18.86 kg/plant and 47.16 t/ha respectively and this was significantly higher than that of sucker ratoon. The number of hands and fingers were also significantly higher for TC ratoon. Two out of 72 tissue culture plants (ratoon) were infected with BSV. The infected samples were sent to ICAR - NRCB, Tiruchirapalli and BSV infection was confirmed.

Jalgaon: The ratoon crop is in vegetative stage. There was no expression of episomal BSV in ratoon crop of tissue culture banana cv. Poovan.

Mohanpur: TC ratoon plants recorded yield on par with sucker ratoon. But the number of fingers and finger weight of TC ratoon was more than sucker ratoon. Earliness in shooting and harvest was also observed in TC ratoon.

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

A trial was conducted to evaluate 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 2cm 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.

Arabhavi: Macro-propagated plants of Grand Naine and Rajapuri varieties has recorded maximum bunch weight (25.65 & 15.00 kg/plant) and BC ratio (4.57 & 3.48) as compared with sucker raised plants.

Bhubaneswar: Trial plot was damaged due to occurrence of cyclone "Fani" on and evaluation results could not be presented for the reporting period.

Gandevi: Macro-propagated plants were performed better over sucker plants in both the varieties. Robusta macro propagated plants has recorded significantly higher bunch weight (28.59 kg) as compared to sucker plants. Also, significantly minimum days to harvest was recorded in macro propagated plants (378.56 days) followed by sucker plants (381.12 days) of Grand Naine. The BC ratio was found higher in macro propagated plants cv. Robusta (4.25) followed by Grand Naine (3.56) over sucker plants of both the varieties.

Jalgaon: The macro-propagated plants of variety Grand Naine performed better with respect to growth, yield (100 t/ha) and BC ratio (2.85) over sucker plantlets. However, the performance of macro-propagated plants of 'Shrimanti' variety was at par with the macro-propagated plants of variety Grand Naine. There were no major incidence of pests and diseases on any of the treatments.

Jorhat: The macro-propagated plants of variety Grand Naine has recorded maximum yield (58.97 t/ha), bunch weight (19.11 kg) TSS (19.55°B), shelf life (6.47 days) and BC ratio (3.548) as compared with respective sucker grown plants.

Kannara: As the second plant crop (PC-2) at bunch development stage for evaluation results could not be presented during the reporting period.

Kovvur: Among the two treatments, slightly higher bunch weights were recorded in plants propagated through macro propagation as compared to sucker propagated ones. However, no significant difference was recorded for growth characters and days to harvest.

Mohanpur: Macro-propagated plants of Grand Naine and Martaman recorded higher bunch weight, productivity (t/ha) and production economics (BC ratio) compared with sucker raised plants. Similarly, the macro-propagated plants of both varieties recorded better finger characters and organoleptic characters compared with the sucker raised plants. The duration from planting to shooting and total

crop duration were recorded lower in case of macro-propagated plants, compared with the sucker raised plants of respective varieties.

Pusa: The second plant crop (PC-2) at bunch development stage and evaluation results of PC-2 not completed during the reporting period.

3.2.7 B. Alleviation of soil moisture deficit stress in banana

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

Arabhavi: The maximum yield and yield parameters were recorded in irrigated control. The yield decreased 41.40 per cent over the control. However, among stress treatments, foliar priming with Acetyl salicylic acid (0.1mM) + soil moisture stress at flowering has recorded maximum bunch weight (21.95 kg/plant). Soil moisture stress at flowering resulted malformed fruits (Table 1 & 2).

Bhubaneswar: The experiment was collapsed due to occurrence of a super cyclone Fani. Suckers were selected and experiment is at vegetative stage.

Gandevi: Increased duration of flowering by 34.75 days was recorded in soil moisture stress at 5 MAP. (Table 1&2). However, among stress treatments, foliar priming with Acetyl salicylic acid (0.1mM) + soil moisture stress at flowering at 5th MAP has recorded maximum bunch weight (26.94 kg/plant).

Jalgaon: Increased duration of flowering by 13.9 days was recorded in soil moisture stress at 5 MAP, the yield was decreased by 51.16 per cent. The maximum yield and yield parameters were recorded with irrigated control. However, among stress treatments, foliar priming with Acetyl salicylic acid (0.1mM) + soil moisture stress at flowering has recorded maximum bunch weight (20.78 kg/plant). Soil moisture stress at flowering resulted malformed fruits (Table 1 & 2).

Kovvur: The soil moisture stress at 5 MAP has recorded increase in the duration of flowering by 4.42 days, yield was decreased to the tune of 33.5 percent. The maximum yield and yield parameters were recorded with irrigated control (Table 1 & 2), although there was no significant difference recorded.

Table-1: Effect of soil moisture stress treatments on growth parameters

Treatments	Days to shooting (Days)			
	Arabhavi	Gandevi	Jalgaon	Kovvur
T ₁ : Irrigated control	230.85	277.45	232.40	212.50
T ₂ : SMS at 5 th MAP	242.78	312.20	246.30	216.92
T ₃ : SMS at flowering	235.87	324.05	230.80	223.91
T ₄ : Foliar priming with ASA (0.1mM) + SMS at 5 th MAP	242.18	287.15	238.70	235.23
T ₅ : Foliar priming with ASA (0.1mM) + SMS at flowering	240.95	315.68	232.20	229.53
CD at 5%	11.98	2.85	1.86	NA

*SMS: Soil moisture stress; ASA: Acetyl salicylic acid; MAP: Month after planting

Table-2: Effect of soil moisture stress treatments on yield parameters of banana.

Treatments*	Bunch weight (kg)				Hands/bunch			
	ARB	GAN	JAL	KOV	ARB	GAN	JAL	KOV
T ₁ : Irrigated control	25.00	31.11	28.87	19.51	12.85	12.15	12.62	9.12
T ₂ : SMS at 5 th MAP	14.65	24.75	14.10	17.15	8.85	10.85	7.88	8.90
T ₃ : SMS at flowering	20.16	20.66	18.75	16.97	10.55	10.45	10.71	8.62
T ₄ : Foliar priming with ASA (0.1mM) + SMS at 5 th MAP	16.35	26.94	17.82	17.90	9.19	11.25	9.24	9.42
T ₅ : Foliar priming with ASA (0.1mM) + SMS at flowering	21.95	23.97	20.78	17.64	10.28	10.95	11.42	8.78
CD at 5%	1.41	3.05	1.14	NA	1.91	1.05	0.84	NA

*SMS: Soil moisture stress; ASA: Acetyl salicylic acid; MAP: Month after planting

ARB- Arabhavi, GAN-Gandevi, JAL-Jalgaon, KOV-Kovvur,

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

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

Arabhavi: There was no extreme weather conditions occurred during the reporting period and hence, no distinct changes on the yield and productivity were observed.

Bhubaneshwar: Extreme weather conditions were observed in the month of May 2019. Cyclone named "Fani" with wind speed more than 275 km/hour causing occurred on 03.05.2019 causing damage to all the plants with bunches. Studies carried out on occurrence of diseases like Sigatoka leaf spot through fixed plot survey revealed that the sigatoka leaf spot disease intensity was highest in the month of August followed by September and July which coincided with ideal maximum temperature of around 31.8°C and high morning relative humidity (93.5%), ideal for the pathogen.

Coimbatore: The incidence of insect pests and diseases (Sigatoka leaf spot-13.8 PDI) were very low that caused no major damage to existing crop.

Gandevi: No distinct change in phenology of the crop was observed during the reporting period.

Jalgaon: No significant change in weather phenomena or phenology of the plant was observed during the period under report.

Jorhat: The daily meteorological data was recorded and no extreme changes in weather and phenology of the crop was observed.

Kannara: During the reporting period, bunch initiation and development stage coincided with comparatively higher maximum and minimum temperature. This might have augmented the bunch emergence and development resulting in early bunching and harvest. Days to bunching during 2019 became early by 60 days in nendran banana, whereas crop duration was reduced by 62 days. Because of this, harvesting coincided with heavy rain period (Aug-Sept) incurring huge loss. New pest and disease incidence like blast and pitting disease (*Pyricularia angulata*) followed by fruit fly attack, banana red rust thrips (*Chaetanophothrips signipennis*) has also been noticed.

Kovvur: No extreme weather conditions were observed during the cropping period and hence no distinct changes were observed in the growth and quality parameters.

Mohanpur: No distinct effects were observed on phenology and productivity with the observed pests and disease incidence as compared to normal situation prevailing in this region.

Pusa: No extreme weather conditions were observed during the cropping period and hence no distinct changes were observed in the phenology and productivity of the crop.

Vengurle: No distinct changes were observed in the phenology and productivity of the crop.

4.2.4 B. Assessment of post-harvest losses in banana

Field level estimation of post-harvest loss (PHL) for a variety using multi-stage stratified random sampling approach. The assessment was made in five stages viz., Identify hot spot area for variety (say district >70% area): two districts to be selected at random, in each district, identify two Talukas (one having > 70% area and other having 30% to 70% of area) select at random, from each Taluka select at random five villages, from each village select at random five orchards, from each orchard at random 10 bunches/orchard at the time of harvest to estimate PHL.

Bengaluru: The post-harvest loss recorded in this centre was 11.03% in 'Ney Poovan' variety. That comprised 4.18% in field level, 2.29% in assembly market, 0.93% in storage and ripening and 3.63% in retail market.

Jalgaon: The centre has estimated as 30.35% total post-harvest losses in Grand Naine. That comprised 6.86% in field level, 4.00% in transport, 1.58% in assembly market, 3.45% in storage and ripening and 14.46% in retail market level.

Kannara: A post-harvest loss of 38.77% was recorded in Nendran. That accounted to 4.15, 4.68, 8.59, 4.64 and 16.72% at field, transport level, assembly/wholesale market, storage and ripening and retail level, respectively).

Kovvur: The post-harvest loss estimated was 22.49%, both in KC Keli and Grand Naine together. The post-harvest losses recorded at various stages were: 4.31% in field level, 1.69% in transport, 4.69% in assembly market, 3.45% in storage and ripening and 8.36% in retail market.

Tiruchirapalli: Post-harvest loss of 11.46% was recorded at this centre both in 'Poovan' and 'Grand Naine' varieties together. The post - harvest losses recorded was 1.21, 0.75, 1.70, 1.81 and 6.00% at Field, transport, assembly/wholesale market, storage and ripening and retail level, respectively (Fig. 5).

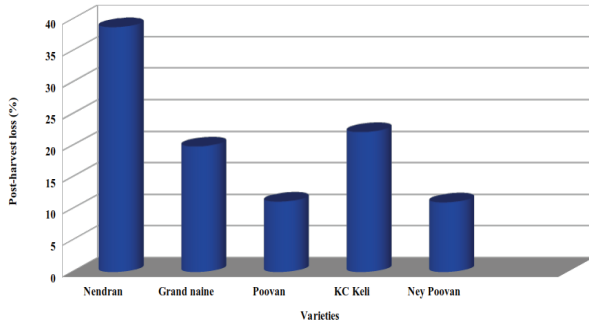


Fig 5. - Post Harvest losses in banana varieties

5.2.1.B Survey of emerging insect pests of banana

The fixed plot and roving surveys for various pests of banana were carried out in different centres to identify the key pests of banana and their natural enemies and also to detect the new potential pests introduced in the region. Fixed plot survey was carried out on 30 selected plants (without spraying) in a selected plot. The observations were taken as mean per cent incidence of the pest. The roving survey was done in banana orchards in various parts of the state to record the presence of emerging/new/introduced pests and their associated predators and parasites. Extent of damage by the new pests was recorded.

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. The pseudostem weevil infestation was less in banana growing area at maturity phase. The rust thrips infestation was noticed moderate in many fields. The leaf damage due to leaf eating caterpillar (*Spodoptera litura*) and semi-looper also was observed with low intensity and unevenly at early stage of crop. The infestation level of hairy caterpillar, lace-wing (Tingid) bug and mite was low, while aphid found very negligible in almost all locations (Table 3).

Jorhat: Surveys were conducted in five districts viz Jorhat, Sibsagar, Golaghat, Dibrugarh and Lakhimpur of Assam. In Jorhat district highest incidence of *Basilepta subcostata* (38%) followed by *Odoiporus longicollis* (22%) *Pentalonia nigronervosa* (20%)

Parasa lepida (12%) *Spodoptera litura* (8%) and lowest incidence of mealy bug (6%) was observed. In Sibsagar district *Odoiporus longicollis* recorded 20%, *Basilepta subcostata* 24%, *Pentalonia nigronervosa* (15%) and *Parasa lepida* 4% were the recorded during the survey period. In Golaghat district highest incidence of *Basilepta subcostata* (24%) followed by *Odoiporus longicollis* (17%), and *Pentalonia nigronervosa* (15%), *Parasa lepida* and *Spodoptera litura* with 5% each and Mealy bug (8%) was observed. In Dibrugarh district 15% *Odoiporus longicollis* were recorded from banana cultivar Jahaji and *Basilepta subcostata* was recorded 20% with *Pentalonia nigronervosa* (10%). Incidence of *Basilepta subcostata* with 25% and *Pentalonia nigronervosa* (8%), were observed in Lakhimpur. Banana cv. 'Bhimkol', cv. 'Athia kol' and cv. 'Kachkol' were free from the attack of *O. longicollis* and *P. nigronervosa*. Banana cultivar 'Jahaji' 'Barjahaji' and 'Amritsagar' were highly susceptible to *Basilepta subcostata*. *Spodoptera litura* had been reported on 'Jahaji' cultivar of banana in Jorhat district. Spider was most frequently encountered natural enemy in the banana plantations (Table 3).

Mohanpur: Roving survey were carried out at the eleven different areas covering two districts (Nadia and Hooghly) of West Bengal. Among the insect pests, banana leaf and fruit scarring beetle, *Basilepta subcostata* was found most prevalent with 100% frequency of occurrence followed by pseudostem weevil, *Odoiporus longicollis*. The second-year crop was more vulnerable to the pest attack. The leaves and tender fingers were severely infested by the scarring beetle. Occurrence of red spider mite, *Oligonychus sp.* was also recorded from banana growing areas of West. Population of *Odoiporus longicollis* and *Basilepta subcostata* ranged from 0.22 – 5.64/plant and 2.26 to 16.90/terminal leaf whorl during the survey period. A new insect, rugose spiraling whitefly infestation has been observed in banana of Nadia district. With infestation level of 3-5%. Another insect thrips was also observed in low level during September to November on variety Martaman but needed further study.

Vengurle: The incidence of new emerging pest (banana skipper) was recorded in Vengurle, Sawantwadi, Kudal and Dodamarg tahasils of Sindhudurg district during July- September 2019. However, the incidence was less than 2 per cent (Table 3).

Table-3: Status of banana pests under roving survey during 2019 across the centres of AICRP on Fruits

Name of insect pests	Name of the centers	Past average incidence reported	Current status	Remarks
A. New/ emerging pest				
Banana skipper butterfly (<i>Erionota torus</i>)	Kannara	0-15 % leaf damage	0-10% leaf damage	Average pest population decreased and infestation was recorded from parts of Palakkad, Wayanadu, Thrissur and Kottayam districts of Kerala
	Vengurle	2 %	2 %	Recorded in Vengurle, Sawantwadi, Kudal and Dodamarg tahasils of Sindhudurg district
Slug caterpillars (<i>Miresa decedens</i>)	Kannara	5-40%	5-35% incidence	Intensity similar to previous year. It is a pest of concern in monsoon and post monsoon period in Kerala.
Banana red rust thrips, <i>Chaetanophothrips signipennis</i> (Bagnall)	Gandevi	10-12% blemished fruits	15-20% blemished fruits	There was increase in fruit infestation during 2019 with minor variation of damage recorded in few villages of Surat, Navsari and Bharuch dist. during Aug.-Sept. The infestation sign observed in mature fruits of banana.
	Kannara	-	5-20% incidence	Severe incidence recorded in Thrissur, Ernakulam and Pathanamthitta district
Banana Flower thrips (<i>Thrips hawaiiensis</i>)	Gandevi	15-18% blemished fruits	15-25% blemished fruits	Damage intensity was unchanged during 2018 in almost area. Moderate damage was observed during May to July unevenly in few pockets of Surat and Narmada dist on developing tender fruits of banana.
	Kannara	-	5-30%	Incidence recorded in Thrissur, Ernakulam, Kottayam and Pathanamthitta district
Leaf thrips, <i>Hercinothrips bicinctus</i>	Kannara	-	5-20% plants	Incidence recorded in Thrissur, Ernakulam, Kozhikode and Pathanamthitta district
Bihar hairy caterpillar, <i>Spilosoma obliqua</i> Waker (= <i>Spilarctia obliqua</i> (Walker))	Ludhiana	Nil	2 per cent damage on leaves	New insect under Punjab conditions

B. Minor/ declining pest

Lace-wing (Tingid) bug (<i>Stephanitis typicus</i>)	Gandevi	1-2% leaf damage	1-2% leaf damage	No major change in damage intensity. Low leaf damage in almost all area during late vegetative stage.
	Kannara	1-5% leaf damage	5-15% leaf damage	Pest incidence increased. Intensity more during summer months
Aphid (<i>Pentalonia nigronervosa</i>)	Gandevi	Very low	Very low	Negligible in almost all area.
	Jorhat	11-22%	15-20%	Banana cultivar 'Jahaji' was found susceptible to the attack of <i>P. nigronervosa</i>
	Kannara	5-10% plants infested	5-10% plants infested	Infestation as seen in previous year. More records from Wayadadu, Kottayam etc.
	Mohanpur	0.6-8.9 (Nos./plant)	-	-

Banana mites	Gandevi (<i>Tetranychus indicus</i>)	Very low	Very low	Low damage in almost area.
	Kannara (<i>Tetranychus</i> sp., and <i>Oligonychus</i> sp.)	50-180 (No./ leaf)	45-230 (No./ leaf)	Pest incidence increased. More in summer months.
	Mohanpur (<i>Oligonychus oryzae</i>)	1.1 - 3.2 (No./3.14 cm ² leaf area)	0.76 -3.26 (No./3.14 cm ² leaf area)	Pest incidence remained same -
Semi-looper (<i>Chrysodeix acuta</i>)	Gandevi	2-3% leaf damage	3-5% leaf damage	No major alternation in infestation. Low leaf damage and infrequent during early vegetative stage of banana.
Hairy caterpillar [<i>Pericallia ricini</i>]	Gandevi	1-2% leaf damage	1-2% leaf damage	No major variation in leaf incidence. Occasional leaf damage observed in few parts during vegetative stage.

5.2.3 B. Management of banana scarring beetle (*Nodostoma viridipenne*)

The experiment was laid out in RBD with 4 replications to standardise the management strategies for banana scarring beetle.

Mohanpur: In 2019 the experiment was on-going to see the residue. The sample has been send for residue analysis at AINP, Pesticide Residue Laboratory, BCKV after harvesting of fruits and found no pesticide contamination or below detectable level of pesticides in the samples. soil application of chlorpyriphos 20EC @ 0.08% (4ml/L) plus bunch spraying with acephate (0.1125%) just after first hand opening followed by bunch cover with polypropylene bag was found the most suitable treatment to manage the notorious scarring beetle (*B. subcostata*) of banana. But, when considered the ill affect of the alternate safe treatment of Soil application of *Beauveria bassiana* (1×10^7 cfu/ml- 200ml/plant) plus bunch spraying acephate (0.1125%) just after first hand opening, followed by bunch cover with polypropylene bag can be demonstrated as safe technology for management of *B. subcostata*.

Jorhat: In 2019 the experiment was on-going to see the residue. The sample has been send for residue analysis at AINP, Pesticide Residue Laboratory, BCKV after harvesting of fruits and found no pesticide contamination or below detectable level of pesticides in the samples. (Plate 1-2).

soil application of chlorpyriphos 20EC @ 0.08% (4ml/L) plus bunch spraying with acephate (0.1125%) just after first hand opening followed by bunch cover with polypropylene bag was found the most suitable treatment to manage the notorious scarring beetle (*B. subcostata*) of banana. But, when considered the ill affect of the alternate safe treatment of Soil application of *Beauveria bassiana* (1×10^7 cfu/ml- 200ml/plant) plus bunch spraying acephate (0.1125%) just after first hand opening, followed by bunch cover with polypropylene bag can be demonstrated as safe technology for management of *B. subcostata*. (Plate 1-2).





Plate 1: Scarring beetle infected fruits



Plate 2 : Treated fruits

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 orydicola*. Root population was counted in 10 g of root sample. In *Heterodera orydicola*, cysts and larvae population were counted separately on 10 g of roots and in 200 cc of soil.

Arabhavi: No new nematode pest was 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 (301 and 168) in Munavalli of Belagavi District in Rajapuri where suckers were planted in medium black soil and 286 and 154 in Yarazarvi of Belagavi District on TC variety Grand Naine planted in Red loamy soil.

Jorhat: No new nematode was recorded during the reporting period.

Kannara: Major banana nematodes viz., *Meloidogyne incognita*, *Radopholus similis*, *Helicotylenchus multicinctus* and *Pratylenchus coffeae* were recorded. Severe infections of burrowing nematodes were recorded from Wayanadu and Ernakulam district leading to decay and death of roots, yellowing of leaves, stunted growth. In Mananathawadi block of Wayanadu district severe infestation of burrowing nematode (*Radopholus similis*) caused severe root damage leading to secondary root rot making the root system weak. In banana plots with these disease complexes, severe toppling of whole banana plants were recorded. Similarly, high incidences of *Meloidogyne* spp. was observed in banana from the surveyed districts. Banana spiral nematode, *Helicotylenchus multicinctus* was more in Wayanadu district. The incidence of *Pratylenchus coffeae* was more at Wayanad, Thrissur, Ernakulam, Malappuram and Kozhikode, Idukki and Kottayam districts.

Radopholus similis was observed to heavily infest banana roots along with *Pratylenchus coffeae*. In Ernakulam and Thrissur Districts. Banana cyst nematode, *Heterodera orydicola* was absent in the samples collected from the surveyed areas (Plate 3).

Mohanpur: Survey were conducted in different locations of Nadia and Hoogly districts of West Bengal. The root knot nematode *Meloidogyne* sp. was observed with 100% frequency of occurrence in Nadia district while the occurrence was lesser in other surveyed locations. Maximum (316.60) number of juvenile stages 2 (J_2) nematode population (250 cc soil+10 g root) was recorded from Habibpur, Fulia. The banana variety Martaman was the most infested during the survey, however, the other cultivars like champa and kanchkola were also found infested with the root knot nematode.



Plate-3. Banana Toppling disease due to severe infestation of burrowing nematode (*Radopholus similis*) on cv. Nendran (Wayanadu 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 165.44 & 133.32 at in 250 cc soil and 25.40 & 30.82 in 10g of roots at vegetative and shooting stage respectively as against standard check (323.30 & 339.56 in soil and 70.46, 79.66 in root respectively). With regard to root necrosis, lower incidence of 9.52 & 15.65 as against 47.52 and 55.77 in standard check at vegetative and shooting stage was recorded respectively.

Jorhat: No significant difference for the nematode population was recorded among the treatment.

Kannara: The experiment was abandoned due to heavy flood during reporting period. A new layout was done. Treatments are being imposed and trial is under progress.

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.

Table-4: Effect of bioagents 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		Mean of three sprays	
	Kannara	Periyakulam	Kannara	Periyakulam
T ₁	16.51 (23.97)	56.55 (48.76)	5.52 (13.59)	21.19 (27.41)
T ₂	15.25 (22.99)	65.90 (54.27)	10.44 (18.85)	27.09 (31.36)
T ₃	17.17 (24.47)	59.17 (50.28)	11.63 (19.94)	32.16 (34.55)
T ₄	15.77 (23.39)	55.75 (48.30)	8.14 (16.58)	24.73 (29.82)
T ₅	16.55 (24.01)	57.19 (49.13)	9.85 (18.29)	25.10 (30.07)
T ₆	14.90 (22.71)	63.20 (52.65)	15.84 (23.45)	65.33 (53.93)
CD at 5%	NS	NS	1.21	2.20

Table-5: Effect of bioagents against Rugose Spiralling Whitefly, *Aleurodicus rugioperculatus* Martin (Hemiptera: Aleyrodidae) in banana across the centres

Treatment	Population per leaf * (Month after spray)*			
	Pre-treatment count		Per cent reduction over control	
	Kannara	Periyakulam	Kannara	Periyakulam
T ₁	12.00	30.00	75.54	68.06
T ₂	11.00	32.00	51.09	45.58
T ₃	13.00	29.00	37.81	39.79
T ₄	11.50	31.00	61.61	57.61
T ₅	12.50	31.75	45.33	51.49
T ₆	12.50	28.50	-	-
CD at 5%	NS	NS	-	-

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

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 studied and incidence of disease was recorded to identify the major disease problems. About 20 plants were selected for observation in each orchard.

Arabhavi: A roving survey was conducted during April, 2019 to December, 2019 in Belagavi, Dharwad, Bagalkot and Vijayapura districts of northern Karnataka on Grand Naine, Rajapuri and Ney Poovan cultivars of banana, no new and emerging disease was recorded. Among the diseases recorded, the *Eumusae* leaf spot was the predominant disease followed by rhizome rot, BBTv, Cordana leaf spot, Freckle leaf spot and CMV disease. The *Eumusae* leaf spot intensity was ranged from 6.0 to 29.65 in July-August, 2019 and 18.36 to 34.47 in Oct – Nov, 2019. The disease appeared in low to medium intensity. The *Eumusae* leaf spot intensity was highest 34.00 (Oct – Nov, 2019), and 29.65 (July to Aug, 2019) in Yarazarvi of Belagavi district. Freckle leaf spot intensity was ranged from 4.0 – 6.00, *Fusarium* wilt ranged from 7.0 to 11.0, the bacterial rhizome rot disease was ranged from 3.0 to 7.0 per cent in July-Aug, 2019 and 4.50 to 9.0 per cent in Oct – Nov, 2019 and the BBTv was ranged from 2.0 to 5.0 per cent (Table 6).

Bhubaneswar: The survey was conducted during reporting period in six districts of Odisha viz., Nayagarh, Rayagada, Gajapati, Khurdha, Puri, and Ganjam. Banana diseases viz., Panama wilt (56-63%), banana bunchy top virus (4-5%), banana bract mosaic virus (1-3%), anthracnose (3-5%), freckle leaf spot (3-4 PDI), rhizome rot (1-5%), banana streak virus (2-4%) and *Eumusae* leaf spot disease (31-39 PDI) were found as an emerging disease of banana in Odisha. Samples of diseased plants/plant parts were collected during the surveys and causal organisms were isolated and identified as *Mycosphaerella eumusae* for *Eumusae* leaf spot, *Fusarium oxysporum* f. sp. *cubense* for *Fusarium* wilt and *Guignardia musae* for Freckle leaf spot disease (Table 6).

Coimbatore: Roving survey was conducted in major banana growing districts viz., Erode and Coimbatore districts 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 were observed. *Eumusae*

leaf spot intensity of 28.5 PDI was recorded on Red banana. The leaf spot was highest in the month of June with 31.0 PDI in Atthani, Mevani and Olagaddam in the varieties Ney Poovan and Red banana, 25.00 PDI was recorded in cv Ney poovan at Kalakaddu of Thirunelveli district. Panama wilt incidence ranged from 7-15 %. *Fusarium* wilt 15.0% was observed at Kalakaddu of Thirunelveli district. Wilt incidence of (7%) was observed in Nanguneri and Valliyur blocks of Thirunelveli district. In Red banana bract mosaic incidence of up to 8%. 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* (Table 6).

Gandevi: No new or emerging disease was observed from banana growing belt of South Gujarat. There was decreased trend of leaf spot and rhizome rot. The Grand Naine and Robusta were found affected against leaf spot mainly during July to December, rhizome rot disease incidence observed 1-2 months after planting and banana bunchy top virus showed symptoms during monsoon period. The incidence of *Fusarium* wilt was reported in Surat district with low intensity. The other fungal and viral diseases of banana were observed in negligible incidence (Table 6).

Jalgaon: No new disease was observed and no remarkable change in disease severity was recorded during the reporting period. *Eumusae* leaf spot was identified as a major problem with 12.00 to 36.0 PDI. The rhizome rot was noticed on sucker plantations with 4.00% as compared to tissue plant (3.00%). The infection of bunchy top virus was observed up to 3.0% in ratoon crop. The Cucumber mosaic virus infection with 2-7% incidence was observed in tissue culture plantation. Overall the disease scenario except *Eumusae* leaf spot was very low. No new pathogen has been identified during the survey period (Table 6).

Jorhat: The survey was conducted in four districts viz Kamrup (Rural), Goalpara under Lower Brahmaputra Valley Zone; Jorhat and Golaghat under Upper Brahmaputra Valley zone; Nagaon and Morigaon under Central Brahmaputra Valley Zone and Sonitpur under North bank plain zone. All the major diseases were prevalent round the year with a higher incidence of *Eumusae* leaf spot during post- monsoon and that of *Fusarium* wilt and Bunchy top during pre-monsoon period. No new disease was recorded. The varieties Bhim kal, Aathia kal and Kach kal were found tolerant to the major diseases and Jahaji was found the most susceptible to *Eumusae* leaf spot as well as BBTv. The cv. Malbhog was found to be the

only susceptible cultivar to Foc during the survey. Two morphologically distinct Foc were identified from Goalpara district and molecular characterization will be done for the same (Table 6).

Kannara: Blast and Pitting disease was first observed in August 2019 at Alangad Panchayat of Ernakulam district in variety Nendran. The intensity of *Eumusae* leaf spot was ranged between 0 and 23 PDI. *Fusarium* wilt incidence ranged between 0 and 40% and Rhizome rot incidence varied from 0 and 30%. *Deightoniella* leaf spot disease intensity varied from 0.0-30.0 PDI. The maximum intensity of the disease (30 PDI) was recorded in Chitoor of Palakkad district. As a viral disease BBTv (1.00%), BBrMV (0-5%), and BSMvV (6.00%) were observed during survey. The pathogens were isolated in artificial medium, the cultures of pathogens maintained are *Sclerotium rolfsi*, *Fusarium oxysporum* f. sp. *cubensi*, and *Erwinia carotovora* (Table 6).

Kovvur: Surveys were conducted in East Godavari, West Godavari, Vizianagaram and Visakhapatnam districts of Andhra Pradesh. *Eumusae* leaf spot, Rhizome rot, *Fusarium* wilt, BBrMV, CMV and BBTv were the major diseases observed in the surveyed districts. Among the diseases, *Eumusae* leaf spot disease incidence was more in the districts surveyed and the average disease incidence was more (20%) in Grand Naine variety followed by Rhizome rot. The prevalence of bacterial rhizome rot was more in Tella Chakkerakeli variety and the average disease incidence was 13.0%. The causal organism was identified as *Erwinia* sp. (Table 6).

Mohanpur: Survey was conducted at 10 different locations covering 20 orchards including both first crop and ratoon crop. There were no changes in the incidence of diseases viz., *Eumusae* leaf spot (38.00 PDI), Panama wilt (9.00 PDI) and some other diseases (bunchy top, rhizome rot, CMV & anthracnose) as compared to previous years (Table 6).

Pusa: During reporting period, roving survey was conducted in different districts of Bihar. 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) Samastipur Muzaffarpur, Vaishali, Hazipur districts. Incidence of Panama wilt incited by *Fusarium oxysporum* f.sp. *cubense* TR4 strain B2 ranged between 14-34% in Koshi belt. *Eumusae* leaf spot (22 PDI) and BBTv (8-12%) were observed as a major problem. In case of *Eumusae* leaf spot, trend of disease development was constant while in case of BBTv trend was decreasing when compared with their incidence in the previous year. Rhizome rot with 0-14% incidence was observed only in Koshi belt on Cavendish group of banana at initial stage of crop. *Fusarium* wilt of banana incited by *Fusarium oxysporum* f.sp. *cubense* was isolated from samples collected from Koshi belt of Bihar (Purnea, Katihar, Navgachhiya, Madhepura and Kisan Ganj) in cv Robusta and Grand naine and the pathogen was identified by ARI, Pune as *Fusarium oxysporum* f.sp. *cubense* race TR4 biotype B2. *Fusarium oxysporum* f.sp. *cubense* was also isolated from cv Malbhog, Alpan and Kothia (Table 6).

Table-6: Scenario of various fungal and bacterial diseases of banana at different locations /states during 2019-2020

Name of centre	Area surveyed	Disease incidence (%)						
		<i>Eumusae</i> leaf spot*	Freckle leaf spot*	<i>Cordana/Deightoniella</i> leaf spot	Pseudo stem rot	Anthracnose/Pitting disease	Panama wilt	Rhizome rot
Arabhavi	Belagavi, Dharwad, Bagalkot and Vijayapura districts of northern Karnataka	6-34 (2-33)	4-6 (2-3)	- (3-4)	-	-	7-11 (-)	3-9 (2-9)
Bhubaneswar	Puri, Khurdha, Ganjan, Rayagada and Gajapati	31-39 (31-39)	3-4 (3-5)			3-5 (3-5)	56-63 (56-63)	1-5 (1-5)
Coimbatore	Erode, Coimbatore, Tirupur and Salem district	2-31 (10-30)	- (-)			5 (-)	7-15 (8-10)	- (0-2)
Gandevi	Surat, Navsari, Valsad, Narmada, Bharuch districts	15-27 (15-26)	- (-)	- (-)	- (-)	- (-)	- (-)	0-2 (0-3)
Jalgaon	Jalgaon, Nandurbar and A.nager district	12-36 (7-33)	- (-)	- (-)	- (-)	- (-)	- (-)	3-4 (4-6)

Table-6: Scenario of various fungal and bacterial diseases of banana at different locations /states during 2019-2020

Name of centre	Area surveyed	Disease incidence (%)						
		<i>Eumusae</i> leaf spot*	Freckle leaf spot*	<i>Cordana/Deightoniella</i> leaf spot	Pseudo stem rot	Anthracnose/Pitting disease	Panama wilt	Rhizome rot
Jorhat	Kamrup Rural, Goalpara and Kokrajhar districts under Lower Brahmaputra Valley Zone	0-36 (0-34)	- (-)	- (-)	- (-)	- (-)	0-31 (0-32)	- (-)
Kannara	Kannur, Kollam, Kottayam, Kozhikode, Malappuram, Palakkad, Thrissur and Waynad	0-23 (0-23)	Trace	/0-30	- (0)	/28	0-40 (0-30)	0-30 (0-30)
Kovvur	East Godavari West Godavari, Vishakapatnam and Vizianagaram	0-20 (5-49)	- (-)	- (-)	- (-)	- (-)	- (0-5)	0-13 (10-19)
Mohanpur	Bagdah, Gadamara, Bangaon ,Haringhata, Mondouri, Fulia, Ranaghat, Habibpur, Kalyani ,Bandel	17-42 (10-41)	- (-)	- (-)	- (-)	- (-)	0-7 (0-7)	0-2 (0-2)
Pusa	Zone- I (Samastipur, Muzaffarpur, Vaishali, Siwan and Saran)	4-18	- (-)	- (-)	- (-)	- (-)	16-34**	2-10 (0-10)
	Zone- II (Katihar, Saharsa, Purnea, Bhagalpur, Madhepura and Kishanganj)	6-22 (0-22)	- (-)	- (-)	- (-)	- (-)	14-34 (14-65)***	4-14 (0-14)

*PDI-Percent disease index; Data in parenthesis indicate the disease incidence/severity during 2018-19; **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

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

The experiment was conducted in sick plot or hot spot (farmer field). 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. Selected varieties at Kannara, Kovvur and Mohanpur were Rasthali, Amritapani and Malbhog respectively.

Kannara: Disease free suckers from disease free field + application of neem cake @ 250g/plant or vermicompost + Dipping in Carbendazim (0.2%) for 30 min followed by carbendazim drenching 0.2% solution (2nd, 4th and 6th month after planting) and carbendazim injection @ 3ml of 2% solution (3rd, 5th and 7th month after planting) was significantly superior in reducing both external and internal wilt index during 2016-17 and 2017-18. However, there

was no significant difference between treatments for yield and its attributes. During 2019, the experiment was laid out in the sick plot of BRS, Kannara and the crop is in vegetative stage.

Kovvur: Percent disease incidence among the treatments ranged from 91.66 to 100 in the 2018 crop. Wilt index ranged from 81.25 to 100 whereas vascular wilt index ranged from 62.50 to 94.44. Shooting was observed in one plant each, in treatments disease free suckers from disease free field and application of neem cake @ 250g/plant along with dipping the suckers in carbendazim (0.2%) for 45 min) and treatment with disease free suckers from disease free field and application of neem cake @ 250g/plant along with soil application of *Trichoderma asperellum* + *Pseudomonas fluorescens* @ 50g/ plant three times (0, 2nd and 4th month after planting) after one year of planting. During 2019, fresh pot culture experiment with four treatments and six replications was initiated during November.

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 vulnerable 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 recorded lower per cent disease index (12.55%) as compared to control (54.28%). During reporting period, fresh planting was done during September, 2018 and the trial is in vegetative stage (Table-7).

Bhubaneswar: The experiment crop at Bhubaneswar was damaged by cyclone "Fani" on 3rd May 2019. New plantation for the experiment was carried out according to the technical guidelines in first week of February 2020.

Coimbatore: A trial was laid out in TNAU orchard as per the recommendations during March 2019. *Eumusae* leaf spot incidence was not observed up to September 2019. Disease symptoms were observed during the month of October and spray schedule was initiated. Trial is in progress.

Jalgaon: Application of Propiconazole (0.1%) + Mineral oil (1%) has effectively controlled *Eumusae* leaf spot disease of banana and recorded lowest per cent disease index (10.46) compared to control (26.72) and higher youngest leaf spotted (8.33) was also recorded in the same treatment (Table-7).

Jorhat: Application of chemicals + mineral oil was most effective in managing the disease with 8.32 disease severity against 58.47 in control. The YLS was found 8.08 in the T₃ against 3.33 in control. The Index of non-spotted leaves (INSL) was also found higher 64.53 in the treatment as against 39.12 in control (Table-7).

Kannara: There was no significant difference between the treatments except in percent disease index at flowering stage. PDI was comparatively high in control at flowering stage whereas treatment effect was insignificant. There was no significant difference between treatments in vegetative and yield characters (Table-7).

Kovvur Application of Propiconazole (0.1%) + mineral oil (1%) 3 sprays at 25 days interval recorded significantly lowest disease severity index of 8.33 against 17.19 in control. Fresh planting was done in February, 2020 and the trial is in vegetative stage (Table-7).

Mohanpur: Application of chemicals + mineral oil was found effective with minimum PDI (15.48) and highest bunch yield (16.34 kg) with maximum B: C ratio (1.61) in the same treatment (Table-7).

Table-7: Effect of chemical and mineral oil treatments on disease severity of *Eumusae* leaf spot of banana

Treatment	Disease Severity (PDI) (%)						
	ARA	JAL	JOH	KAN (6MAP)	KAN (Shooting)	KOV	MHP
T ₁ : Control (Untreated)	54.28	26.72	58.47	8.55	17.15	17.19	45.45
T ₂ : Propiconazole (0.1%) + mineral oil (1%) 3 sprays at 25 days interval	21.51	10.46	31.81	8.13	9.66	8.33	30.20
T ₃ : Chemicals + mineral oil	12.55	15.06	8.32	6.71	7.64	9.79	15.48
T ₄ : Alternation of chemicals alone	22.42	15.10	32.61	7.84	9.30	10.12	25.37
T ₅ : Mineral Oil (1%) 3 sprays at 25 days interval	33.35	16.87	-	8.42	9.78	14.08	-
CD at 5%	1.13	1.60	1.16	NS	3.03	0.53	2.43
ARA-Arabhavi, JAL-Jalgaon, JOH-Jorhat, KAN-Kannara, KOV-Kovvur, MHP-Mohanpur							

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

The accessions and the planting materials used in experiments were screened for the presence of known viruses by molecular/ serological methods.

Arabhazi: Of 55 germplasm accessions, none of the accessions were infected with viruses. The result was based on the report from ICAR - NRCB, Tiruchirapalli.

Bhubaneswar: Of 15 germplasm accessions, none of the accessions were infected with viruses. The result was based on the report from Department of Biotechnology, OUAT and Bhubaneswar.

Coimbatore: Of 206 germplasm accessions, 18 accessions *viz*; BRS1, BRS2, Singan, AttuNendran, Big Ebanga, Manjeri, Rasthali, Martaman, Nendran, Swarnamikhi, Sannachekadali, Anaikomban, Ambalakadali, H510, H212, H531, NPH02-01, H96/7 were free of virus infection. The result was based on the serological indexing and molecular indexing reports of TNAU, Coimbatore and ICAR - NRCB, Trichy. Another set of 23 germplasm accessions *viz*., Peykunnan, Thenkunnan, Jurmony, Kothia, Muthiah, Adukukunnan, Bhimkol, Neypoovan, Chakkiya, Onkamannan, Kali, Krishnavazhai, KalarLadan, Mottapooan, Kombillavazhai, Santhanavazhai, Karpooravalli, Rose, Chengalikodan, Birbutia, H 201, Gouria and Sannachenkadali were free of BBrMV in serological indexing.

Gandevi: Of the 63 germplasm accessions, 15 accessions *viz*., Annaikomban, Ambalakadali, Neypoovan, Valiakunnan, Thonkunnan, Gros Michel, KBS-8, Mahalaxmi, NRCB-10, Pachakadali, Panchadum, Nandran, Champa, Karimkadali and Poovan were free of banana viruses. The result was based on the report from ICAR - NRCB, Trichy. Another set of 18 accessions *viz*., Erachivazai (BB), Basarai (AAA), Grand Naine (AAA), Hannuman (AAA), Shrimanthi (AAA), CheanKadali (AAA), Giant (AAA), Lacaton (AAA), cv. Rose (AAB), Raja Balae (AAB), Rajapuri (AAB), Cherapadathi (AAB), AdakkaKunan (AAB), Krishna vazai (AAB), Bluggoe (Kothia)(ABB), Saba (ABB), Bankel (ABB) and Nalabonatha (ABB) were sent to ICAR-NRCB, Trichy for diagnosis of virus.

Jalgaon: Of 17 germplasm accessions, 10 accessions were indexed and found free of banana viruses. The result was based on the report from ICAR - NRCB, Tiruchirapalli.

Kannara: Of the 220 germplasm accessions, three accessions *viz*; Mottapooan Karpoorachakkarakeli and Silk were infected with BBrMV, one accession

Sikuzani was infected with BBTv and one accession Mottapooan was infected with BSMv. None of the accession was infected with CMV. Natural screening of germplasm accessions (based on symptom and DAC ELISA) for eleven years from 2008 to 2019 showed that eight accessions were free of BBTv, BBrMV and CMV infection.

Kovvur: Of the 124 germplasm accessions, 7 accessions *viz*., Sannachenkadali, Samarai-2, Gross Micheal, Red banana, Jahaji, Gandevi and Njalipoovan were infected with BBrMV, two accessions *viz*., Sannachenkadali and Manoranjitham were infected with BBTv and CMV.

Pusa: Of the 79 germplasm accessions, five accessions *viz*; Robusta, Grand Naine, Basrai, Kothia and Alpan were infected with BBTv and one accession *viz*; Grand Naine was infected with CMV.

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

The experiment was laid out in 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. Varieties chosen at Coimbatore, Kannara, Kovvur, Gandevi and Mohanpur are Karpuravalli, Amritapani, and Martaman. IMTP ratings were followed for recording observations. At all the five centres, the crop is in vegetative stage and treatment application is going on as per the technical guidelines.

Coimbatore: Received the CSSRI bioformulation and initiated the experiment.

Kannara: Received the CSSRI bioformulation and initiated the experiment.

Kovvur: Received the CSSRI bioformulation and initiated the experiment.

Gandevi: received the CSSRI bioformulation and initiated the experiment.

Mohanpur Received the CSSRI bioformulation and initiated the experiment.

The other centres Arabhazi, Bhubaneswar, Jorhat and Pusa will initiate the experiment after receiving bio formulation. At Jalgaon centre, survey was made for identifying hot spots in farmers' field of Jalgaon district. However, no wilt incidence was observed. Incidence of *Fusarium wilt* was also not observed at the research station.

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 1 and the centre wise results are given below. During period total 83 accessions were characterized by different centres.

Ludhiana: Among the seventeen sweet orange varieties evaluated, maximum canopy volume in Vernia (25.8 m³), minimum canopy volume in Saugni Blood (6.6 m³), maximum stock girth in Vernia (47.8 cm), maximum fruit weight in Cara Navel (189.7 g), maximum yield per tree in Mosambi (29.1 kg), maximum TSS in Crescent (9.8°B) and maximum acidity in Fucomoto marvel (0.91%) were recorded.

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

Pasighat: Forty superior type pummelo germplasm were collected and they exhibited noticeable variation in the morphological and biochemical characteristics. Two promising clones of Khasi mandarin also collected by the Pasighat centre in Arunachal Pradesh.

Rahuri: Total 65 Citrus germplasm accessions are maintained for characterization and evaluation.

Sriganganagar: Three germplasms were collected. Out of three 2 (one Acid lime i.e. Gol Nimboo and one Lemon - Assam Lemon) were from AAU, Jorhat, Assam and 1 (Acid lime i.e. Rasraj) from IIHR, Bengaluru. Collected germplasm were conserved in germplasm repository. Total 40 Citrus germplasm were evaluated.

Tinsukia: Five new collections of germplasm [rough lemon (Sohjieu), Chambula, Sweet lime, *Citrus macroptera*, Chinera (*Citrus ichangensis*)] were added to existing germplasm and are being conserved for further evaluation. This year total 38 accession were evaluated.

Tirupati: Thirteen sweet orange accessions were evaluated for growth, yield and quality characters. The maximum plant height (4.03 m) and canopy volume (41.78 m³) in Mediterranean sweet orange. Maximum number of fruit (193 fruit/tree) was notice in Pineapple, whereas, fruit weight in S/CM sweet orange (192.0 g) high TSS in Parson Brown (12.30°B) low acidity (0.30%) and high TSS acidity ratio (42.40) in Valencia were observed.

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 (3.25 m), canopy volume (9.07 m³), number of fruits per tree (286.30), yield (48.30 kg/tree) and juice content (46.08%) as compared to other mandarin varieties.

Ludhiana: Mudkhed seedless recorded maximum plant height (4.90 m), canopy volume (35.90 m³) followed by Khasi mandarin (26.4 m³).

Nagpur: The highest canopy volume (46.77 m³) was found in Darjeeling mandarin. Kinnow mandarin recorded highest fruit weight (177.73 g). Khasi mandarin fruit was found having highest TSS (10.53°B).

Sriganganagar: Growth parameters recorded revealed that maximum plant height (3.01 m) in Coorg mandarin while, Kinnow mandarin recorded maximum canopy volume (10.70 m³).

Tinsukia: Coorg mandarin recorded the highest plant height (2.78 m), whereas canopy volume was found to be highest in Nagpur mandarin (4.69 m³). Darjeeling mandarin reported highest number of fruits (80/tree, while Mudkhed seedless reported (13.15 kg). maximum yield. The maximum TSS (10.24°B) as well as lowest acidity (1.00%) was observed in Khasi mandarin.

(c) Acid lime

Five acid lime varieties viz., Pramalini, Vikram, PKM-1, Sai-Sharbati and Balaji have been evaluated at Tirupati.

Tirupati: There was no significant variation observed among the varieties with respect to growth parameters. However, significantly maximum no. of fruits per tree (688.75), yield (28.00 kg/plant & 7.76 t/ha) and TSS (8.85°B) were recorded in PKM-1.

1.1.3 (a) C. Clonal selection in mandarin

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

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

Chettalli: Clone-8 was found to be superior among others clones with respect to yield (254.30 number of fruits/trees weighing 30.77 kg/tree having average fruit weight 131.22 g) and fruit quality (TSS 8.90°B having juice 52.40%).

Ludhiana: Among the different clones of Kinnow mandarin evaluated, Kinnow-9 recorded the maximum plant height (2.99 m), whereas maximum canopy volume was recorded in Kinnow (8.90 m³).

Tinsukia: Clone CRS-4 recorded maximum vegetative growth (plant height 5.14 m and canopy volume 18.70 m³).

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 are mentioned below.

New Delhi (Sweet orange cv. Malta clones: 12 nos)	Rahuri (Sweet orange cv. Mosambi: 10 clones)	Tirupati (Sweet orange cv. Sathgudi clones: 6 clones)
MS-1, 2, 3, 4, 7, 8, 10, 14, 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 thirteen 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 4.51 m in MS-3 to 2.52 m in MS-17. Most of the clones had canopy diameter less than 4.5 meter suggesting the suitability of their planting at 5 x 5 m distance i.e., moderate plant density. Moreover, canopy volume varied from 56.43 m³ in MS-9 to 196.04 m³ in MS-3. Among these clones, fruit weight varied from 198.70 g in MS-15 to 303.88 g in MS-3 as compared to Pusa Sharad (201.68 g) and Pusa Round (208.94 g). MS-3 clone has yielded the highest fruit yield (53.99 kg/tree, 33.75 t/ha) as compared to check varieties (Table 8).

Rahuri: Of the ten promising clones of sweet orange cv. Mosambi evaluated, the maximum plant height (3.34 m), canopy volume (13.45 m³), scion girth (43.10 cm), fruit weight (178.89 g), number of fruits (196.40 fruits/tree) and yield (35.11 kg/tree, 9.72 t/tree) were recorded in selection No. 3. For

quality parameters, significantly the maximum juice (56.30%) was recorded in the treatment T₈ i.e. clone no. 8. The treatment T₁₀ i.e. clone no. 10 recorded significantly the maximum TSS (9.90°B). The treatment T₁ i.e. clone no. 1 recorded the maximum non-reducing sugars (2.78%), total sugars (6.12%) with minimum acidity (0.27%). The maximum ascorbic acid (52.19 mg/100 ml juice) was recorded by the treatment T₆ i.e. clone no. 6. The treatment T₅ recorded significantly the maximum reducing sugars (4.24%).

Tirupati: Among the six promising clones of sweet orange cv. Sathgudi evaluated along with local check Sathgudi, the TS₆ clone recorded the higher scion girth (40.00 cm) and canopy volume (13.52 m³) after eleven years of planting. Significantly maximum no. of fruits per tree (260) and yield (34.67 kg/plant) were recorded in TS₅ followed by Sathgudi clone (240 fruits/tree and 30.61 kg/plant) and TS₆ (228 fruit/tree and 29.26 kg/tree) (Table 9).

Table-8: Growth, yield and fruit quality attributes of sweet orange clones at New Delhi

Clones	Canopy volume (m ³)	Fruit weight (g)	Yield (kg/tree)	Juice (%)	TSS (°B)	Ascorbic acid (mg/100 ml juice)
MS-1	169.86b	260.62 ^{bc}	25.84 ^{def}	43.26 ^{edf}	9.52 ^{bdc}	45.26 ^{fg}
MS-2	120.33c	245.35 ^{dc}	29.84 ^{de}	48.50 ^{bac}	9.24 ^{dec}	57.06 ^{bc}
MS-3	196.04a	303.88 ^a	53.99 ^a	49.15 ^{ba}	9.94 ^{bac}	62.70 ^a
MS-4	94.70e	204.42 ^e	21.71 ^{ef}	50.32 ^a	9.08 ^{de}	51.43 ^{de}
MS-7	71.63h	225.42 ^{de}	42.68 ^{bc}	40.25 ^f	7.56 ^f	49.14 ^{fe}
MS-8	89.42fe	279.35 ^{ba}	18.39 ^f	41.43 ^{ef}	10.04 ^{ba}	54.07 ^{dc}
MS-9	56.43i	221.54 ^{de}	46.00 ^{ba}	46.90 ^{bdac}	9.16 ^{dec}	50.72 ^{de}
MS-10	78.91hg	202.38 ^e	33.18 ^{dc}	43.76 ^{edfc}	8.54 ^e	49.14 ^{fe}
MS-14	110.76d	248.66 ^{dc}	19.31 ^f	40.57 ^f	9.74 ^{bdac}	57.77 ^{bc}
MS-15	92.36e	198.70 ^e	4.58 ^g	44.49 ^{ebdfc}	10.4 ^a	59.88 ^{ba}
MS-17	28.72j	265.04 ^{bc}	26.68 ^{def}	41.58 ^{ef}	7.64 ^f	50.02 ^{de}
MS-21	75.19h	245.59 ^{dc}	24.17 ^{def}	46.91 ^{bdac}	9.66 ^{bc}	42.44 ^g
Pusa Sharad	93.38e	201.68 ^e	45.35 ^{ba}	48.02 ^{bdac}	9.18 ^{de}	50.55 ^{de}
Pusa Round	83.40fg	208.94 ^e	46.22 ^{ba}	46.16 ^{ebdac}	9.34 ^{bdc}	50.19 ^{de}
CD at 5%	7.41	27.26	9.52	4.79	0.76	4.59

Table-9: Growth, yield and Quality attributes of different clones of sweet orange

Clones at Rahuri	Canopy volume (m ³)	Fruits/ tree	Yield (kg/ tree)	Clones at Tirupati	Canopy volume (m ³)	Fruits/ tree	Fruit yield (kg/ tree)	TSS (°B)	Acidity (%)
Sel No. 1	10.95	166.20	24.16	TS ₁	5.98	146	19.55	10.37	0.52
Sel No. 2	11.30	167.10	25.95	TS ₂	5.31	147	19.14	10.90	0.50
Sel No. 3	13.45	196.40	35.11	TS ₃	6.01	195	24.87	11.33	0.51
Sel No. 4	12.30	182.30	31.04	TS ₄	9.62	213	27.10	11.73	0.61
Sel No. 5	10.05	162.90	24.17	TS ₅	9.82	260	34.67	11.20	0.58
Sel No. 6	10.25	152.30	24.83	TS ₆	13.52	228	29.26	12.23	0.54
Sel No. 7	12.80	187.80	33.10	TS ₇	8.51	240	30.61	11.70	0.61
Sel No. 8	10.10	159.60	25.66	CD at 5%	4.63	4.64	1.95	0.49	0.09
Sel No. 9	11.35	168.10	26.15	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)					
Sel No. 10	10.11	155.90	23.84						
Phule Mosambi (check)	10.60	170.20	29.29						
CD at 5%	1.92	7.59	2.24						

Tree age : 7.5 years at Rahuri : Tree age : 11 Years at Tirupati.

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 33 acid lime clones also with

02 check varieties evaluated, the clone no.21 (ALC-75) recorded the maximum plant height (3.75 m). The Clone no. 7 (ALC-21) recorded maximum Canopy volume (133.41 m³). The clone no. 29 (ALC-101) recorded the maximum number of fruits/tree (308.67) and ascorbic acid (41.10 mg / 100 ml juice). The clone no. 2 (ALC-4) recorded the maximum fruit

weight (45.06 g). The clone no. 19 (ALC-73) recorded the maximum juice (57.60%). The clone no. 33 (ALC-114) recorded the maximum TSS (8.16 °B). Whereas, the clone no. 8 (ALC-24) recorded the maximum acidity (7.16%). Out of 33 acid lime clones, the clone no. 4 (ALC-11), clone no. 8 (ALC-24), clone no. 9 (ALC-35), clone no. 16 (ALC-64), clone no. 29 (ALC-101) and clone no. 31 (ALC-103) were found promising based on yield and other horticultural traits.

Rahuri: Among six acid lime clones, the clone no.4 recorded the maximum plant height (3.10 m), canopy volume (17.70 m³), stem girth (42.40 cm) and TSS (7.00°B). The clone no. 3 recorded the maximum fruit weight (47.80 g) and yield (38.11 kg/tree). The check variety Phule Sharbati recorded the maximum juice (45.18%). Whereas, the clone no. 6 recorded the maximum acidity (6.84%) and ascorbic acid (41.22 mg / 100 ml juice). Early precocity was noticed in clone no.3.

Tirupati: Among 37 acid lime clones and 01 check variety. The clone no. 37 (PKM-1) recorded the maximum plant height (3.17 m), canopy volume (21.92 m³) and stem girth (44.33 cm). The clone no. 33 (Selection-16) recorded the maximum number of fruits/tree (864.50). Whereas, the clone no. 11 (Balaji) recorded the maximum yield (36.51 kg/tree).

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 max yield parameters (48.01 kg/tree, average weight 164.18 g). Clone 43 recorded 321.60 fruits/tree as compared to other mandarin clones evaluated whereas Mandarin-182 recorded highest juice percentage (46.60%).

Chettalli: The Clone M 182 recorded maximum yield parameters (159.00 /tree fruits weighing 19.23 kg) having average fruit weight (137.53 g) with juicy fruits (51.20%).

Ludhiana: Among all the mandarin clones maximum plant height was recorded in N-34 (4.30 m), whereas the maximum canopy volume was recorded in Kinnow mandarin (32.60 m³).

Nagpur: Nagpur mandarin recorded the maximum plant height while, N-28 registered the maximum canopy volume (18.95 m³). The clone 11 was found to have maximum fruit weight (147.67 g) whereas, clone N-4 found juicy (47.28%) having least no. of seeds (0.8/fruit).

Sriganganagar: Clone N-4 recorded maximum plant height (3.38 m), canopy volume (11.87 m³).

Tinsukia: The maximum values for growth parameter (plant height, 2.06 m and canopy volume 2.07 m³) were recorded by clone N-51. The highest number of fruits/tree (87) having maximum TSS (10.18°B) and lowest acidity (1.07%) were observed in CRS-4 recorded the maximum plant height (1.94 m) and canopy volume (2.03 m³) (Table 10 & 11).

Table-10: Growth and yield attributes of mandarin clones at different centres

Clones	Canopy volume (m ³)					Fruit weight (g)				Fruits/tree			Yield (kg/tree)		
	AKL	LUD	SNG	TNK	CHT	AKL	TNK	CHT	NGP	AKL	TNK	CHT	AKL	TNK	CHT
N-4	13.63	12.40	11.87	1.76	2.31	156.60	175.00	117.59	128.52	250.42	85.00	117.00	37.25	14.66	14.15
N-28	6.42	16.40	6.64	1.49	2.14	152.78	164.00	121.53	137.23	245.64	61.00	109.00	35.65	10.21	13.18
N-34	4.38	15.40	6.90	1.67	2.04	164.18	157.00	119.42	118.45	307.82	82.00	145.00	48.01	13.13	17.54
N-38	7.96	13.20	8.75	1.45	2.60	151.88	173.00	128.69	139.44	175.97	63.00	122.00	25.39	11.32	14.76
N-43	6.19	11.10	8.32	1.05	2.17	150.08	162.00	137.40	145.55	321.60	69.00	131.00	45.85	11.41	15.85
N-51	4.98	14.30	8.41	2.07	1.85	151.88	170.00	123.54	130.77	254.47	76.00	129.00	36.72	13.19	15.61
Mandarin-182	7.25	4.90	7.98	0.86	2.18	155.97	-	137.53	107.83	297.40	-	159.00	44.07	-	19.23
CRS- 4	5.38	9.60	5.45	1.81	2.07	152.08	162.00	98.56	125.36	261.30	87.00	95.00	37.75	14.37	11.49
Clone-11	2.35	8.80	11.00	0.78	2.17	150.67	-	101.34	147.67	209.08	-	108.00	29.93	-	13.06
Nagpur mandarin	11.13	-	-	-	-	156.40	-	-	-	274.37	-	-	40.76	-	14.15
Kinnow mandarin	-	32.60	-	-	-	-	-	-	-	-	-	-	-	-	-
CD at 5%	6.19	7.00	2.17	0.38	NS	NS	-	NS	12.23	31.68	-	NS	3.19	-	NS

AKL: Akola; LUD: Ludhiana; SNG: Sriganganagar; TNK: Tinsukia; CHT: Chettalli; NGP: Nagpur

Table-11: Quality attributes of mandarin clones at different centres

Clones	TSS (°B)				Acidity (%)				Juice (%)		
	AKL	TNK	CHT	NGP	AKL	TNK	CHT	NGP	AKL	CHT	NGP
N-4	10.32	8.67	8.50	7.42	0.66	1.25	0.39	0.71	44.80	46.50	47.28
N-28	9.88	8.42	9.90	9.32	0.66	1.53	0.31	0.81	45.84	45.00	41.20
N-34	13.30	9.18	8.60	8.78	0.65	1.51	0.39	0.96	44.32	46.20	46.16
N-38	7.03	9.11	9.60	8.94	0.77	1.40	0.31	0.85	45.53	41.80	45.90
N-43	12.70	8.63	10.20	8.35	0.66	1.23	0.31	0.80	45.53	41.60	45.67
N-51	10.17	9.27	8.50	8.94	0.62	1.53	0.31	0.68	44.92	49.00	43.32
Mandarin-182	12.21	-	10.40	8.40	0.68	-	0.30	0.81	45.67	51.20	44.34
CRS-4	10.46	10.18	8.20	8.97	0.82	1.07	0.29	0.84	43.89	46.40	40.25
Clone-11	8.29	-	8.70	9.04	0.79	-	0.39	0.84	43.06	44.60	37.23
Nagpur mandarin	11.29	-	-	-	0.71	-	-	-	44.92	-	-
Kinnow mandarin	-	-	-	-	-	-	-	-	-	-	-
CD at 5 %	0.09	-	1.87	0.96	NS	-	NS	0.06	2.85	5.63	8.45

AKL: Akola; LUD: Ludhiana; SNG: Sriganaganagar; TNK: Tinsukia; CHT: Chettalli; NGP; Nagpur

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 was recorded in M-3 (3.40 m), whereas maximum canopy volume (20.1 m³), maximum yield (48.0 kg/plant). The maximum TSS was recorded in M-8 Clones (10°B), whereas, the lowest acidity (0.38%) was recorded in Phule Mosambi.

Nagpur: The maximum plant height was recorded by Phule Mosambi (2.85 m). Maximum canopy volume was recorded by Local Check Mosambi (10.04 m³). The maximum of 395 fruits were recorded by M-8. Phule Mosambi recorded maximum fruit weight (222.6 g), whereas Local Check Mosambi recorded the maximum TSS (12.17°B). The highest juice content (48.04%) was recorded in M-3 clone (Table 12).

Rahuri: Promising clone M-8 recorded significantly the maximum plant height (2.74 m), canopy volume

(10.95 m³), scion girth (36.95 cm), number of fruits (179.60 fruits/tree) and yield (30.82 kg/tree and 8.53 t/ha) as compared to other promising clones of sweet orange. Whereas, the treatment T₃ i.e. promising clone M-4 recorded the maximum fruit weight (173.80 g). For quality parameters, promising clone Phule Mosambi recorded significantly the maximum juice (45.99%) with minimum acidity (0.34%). Check variety Mosambi recorded significantly the maximum TSS (8.47°B), reducing sugars (3.70%) and total sugars (5.18%). Whereas, promising clone M-3 recorded the maximum ascorbic acid (53.51 mg /100 ml juice). Whereas, the treatment T₆ i.e. promising clone Shamouti orange recorded significantly the maximum non-reducing sugars (2.24%).

Tirupati: There was no significant difference for growth parameters, however, M-3 clone was found more vigorous. Significantly highest fruit yield was recorded in M8 clone (116 fruits/plant, 18.23 kg/plant) followed by Sathgudi clone (15.96 kg/plant) and M4 clone (15.40 kg/plant) clones. However, there was no fruiting in Shamouti clone. Significantly highest juice content (46.29%) minimum acidity (0.51%) and good TSS and acid blend (23.74) were recorded in Phule mosambi clone. Whereas, maximum TSS was recorded in Sathgudi clone (12.60°B).

Table-12: Growth, yield and quality performance of promising clones of sweet orange at different centres.

Clones	Canopy volume (m ³)				Fruits/tree				Yield (kg/tree)			TSS (°B)			
	LUD	NGP	RHR	TPT	LUD	NGP	RHR	TPT	LUD	RHR	TPT	LUD	NGP	RHR	TPT
Phule Mosambi	13.1	7.10	10.06	9.34	238.5	293.0	170.20	79.67	44.0	29.29	11.90	9.2	9.47	8.26	11.97
M-3	17.5	6.53	8.10	10.97	119.8	316.0	128.45	71.75	23.0	20.43	10.70	9.6	9.00	6.97	11.90
M-4	18.6	8.74	8.57	7.58	258.6	322.3	155.20	107.00	45.0	27.11	15.40	9.8	9.07	7.25	11.00
M-8	12.8	7.97	10.95	7.23	225.1	395.0	179.60	116.33	40.2	30.82	18.23	10.0	10.17	8.38	11.63
Kodur Sathgudi	20.1	8.50	8.90	8.04	259.3	284.7	145.70	96.25	48.0	22.57	14.81	9.5	10.20	7.20	12.53

Clones	Canopy volume (m ³)				Fruits/tree				Yield (kg/tree)			TSS (°B)			
	LUD	NGP	RHR	TPT	LUD	NGP	RHR	TPT	LUD	RHR	TPT	LUD	NGP	RHR	TPT
Shamouti orange	11.8	5.23	9.75	7.44	6.3	114.3	158.30	-	-	24.10	-	-	8.90	7.18	-
Local checks *	16.0	10.04	8.00	7.78	256.4	233.7	161.80	103.25	42.0	27.06	15.96	9.0	12.17	8.47	12.60
CD at 5%	2.9	2.63	2.14	NS	95.4	18.5	37.44	9.75	8.8	6.49	1.45	0.4	1.15	0.26	0.65

Local checks: *Mosambi at Nagpur, Ludhiana & Rahuri *Sathgudi at Tirupati
LUD: Ludhiana; NGP: Nagpur; RHR: Rahuri; TPT: Tirupati

1.1.4(c) 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-1 2 from CCRI, Nagpur along with local check variety for growth and yield characters.

Akola: Maximum plant height (2.43 m), canopy volume (5.52 m³) and no. of fruits per plant (125.20) was recorded in Akola lime (PDKV lime).

Nagpur: Among all the clones evaluated highest fruits (467 fruits/plant) was harvested in Phule Sharbati

followed by NRCC Nimboo-3 (436 fruits/plant)

Periyakulam: The clone NRCC Nimboo-3 recorded the maximum plant height (5.04 m) and number of fruits (320.10).

Rahuri: The clone NRCC Nimboo-3 recorded the maximum plant height (3.08 m) and the maximum canopy volume (18.95 m³). However, the maximum number of fruits per tree (911.09) was recorded in clone TAL-94/14.

Tirupati: The NRCC, Nimboo-3 recorded maximum plant height (3.79 m) and number of fruits per tree (887.67) (Table 13).

Table-13: Growth and yield parameters of acid lime clones

Clones	Canopy volume (m ³)					Fruits/tree				
	Akola	Rahuri	Tirupati	Nagpur	PKM	Akola	Rahuri	Tirupati	Nagpur	PKM
TAL-94/13	2.75	14.75	20.21	3.66	7.42	30.20	719.50	216.67	378.30	78.00
TAL-94/14	1.51	17.25	13.07	2.55	8.16	70.20	911.09	681.00	433.00	140.12
Phule Sharbati	3.23	16.10	24.64	3.35	2.58	80.20	782.52	593.67	467.00	78.40
Akola lime (PDKV lime)	5.52	13.25	18.14	2.83	2.70	125.20	730.60	530.00	428.30	32.40
NRCC, Nimboo-2	2.36	15.20	22.35	4.67	5.04	90.50	772.02	609.67	406.70	108.20
NRCC, Nimboo-3	2.30	18.95	33.28	2.82	25.10	110.50	745.50	887.67	436.00	320.10
NRCC, Nimboo-4	2.75	12.05	14.35	4.59	9.80	86.20	693.20	334.67	426.70	180.16
KL-12	1.18	15.60	21.68	5.53	28.72	35.20	752.02	634.00	333.30	65.10
K. lime local	0.52	-	-	-	-	55.20	-	-	-	-
PKM-1	-	-	-	-	10.90	-	-	-	-	280.10
Sai Sharbati	-	16.00	-	-	-	-	776.50	-	-	-
Balaji	-	-	29.68	-	-	-	-	325.00	-	-
CD at 5%	1.59	5.35	NS	0.99	6.78	13.38	14.34	23.07	23.49	20.04

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: Significantly maximum plant height (4.5 m) and canopy volume (54.9 m³) were recorded in

NRCC Pummelo-2. Whereas, fruit weight (930.8 g) and fruit yield (121.3 kg/tree) were recorded in NRCC Pummelo-5. Maximum TSS (9.3°B) was recorded in NRCC Pummelo-1.

Nagpur: Maximum plant height (3.99 m) was observed in NRCC Pummelo-1. The clone NRCC Pummelo-5 recorded maximum canopy volume (16.92 m³) and the clone NRCC Pummelo-1 recorded the maximum no. of fruits per tree (120). The maximum TSS (10.27°B) was recorded in NRCC Pummelo-2 and minimum fruit acidity (0.73%) was

recorded in NRCC Pummelo-5.

Tinsukia: Significantly maximum plant height (3.07 m) and canopy volume (5.78 m³) were recorded in NRCC Pummelo-4 clone.

Tirupati: None of the clones were found significant compared to check Pummelo Pink for plant growth and fruit yield parameters. Among nine Pummelo clones NRCC Pummelo -5 clone has recorded

significantly highest plant height (2.83 m), scion girth (47.33 cm), canopy volume (13.84 m³) and maximum fruit yield (44.32 kg/plant). Fruit rind was very thin (4.41 mm) in NRCC Pummelo -2 clone and highest TSS was recorded in NRCC Pummelo -5 clone (13.2°B). Deformed fruits were noticed in PTF-1 clone. PTF-3 and PTF-4 clones were severely affected by water shortage (Table 14).

Table-14: Growth, quality and yield performance of promising clones of pummelo

Clone	Canopy volume (m ³)			Fruits/tree			TSS (°B)			Acidity (%)	
	Ludhiana	Nagpur	Tinsukia	Tirupati	Ludhiana	Nagpur	Tirupati	Ludhiana	Nagpur	Ludhiana	Nagpur
PTF- 1	28.6	12.25 ^{AB}	0.67	5.52	112.0	51 ^C	8.67	6.6	8.66 ^C	1.28	0.93 ^{AB}
PTF- 2	23.6	13.91 ^{AB}	0.63	10.40	139.5	61 ^C	10.33	8.1	10.04 ^{AB}	1.23	0.77 ^{ABC}
PTF- 3	20.9	6.60 ^C	0.61	2.84	59.7	45 ^C	-	8.8	10.13 ^{AB}	1.32	0.96 ^A
PTF- 4	22.9	10.09 ^{BC}	0.62	2.84	90.5	52 ^C	-	7.8	8.87 ^C	1.31	0.74 ^C
NRCC P -1	11.5	13.75 ^{AB}	3.80	5.50	137.0	120 ^A	14.0	9.3	9.03 ^{BC}	1.18	0.76 ^{BC}
NRCC P -2	54.9	14.20 ^{AB}	3.46	8.24	163.6	65 ^C	24.33	7.0	10.39 ^A	1.22	0.81 ^{ABC}
NRCC P -3	47.0	12.83 ^{AB}	2.41	4.03	118.8	64 ^C	30.33	6.2	9.03 ^{BC}	1.09	0.92 ^{AB}
NRCC P -4	17.3	9.93 ^{BC}	5.78	4.05	70.3	67 ^{BC}	16.0	6.9	10.20 ^A	1.09	0.78 ^{ABC}
NRCC P -5	23.6	16.92 ^A	2.03	13.84	130.3	93 ^B	19.67	7.6	9.53 ^{ABC}	1.09	0.71 ^C
Local Check*	18.2	--	1.21	23.70	100.4	--	60.0	8.2	--	1.09	--
CD at 5%	12.8	5.55	0.37	5.73	10.3	27.09	11.0	0.3	1.14	0.0	0.17

Ludhiana: 7-year-old; Tirupati: 7 years old; *local check: White pummel 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: Maximum plant height (1.95 m) was recorded under Flame grapefruit but the difference among the genotypes were non-significant. The maximum scion girth (12.57 cm) at this centre was recorded for clone NRCC6 grapefruit, which was statistically at par with that of Star Ruby, Red Blush, Marsh Seedless and Local check but significantly higher than rest of the genotypes.

Ludhiana: Maximum plant height (0.85 m) was noted in Flame grapefruit, which was statistically at par with that of clone NRCC6 grapefruit and varieties Star Ruby and Marsh Seedless, but significantly higher than rest of the genotypes. The highest canopy volume (0.81 m³) was also obtained for Flame grapefruit which was statistically equivalent to NRCC6 grapefruit (0.80 m³). The scion girth was found maximum in NRCC6 grapefruit (5.68 cm) which was statistically equal to all other genotypes

except Imperial grapefruit.

Nagpur: Maximum plant height (1.05 m) was reported for Flame grapefruit.

Rahuri: Maximum plant height (1.20 m) and canopy volume (0.89 m³) were obtained under Imperial grapefruit. The significantly lowest plant height (0.88 m) and canopy volume (0.35 m³) at this centre were obtained for Star Ruby and Flame grapefruit, respectively. The maximum scion girth (12.50 cm) was obtained in clone NRCC6 grapefruit, which was though statistically equivalent to Imperial and Foster grapefruit.

Tinsukia: Maximum plant height (1.40 m), canopy volume (4.00 m³) and scion girth (4.0 cm) were obtained under Local check grapefruit, clone NRCC6 grapefruit and Star Ruby, respectively.

Tirupati: Maximum plant height (0.88 m) was recorded for Red Blush and Foster grapefruit.

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, Sriganaganagar, Tinsukia and Nagpur.

Akola: The average plant height of Nagpur mandarin plant was 1.17 m while PDKV mandarin recorded 1.12 m.

Ludhiana: Genotypes had significant difference in terms of growth, maximum plant height (1.32 m) and largest canopy volume (4.39 m³) were recorded in Kinnow mandarin.

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

Sriganganagar: Plant height (1.75 m) was found to be maximum with Nagpur mandarin while, significantly maximum canopy volume (1.36 m³) was recorded with PDKV mandarin 5 clone.

Tinsukia: Significant differences reported for growth parameters, maximum plant height (1.45 m) was found with Nagpur mandarin while, maximum canopy volume (3.00 m³) was recorded with PDKV mandarin 5.

Chettali: 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 and Sriganganagar has been initiated.

Akola: NRCC AL-7 had maximum plant height (66 cm) followed by PDKV Bahar (62.65 cm), whereas, PDKV Chakradhar recorded maximum stem girth (10.75 cm) and NRCC AL-8 recorded maximum number of leaves on seedling.

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

Periyakulam: Pusa Abhinav (T₆) was recorded maximum plant height (1.39 m) followed by Pusa udit (T₅) (1.32 m).

Rahuri: All Acid lime clones were planted in December 2017; no plant growth data were reported during this period.

Sriganganagar: Among all the Acid lime clones, average plant height (1.83 m) was recorded in local check (Kagzi lime). Plant girth (122.7 mm) was found to be significantly maximum with SGNR AL-1 (T₇) followed by NRCC AL-8 (T₄) (121.0 mm).

Tirupati: Procured the acid lime planting material and planting was done during September, 2018. At initial stage the maximum height was recorded in local variety Balaji (1.14 m).

1.1.7. C. Rootstock breeding in Citrus

Controlled hybridization of Rough lemon with trifoliolate orange were attempted to produce rootstock hybrids.

Result: During the March 2018, a total of 335 flowers of Rough lemon were emasculated and controlled pollinated with Rubidoux trifoliolate (an accession of *Poncirus trifoliata*) pollen. Of the crossed flowers, 224 flowers developed into fruits and finally 47 fruits were retained on the tree. The 47 fruits yielded 382 seeds, of which 275 (71.9%) germinated. The 275 seeds produced 383 seedlings. The trifoliolate leaf of *Poncirus trifoliata* is reported to be dominant over monofoliolate leaves of Citrus. From 383 seedlings, 5 seedlings contained trifoliolate leaves and were, thus, selected as hybrids. (Fig. 6)

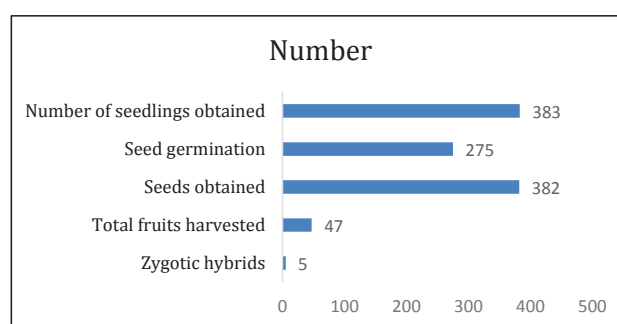


Fig.6: Account of harvested crossed fruits, total seeds and hybrids obtained in a Rough lemon X *Poncirus trifoliata* cross

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. Status of the trial is new. Trial is in progress.

Pasihat: Experiment has been laid out and planted in September-2019.

Rahuri: The experiment was allotted during the year 2019-20. As per the technical programme, the grafts of Cutter Valencia and Mosambi were procured from CCRI, Nagpur and Sathgudi grafts was collected from CRS, Tirupati. The trial was planted in the field in November-2019. The trial is in progress.

Tinsukia: Sweet orange clones have been collected and will be planted in March-2020. Layout for the experiment has already prepared. Planting materials are in establishment stage.

Tirupati: Procured the sweet orange planting materials from CCRI, Nagpur and planted in August-2019.

2.1.5.C. Evaluation of promising rootstocks in Citrus

To evaluate the influence of Citrus rootstocks on different mandarin varieties, a trail 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-4 rootstock recorded maximum canopy volume (23.60

m³). Maximum number of fruits per tree (565.4) and yield (98.0 kg/tree) was recorded in Rough lemon. Maximum TSS (10°B) was recorded in Carrizo root stock (Table 15).

Sriganganagar: Jatti khatti recorded maximum plant height (2.81 m) and canopy volume (2.48 m³). CRH 12 rootstock is not surviving under Sriganganagar condition (Table 16).

Tinsukia: Rootstocks did not significantly influence the plant growth of Khasi mandarin (Table 16).

Table-15: Performance of different rootstocks for mandarin at Ludhiana

Rootstocks	Plant height (m)	Canopy volume (m ³)	Fruit wt. (g)	Fruit/tree	Yield (kg/tree)	TSS (°B)	Acidity (%)
NRCC-2	3.3	22.2	175.5	390.3	68.5	9.7	0.78
NRCC-4	3.5	23.6	174.5	451.7	78.8	9.1	0.77
NRCC-5	3.3	16.2	171.0	466.1	79.7	9.6	0.79
NRCC-6	3.6	18.6	162.0	258.7	41.9	9.3	0.74
CRH-12	3.4	15.2	203.6	288.8	58.8	9.2	0.83
Alemow	2.9	11.3	185.6	411.9	76.4	9.2	0.77
Jatti Khatti	-	-	-	-	-	-	-
Carrizo*	3.5	22.7	173.0	440.4	76.2	10.0	0.83
Rangpur lime	-	-	-	-	-	-	-
Rough lemon	3.3	16.8	173.3	565.4	98.0	9.3	0.83
CD at 5%	0.3	5.2	11.3	95.0	16.2	0.3	0.04

Carrizo* rootstock is included at Ludhiana centre as per proceedings of 5th GD held at NRC Banana, Trichy.

Table-16: Performance of different rootstocks for mandarin at Sriganganagar and Tinsukia

Rootstocks	Plant height (m)		Canopy volume (m ³)	
	Sriganganagar	Tinsukia	Sriganganagar	Tinsukia
NRCC-2	2.68	1.00	2.10	0.34
NRCC-4	2.70	1.20	2.19	0.57
NRCC-5	2.12	1.23	1.20	0.58
NRCC-6	2.38	1.05	1.65	0.46
CRH-12	1.24	0.98	0.15	0.41
Alemow	2.59	1.21	1.75	0.54
Jatti Khatti	2.81	-	2.48	-
Rough lemon	2.74	1.75	2.28	0.63
CD at 5%	0.31	NS	0.56	NS

(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: Sweet Orange on Rough lemon rootstock has recorded significantly maximum plant height (2.83 m) followed by CRH-12 (2.80 m). Whereas, maximum canopy volume (13.71 m³) which is at par with CRH-12 (13.08 m³) and yield (25.62 kg/tree & 6.53 t/ha) was recorded in Rangpur lime (Table 13). NRCC-4 had high N (253.0 kg/ha) in NRCC rootstock-4 while P (39.2 kg/ha) and K content (587.5 kg/ha) was highest in Rangpur lime.

Rahuri: Significantly the maximum plant height (2.82 m) and canopy volume (9.96 m³) were recorded in Phule mosambi sweet orange budded on Rangpur lime rootstock. Maximum fruit weight (175.80 g), number of fruits (192.80 fruits/tree) and yield (33.93 kg/tree and 9.39 t/ha) were recorded on NRCC rootstock-4.

Tirupati: Rootstocks did not significantly influence the growth of Sathgudi sweet orange. However, significantly maximum number of fruits per tree (263.33 fruits/tree) and yield (32.55 kg/tree) were noticed in NRCC-6 rootstock (Table 17).

Table-17: Performance of different rootstocks for sweet orange at different centres

Rootstocks	Canopy volume (m ³)			Yield (kg/tree)		
	Rahuri	Nagpur	Tirupati	Rahuri	Nagpur	Tirupati
T ₁ - NRCC -2	8.77	8.32	6.19	29.60	17.34	25.78
T ₂ - NRCC -4	9.41	11.99	5.50	33.93	21.34	16.74
T ₃ - NRCC -5	7.35	7.90	6.83	27.27	20.13	18.99
T ₄ - NRCC -6	7.71	10.78	7.83	28.45	18.24	32.55
T ₅ - CRH-12	4.60	13.08	2.62	17.11	16.27	3.06
T ₆ - Alemow	5.54	6.93	7.35	22.31	16.62	30.87
T ₇ - Rangpur lime	9.96	13.71	6.35	32.43	25.62	25.84
T ₈ - Rough lemon	-	11.19	6.78	-	23.41	25.32
CD at 5%	1.13	NS	NS	3.50	-	1.27

Rahuri: Phule Mosambi; Tirupati: Sathgudi; Nagpur: Mosambi

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

The trial was laid out to study the effect of different spacing (6x6m, 6x5m, 6x4m) and levels (RDF as 75% inorganic source + 25% (organic source-FYM), 50% inorganic source + 50% (organic source-Vermicompost or Green manure), 100% inorganic source only as check) of nutrient on growth, yield and fruit quality.

(a) Mandarin

Akola: Different spacing, fertilizer levels and their interaction on growth and yield of Nagpur mandarin were not significant. However, 6 x 6 m spacing with 75% inorganic source + 25% (organic source-FYM) recorded significantly maximum number of fruits (111.25 fruits/tree).

Table-18: Vegetative growth and fruit yield parameters affected by nutrition and spacing interaction under high density planting

Treatment [#]	Plant height (m)			Canopy volume (m ³)			Fruits/ plant			Fruit yield (kg/ tree)		
	Akola	Ludhiana	Tinsukia	Akola	Ludhiana	Tinsukia	Akola	Ludhiana	Tinsukia	Akola	Ludhiana	Tinsukia
S ₁ L ₁	3.38	3.40	3.40	12.12	32.10	15.71	111.25	686.00	262.00	15.29	142.76	28.45
S ₁ L ₂	3.82	3.41	2.93	15.75	31.05	8.88	106.25	653.00	190.00	14.68	134.19	21.62
S ₁ L ₃	3.20	3.37	3.23	12.10	29.75	12.68	94.50	645.00	174.00	13.35	129.71	19.23
S ₂ L ₁	3.59	3.53	3.58	16.40	31.78	17.83	94.70	666.00	264.00	13.39	135.86	31.20
S ₂ L ₂	4.01	3.51	3.38	17.14	30.01	14.03	99.30	658.00	207.00	14.10	130.61	22.75
S ₂ L ₃	3.28	3.43	3.29	13.09	30.75	11.62	88.20	650.00	189.00	12.60	130.00	18.69
S ₃ L ₁	2.97	3.83	3.88	8.47	32.01	17.12	87.30	630.00	248.00	12.64	118.06	30.36
S ₃ L ₂	3.85	3.74	3.43	18.05	30.51	13.74	87.40	610.00	196.00	12.92	111.94	20.93
S ₃ L ₃	3.57	3.67	3.78	14.54	29.90	16.01	74.50	595.00	178.00	11.20	107.82	19.78
CD at 5%	NS	0.19	NS	NS	NS	3.40	7.15	17.00	4.10	NS	4.01	-

S₁ = Recommended spacing (6x6 m), S₂ = 20% increase in density (6x5 m), S₃ = 50% increase in density (6x4 m), L₁: 75% N (Inorganic source) + 25% N (Organic source-FYM) + 100% P & K (100% Inorganic - P & K supplied through FYM), L₂: 50% N (Inorganic source) + 50% N (Organic source - Vermicompost) + 100% P & K (100% Inorganic P & K Supplied through Vermicompost), L₃: 100% Inorganic only (Check)

Ludhiana: Spacing and nutrient levels alone did not vary significantly for plant height and canopy volume. However, the maximum plant height (3.83 m) was observed in the treatment with spacing 6 x 4 m with 75% inorganic source + 25% organic sources. 6x6 m spacing with 75% inorganic source + 25 %organic sources recorded maximum no. of fruits per plant (686) and yield (142.76 kg/ plant). Leaf as well as soil nutrient status did not vary significantly with different treatment combinations. (Table 18).

Tinsukia: Nutrition level and spacing did not affected plant height and spread, however maximum

canopy volume (17.83 m³) was recorded with a plant spacing of 6m X 5m in S₂ L₁. Higher organic carbon and nutrient status were also found in S₃ L₁ treatment and indicated building of soil nutrient levels by the inclusion of both organic and inorganic sources of nutrients. No significant difference was observed in different micronutrient levels of soil as well as leaf nutrient content. However, maximum number of fruits per tree (264) having TSS (9°B) were observed in treatment (S₂ L₁).

(b) Sweet orange

Rahuri: The interaction effect due to different

spacing and levels of nutrients were significant. Maximum plant height (3.44 m), canopy volume (20.75 m³), fruit weight (178.90 g), number of fruits per plant (378.50), yield (67.68 kg/tree), juice content (49.17%) and TSS (10.78°B) with minimum acidity (0.49%) were recorded in treatment S₁L₂ with 6 x 6 m spacing with 50% N (Inorganic source) + 50% N (Organic source - Vermicompost) + 100 P and K (100% Inorganic - P and K supplied through Vermicompost).

Tirupati: Among interaction effects, Treatment T₃ (S₁L₃) with the spacing of 6x6 m and 100% RDF has recorded significantly maximum canopy volume (16.27 m³) and number of fruits per tree (299.33) was recorded in Treatment T₅ (S₂L₂) with the spacing of 6x5 m and 50% N (Inorganic sources) + 50% (organic sources-Vermicompost) + 100% P & K (100% Inorganic-P & K supplied through Vermicompost). Nonsignificant effect on quality parameters was found (Table 19).

Table-19: 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
T ₁ (S ₁ L ₁)	19.25	15.83	61.61	37.45	47.20	46.51	10.60	11.00	0.52	0.66
T ₂ (S ₁ L ₂)	20.75	15.39	67.68	38.36	49.17	41.31	10.78	10.60	0.49	0.57
T ₃ (S ₁ L ₃)	18.70	16.27	59.46	38.10	45.34	42.65	10.35	11.03	0.53	0.61
T ₄ (S ₂ L ₁)	18.60	9.11	56.22	42.26	46.19	46.01	10.43	11.37	0.57	0.63
T ₅ (S ₂ L ₂)	19.10	11.13	60.76	43.46	48.31	40.79	10.64	11.17	0.55	0.66
T ₆ (S ₂ L ₃)	18.55	10.61	51.79	42.85	44.69	42.72	10.26	10.87	0.59	0.68
T ₇ (S ₃ L ₁)	17.35	13.76	53.49	38.56	45.20	42.22	10.19	11.60	0.58	0.57
T ₈ (S ₃ L ₂)	17.65	11.96	55.94	37.94	46.71	45.27	10.32	11.50	0.56	0.57
T ₉ (S ₃ L ₃)	17.10	13.65	49.24	41.63	42.05	34.13	10.16	11.37	0.60	0.54
CD at 5%	2.83	3.64	6.98	NS	NS	NS	0.087	NS	NS	0.07

S₁ = Recommended spacing (6x6 m), S₂ = 20% increase in density (6x5 m), S₃ = 50% increase in density (6x4 m), L₁: 75% N (Inorganic source) + 25% N (Organic source- FYM) + 100% P & K (100% Inorganic - P & K supplied through FYM), L₂: 50% N (Inorganic source) + 50% N (Organic source - Vermicompost) + 100% P & K (100% Inorganic P & K Supplied through Vermicompost), L₃: 100% Inorganic only (Check)

(c) Acid lime

Periyakulam: The maximum plant height (6.94 m) and canopy volume (86.02 m³) were recorded under 6 x 6 m spacing with 50% N (Inorganic source) + 50% N (Organic source - Vermicompost) + 100% P and K (100% Inorganic - P and K supplied through

vermicompost). The yield contributing traits viz, number of fruits per tree (988 fruits/tree) and yield (51.38 kg/plant) were highest under 6 x 5 m spacing with 75% N as inorganic source + 25% N as organic source through FYM + 100% P and K as 100% inorganic - P and K supplied through - FYM.

Table-20: Effect of different spacing and nutrient levels on growth and yield of acid lime

Treatments	Canopy volume (m ³)			Yield (kg/tree)		
	Periyakulam	Rahuri	Tirupati	Periyakulam	Rahuri	Tirupati
T ₁ (S ₁ L ₁)	75.90	37.05	23.99	45.32	71.22	37.70
T ₂ (S ₁ L ₂)	86.02	39.20	30.13	39.38	74.80	41.21
T ₃ (S ₁ L ₃)	79.10	35.30	20.71	31.76	68.39	39.31
T ₄ (S ₂ L ₁)	75.76	35.22	19.81	51.38	62.44	60.97
T ₅ (S ₂ L ₂)	71.80	38.30	18.55	39.00	66.79	43.68
T ₆ (S ₂ L ₃)	61.20	34.40	26.61	29.86	60.21	70.45
T ₇ (S ₃ L ₁)	52.14	33.30	30.20	39.84	56.75	51.07
T ₈ (S ₃ L ₂)	64.22	35.05	37.43	37.26	58.87	54.13
T ₉ (S ₃ L ₃)	58.80	30.35	26.00	31.64	53.29	33.27
CD at 5%	14.06	4.97	10.28	5.12	5.20	6.94

S₁ = Recommended spacing (6x6 m), S₂ = 20% increase in density (6x5 m), S₃ = 50% increase in density (6x4 m), L₁: 75% N (Inorganic source) + 25% N (Organic source- FYM) + 100% P & K (100% Inorganic - P & K supplied through FYM), L₂: 50% N (Inorganic source) + 50% N (Organic source - Vermicompost) + 100% P & K (100% Inorganic P & K Supplied through Vermicompost), L₃: 100% Inorganic only (Check)

Rahuri: The interaction effect of spacing and levels of nutrients recorded maximum plant height (3.65 m), canopy volume (39.20 m³), fruit weight (47.80 g), number of fruits (1565.40 fruits/tree) and yield (74.80 kg/tree) in treatment involving 6 x 6 m spacing with 50% N (Inorganic source) + 50% N (Organic source - Vermicompost) + 100% P and K (100% Inorganic - P and K supplied through Vermicompost). The treatment combination involving 6 x 6 m spacing with 100% N inorganic source was the best treatment for fruit quality with maximum juice content (46.10%), TSS (7.47°B), acidity (7.27%) and ascorbic acid (36.01 mg / 100 ml juice).

Tirupati: The interaction effect of spacing and nutrition, recorded significantly maximum plant height (3.48 m) and canopy volume (37.43 m³) in treatment 6 x 4 m spacing with 50% N (Inorganic source) + 50% N (Organic source - Vermicompost) + 100% P & K (100% Inorganic P and K Supplied through Vermicompost). However, maximum number of fruits (1882 fruit/tree) and yield (70.45 kg/tree) were recorded in treatment 6 x 5 m spacing with 100% inorganic only (Table 20).

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 (A₁B₁, A₁B₂, A₁B₃, A₂B₁, A₂B₂, A₂B₃, A₃B₁, A₃B₂, A₃B₃) comprising of three levels of age wise nutrient: i.e. i) Application of 1/10 of RDF for 10 years (A₁), ii) Application of 1/8 of RDF for 8 years (A₂) and iii) Application of 1/6 of RDF for 6 year (A₃) and three age wise dose of nutrients viz. 100% RDF after 10 years (B₁), 80% of RDF after 8 years (B₂) and 60% RDF after 6 years (B₃) 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) (Table 20).

(a) Mandarin

Akola: Maximum plant height (5.17 m) and canopy volume (82.24 m³) were recorded under interactive treatment T₈: A₃B₂ (Application of 1/6 of RDF for 6 year and 80% of RDF after 8 years). Whereas, fruit weight (149.63 g) and fruit yield (60.49 kg/tree) were recorded under interactive treatment T₉: A₃B₃ (Application of 1/6 of RDF for 6 year and 60% of RDF after 10/8/6 years).

Ludhiana: The maximum fruit yield (150.8 kg/tree), fruit weight (220.15 g), juice content (50.75%)

and TSS (11.40°B) was observed under T₇: A₃B₁ i.e. application of 1/6 RDF for 6 years followed by application of 100% RDF after 10 years.

Nagpur: Maximum canopy volume (0.88 m³), macronutrients (2.46% N, 0.14% P and 1.48% K) and micronutrient (81.2 ppm Fe, 53.2 ppm Mn and 29.1 ppm Zn) and maximum fruit yield (53.80 kg/tree) and maximum juice content (46.10%) and TSS (9.9°B) were also observed under the treatment T₉, as A₃B₃ carrying 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 such RDF needs to be adjusted in the context of nutrient residual pattern adjudged from cumulative response of applied fertilizers with their annual residual effects.

Sriganganagar: Maximum plant height (4.01 m) and canopy volume (33.93 m³) were recorded under interactive treatment T₈: A₃B₂ (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 also observed under the treatment T₉, as A₃B₃ carrying application of 1/6 of RDF up to six years followed by addition of 60% of RDF upto next six years.

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

(b) Sweet orange

Rahuri: Maximum plant height (3.56 m), canopy volume (22.90 m³), fruits per tree (392.90) and yield (69.86 kg/tree and 19.35 t/ha) were observed under the interactive treatment T₁: A₁B₁ (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 (51.16%), TSS (10.55°B), minimum acidity (0.47%) and maximum ascorbic acid (55.15 mg/100 ml juice) was observed under T₅: A₂B₂ i.e. application of 1/8 RDF for 8 years followed by application of 80% RDF (Table 21).

Tirupati: The interaction effect of different treatments had no significant influences on growth parameters. Maximum fruit yield (6.15 t/ha) were observed under the interactive treatment T₇: A₃B₁. Best internal fruit quality attributes, maximum TSS (12.0°B) was recorded under the treatment T₃: A₁B₃ (Table 21).

Table-21: Effect of age wise nutrient levels and age wise nutrient doses on growth and yield attributes

Treatments [#]	Canopy volume (m ³)		Fruits/tree		Yield (t/ha)	
	Rahuri	Tirupati	Rahuri	Tirupati	Rahuri	Tirupati
A ₁	21.90	6.25	377.46	97.72	18.32	4.19
A ₂	18.33	5.63	347.23	143.36	15.78	5.74
A ₃	19.26	5.86	358.20	134.58	16.55	5.56
CD at 5%	1.48	NS	13.56	1.94	1.16	0.15
B ₁	19.88	5.71	358.83	130.81	16.73	5.34
B ₂	20.04	6.09	365.56	123.11	17.13	5.16
B ₃	19.57	5.94	358.50	121.75	16.78	4.99
CD at 5%	NS	NS	NS	1.94	NS	0.27
T ₁ : A ₁ B ₁	22.90	6.77	392.90	94.08	19.35	3.87
T ₂ : A ₁ B ₂	21.74	6.53	371.10	91.25	17.98	4.21
T ₃ : A ₁ B ₃	21.05	5.44	368.40	107.83	17.64	4.50
T ₄ : A ₂ B ₁	18.56	5.58	339.50	147.25	15.13	5.99
T ₅ : A ₂ B ₂	18.82	4.92	352.90	151.83	16.06	5.98
T ₆ : A ₂ B ₃	17.60	6.39	349.30	131.00	16.14	5.26
T ₇ : A ₃ B ₁	18.18	4.79	344.10	151.08	15.72	6.15
T ₈ : A ₃ B ₂	19.55	6.80	372.70	126.25	17.37	5.29
T ₉ : A ₃ B ₃	20.05	6.00	357.80	126.42	16.57	5.23
CD at 5%	2.56	NS	23.49	3.35	2.01	0.27

[#]Refer methodology for the treatment details

(c) Acid lime

Periyakulam: The maximum plant height (6.04 m) was recorded under T₇: A₃B₁ (Application of 1/6 of RDF for 6 years and 100% of RDF after 10/8/6 years) and canopy volume (63.60 m³) was recorded under T₈: A₃B₂ (Application of 1/6 of RDF for 6 year and three age wise dose of nutrients viz. 80% RDF after 10/8/6 years) and number of fruits per tree (782) and fruit yield (39.10 kg/tree) were recorded under the treatments T₈: A₃B₂ (Application of 1/6 of RDF for 6 year and 80% of RDF after 8 years).

Rahuri: The maximum plant height (3.66 m), canopy volume (39.15 m³), number of fruits per tree (1568.45), fruit yield (75.11 kg/tree), juice

(58.24%), TSS (7.78°B), acidity (7.36%) and ascorbic acid content (40.50 mg/ 100 ml juice) were recorded under the treatments T₃: A₁B₃ (Application of 1/10 of RDF for 1 to 10 years followed by application of 80% RDF after 6 years) (Table 22).

Tirupati: The effect of age wise nutrient level (factor A), nutrient doses (factor B) and interactions (AxB) were not significant. With significantly maximum number of fruits per tree (2544.00) was recorded under the treatment T₉: A₃B₃ (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 T₆: A₂B₃ (Application of 1/8 of RDF for 8 years and 60% RDF after 10/8/6 years) (Table 22).

Table-22: Effect of age wise nutrient levels and nutrient doses on growth and yield parameters

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	5.80	3.59	3.40	47.68	36.93	33.48	624	1523.88	2334.89	32.44	71.24	83.67
A ₂	5.70	3.41	3.61	54.12	34.73	38.93	720	1450.86	2392.56	36.72	63.21	87.27
A ₃	5.84	3.45	3.64	64.88	33.45	35.30	732	1451.70	2382.78	37.24	60.89	85.48
CD at 5%	NS	NS	NS	12.10	NS	NS	11.02	25.92	NS	1.10	4.83	9.47
B ₁	5.80	3.45	3.51	54.80	34.50	33.96	684	1460.28	2372.78	34.88	63.05	85.32
B ₂	5.78	3.46	3.64	55.64	34.75	36.41	712	1470.11	2267.20	37.02	65.02	80.82
B ₃	5.72	3.54	3.51	55.10	35.87	37.34	704	1496.05	2470.22	35.90	67.27	90.29
CD at 5%	NS	NS	NS	NS	NS	NS	11.22	25.92	80.45	1.28	NS	4.79
T ₁ : A ₁ B ₁	6.02	3.55	3.54	46.10	35.45	34.22	684	1508.15	2351.33	35.56	70.11	85.19
T ₂ : A ₁ B ₂	5.60	3.58	3.44	46.02	36.20	34.46	696	1495.05	2182.67	36.20	68.50	75.17

Table-22: Effect of age wise nutrient levels and nutrient doses on growth and yield parameters

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
T ₃ : A ₁ B ₃	5.54	3.66	3.23	46.70	39.15	31.77	670	1568.45	2470.67	34.84	75.11	90.66
T ₄ : A ₂ B ₁	5.70	3.40	3.32	53.12	35.35	32.86	698	1446.60	2415.00	36.20	62.79	87.13
T ₅ : A ₂ B ₂	5.88	3.45	3.95	52.64	35.00	43.31	712	1464.10	2366.67	35.60	64.73	85.58
T ₆ : A ₂ B ₃	5.60	3.38	3.58	53.48	33.85	40.62	674	1441.90	2396.00	35.04	62.11	89.11
T ₇ : A ₃ B ₁	6.04	3.41	3.68	63.56	32.70	34.79	746	1426.10	2352.00	38.70	56.25	83.64
T ₈ : A ₃ B ₂	5.90	3.36	3.51	63.60	33.05	31.45	782	1451.20	2252.33	39.10	61.82	81.71
T ₉ : A ₃ B ₃	5.80	3.60	3.73	62.28	34.60	39.64	694	1477.80	2544.00	34.70	64.59	91.11
CD at 5%	0.48	NS	NS	0.70	6.28	NS	18.12	44.90	139.34	3.28	8.37	8.30

[#]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 (Table 23).

The dose of nutrients at different stages was varied to increase nutrient use efficiency compared to the existing practice.

Table-23: The treatment details of stage-wise requirement of nutrients in Citrus

Treatment	Percent RDF supplied through soil application																	
	Stage-I (Jan-Feb.)			Stage-II (Mar-April)			Stage-III (May-June)			Stage-IV (July-Aug.)			Stage-V (Sept-Oct.)			Stage-VI (Nov-Dec)		
	N	P ₂ O ₅	K ₂ O	N	P ₂ O ₅	K ₂ O	N	P ₂ O ₅	K ₂ O	N	P ₂ O ₅	K ₂ O	N	P ₂ O ₅	K ₂ O	N	P ₂ O ₅	K ₂ O
T ₁	0	0	0	40	50	0	40	50	0	20	0	50	0	0	25	0	0	25
T ₂	0	0	0	30	40	10	30	35	10	20	25	30	10	0	25	10	0	25
T ₃	0	0	0	30	40	0	30	35	0	40	25	30	0	0	35	0	0	35
T ₄ : Control:	1200:400:400 N: P: K g/plant (Akola); Split as per package of practices of the particular region																	

(a) Mandarin

Akola: Maximum canopy volume (96.13 m³), number of fruits per plant (850.30 fruits/plant) and yield (124.74 kg/plant and 34.55 t/ha) with higher percentage of juice (46.71%), TSS (11.06°B) with minimum acidity (0.60%) were found in the treatment T₂ i.e. 0:0:0, 30:40:10, 30:35:10, 20:25:30, 10:0:25, 10:0:25 % recommended dose of

N:P₂O₅:K₂O for stage-I (Jan-Feb) to stage-VI (Nov-Dec), respectively.

Ludhiana: Maximum canopy volume (36.85 m³), number of fruits per plant (690 fruits/plant), yield (145.25 kg/tree), juice (52.35%) and TSS (10.80°B) were recorded significantly higher in treatment T₂ i.e. 0:0:0, 30:40:10, 30:35:10, 20:25:30, 10:0:25 and 10:0:25% RDF of N:P₂O₅:K₂O at stage -I (Jan- Feb) and stage -VI (Nov.-Dec), respectively (Table 24).

Table-24: Effect of stage-wise application of nutrients on growth, yield and fruit quality in mandarin

Treatments	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	93.56	31.50	742.50	600	108.17	111.18	45.67	48.50	10.72	10.50	0.66	0.83
T ₂	96.13	36.85	850.30	690	124.74	145.25	46.71	52.35	11.06	10.80	0.60	0.79
T ₃	73.90	34.10	612.10	630	87.30	125.84	42.79	50.60	10.55	10.40	0.73	0.81
T ₄	85.50	33.50	676.50	585	97.87	104.33	40.97	48.75	10.65	10.30	0.68	0.82
CD at 5%	14.25	2.70	45.00	37.50	21.5	15.60	3.81	1.17	0.09	0.27	0.02	NS

[#]Refer methodology for the treatment details. AKL: Akola; LDH: Ludhiana

(b) Sweet orange

Tirupati: There was significantly highest number of fruits (275.20 fruits/plant) and yield (34.15 kg/ tree, 9.46 t/ha) with highest TSS (12.98°B) were recorded with treatment T₃, in which plants were subjected to stress during November-December months (Stage-I: no fertilizers 0:0:0) followed by application of 30:40:0 percent RDF during January- February (Stage-II : flowering), 30:35:0, percent RDF during March- April (Stage-III: fruit setting and growth), 40:25:30 percent RDF during May-June (Stage-IV: fruit growth and development), 0:0:35 percent RDF during July-August (Stage-V: fruit size enlargement), 0:0:35 percent RDF N:P₂O₅:K₂O during September-October (Stage-VI: harvesting), respectively. Maximum benefit cost ratio (1.58) was recorded with the same treatment followed by control (1.32).

(c) Acid lime

Periyakulam: Maximum plant height (5.80 m) and canopy volume (36.42 m³) were observed in treatment T₁. Whereas, the number of fruits (796 fruits/tree), yield (38.20 kg/tree) and juice content (48.80%) were found to be significantly more in treatment (T₂) 0:0:0, 30:40:10, 30:35:10, 20:25:30, 10:0:25 and 10:0:25 percent RDF of N:P₂O₅: K₂O for stage-I to stage-VI, respectively among the different stage wise application of nutrients.

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

Akola: The result indicated, significantly high fruit yield (108.09 kg/plant and 27.09 t/ha) having number of fruits/plant (823), juice content (47.04%), were recorded by application of 75% vermicompost (on N-equivalent basis of RDF) + *Trichoderma harzianum* (40 ml/plant) + azadirachtin (1% at 4 ml/l) + *Pseudomonas fluorescens* (30-40 ml/plant) in mandarin. Leaf and soil nutrient status was also improved with the application of 75% vermicompost (on N-equivalent basis of RDF) + *Trichoderma harzianum* (30-40 ml/plant) + azadirachtin (1% at 4 ml/l) + *Pseudomonas fluorescens* (40 ml/plant).

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) recorded maximum plant height (3.73 m), canopy volume (5.61 m³), fruit yield (78.69 kg / tree), juice content (53.45%), TSS (11.73°B) with minimum acidity (0.88%)(Table 25).

Tinsukia: Maximum plant height (4.51 m), canopy volume (33.16 m³), number of fruits per plant (483), average weight of fruit (120.25 g), Juice (48.7 %), TSS (11.2°B) and also maximum soil nutrient status and higher organic carbon content and Microbial population of bacteria, fungi, Actinomycetes and *Azospirillum* in soil were also found higher in the treatment T₄, 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/l as spray).

Table-25: Effect of organic manures and bio agents on growth and yield

Treatments	Canopy volume (m ³)			Yield (kg/tree)		
	Tinsukia	Sriganganagar	Akola	Tinsukia	Sriganganagar	Akola
T ₁	20.14	2.70	71.02	30.77	26.48	80.56
T ₂	22.30	3.29	71.23	40.47	37.90	90.54
T ₃	29.66	3.71	88.92	39.79	54.38	95.86
T ₄	33.16	5.61	97.72	58.08	78.69	108.09
T ₅	20.69	4.34	40.03	32.49	71.75	74.56
CD at 5%	0.96	1.03	18.71	3.86	7.58	8.29

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

Sweet orange

Tirupati: Application of recommended dose of fertilizers, recorded significantly highest number of fruits (232 fruits /plant), maximum fruit yield (36.29 kg/tree and 10.05 t/ha) was recorded in followed by organic treatment T₂ (100% Vermicompost on N-equivalent basis of RDF). Highest quality fruits were obtained when plants were supplied with 75% Vermicompost along with bio agents (T₄). The quality with respect to juice and TSS contents was non significantly influenced by the application of manures and bio fertilizers while the lowest acidity (0.50%) was noticed in the treatment T₄.

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 tried for economizing water needs in Citrus.

(a) Mandarin

Tinsukia: Maximum canopy volume (13.28 m³), fruit weight (110.25 g), number of fruits per tree (96) and available N (350 kg/ha) were recorded in the treatment T₄, i.e. application of irrigation at 80:80:80:80:80:80% ER. Plant height, E-W spread, N-S spread and stem girth showed non-significant differences between the treatments.

(c) Acid lime

Tirupati: Stage wise water application has not significantly influenced on plant growth parameters in ten years old trees of acid lime (Balaji). The maximum number of fruits/tree (1471.70) and yield (61.31 kg/tree and 16.98 t/ha) were recorded in the treatment T₄ i.e. application of irrigation at 80-80-80-80-80-80% ER. However, the maximum juice (51.10%) and acidity (7.58%) were recorded in the treatment T₁, i.e. application of irrigation at 30:40:30:40:30:40 % ER. TSS and acidity showed non-significant results between the treatments. The total quantity of water required from stage-I to stage-VI was in the range from 3108 to 8287 litre/year/plant.

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 and sunshine hours and analysis of the data on phenology and productivity in relation to observed trends in weather patterns recorded at different centres are presented herewith. Impact on insect pest and disease incidence has been furnished.

A. Impact of climate on crop phenology and productivity

(a) Mandarin

Akola: Timely *Mrig* (2019) flowering reported which was from second fortnight of June on wards in mandarin. Profuse ie 70 to 80 % *Mrig* flowering reported in mandarin, however persistent rainfall during July- Sept leads to flower and fruit drop. Around 20-30% delayed flowering *i.e.* in the month of August were also reported. Persistent lower temp $\leq 10^{\circ}\text{C}$ from second fortnight of December-Jan leads to profuse flowering (80% and more) in mandarin it remained continued up to second fortnight of March. Heavy fruit drop of *Ambia* (2019) reported in March- April (20-30%) and due to high temperature than normal and soil moisture fluctuation as well as difference in day night temperature. Similarly, in mandarin heavy continuous rain from July to Nov. caused *Ambia bahar* (2019) fruit drop (60-65%). Sunburn injury (browning, necrosis, bleaching) 10 to 12% (Nov- Jan) predominant feature of *Mrig bahar* (fruits) this year. An events of hail storm reported in the month of Dec- Jan 2019 in Vidarbha caused fruit drop and fruit injury as high as 60% as breaking of the tree branches. Overall, though season was very good for induction of flowering but adverse conditions *i.e.*, persistent rain fall during flowering and fruit development and untimely rains (July- Nov), high temperature than normal during the critical stage *i.e.* fruit set and pea size fruits (March- April) leads to poor season (Table 26).

Table-26: Extreme Events / Natural calamities and its effect on physiology of Nagpur mandarin and acid lime at Akola

Extreme event	Period	Effect
Heavy rains than normal	23 to 29 July 2019 106 mm (44.2) and 30 July - 5 August 118.7(49.3), 6- 12 August 79 mm (9.9), 17- 23 Sept 118.1 mm (24.6) 24- 30 Sept 82.0 mm (24.4), 22-28 Oct. 67.5 mm (10), 29 Oct- 4 Nov, 11.8 (2.3)	➤ Water stagnation, fruit drop of <i>Ambia bahar</i> (50-60%)
Continuous uninterrupted rains	Continuous rains from 18 July – 4 Nov. 2019, July 285.7mm (212.2), August 179.5mm (215.7) Sept. 263.1mm (111.1), Oct. 85.1 mm (52)	➤ Flower and fruit drop (30% <i>Mrig bahar</i>)

Extreme event	Period	Effect
High temp during fruit setting	<ul style="list-style-type: none"> ➤ 26March-1 Apr 41.2 (39.0) ➤ 2-8 Apr 42.1 (40.1) ➤ 9-15 43.1(40.8) ➤ 23-29 44.3(42.1) 	Flower, fruit let and fruit drop as high 20-30 % of <i>Ambia bahar</i> reported

Ludhiana (Abohar): The temperature of February and March months in 2019 was less than the decennial average temperature for these months. The upper temperature limit in the months from January to April is critical for next season vegetative flush, flower initiation, flowering duration and fruit set. The average maximum temperature of months April, May, June, July and August was more than 35.0°C. Abohar has a semi-arid climate. The average annual rainfall of this place is 284 mm. Over the past 10 years, the years 2011, 2014, 2015, 2017 and 2019 have recorded a rainfall amount higher than this average. Usually, the bud sprouting for spring flush in Abohar conditions starts on 15th to 20th of February. In the year 2019, the rains of low to moderate amount were recorded on 1st, 7th, 21st and 26th of February. Due to these rains, the average maximum and average minimum temperature of this month was lesser than that of 2018. Due to the relatively cool period, the buds sprouting for spring flush for 2019 started in 1st week of March, which was approximately 10-15 days late than 2018. The flower onset was also delayed. The peak flowering in Kinnow mandarin was observed during 25th of March to 3rd of April, 2019. The overall flowering in 2019 was 10-15% less than that of 2018. The yield was 2-5% lower than the previous year.

Sriganganagar: First vegetative flush was observed in the last week of February, 2018. Flowering was observed from the first week of March to 17th April. Fruit yield of Kinnow observed lesser this year (13-17 tons/ha) that was may be due to low rainfall throughout the year and increase in maximum and minimum temperatures in the month of March 2018 resulted medium flowering and fruit set under Sriganganagar conditions. Colour break in fruit was observed in the second week of November 2018. Increase in maximum and minimum temperatures tends to more dropping of the flowers and fruit cause low yield. Increase in maximum and minimum temperatures in the month of March 2018 resulted medium flowering and fruit set under Sriganganagar conditions Increase in maximum and minimum temperatures tends to more dropping of the flowers and fruit cause low yield. Maximum rainfall was observed in the month of July (133.90 mm) followed by June, 2018 (75.50 mm). Total rainfall of the year 2018 was lesser over past 35 year's average value. No. of Rainy days also reduced. Higher pan evaporation

and sunshine hours during fruit development month reduced the fruit growth. Fruit drop was also recorded higher during April to September months.

Tinsukia: The highest rainfall (2941mm) and rainy days (154) were observed in the year 2017 while, the lowest rainfall (1989.2) was observed in the year 2018 and rainy days (128) was observed in both the year of 2018 and 2019. Again, highest average maximum temperature (28.80°C) was observed in the year 2017 while, the lowest average maximum temperature (27.79°C) was observed in the year 2019. Average minimum temperature of 16.3, 17.15, 15.11 and 18.46°C were recorded in the year 2016, 2017, 2018 and 2019 respectively. Relative humidity of 80.50% was recorded highest in the year 2018 and the lowest relative humidity (63.50%) was recorded in the year 2019. The yield of the Khasi mandarin plants (387 fruits/plant) was reduced in 2019, which may be due to abnormally high rainfall particularly during the months of April-August as well as hailstorm that occurred during the month of February and resulted in flower drop in mandarin trees. Higher fruit yield (510 fruits/plant) was observed in 2018. Optimum annual rainfall coupled with optimum average temperature may have resulted in increase in yield. In 2019, new growth flushes occurred in the month of February-March. Flowering was observed from 10th of February to 22nd of March.

(b) Sweet orange

Rahuri: Due to drought condition during June to August, 2019 the growth and development of sweet orange fruits was not satisfactory which lead to slight reduction in yield of sweet orange as compared to last year.

Tirupati: Early fruit ripening was noticed for Hasta bahar crop, Sun scorching, fruit cracking and fruit dropping symptoms noticed due to high temperatures at fruit development stage for Ambe bahar crop. Weather conditions: To study the trend of recent variation in the climate, the decennial average maximum and minimum temperature (°C), rain fall (mm) and relative humidity were computed for different months for the period 2007-16 and were compared against the respective average monthly maximum and minimum temperatures over three years. A noticeable rise has occurred in the average maximum temperature from March to June months

in the years 2017, 2018 and 2019 as compared to the decennial average maximum temperatures for these months. Among these four months, the steepest increase has been observed for March month. An increase of 1.82 (in 2017) to 3.44°C (in 2019) has been observed in the average maximum temperature of this month from the decennial average maximum temperature. The upper temperature limit in these months is critical for fruit set and development of *Ambe bahar* crop. The average minimum temperature was also very low (2.5°C) during March, 2019. Due to large difference in diurnal temperatures during March early fruit ripening was noticed in Citrus orchards. The decennial average annual rainfall of this place is 1049.98 mm distributed in 55 rainy days. The maximum rainfall of 1213 mm (71 rainy days) was recorded in the year 2017 followed by deficit rain fall of 686.6mm (38 rainy days) during 2018. The months of August to December are the rainy months of Tirupati region. However, the observation of past years showed that maximum rain fall was recorded during November month. A large variation has been observed in the quantity of rains received during different months, but, overall, the total rainfall pattern is erratic. A relative increase in the relative humidity has been observed in the years 2017, 2018 and 2019 from august to December months. The yearly maximum relative humidity was observed during December and January months. The data on average minimum and maximum relative humidity also amply indicate that 2018 was slightly drier year.

(c) Acid lime

Rahuri: Due to drought condition and shortage of irrigation water from June to August, 2019 early flowering of *hasta bahar* was noticed. Also, due to drought conditions during June to August, 2019 the growth and development of acid lime was not satisfactory which affected the slight reduction in yield of acid lime.

Tirupati: *Ambia* flowering was initiated during first fortnight of February. Flower & fruit drop were reported during March. Fruit drop and fruit cracking was noticed during March. Severe leaf fall was noticed due to variations in maximum and minimum temperatures. *Hasta Bahar* fruiting was less (25%) with good quality.

Impact on Pest incidence

(a) Mandarin

Akola: Citrus psylla population on Nagpur mandarin ranged between 0.0 and 8.85/5 cm twig. Citrus Psylla population was maximum (8.85) in second fort

night of February and showed significant negative correlation with minimum temperature. The leaf miner infestation was medium to high level throughout the year and it ranged from 3.34 to 22.27 per cent leaf infestation from April 2018 to February 2019. The highest infestation was in second fort night of August; whereas it was lowest in June first fort night. The leaf miner showed significant negative correlation with maximum temperature and bright sunshine hours and positive significant correlation with morning relative humidity and evening relative humidity. Mite population initiated in second fort night of July and was maximum (6.73) in October second fort night. The mite population was ranged from 0 to 6.73 per 5 cm twig it was at moderate level. Aphid population was observed in first fort night of October and was maximum in first fort night of January and showed significant negative correlation with maximum and minimum temperature. The fruit sucking moth damage on *Ambia bahar* fruit was initiated in August first fort night and reached maximum of 34.17 per cent in first fort night of November. The population of white fly/black fly was very meagre in the season and ranged from 0.00 to 1.06 egg/ nymphs/pseudo pupae/sq cm with maximum in first fort night of December. Their incidence levels reported significant negative correlation with maximum and minimum temperature and positive significant correlation with morning relative humidity. The minimum temperature had played negative role in Citrus psylla and aphid development. The maximum temperature and bright sunshine hours had negative and morning and evening relative humidity had positive impact on Citrus leaf miner incidence.

Ludhiana (Abohar): The Citrus psyllid is the main insect pest of Citrus in the region. The adult population was reported in all months, ranging from 7.9 in October to 60.5/5 cm shoot in April. The nymphal population was high in the months of March-April, which again peaked in September. The leaf miner was observed in April to June and again in August to October. A survey of orchards on the infested fruits during September revealed that thrip and mite complex was in the range of 2.0 to 5.0% in the year 2019. The Citrus leaf miners were in the range of 0 to 4.1%. Sporadic incidence of Fruit sucking moth was also observed during September end.

Sriganganagar: In Kinnow mandarin, Citrus psylla, Leaf minor and thrips was the major enemy during the year except January, November and December months. Citrus psylla caused maximum damage in the months of March – April followed by July to September months. Leaf minor 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. Infestation of grey weevil a new emerging pest for kinnow noted low active during April to October. Fruit sucking moth again caused serious damage in the Months of October and November.

Tinsukia: High incidence of Citrus leaf miner (*Phyllocnistis citrella*) and Trunk borer (*Anoplophora versteegi*) was found in the surveyed orchards. The leaf miner infestation was maximum with 39.50% in the month of April followed by Trunk borer (31.15%) in the month of August. It was observed that Bark eating caterpillar (*Indarbella* spp.) infestation was more in old orchards while leaf miner (*Phyllocnistis citrella*); Citrus psylla (*Diaphornia citri*), lemon butterfly (*Papilo demoleus*) and Citrus looper infestation was serious in young orchards of different areas.

(b) Sweet orange

Rahuri: There was heavy incidence of mites and psylla throughout the year. In general, the incidence of stem end rot and fruit sucking moth was minimum because there was no rain during the month of June to August, 2019.

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

(c) Acid lime

Akola: Citrus psylla population ranged between 0.32 and 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 per cent leaf folder damage was noted in August second fortnight and lowest in May first fortnight with 0.93 per cent 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 meager 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.

Periyakulam: The pest disease calendar for 2019 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.

Rahuri: Heavy incidence of mites and scale was observed during this year. The incidence of Citrus canker was less due to unfavourable climatic conditions.

Tirupati: Acid lime pest calendar revealed that leaf minor damage was moderate during July to September and Citrus butterfly was also moderate during August-September; Rust mite and Thrips damage was high during January to April. Among minor pests, snow scale damage was noticed on tree trunk region during March- April. Citrus Hindu mite/ Citrus nest webbing mite damage was high on leaves from January to August.

Impact on disease incidence

(a) Mandarin

Akola: Twig blight (*Colletotrichum gloeosporioides* and *Diplodia natalensis*) was the major disease observed on Nagpur mandarin. Twig blight incidence was observed on all age group gardens, with highest (30.0%) at Achalpur Tahsil of Amravati district and lowest (2.33%) at Karanja lad Tahsil in Washim district.

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

Tinsukia: Three major fungal diseases viz., *Phytophthora* root rot (*Phytophthora* sp.), twig blight (*Colletotrichum gloeosporioides*) and fruit drop due to stem end rot along with minor diseases viz., Scab were recorded. Sooty mould (*Capnodium citri*) and Felt (*Septobasidium pseudopedicellatum*) were recorded in all Khasi mandarin orchards. Disease calendar revealed that incidence of *Phytophthora* root rot was very high during May to July and twig

blight was very high during the months of September to December. Incidence of stem end rot was maximum during the months of June to August with moderate activity during September.

(b) Sweet orange

Rahuri: In general, the incidence of stem end rot during this year was very low.

Tirupati: Bacterial canker and greasy spot incidence was high during August-December. High incidence of twig blight was noticed during July and November.

(c) Acid lime

Akola: Bacterial canker (*Xanthomonas citri*) was predominant in all Acid lime gardens. Significant correlations observed between bacterial canker incidence and temperature (maximum and minimum). Other weather parameters, sunshine, evaporation and rainfall and rainy days showed non-significant correlation.

Periyakulam: The diseases recorded were twig blight, bacterial canker, gummosis and Citrus greening. The diseases like greening and gummosis were present in all the observed plants, but the expression of the diseases varied across the months. The expression of greening was high during October and December. In the gummosis affected plants oozing of gum was recorded during February to July.

Rahuri: The heavy incidence of mites and scale was observed during this year. The incidence of canker was less due to unfavourable climatic conditions.

Tirupati: Acid lime disease calendar revealed bacterial canker was severe during August-December, 2019, Twig blight was severe during August, 2019 and Greasy spot incidence was noticed all-round the year, however it was high during July-December, 2019.

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, 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: Spider viz., *Araneus ellipticus* (Tikader and Bal), *Epeus flavobilineatus* (Doleschall), *Epocilla calcarata* (Karsch), *Gasteracantha cancriformis* (Linnaeus) and *Neoscona punctigera* (Doleschall) was reported from Kinnow orchards in District

Hoshiarpur and Ludhiana.

Periyakulam: Incidence of leaf roller, *Psorosticha zizyphi* (Stainton) 3.17% (Lepidoptera: Oecophoridae) on acid lime during August-September 2019, was observed.

Rahuri: No new insect-pests have been reported.

Tinsukia: Citrus green bug, *Rhynchocoris humeralis* (Thunberg) (Pentatomidae: Hemiptera) and stink bug, *Cappaea taprobanensis* (Dallas) (Pentatomidae: Hemiptera) and predatory bug, *Rihirbustrochantericus* Stal (Hemiptera: Reduviidae), a potential predator of tea mosquito bug, *Helopeltis* spp. (Hemiptera: Miridae) were reported.

Tirupati: No new insect-pests have been reported.

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

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

Ludhiana: Minimum fallen fruit due to fruit sucking moth was recorded in T₃ (Petroleum spray oil @ 2%) at 10 (Days After Treatment) DAT (20.1%), 20 DAT (22.4%) and 30 DAT (24.4%) compared to control at 10 DAT (42.3%), 20 DAT (46.1%) and 30 DAT (54.7%). The treatment with Petroleum spray oil @ 2% recorded maximum fruit yield (17.9 t/ha) and B:C ratio (10.8: 1).

Rahuri: The trial was not conducted due to severe drought conditions.

Tinsukia: Petroleum spray oil @ 2% (T₃) recorded significantly low fruit drop due to fruit sucking moth damage at 10 DAT (12.80%), 20 DAT (14.90%) and 30 DAT (16.80%) compared to control at 10 DAT (39.40%), 20 DAT (38.50%) and 30 DAT (40.20%). Petroleum spray oil @ 2% (T₃) also recorded highest yield (17.7 t/ha) and B:C ratio (2.38).

Tirupati: Neem oil @ 1% (T₁) recorded significantly low per cent fallen fruits due to fruit sucking moth at 10 DAT (9.48%), 20 DAT (9.96%) and 30 DAT (8.74%) followed by Petroleum Spray oil @ 2% (T₃) at 10 DAT (9.50%), 20 DAT (10.38%) and 30 DAT (8.10%). The treatment with Neem oil @ 1% (T₁) recorded the highest yield (20.30 t/ha) with B:C ratio of (2.25) and it was at par with Petroleum Spray oil @ 2% (T₃) yield (20.13 t/ha.) with B:C ratio (2.10) (Table 27).

Table-27: Efficacy of different repellents against fruit sucking moths at different centres 30 days after treatment

Treatments	Ludhiana	Tinsukia	Tirupati
T ₁ : Neem oil 1%	30.8 (33.7)	28.66 (32.36)	8.74 (17.07)
T ₂ : Azadirachtin 1% @ 3ml/l	37.4 (37.7)	36.80 (37.35)	10.84 (19.19)
T ₃ : Petroleum spray oil 2%	24.4 (29.6)	16.80 (24.20)	8.10 (16.49)
T ₄ : Citronella oil 2%	43.0 (41.0)	38.56 (38.39)	13.97 (21.92)
T ₅ : Soapnut extract 2%	37.6 (37.8)	26.70 (31.11)	18.80 (25.67)
T ₆ : Mustard oil 2%	41.4 (40.1)	38.20 (38.10)	23.15 (28.73)
T ₇ : Jatropa oil 2%	43.1 (41.0)	20.80 (27.13)	11.27 (19.59)
T ₈ : Pongamia oil 2%	40.1 (39.3)	37.66 (37.85)	21.95 (27.92)
T ₉ : Control	54.7 (47.7)	40.20 (39.35)	48.75 (44.26)
T ₁₀ : Botanical pesticide	41.3 (40.0)	-	-
CD at 5%	3.72	2.20	2.41

*Figures in parentheses are arc sin transformed values;

*Observation at Rahuri could not be continued due to late harvesting and experiment was discontinued at Nagpur centre.

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: Foliar application of propargite 57EC @ 0.057 per cent was found to be superior with minimum mite population in leaf (0.45 mites/leaf) and fruit infestation (3.67%) due to mites at 14 DAT. This was followed by Spiromesifen 240 SC (0.09%) and Fenazaquin 10 EC (0.01%) recorded by less mite population in leaf (0.87 mites/leaf and 1.27 mites/leaf) and fruit infestation (6.87% and 7.25%) as against control it was 16.12 mites/leaf and 25.89 per cent (Table 28).

Rahuri: The mite population/leaf were significantly low in spiromesifen 240 SC (0.009%) at 14 days with 4.0 mites/leaf followed by propargite 57EC (0.057%) with 6.0 mites/leaf. The control recorded maximum mites population (49.75 mites/leaf). The yield data was not recorded because of less fruit bearing in ambia bahar due to severe drought conditions.

Tinsukia: Propargite was significantly more effective in reducing mite population and at 14 days after treatment, significant reduction of mite population was observed in the treatment of propargite (2.11mites/leaf) with a maximum B:C ratio of 2.80.

Tirupati: Foliar application of spiromesifen 240 SC (0.009%) on sathgudi sweet orange was found to be significantly superior in recording lowest rust mite infestation on leaves and fruits 7.13 mites/leaf (5.19%) as compared to other acaricidal treatments maximum in control (39.10%) at harvest. The effect of acaricides treatment on crop yield indicated that maximum yield of 21.53 t/ha was noted in T¹ with higher B: C ratio of 2.80.

Table-28: Effect of acaricides against leaf mite population infesting Citrus

Treatments	Population counts of mites/leaf			
	Periyakulam	Rahuri	Tinsukia	Tirupati
T ₁ : Spiromesifen 240SC (0.009%)	0.87(0.93)	4.00 (2.50)	2.78 (1.81)	7.13 (2.85)
T ₂ : Fenazaquin 10 EC (0.01%)	1.27 (1.13)	8.25 (3.37)	3.65 (2.04)	11.57 (3.54)
T ₃ : Propargite 57 EC (0.057%)	0.45 (0.67)	6.00 (2.95)	2.11 (1.44)	8.32 (3.02)
T ₄ : Local check (Dicofol 18EC@0.04%)	5.17 (2.27)	12.75 (4.07)	3.35 (1.95)	14.51 (3.93)
T ₅ : Control	16.12 (4.02)	49.75 (7.55)	20.17 (4.55)	27.43 (5.33)
CD at 5%	1.02	3.38	0.25	0.377

*Figures in parentheses are square root (values^{*0.5}) transformed values; **Date recorded at 14 days after treatment

5.1.5 C Testing of crop phenology based Citrus insect pest management for Ambia crop

The experiment was laid out in Kinnow mandarin, Acid lime - PKM-1, Sweet orange - Phule mosambi,

Khasi mandarin, sweet orange – Sathgudi at Ludhiana, Periyakulam, Rahuri, Tinsukia and Tirupati, respectively comprising two modules viz., T₁: Crop phenology-based insect pest management modules and T₂: university recommendation followed at

respective places with 40 trees/treatments in T-test design. The observations on insect pest incidence before treatment and 15 days after each subsequent spray were carried out as and when required at different crop phenological stages.

Ludhiana: The population of Citrus aphids (3.0 nymphs/twig) and psylla (5.5 nymphs/twig) were low in Crop phenology-based module. However, minimum mite population (5.33 mites/twig), fruit drop due to fruit sucking moths (28.8%) and fruit drop due to fruit flies (25.8%) were observed in University recommended treatment module. The maximum yield (17.3 t/ha) and benefit: cost ratio (10.3:1) were recorded in the phenology-based insect pest management module (Table 29 & 30).

Periyakulam: The minimum sucking pest population was recorded as aphids (0.89 nymphs/twig) and psylla (0.97 nymphs/twig) in Crop phenology-based module with maximum yield (22.75 t/ha) and BC ratio (2.25).

Rahuri: Crop phenology-based insect pest management module significantly reduced the

population of psylla (6.65 nymphs/twig), aphids (16.55 nymphs/twig) and mites (9.65 mites/twig). Likewise, minimum fruit drop due to fruit sucking moth (9.42%) and increase the yield of sweet orange (8.13 t/ha) were observed in crop phenology-based module as against university recommendation.

Tinsukia: No significant differences were observed in different modules for sucking pest population of aphids, psylla, blackfly, thrips and mites. Minimum fruit drop due to fruit sucking moth damage and fruit fly damage were recorded to be 10.50% and 5.80%, respectively in crop phenology-based module. Maximum yield (18.20 t/ha) and BC ratio (2.60) were recorded in the phenology-based insect pest management module as against university recommendation.

Tirupati: The population of Citrus aphids (1.80 nymphs/twig) and psylla (3.47 nymphs/twig) were significantly low in Crop phenology-based module in comparison to University recommended treatment module. Similarly, maximum yield (23.32 t/ha) and BC ratio (2.73) were recorded in the crop phenology-based insect pest management module as against university recommended treatment module.

Table-29: Comparative efficacy of different modules against aphids and psylla

Treatments	Aphid (population/twig)					Psylla (population/twig)					Leaf mite (population/twig)		
	LUD	PKM	RHR	TNK	TPT	LUD	PKM	RHR	TNK	TPT	LUD	RHR	TNK
T ₁	3.0	0.89	16.5	2.45	1.80	5.5	0.97	6.65	1.54	3.47	6.67	9.65	0.30
T ₂	4.7	3.31	36.2	6.20	2.70	6.3	2.65	13.1	3.24	8.05	3.33	42.72	0.61
T value	1.10	2.34*	13.11*	1.52	2.27*	0.45	0.64	8.02*	1.50	2.11*	2.01*	23.09*	0.13

T1: Crop phenology-based module, T2: As per the respective University recommendation; * Significant at 5% level
LUD: Ludhiana; PKM: Periyakulam; RHR: Rahuri; TNK: Tinsukia; TPT: Tirupati

Table-30: Effect of different treatment schedules against fruit sucking moth and fruit fly

Treatments	Fruit drop due to fruit sucking moth (%)			Fruit drop due to fruit fly (%)	
	Ludhiana	Rahuri	Tinsukia	Ludhiana	Tinsukia
T ₁	34.1	9.42	9.05	30.3	5.68
T ₂	25.3	15.1	22.70	22.3	6.90
T value	3.45*	4.71*	2.43*	2.56*	0.36

T1: Crop phenology-based module, T2: As per the respective University recommendation; * Significant at 5% level

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, 150 Nagpur mandarin orchards of different age groups, 12 Sweet orange orchards and 68 Acid lime orchards from Vidarbha region of Maharashtra, 20 Sweet orange and 17 Acid lime from Tirupati, 30 Acid lime from Periyakulam, 27 Sweet orange and 49 Acid lime from Rahuri, 35 Kinnow mandarin orchards in the three agro-climatic zones of Punjab and 42 Khasi

mandarin orchards from Assam were surveyed during roving survey for the year 2019-20.

(a) Mandarin

Akola: Twig blight (4.66 – 20.90% incidence), Stem end rot (2.44 – 16.66%), Brown rot (10.33 – 34.66%) and Gummosis (0.80 – 3.80%) were recorded.

Ludhiana: *Phytophthora* foot rot/gummosis (6.67 – 17.89%), Bacterial canker (1.67 – 12.50%) and Citrus ring spot (0.71 – 9.84%) are most wide spread and serious diseases. Other commonly occurring

diseases were Citrus greening and Citrus ring spot (2.30 – 13.0%).

Tinsukia: Twig blight (6.66 -36.66%), Gummosis/ Foot rot (6.66 – 26.66%), Fruit drop due to pre-harvest stem end rot (up to 30.0%) and minor fungal diseases like Scab (3.33-18.33%) and Sooty mould (up to 11.66%) were recorded.

(b) Sweet orange

Akola: Twig blight (2.63 – 9.90%), Gummosis (2.10 – 3.60%) and greening (up to 1.20%) were recorded.

Rahuri: Twig blight, foot rot and gummosis and greening emerged as the major disease problems in the orchards surveyed. Twig blight incidence was observed in all the age groups with the highest incidence of 25.62%. Greening incidence was 20.65% followed by foot rot and gummosis incidence (13.17%), whereas greasy spot and tristeza disease was appeared with very low incidence.

Tirupati: Citrus greening (0.80-47.20%), Citrus yellow mosaic (3.2 – 36.80%), gummosis (0-11.20%) and dry root rot (3.2-45.60%) are the major diseases observed. Incidence of greasy spot (1.28-6.08%) and twig blight (8.80%) was also observed.

(c) Acid lime

Akola: Bacterial canker (11.90 to 30.56%) and twig blight (4.55 to 23.44%) predominant in all age group of surveyed orchards. Witches broom prevalence mostly recorded in Akola district to the tune of 2.40 - 5.80%.

Periyakulam: The diseases viz., twig blight, bacterial canker, stem end rot, gummosis and greening were recorded in the roving survey conducted at Dindigul, Theni, Tirunelveli, Trichy and Madurai districts of Tamil Nadu. Average incidence of twig blight was 20.88%, bacterial canker was 22.22%, stem end rot was 9.1%, gummosis was 11.97% and greening was 14.52%.

Rahuri: Twig blight incidence was observed with the highest incidence of 30.71% followed by canker (24.84%). However, tristeza and greasy spot appeared with very low incidence.

Tirupati: Bacterial canker (3.0 -12.64%), greasy spot (1.2 - 8.80%), dry root rot (2.40-8.80%) and gummosis (0.6.40%) were recorded in all locations in Andhra Pradesh. LBWSD (0-19.20%), twig blight (0-10.40%) and diplodia gummosis (0-8.80%) were also reported during survey. Ganoderma incidence up to 2.40 per cent recorded in Vengamambapuram village, Nellore district.

6.1.2(a) C. Integrated management of *Phytophthora* root rot and gummosis of mandarin

The experiment was laid out using different chemical fungicides and bio-control agents in FRBD with 7 treatments replicated 4 times for the management of *Phytophthora* root rot.

Akola: Maximum recovery from tree trunk lesion (37.50%), maximum per cent increase canopy volume (9.02%) and highest yield (66.72 kg/tree) and B:C ratio (4.92) was recorded in treatment T₆ where chemical spray of Potassium Phosphonate @ 3g/l foliar spray was given.

Ludhiana: Among the different treatments, maximum (67.23%) recovery from trunk lesion and maximum yield (63.07 kg/tree) were recorded in treatment T₆ {Potassium Phosphonate (3 g/l)}. The bioagent application followed by fungicide application (T₄ & T₅) showed moderate effect on percent recovery from trunk lesion.

Tinsukia: Maximum increase in trunk lesion recovery (50.70%), fruit yield (51.4 kg/tree) and B:C ratio (2.28) was recorded in treatment (T₆) by the application of Potassium Phosphonate (3 g/l) with the reduction in disease severity of 50.70%.

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. Culture of *Phytophthora* isolated from root adhering soil from Citrus orchards was multiplied. The multiplied culture of *Phytophthora* was collected in sterilized water and inoculations were carried out.

Phytophthora root rot

Akola: The minimum per cent seedling mortality (13.33%), feeder root rating (1.00) and lowest leaf fall (7.14%) were observed in Rangpur lime.

Ludhiana: The minimum per cent seedling mortality (18.0%), feeder root rating (1.63) and lowest leaf fall (20.36%) was observed in Australian Sour orange while, highest seedling mortality (40.32%) was recorded in CRH-12.

Rahuri: Rangpur lime Rahuri (Marmalade orange) recorded lowest per cent mortality (8.33%), feeder root rating (0.87) and leaf fall (11.54%) while, maximum seedling height (41.0 cm), tap root length (18.73 cm) in *C. jambhiri* and maximum seedling girth (1.74 cm) in Rangpur lime Shirampur was recorded.

Fusarium root rot

Tirupati: The percent mortality was significantly

low in case of Australian Sour orange (0.0%) and CRH-47 (6.67%) when compared to susceptible check Jambheri (40.00%).

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 2019 -2020 The bioagent, *P. fluorescens* PDKV was found very effective by recording the highest per cent inhibition of *Phytophthora* spp. i.e. 74.31 per cent. The next best bio-agent was *T. harzianum* 1, which recorded 67.49 per cent inhibition over control and *B. subtilis* recorded the least inhibition.

Ludhiana: Out of the eighteen soil samples collected from the rhizosphere of different Citrus orchards of south-western region of Punjab, five isolates of *Trichoderma* were recovered. Among these isolates, isolate ITW₁ showed maximum percent growth inhibition of 68.88 per cent followed by IK₁ (53.71%) where growth inhibition of *Phytophthora* was observed.

Periyakulam: Among the bioagents, the *Trichoderma* isolate TS 2 was found effective against *Fusarium* sp. exhibiting the highest mycelial inhibition of 62.68 per cent over the control. This was followed by the isolate *P. fluorescens* (BPKM 27). Hence, these two bioagents were mass multiplied and applied to the pot culture studies. Results revealed that the soil application of *Trichoderma* spp. TS2 was highly effective showing the highest disease reduction of 71.42% over control.

Tirupati: The experimental data revealed that the per cent inhibition on the growth of the pathogen by eight endophytic bacteria was in the range of 49.17 to 66.39 per cent. Among them isolate EPB 7 (66.39%) has shown highest inhibition zone over the control. Further, the effective isolate was identified as *Pseudomonas aeruginosa* based on sequencing results of 16S rRNA gene.

Tinsukia: Four isolates of *Trichoderma* and one isolates of *Pseudomonas fluorescens* were recovered, which on evaluation against *Phytophthora* under in vitro conditions by dual culture technique, showed percent growth inhibition of 73.95 to 62.39 per cent. Among these isolates, TKaP1 showed maximum percent growth inhibition of 74.86 per cent followed

by CRSpf1, TkhP2, Twoi2, Twoi1 and where percent growth inhibition of *Phytophthora* was recorded as 71.07, 64.89, 63.57 and 62.39 per cent respectively.

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 T₄ (50% more than recommended dose of Phosphorus (RDP) + Tetracycline hydrochloride 600 ppm + ZnSO₄ + FeSO₄ (200g each) recorded lowest disease severity (20.48%) and highest yield (48.00 kg/tree) followed by treatment T₅ (T₁ + ZnSO₄ + FeSO₄ (200g each)) and T₃ (Tetracycline hydrochloride 600 ppm + ZnSO₄ + FeSO₄ (200g each)) which was effective in reducing the severity of the disease and higher yield as compared to control.

Ludhiana: The treatment T₄ with 50% more than recommended dose of Phosphorus (RDP) + Tetracycline hydrochloride 600ppm + ZnSO₄ + FeSO₄ (200g each) was found most effective in reducing the disease severity (33.35%), Canopy volume (11.0 m³) and yield (67.0 kg/tree) were also recorded maximum with this treatment.

Periyakulam: The treatment T₄ consisting of T₁ (50% more than recommended dose of Phosphorus (RDP) + T₃ (Tetracycline hydrochloride 600ppm + ZnSO₄ + FeSO₄ (200g each)) was found effective in reducing the severity of the disease compared to the control. The extent of disease in T₄ was 30.0 per cent and recorded an average yield of 27.5 kg per plant whereas in control, the disease intensity was 42.5%.

Rahuri: Treatment T₄ (i.e. 50% more than recommended dose of phosphorus + Tetracycline hydrochloride 600 ppm and micronutrients) has recorded lowest disease severity 25.00 per cent with 11.11% disease control as compared to other treatments. Highest canopy volume (7.56%) and fruit yield (33.44 kg/tree) as compared to other treatments.

Tinsukia: The treatment T₄ (50% more than recommended dose of Phosphorus (RDP) + Tetracycline hydrochloride 600ppm + ZnSO₄ + FeSO₄ of 200g each) was found better in terms of per cent disease control (47.19%) and yield (47.24 kg/tree) followed by treatment T₅ {50% more than recommended dose of Phosphorus (RDP)+ ZnSO₄ + FeSO₄ (200g each)}.

Tirupati: Among the treatments highest percent of disease reduction of 29.37, 28.41 and 26.22 per cent

was recorded in T₄, T₅ and T₃, respectively and which were on par with each other. Highest fruit yield per tree was recorded in T₄ (34.21 kg/tree). Canopy volume increase was found non-significant.

GRAPES

1.4.7. Gr. Evaluation of coloured table varieties

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

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

Pune (NRCG): Fruit pruning was done on 15th October, 2019.

Periyakulam (Theni): Among the different table

grape varieties, higher bunches per vine (31.70) and yield per vine (7.19 kg/vine) was recorded in Manjari Shyama over other varieties (Table 31). Whereas, variety Red Globe has recorded maximum bunch weight (421.66 g) followed by Fantasy Seedless (314.79 g). Fantasy Seedless performed better with maximum total soluble solids (20.75°B) and minimum acidity (0.52%) which was on par Nana Saheb Purple (19.97°B).

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

Rajendranagar: Fruit pruning was done on 25th October, 2019.

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

Table-31: Evaluation of coloured table grape varieties for yield and fruit quality attributes at Periyakulam (Theni)

Varieties	Bunches per vine	Yield (kg/vine)	Bunch weight (g)	TSS (° B)	Acidity (%)
V ₁	12.27	5.15	421.66	18.40	0.77
V ₂	14.62	4.60	314.79	20.75	0.52
V ₃	17.51	3.91	221.98	19.52	0.74
V ₄	31.70	7.19	227.08	19.15	0.68
V ₅	9.70	2.95	304.72	19.97	0.72
V ₆	18.95	5.62	295.59	19.46	0.73
CD at 5%	1.93	0.80	12.36	1.24	0.01

V₁ - Red Globe, V₂ - Fantasy Seedless, V₃ - Crimson Seedless, V₄ - Manjari Shyama A-18/3, V₅ - Nana Purple, V₆ - Sharad Seedless

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): The vines are at establishment stage.

Mandsaur: The vines are at establishment stage.

Periyakulam (Theni): Among the four raisin varieties evaluated, maximum number of bunches per vine (32.93), bunch weight (290.33 g) and fruit yield (6.64 kg/vine) was recorded in grape variety Thompson Seedless which is on par with 2A-Clone (30.84, 302.9 g & 6.29 kg/vine respectively). However, maximum TSS (23.93°B), raisin recovery (23.54%) with minimum acidity (0.49%) was recorded in Merbein Seedless (Table 32).

Pune (NRCG): Fruit pruning was done on 15th October, 2019, data on bunch and berry traits as per the technical programme during fruiting season is under process. Raisins were prepared from four white grape varieties under evaluation and Sensory evaluation of raisin made from different varieties was carried out. Based on hedonic scale of 1-9, sensory data showed that 2A-Clone scored maximum for all sensory parameters (colour, texture, sweetness, flavour, mouthfeel, taste and overall acceptability) followed by Thompson Seedless (Fig. 7 and Plate 4).

Rahuri: The vines are at establishment stage.

Rajendranagar: Fruit pruning was done on 25th October, 2019, data on bunch and berry traits as per the technical programme during fruiting season is under process.



Merbelin Seedless



2A-Clone



Manjari Kishmish



Thompson Seedless

Plate 4: Raisins prepared from four white grape varieties under evaluation

Table- 32: Evaluation of raisin grape varieties for yield and quality parameters at Periyakulam

Varieties	Bunches per vine	Bunch weight (g)	Yield (kg/vine)	TSS (°B)	Acidity (%)	Raisin recovery (%)
V1-Merbein Seedless	28.91	164.14	3.10	23.93	0.49	23.54
V2- 2A-Clone	30.84	302.09	6.29	22.07	0.61	20.65
V3- Manjari Kishmish	24.33	262.48	3.75	22.34	0.53	22.32
V4-Thompson Seedless (Check)	32.93	290.33	6.64	21.24	0.55	22.21
CD at 5%	2.23	16.35	0.54	1.70	0.03	0.80

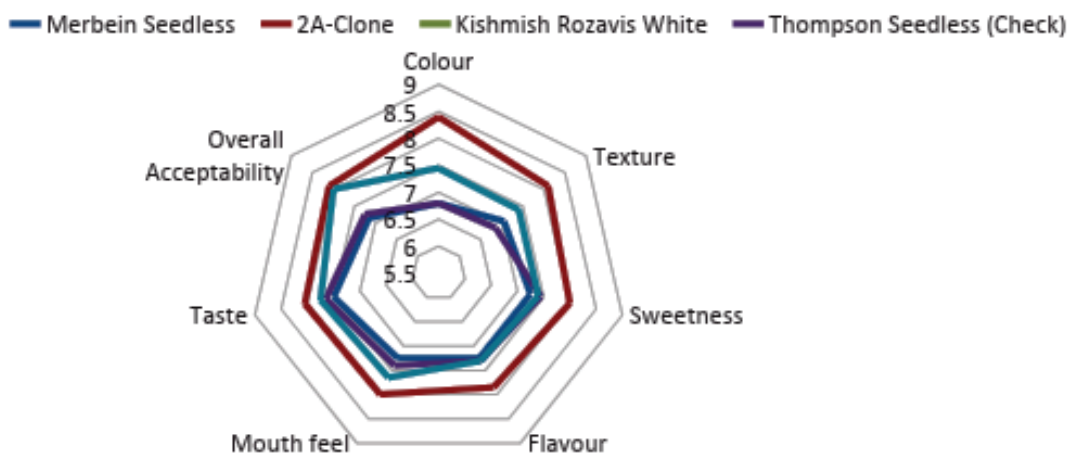


Fig.7 Hedonic scale (1-9) based sensory evaluation of raisins varieties at Pune (NRCG)

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.

Mandsaur: The vines are at establishment stage.

Periyakulam (Theni): Among the different juice grape varieties evaluated, maximum values of yield characters were recorded in grape hybrid Manjari Medika with respect to bunch weight (399.35 g) and fruit yield (11.50 kg /vine) which is on par with Punjab MACS Purple (11.04 kg/vine). Whereas, maximum number of bunches per vine (55.32), TSS (21.72°B), juice recovery (60.94%) and the

minimum acidity (0.55%) were recorded in Punjab MACS Purple (Table 33).

Pune (ARI): Foundation and fruit pruning was carried out and vines are maintained as per standard package of practices.

Pune (NRCG): Foundation and fruit pruning was carried out and vines are maintained as per standard package of practices.

Rahuri: The vines are at establishment stage.

Rajendranagar: Foundation and fruit pruning was carried out and vines are maintained as per standard package of practices.

Vijayapura: The vines are at establishment stage

Table-33: Evaluation of juice varieties for yield and quality characters at Periyakulam

Varieties	Bunches per vine	Bunch weight (g)	Yield (kg/vine)	TSS (°B)	Acidity (%)	Juice recovery (%)
V ₁ . Manjari Medika	27.59	399.35	11.50	21.09	0.59	58.05
V ₂ . Gulabi x Bangalore Purple	25.60	172.75	4.45	18.70	0.82	54.45
V ₃ . Punjab MACS Purple (H 516)	55.32	208.44	11.04	21.72	0.55	60.94
V ₄ . Concord	25.70	120.65	3.10	17.28	0.83	53.34
V ₅ . Bangalore Blue (Check)	30.09	163.00	4.91	17.51	0.77	54.19
CD at 5%	4.01	16.51	1.15	0.55	0.07	1.81

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).

Ludhiana: The rooted cutting of rootstocks was collected from ICAR-NRCG, Pune and planted in the field. The grafting of scion was done during August-September, 2018.

Mandsaur: The experiment had been laid out in March, 2018. However, due to excess and continuous rainfall in the region, vines could not be established in the field.

Periyakulam: The rootstocks were planted and *in situ* grafting was carried out during November, 2018. Crop is in vegetative stage.

Pune (NRCG): Foundation pruning and fruit pruning has been done on 18th April and 14th October, 2019 respectively. The data recording on bunch and berry characters as per the technical programme during fruiting season is in progress.

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

Rajendranagar: Rooted cuttings were planted in March 2019.

Vijayapura: Vines were established following all standard recommended cultural practices and forward pruning was done on 9th October, 2019. Data recording is under progress.

3.4.3. Gr. Improving water use efficiency in grapes through subsurface irrigation

Result: Trial is in initial stage

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): The data on post-harvest losses in grape during fruiting season of 2019 were collected at farm level and market level (wholesale and retail market). During the period of report, Thompson Seedless and its clonal selections were targeted as

maximum area is covered by these varieties. A total of 14.12 per cent losses were recorded from farm to retailing (Table 34). Maximum loss of 4.45 per cent was recorded in the retailing process. During harvesting, minimum loss (1.49%) was observed.

Periyakulam: Surveys for post-harvest losses is

under progress.

Rahuri: During reporting period losses up to 21 per cent were recorded.

Rajendranagar: Surveys for post-harvest losses is under progress.

Table- 34: Post-harvest losses of grapes at different level in different centres

Process of post handling of grapes	Postharvest loss (%)	
	Pune (ICAR-NRCG)	Rahuri
a. Farm level (Interview):	1.4	7.5
b. Farm level (Observation)	1.49	9.0
c. Losses during cleaning/grading and sorting	4.04	4.0
d. Losses at market level (personal interview)	2.5	5.0
e. Losses at market level (Observation):	4.12	4.0
f. Estimation of loss during retailing by personal interview	4.45	4.0
Total losses (b + c + e + f)	14.1	21.0

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

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

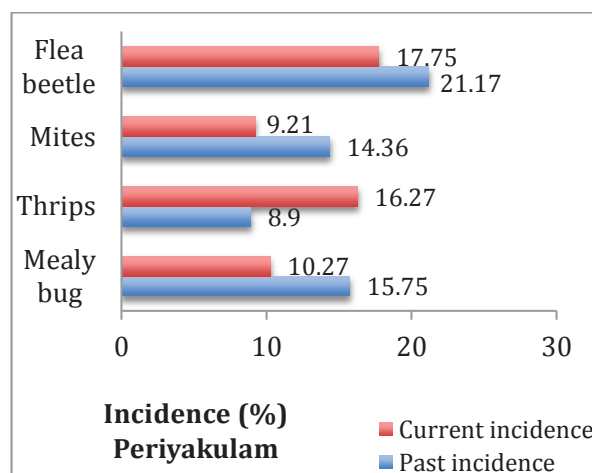
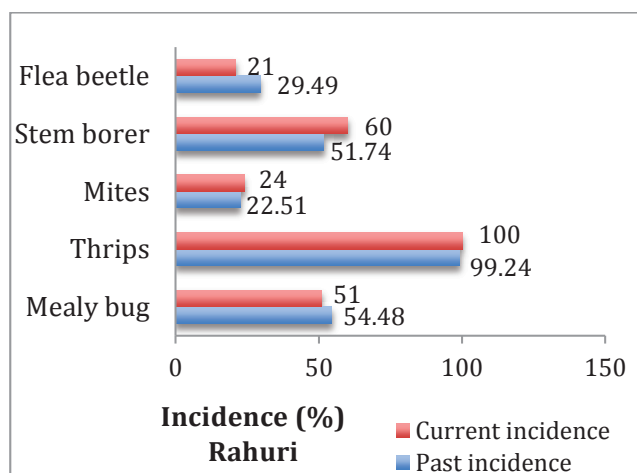
Ludhiana: During reporting period, new insect pests, Chafer beetles (*Apogonia* sp. and *Adoretus* sp.) were reported with low level of incidence. The predatory Spiders, *Clubiona* sp. and *Heteropoda* sp. were also observed in grapes orchards. The incidence of black thrips, (*Rhipiphorothrips cruentatus* Hood and *Haplothrips* sp.), Wasps and six-spotted beetle (*Scelodonta strigicollis* Motschulsky) was increased by 1 per cent.

Mandsaur: During reporting period, thrips (37.50%), mites (1.72%) and mealybug (49.12%) remains as a major pest with high to moderate level of infestation (Fig. 8).

Periyakulam: The mealybug and thrips were observed as a major pest during reporting period however, the infestation of thrips was increased by 7.37 per cent. While, the infestation of Flea beetle (21.17%) and mealy bug (15.75%) were decreased to 17.75 per cent and 10.27 per cent respectively (Fig. 8).

Pune (NRCG): During reporting period, a new insect pest, Red stem borer (18%) and Shot hole borer (2.76%) from Nashik and Sangli respectively were identified during fruiting season (Fig. 8).

Rahuri: No new insect pest has been reported, while the infestation of stem borer was increased by 8.26 per cent as compared to past average of 51.74 per cent (Fig.3). The infestation of thrips and mites was increased by 0.76 and 1.49 per cent respectively. Whereas, the infestation of Flea beetle and mealy bug were decreased by 8.49 and 3.48 per cent, respectively.



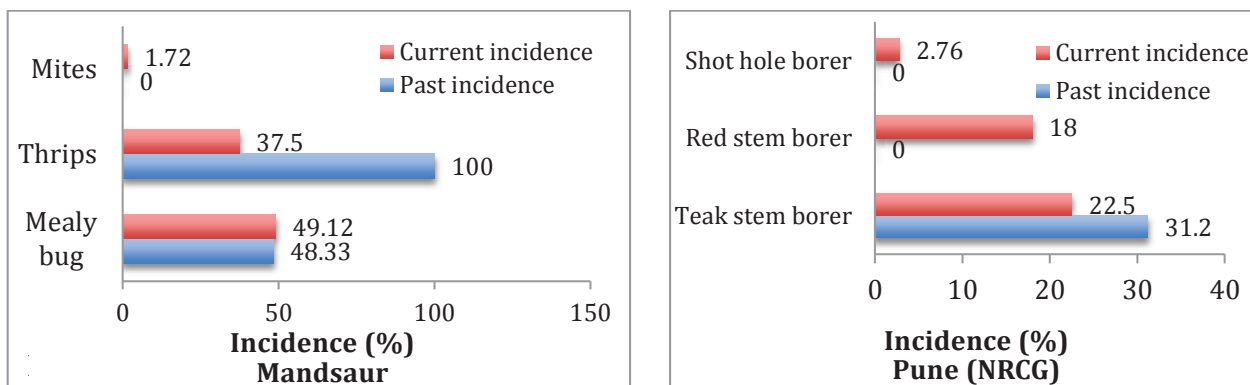


Fig 8. Status of new and emerging insect pest of grape at different centres

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 of Perlette and Flame Seedless were surveyed during reporting period. PDI of anthracnose disease was recorded in the range of 2.00-12.33 and 11.00-28.50 at 91-135 and 136-180 days after pruning, respectively. PDI of powdery mildew was recorded in the range of 0-1 and 0-4 at 61-90 and 91-135 days after pruning, respectively. Whereas, PDI of downy mildew was recorded in the range of 0-5 and 6.50-13.67 at 91-135 and 136-180 days after pruning, respectively.

Mandasaur: Ten vineyards were surveyed during reporting period. However, only anthracnose incidence was reported in the range of 1.0-3.0 PDI at 31-60 and 61-90 days after foundation pruning.

Pune (ICAR-NRCCG): Twenty-four vineyards were surveyed during reporting period. PDI of anthracnose was recorded in the range of 0-20.35 and 0-25.54 at 61-90 and 91-140 days respectively after foundation pruning. PDI of downy mildew was recorded in the range of 0-30.24 and 0-30.25 at 61-90 and 91-140 days after foundation pruning. PDI of powdery mildew disease was recorded in the range of 0-3.51 and 0-6.14 at 61-90 and 91-140 days after foundation pruning. PDI of alternaria leaf blight was observed in the range of 0-17.35 during 61-90 days after foundation pruning and 0-25.7 during 91-140 days after foundation pruning.

Whereas, surveys carried out after fruit pruning, has recorded PDI of anthracnose in the range of 0-2.17 and 0-11.5 at 60-90 and 90-130 days after fruit pruning. PDI of downy mildew was recorded in the range of 5.1-15.87 and 0-12.57 at 60-90 and 91-130 days after fruit pruning. PDI of powdery mildew was

observed in the range of 1.8-5.7 and 0-10.51 at 60-90 and 91-130 days after fruit pruning. PDI of bacterial leaf spot was recorded in the range of 0-5.17 and 0-9.57 at 60-90 and 91-130 days after fruit pruning.

Periyakulam: Twenty-seven vineyards were surveyed during the reporting period. PDI of Downy mildew incidence was recorded in the range of 2.27-43.53, 12.27-45.67, 0-17.44 and 0-10.15 during 0-30, 31-60, 61-90 and 91-140 days after forward pruning, respectively. Whereas, the PDI of Powdery mildew incidence was observed in the range of 0-18.25, 4.44-44.55, 23.15-45.36 and 15.27-45.3 during 0-30, 31-60, 61-90 and 91-140 days after pruning, respectively.

Rahuri: During the reporting period, thirteen vineyards were surveyed. The incidence of anthracnose was recorded in the range of 0-9.15 and 0-26.15 at 61-90 and 91-135 days after foundation pruning. PDI of Downy mildew incidence was recorded in the range of 0-4.12, 0-32.08 and 0-34.12 during 31-60 days, 61-90 days and 91-135 days after foundation pruning, respectively. PDI of powdery mildew was recorded in the range of 0-3.16, 0-26.32, 0-18.12 and 0-3.12 during 1-30, 31-60, 61-90 and 91-135 days after foundation pruning respectively. Whereas, surveys carried out after fruit pruning, has recorded the PDI of anthracnose in the range of 0-4.12 and 0-5.25 at 1-30 and 31-60 days. PDI of downy mildew was observed in the range of 0-33.15 and 0-18.12 at 1-30 and 31-60 days. PDI of powdery mildew was observed in the range of 0-2.15 and 0-4.55 at 1-30 and 31-60 days respectively.

Rajendranagar: During reporting period, thirteen vineyards were surveyed and no new diseases were observed. Whereas, PDI of downy mildew was recorded in the range of 2.5-6.25.

Vijayapura: Survey for disease incidence in different vineyards was in progress.

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 (Fig 9).

Mandsaur: Maximum incidence of powdery mildew (38.40) has recorded in the advisory plot after the forward pruning.

Periyakulam: Downy mildew incidence after foundation pruning was recorded from 0.5-3.9 per cent in advisory plots while, 1.3-13.4 per cent in farmers practice plot. The incidence of powdery mildew was in the range of 5.2 - 11.3 percent at advisory plot. Whereas, it varied from 9.5 to 24.7 per cent in farmers practice plot (Fig. 9). However, during forward pruning maximum incidence of downy mildew and powdery mildew (2.5 & 16.00 respectively) has recorded in the advisory plot. Comparatively less number of sprays were taken for

management of downy and powdery mildew in the advisory plots resulted in saving of Rs. 47,850/ha.

Rahuri: Downy mildew incidence after foundation pruning in advisory plots was 0.3-2.8 per cent. However, farmers practice plot reported with 0.4-8.4 per cent (Fig. 9). The powdery mildew incidence at advisory plot was 0.0-1.1 per cent, whereas, farmers practice plot reported with 0.5-5.5 per cent, respectively. However, during forward pruning maximum incidence of downy mildew and powdery mildew (4.8 & 11.5 respectively) has recorded in the advisory plot. Comparatively less number of sprays were taken for management of downy and powdery mildew in the advisory plots resulted in saving of Rs. 46,157/ha.

Rajendranagar: During forward pruning maximum incidence of downy mildew and powdery mildew (1.5 & 3.8 respectively) has recorded in the advisory plot. Comparatively less number of sprays were taken for management of downy and powdery mildew in the advisory plots resulted in saving of Rs. 60,390/ha.

Vijayapura: During forward pruning maximum incidence of downy mildew and powdery mildew (16.9 & 19.2 respectively) has recorded in the advisory plot. A total of 10 sprays can be effectively saved for management of both powdery mildew and downey mildew by adopting online advisory system has saved cost of Rs. 50,193/ha compared to farmers practice.

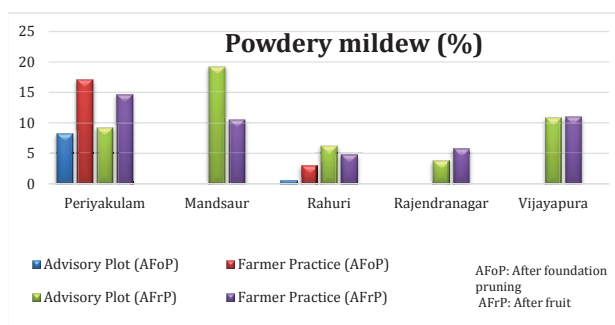
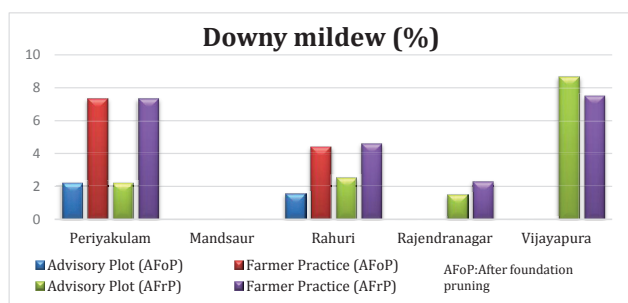


Fig. 9 Comparative disease at different centres

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 study the morphological characteristics besides conserving diversity was planned for selecting the promising genotypes based on yield, quality, pest and disease resistance.

Udaipur: Total 37 germplasms of guava are being maintained in field gene bank were characterized. Under evaluation, germplasms Red Fleshed, RCGH-1 and Safed Jam exhibited vigorous growth. Red Fleshed was recorded with the maximum values for vegetative growth and number of fruits per tree (400). Whereas, maximum fruit yield (110.99 kg/tree), fruit weight (395 g) and TSS (14.80°B) was recorded by var. Shweta.

Ludhiana: During reporting period, 44 genotypes were collected in field gene bank and 12 genotypes were evaluated and the results revealed that the maximum tree height (6.8 m) was registered in hybrid 1716, followed by G. Vilas (6.5 m). Maximum fruit length (7.8 cm) and fruit breath (7.7 cm) was recorded in variety G. vilas. Whereas, maximum yield (89.09 kg/tree) and TSS (13.3°B) was recorded in var. Shweta followed by Hisar Safeda (12.3°B). The fruit shape in different varieties ranged from round, oval, ovate to pyriform. The acidity in different varieties ranged from 0.54 percent in (Allahabad Safeda) to 0.70 percent (hybrid Punjab Pink). Variety Shweta has recorded 423 seeds per fruit and hardy nature.

Bengaluru: Sixty-five accessions including related species were maintained in the field gene bank.

Pantnagar: During the reporting period, six accessions were characterized. Maximum plant height (4.30 m) and yield per plant (66.15 kg) was recorded in accession Kg guava. Whereas, maximum fruit weight (185.60 g) was recorded in accession Hisar Surkha. Quality parameters viz., maximum TSS (10.20°B) and minimum acidity (0.24 per cent) were in cultivar Sanga Reddy. Meanwhile, maximum ascorbic acid (153.40 mg/100 g pulp) and test weight of seeds (1.29 g) was recorded in cultivar Hisar Safeda.

Sangareddy: Twenty-four guava accessions were evaluated during reporting period, among them, maximum number of fruits per tree (342) and yield (61.56 kg/tree) was recorded in Lucknow-49. Among the physico chemical characteristics maximum fruit weight (210 g) was registered in Arka Amulya. However, maximum TSS (13°B) was recorded in FRS Selection while minimum acidity of 0.10 per cent was recorded in Arka Mridula. Among the pests, spiralling white fly was recorded in Allahabad Safeda,

Red fleshed, Kohir safeda, Sabdani badari, Lucknow-49 and Banaras round.

Rewa: During reporting period, two accessions were added to the existing 75 germplasm. Forty-two germplasm were evaluated for the growth and 20 for yield parameters. Result indicated that the maximum yield was recorded in Behat coconut (120.00 kg/tree) with favourable growth characters. Maximum weight of fruit was recorded in Dharwar (165.0 g) followed by Portugal (149.0 g) and minimum was recorded in kotherred (80.0 g) and Seedrolf (99.0 g) respectively.

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

Guava varieties released by different centres were tested by 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: Maximum number of fruits per tree was recorded by variety Lalit (289). Whereas, Arka Mridula has recorded maximum yield (41.50 kg/tree). Maximum fruit weight (163 g) was recorded by var. Shweta.

Rewa: Maximum number of fruits per tree (196), fruit weight (150 g) and fruit yield (29.35 kg/tree) were recorded by variety Shweta (Table 35 & 36).

Sabour: Variety Shweta has recorded maximum number of fruits per tree (87), fruit weight (132 g), yield (11.55 kg/tree), TSS (10.30°B) were recorded (Table 35-37).

Udaipur: Maximum number of fruits per tree (268), fruit yield (60.30 kg/tree) were recorded by variety Lalit. Whereas, maximum fruit weight (280 g), TSS (15.10°B) and vitamin C (187 mg/100g) was recorded in var. Shweta (Table 35-37).

Table-35: Performance of promising hybrid/selection of guava on fruits per tree at different centres

Hybrids/selections	Udaipur	Rewa	Bengaluru	Sabour
Arka Amulya	247.00	195.5	230.0	--
Arka Mridula	233.8	160.6	260.0	64.0
Lalit	268.0	168.5	289.0	70.3
Shweta	203.20	195.4	158.6	87.4
CISH G-1/ MPUAT S-1/ All. Safeda	242.0	178.5	95.0	72.4
IIHR - H- 21/MPUAT S-2	231.0	-	-	83.4
CD at 5%	30.50	7.93	-	-

Note: Bengaluru- Arka Amulya, Arka Mridula; Lalit, Shweta, CISH G-1; Udaipur-MPUAT S-1, MPUAT S-2; Lalit, Shweta, Arka Amulya, Arka Mridula; Rewa-Arka Amulya, Arka Mridula, CISH G-1, Shweta, Lalit; Sabour-Arka Mridula, Lalit, Shweta, CISH G-1, Allahabad Safeda.

Table-36: Performance of promising hybrid/selection of guava on fruit weight and yield at different centres

Hybrids/selections	Fruit weight (g)				Yield (kg/tree)			
	Udaipur	Rewa	Bengaluru	Sabour	Udaipur	Rewa	Bengaluru	Sabour
Arka Amulya	190.0	130.4	136.0	--	46.93	25.49	37.20	--
Arka Mridula	205.0	127.0	152.0	104.0	47.97	20.40	41.50	6.66
Lalit	225.0	125.0	126.0	118.8	60.30	21.10	38.00	8.35
Shweta	280.0	150.2	163.0	132.2	56.90	29.35	19.50	11.55
CISH G-1/ MPUAT S-1/ All. Safeda	185.0	130.0	150.0	100.4	44.77	23.21	15.00	7.27
IIHR - H- 21/MPUAT S-2	235.0	--	--	158.0	54.29	-	-	13.18
CD at 5%	29.95	6.40	--	--	6.98	3.81	-	-

Note: Bengaluru- Arka Amulya, Arka Mridula; Lalit, Shweta, CISH G-1; Udaipur-MPUAT S-1, MPUAT S-2; Lalit, Shweta, Arka Amulya, Arka Mridula; Rewa-Arka Amulya, Arka Mridula, CISH G-1, Shweta, Lalit; Sabour-Arka Mridula, Lalit, Shweta, CISH G-1, Allahabad Safeda.

Table-37: Performance of promising hybrid/selection of guava on quality parameters at different centres

Hybrids/selections	TSS (°B)				Vitamin C (mg/100g)			
	Udaipur	Rewa	Bengaluru	Sabour	Udaipur	Rewa	Bengaluru	Sabour
Arka Amulya	12.4	8.9	11.2	-	180.0	-	173.2	-
Arka Mridula	12.5	8.7	11.4	8.6	178.2	-	168	142.3
Lalit	13.7	9.6	11.1	9.8	175	-	170	245.9
Shweta	15.1	9.6	11.5	10.3	187	-	170	219.0
CISH G-1/ MPUAT S-1/ All. Safeda	15.3	9.4	10.9	9.6	185	-	165	189.7
IIHR - H- 21/MPUAT S-2	13.9	-	-	10.6	183	-	-	232.0
CD at 5%	1.8	0.2	-	-	NS	-	-	-

Note: Bengaluru- Arka Amulya, Arka Mridula; Lalit, Shweta, CISH G-1; Udaipur-MPUAT S-1, MPUAT S-2; Lalit, Shweta, Arka Amulya, Arka Mridula; Rewa-Arka Amulya, Arka Mridula, CISH G-1, Shweta, Lalit; Sabour-Arka Mridula, Lalit, Shweta, CISH G-1, Allahabad Safeda.

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

A trial has been laid out with 10 varieties released by different centres 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) along with Allahabad Safeda as standard check.

Bengaluru: Among the new promising hybrids, Arka Kiran has recorded maximum number of fruits (310) and yield (47.30 kg/tree). Whereas, RCGH-1 has recorded maximum fruit weight (162 g), RCGH-7 has recorded maximum TSS (12.10°B).

Ludhiana: Allahabad Safeda has recorded maximum

number of fruits (438) which was at par with MPUAT S-2 (431) whereas, maximum fruit weight (200 g), yield (80.60 kg/tree) was recorded by CISH G-35 which was at par with SRD H-4 (191g & 73.99 respectively).

Lucknow: Arka Kiran has recorded maximum fruit weight (206 g), maximum yield (35.20 kg/tree) has recorded by CISH G-35. Whereas, MPUAT S-2 has recorded maximum vitamin C (219 mg/100 g).

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

Pantnagar: RCGH-7 has recorded maximum yield (66.29 kg/tree) whereas, RCGH-11 has recorded maximum fruit weight (188 g) and vitamin C (203 mg/100 g) whereas, which was at par with MPUAT S-1 (180 g).

Rahuri: Among the new promising hybrids/selections, RCGH-1 has recorded maximum number of fruits per tree (88), fruit weight (138 g) and yield (10.37 kg/tree) compared to other hybrids.

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

Rewa: Variety Allahabad Safeda has recorded significantly maximum number of fruits (179), fruit weight (181 g), yield (32.35 kg/tree) and TSS (10.90°B).

Sabour: MPUAT S-2 has recorded maximum number of fruits (72) and yield (6.96 kg/tree). Whereas, regarding quality character CISH G-35 has recorded maximum TSS (11°B)

Udaipur: RCGH-1 has recorded maximum number of fruits per tree (265) which was at par with RCGH-11 (253). Whereas, maximum fruit weight (242 g), yield (52.76 kg/tree) and TSS (13.50°B) was recorded by MPUAT S-2.

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: Two hybrids Arka Rashmi and IIHR-13-14 have been procured and planted and remaining CISH hybrids will be planted after procuring.

Neri: CISH-GS-15 and Allahabad Safeda were planted in November, 2018 and rest will be planted in next season.

Periyakulam: Two hybrids Arka Rashmi and IIHR-13-14 have been procured and planted and remaining CISH hybrids will be planted after procuring.

Rahuri: Trial was initiated and planting is in initial stage.

Rewa: Grafting has been done and the plants are Juvenile stage.

Udaipur: Due to graft union failure the plants of hybrid CISH-GS15 and IIHR-13-14 become dried and dead entirely while, only few plants of CISH-GS14 and Arka Rashmi were able to survive data will be recorded in the ensuing season.

1.2.7. G. Testing the performance of promising hybrid 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: The trial has been implemented and plants are in juvenile stage. Among the five treatments, drip irrigation at 90% ER has recorded maximum and vigorous vegetative growth.

Udaipur: Plants are in juvenile stage, among five treatments, irrigation with 90 per cent ER exhibited vigorous growth and produced maximum plant height (3.15 m), stem diameter (21.40 cm) and canopy volume (0.863.86 m³) as compared to the other irrigation treatments.

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 @ 250 g/ tree + PSB @ 250 g/tree has recorded the maximum number of fruits per tree (379.7) and yield (67.6 kg/tree). There is no significant difference were recorded for qualitative parameters.

Rahuri: Significantly maximum number of fruits per tree (722.74) and yield (120.27 kg/tree) was recorded by the application of vermicompost (30 kg/plant) + *Azospirillum* culture @ 250 g/ tree + PSB @ 250 g/tree + vermiwash (dilution with water @ 1:1).

Sabour: Maximum number of fruits per tree (224.67) and yield of 34.34 kg/tree was recorded in the plants supplied with vermicompost (30 kg/plant) + *Azotobactor* @ 250 g/ tree) + PSB @ 250 g/ tree.

Sangareddy: Application of vermicompost (30 kg/plant) + *Azotobactor* @ 250 g/tree) + PSB @ 250 g/ tree has recorded maximum number of fruits per tree (350). TSS (12.50°B) and yield of 45.5 kg/tree when compared to other treatments (Fig. 10 & Table 38).

Vengurle: Significantly maximum number of fruits per tree (78.67) and yield (16.36 kg/tree) was recorded in the plants supplied with vermicompost (30 kg/plant) + *Azotobactor* @ 250 g/tree) + PSB @ 250 g/ tree (Fig.10 & Table 38).

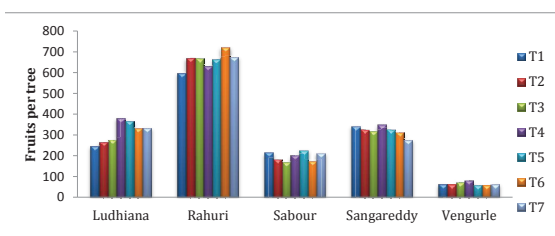


Fig. 10 Effect of organic source of nutrients on fruits per tree

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

Table -38: Effect of organic practices on yield (kg/ per tree) at different centres

Treatments	Ludhiana (Arka Amulya)	Rahuri (L-49)	Sabour (Allahabad Safeda)	Sangareddy (L-49)	Vengurle (Allahabad Safeda)
T ₁	48.6	93.66	32.67	37.4	10.94
T ₂	58.2	109.68	27.03	39.0	10.89
T ₃	50.0	104.59	24.64	39.3	12.33
T ₄	67.6	99.69	29.67	45.5	16.36
T ₅	63.1	99.37	34.34	48.7	10.64
T ₆	67.9	120.27	24.09	40.3	10.22
T ₇	64.2	117.43	31.67	37.1	10.50
CD at 5%	5.06	19.14	2.13	7.55	2.53

T1: FYM (30 kg/plant); T2: FYM (30 kg/plant) + *Azospirillum* culture (250 g/ tree) + PSB (250 g/ tree); T3: Vermicompost (30 kg/plant); T4: Vermicompost (30 kg/plant) + *Azospirillum* culture (250 g/ tree)+ PSB (250 g/ tree); T5: Vermicompost (30 kg/plant) + Azotobacter + PSB (250 g/ tree); T6: Vermicompost (30 kg/plant) + *Azospirillum* culture (250 g/ tree)+ PSB (250 g/tree) + vermiwash foliar spray (dilution with water @ 1:1); T7: Vermicompost (30 kg/plant) + Azotobacter + PSB (250 g/tree)+ vermiwash foliar spray (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 ZnSO₄ & H₃BO₃. The Fe @ 0.5 & Mn @ 0.4 was also added as micronutrients at Periyakulam, Rewa, Sabour and Sangareddy.

Lucknow: Number of fruits per tree (116.33), fruit weight (213.70 g), fruit yield (24.88 kg/tree), TSS (13.58 °B), shelf life (5.00 days) and B: C ratio (2.71) were recorded significantly maximum in the treatment of T₁ [Raised bed cultivation + Drip irrigation + Fertigation (75% RDF) + Mulching with 100-micron UV stabilize black polythene + Micro nutrients spray (ZnSO₄ & Boric acid @ 0.02%)].

Mohanpur: Treatment involving, raised bed cultivation + Drip irrigation + Fertigation (75% RDF) + Mulching with 100-micron UV stabilize black

polythene + Micro nutrients spray (ZnSO₄ & Boric acid @ 0.02%) has recorded maximum number of fruits per tree (207.90), fruit weight (162.20g), fruit yield (33.90 kg/tree), shelf life (6.65 days) and B: C ratio (3.17) given in table 39-40.

Neri: The trial has been initiated in 2019.

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 (ZnSO₄ & Boric acid @ 0.02%) has recorded higher values for plant height (1.19 m) and canopy volume (0.51 m³).

Periyakulam: Maximum fruit yield (48.50 kg/tree), TSS (13.94°B) and ascorbic acid content (178.42 mg/100g) was recorded by the treatment, T₁ [Raised bed cultivation + Drip irrigation + Fertigation (75% RDF) + Mulching with 100-micron UV stabilize black polythene + Micro nutrients spray (ZnSO₄ & Boric acid @ 0.02%)].

Rewa: Maximum number of fruits per tree (175.50), fruit yield (19.31 kg/tree), TSS (11.13°B) and acidity (0.85%) was recorded in the treatment of T₁ [Raised bed cultivation + Drip irrigation + Fertigation (75% RDF) + Mulching with 100-micron UV stabilize black polythene + Micro nutrients spray (ZnSO₄ & Boric acid @ 0.02%)].

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

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

Udaipur: Treatment involving, T₁ [Raised bed cultivation + Drip irrigation + Fertigation (75% RDF) + Mulching with 100-micron UV stabilize black polythene + Micro nutrients spray (ZnSO₄ & Boric acid @ 0.02%)] has recorded maximum number of fruits per tree (35), fruit weight (210 g), fruit yield (7.35 kg/tree), TSS (13.50°B), ascorbic acid content (190 mg/100g) and shelf life (7 days).

Table-39: Effect of different inputs on number of fruits/trees in different cultivars of guava at different centres

Treatments	Fruits/tree				Yield (kg/tree)				
	Lucknow	Mohanpur	Udaipur	Rewa	Lucknow	Mohanpur	Udaipur	Rewa	Periyakulam
T ₁	116.33	207.90	35.0	175.50	24.88	33.90	7.35	19.31	48.50
T ₂	109.00	202.10	30.2	132.60	22.33	29.40	5.85	13.03	35.50
T ₃	75.00	197.50	28.0	115.80	13.87	27.50	5.18	12.99	32.50
T ₄	71.33	194.60	25.4	101.20	12.07	24.30	4.50	14.17	30.42
T ₅	68.00	185.50	21.0	80.60	9.52	19.10	3.57	11.12	28.42
CD at 5%	18.32	12.36	3.9	11.90	3.84	1.30	0.75	3.44	2.01

T₁: a+b+c+d+e; T₂: a+b+c+d; T₃: a+b+c+e; T₄: a+b+e (RDF as soil application); T₅: Control (soil application of RDF, basin irrigation and no mulching) a) Raised bed cultivation b) Drip irrigation (80% ER at all stages) c) Fertigation (75% RDF); d) Mulching with 100 micron UV stabilize black polythene; e) Micro nutrients spray (ZnSO₄ & Boric acid 60.2%)
 Lucknow: Lalit; Mohanpur: Sardar; Udaipur, Periyakulam & Rewa: Allahabad Safeda

Table-40: Effect of different inputs on fruit quality in different cultivars of guava at various centres

Treatments#	TSS (°B)					Fruit weight (g)			
	Lucknow	Mohanpur	Udaipur	Periyakulam	Rewa	Lucknow	Mohanpur	Udaipur	Rewa
T ₁	13.58	11.00	13.5	13.94	11.13	213.70	162.20	210.0	110.00
T ₂	12.45	10.83	12.6	13.62	10.40	204.82	145.30	195.0	98.30
T ₃	11.55	10.70	12.0	13.10	9.56	184.98	139.70	185.0	112.20
T ₄	11.13	10.43	11.0	12.50	8.64	167.38	125.10	180.0	140.00
T ₅	10.95	10.34	10.7	12.00	9.78	140.01	103.40	170.0	138.00
CD at 5%	1.23	0.31	1.63	0.52	0.89	6.78	4.87	25.7	8.83

T₁: a+b+c+d+e; T₂: a+b+c+d; T₃: a+b+c+e; T₄: a+b+e (RDF as soil application); T₅: Control (soil application of RDF, basin irrigation and no mulching) a) Raised bed cultivation b) Drip irrigation (80% ER at all stages) c) Fertigation (75% RDF); d) Mulching with 100-micron UV stabilize black polythene; e) Micro nutrients spray (ZnSO₄ & Boric acid each @ 0.2%)
 Lucknow: Lalit; Mohanpur: Sardar; Udaipur, Periyakulam & Rewa: Allahabad Safeda

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

Methodology: 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 maximum number of fruits and yield per tree (587.14 and 73.15 kg/ tree, respectively), TSS (13.21°B) and vitamin C (245.72 mg/100 g) were recorded in the treatment (T₃) involving the application of 75% Recommended

dose of N and P₂O₅ + AMC soil application (12.5 kg/ha) twice a year along FYM (Table 41).

Rahuri: The trial is at initial stage.

Rewa: The trial is at initial stage.

Sabour: The trial is at initial stage.

Sangareddy: The trial is at initial stage.

Udaipur: Application of 75% recommended dose of N and P₂O₅ + AMC soil application (12.5 kg/ha) twice a year along FYM (T₃) has recorded significantly higher number of fruits (220), yield (38.50 kg/tree), TSS (13.8°B) and vitamin C (186 mg/100g).

Table-41: Effect of different treatments on yield and quality parameters of different cultivars of guava at Pantnagar and Udaipur centres (2019)

Treatments	Fruits/tree		Yield (kg/tree)		TSS (°B)		Vitamin C (mg/100 g pulp)	
	Pantnagar (cv. Sardar)	Udaipur (cv. Allahabad Safeda)	Pantnagar (cv. Sardar)	Udaipur (cv. Allahabad Safeda)	Pantnagar (cv. Sardar)	Udaipur (cv. Allahabad Safeda)	Pantnagar (cv. Sardar)	Udaipur (cv. Allahabad Safeda)
T ₁	435.71	177.00	51.47	26.55	11.73	12.8	217.05	180
T ₂	275.71	190.20	39.46	30.42	11.89	13.1	211.97	182
T ₃	587.14	220.00	73.15	38.50	13.21	13.8	245.72	186
T ₄	284.29	160.40	35.72	22.40	11.45	12.2	202.64	178
CD at 5%	51.95	3.40	10.08	1.07	1.02	1.63	22.89	3.34

T₁:100% Recommended dose of fertilizers (Soil application); T₂:75% Recommended dose of N and P₂O₅ + AMC soil application (4 times @ 5g/l) through biofertilization; T₃:75% Recommended dose of N and P₂O₅ + AMC soil application (5 kg/acre) twice a year along FYM; T₄:75% Recommended Dose of N and P₂O₅

5.2.2 G New and emerging pests in guava

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

Lucknow: Fruit flies (*Bactrocera dorsalis*) were severe in third week of July 2019, incidence was up to 60-65 per cent. Infestation of anar caterpillars (*Deudorix isocrates*) was observed up to 10-15 per cent. Apart from these two major pest incidences of bark eating caterpillar was observed up to 8 per cent during November 2019.

Ludhiana: Incidence of thrips, *Rhipiphorothrips* sp. (1%) and Blackfly, *Aleurocanthus husaini* Corbett (2%) was observed first time on guava in Punjab. Severe incidence of fruit flies, *Bactrocera dorsalis* (Hendel) and *Bactrocera zonata* (Saunders) up to 80-85 per cent was recorded. Incidence of Castor fruit and shoot borer, *Conogethes punctiferalis* Guenee recorded upto 10-15 per cent.

Pantnagar: A rich diversity of insect fauna was found to be associated with guava ecosystem at Pantnagar. Major insect pest was fruit and shoot borer, *Dichocrosis punctiferalis* (> 25% incidence) and fruit fly, *Bactrocera dorsalis* (>10% incidence). Besides, Mango mealy bug, *Drosicha mangiferae* (Green), Aphid, *Myzus persicae*; Coccids, *Chloropulvinaria psidii*; Semilooper; Anar butterfly, *Deudorix*

(*Virachola*) *isocrates*; Leaf cutter bee *Mechachile* sp., *Spodoptera litura* and defoliating beetles and various lepidopterans larvae were also observed on guava during the vegetative to fruiting stage.

Rahuri: Incidence of Anar caterpillars *Deudorix isocrates* was seen in the second week of November 2019 up to 5.60 per cent. Mealy bug (*Ferrisia virgata*) also reported during March 2019. The incidence of caster capsule borer (*Conogethes punctiferalis*) was seen in the third week of June 2019 in high density guava plantation and it was increased to 5.12 per cent in the second week of July 2019. Whereas, fruit flies (*Bactrocera dorsalis*) were severe in third week of September 2019. The newly reported pest wax scales (*Ceroplastes destructors* Newstead) was observed in the month of September 2019 and the infestation level was up to 7.25 per cent in the month of October 2019. The per cent infestation of Anar caterpillars (*Deudorix isocrates*) was decreased by 0.4 per cent during this year as compare to past year status. The pest status of this year showed that the fruit fly infestation was increased from 42.00 to 44.25 per cent i.e. 2.25 per cent increase in infestation and Wax Scale (*Ceroplastes destructors* Newstead) infestation was increased by 0.25 per cent.

Sangareddy: The dynamics of pest population in guava post monsoon period of 2018-19 revealed that

spiralling whitefly and fruit flies is more incidence whereas coccids and bark eating caterpillar has recorded less incidence. The bark eating caterpillar damage was observed throughout the year and fruit borer incidence is more compared to previous year

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

Result: The trails have been initiated as per the envisaged programme. Initial observations like number of 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.

6.2.2 G. New and emerging diseases of 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 monsoon and pre-monsoon period, canker was the major disease of guava (28.66%).

Ludhiana: During monsoon period highest incidence of anthracnose (22.67%) was observed whereas, low incidence of wilt (1.53-6.25%), *Phytophthora* fruit rot (2.00%) and fruit canker (3.11%) was observed during monsoon and post-monsoon periods (Fig. 13).

Rewa: During pre-monsoon and monsoon period, higher incidence of anthracnose (19.7 to 39% respectively) and incidence of wilt (2.7 to 4.8%) was observed.

Rahuri: During monsoon period maximum incidence of canker (12.38%) and anthracnose (25.16%) was reported.

Mohanpur: During pre-monsoon and monsoon period canker (5.00 & 16.50% respectively) was reported and during monsoon period, anthracnose (15.75%) incidence was reported (Fig. 11).

Sabour: During monsoon period 15.5 per cent of anthracnose incidence and 6.7 per cent of canker was reported (Fig. 12).

Sangareddy: During pre-monsoon and post-monsoon period anthracnose was reported 9.4 per cent and 16.6 per cent respectively.

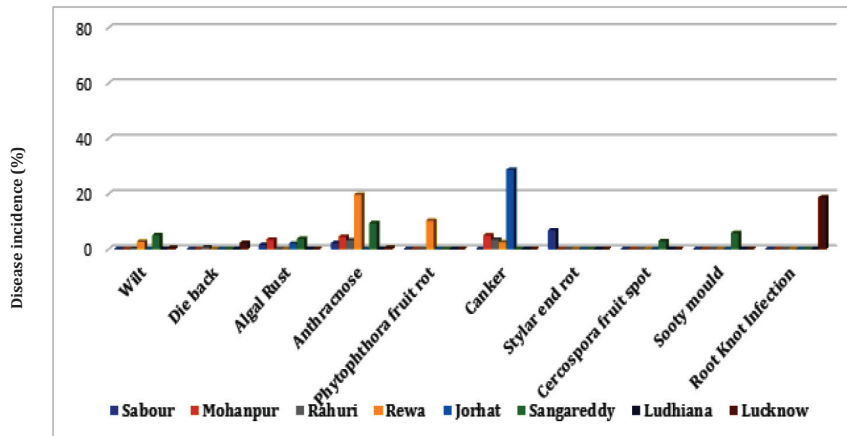


Fig. 11. Distribution of diseases in guava across the centres in pre-monsoon period Feb-May, 2019

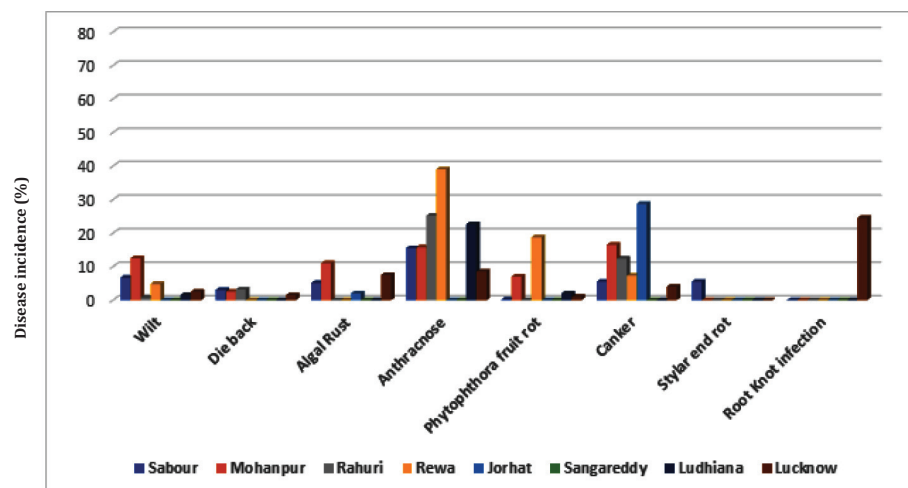


Fig. 12. Distribution of diseases in guava across the centres in monsoon period June-Sept, 2019

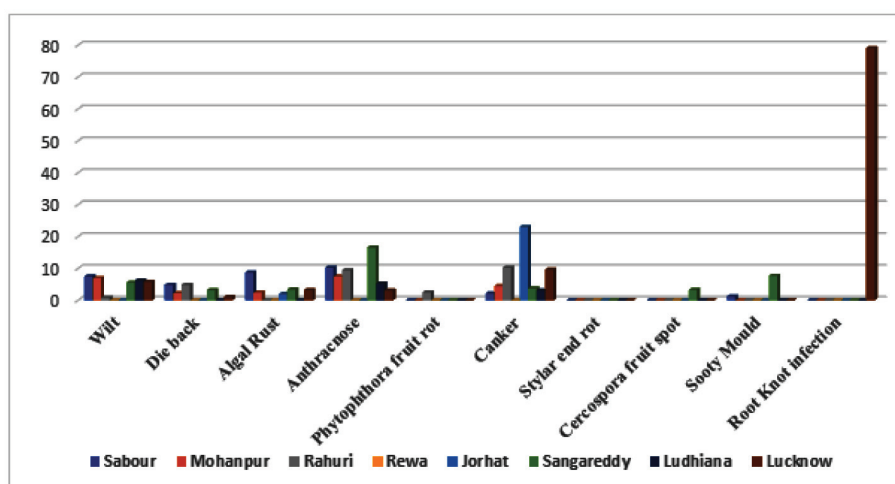


Fig. 13. Distribution of diseases in guava across the centres in Post-monsoon period of Oct 2019 - Jan 2020



Plate: 5 Wilt affected guava trees at Mohanpur

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 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 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 66.4 and 67.8 kg per tree during winter season and 52.9 and 55 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, 60 per cent mortality was observed in T₁, T₂, T₃ and T₅ treatments. Wilted plant symptom was depicted in plate 5.

Sangareddy: No wilt symptoms were observed so far.

JACKFRUIT

1.5.1 J. Collection, characterization, conservation, evaluation and utilization of jackfruit 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 Bioersity International (IPGRI).

Jorhat: In-situ evaluation and characterization of 18 local genotypes of three agro climatic zones in four districts (Morigaon, Kamrup, Barpeta & Darang) of Assam viz., Central Brahmaputra Valley Zone-CBVZ (5), Lower Brahmaputra Valley Zone-LBVZ (9) and North Bank Plains Zone-NBPZ (4) was recorded. Among 18 local genotypes, maximum fruit number (270.33) was recorded in MGN5 and minimum (93) in BRP2. Maximum fruit weight (10.58 kg) was recorded in BRP3 and minimum fruit weight (2.08 kg) in KMP5. Maximum flake number (40.37) per kg of fruit & flake to fruit ratio (0.74) was recorded in

KMP6 and minimum (8.55) was recorded in DNG1.

Kannara: A total of 10 accessions were conserved in the field gene bank, 16 genotypes were evaluated, 11 were collected and three genotypes were characterized. Among the genotypes, three genotypes from Wayanad (KJ-35, 36 & 37/19) and one from Chittur (KJ-39/19) were off season bearing (Sept.-Oct.) and has recorded maximum fruit weight (17.80 kg) and fruit width (38.90 cm). Genotype KJ-38/19 collected from Thrissur district is a gumless all-purpose type with orange red flakes. Seven genotypes (KJ-27, 28/18, 4/15, 31, 37, 38 & 39/19) were all purpose types and KJ-26/18 was exclusively suitable for chips. Genotype collected from Thrithallur, KJ-34/18 is an early bearing type (January), with orange flake. Highest fruit girth (92.00 cm) and flake weight with seed (10.90 kg) was recorded in KJ-26/18. Maximum number of flakes per fruit (308) was recorded in KJ-31/19 whereas lowest was in KJ-32/19 (29). Highest flake length & width was recorded in genotype KJ 27/18 (8.50 cm 5.20 cm). Maximum chips recovery (68%) was recorded in KJ- 25/18. Maximum TSS (30°B) was recorded in KJ-25 and 30/18.

Kovvur: During reporting period one new genotype was collected with small and round fruit from Devarapalli village, West Godavari District of Andhra Pradesh. Thirty-one genotypes are being conserved in the field gene bank, among them 26 genotypes are in bearing stage and 5 genotypes are in pre-bearing stage. Palur-1 recorded maximum number of fruits (59.5) whereas, maximum yield was recorded by

Tanjavur (47.4 t/ha). Maximum fruit weight (14.7 kg) was recorded in Bodurulu-4 while minimum (4.0 kg) in NJ-1. Budurulu-1 recorded maximum number of flakes per fruit (460). Maximum TSS (39.1°B) was recorded in M. Varikka.

Mohanpur: During the reporting period, two new accessions were collected. A total of fifty-eight genotype were conserved. Characterization and evaluation of forty-one genotypes has recorded that BCJ-24 & BCJ- 26 bearing maximum maximum numbers of fruits (73 & 71). BCJ- 27 is suitable for dessert purpose has recorded average fruit weight of 2 kg. BCJ-30 (16.0 kg) & BCJ-22 (15.3 kg) has recorded big sized fruit, BCJ- 34, BCJ-35, BCJ-36 & BCJ-37 produced fruits year-round.

Periyakulam: Explorations carried out in Kulasekarem, Thiruvaadanai, Sethaiyathoppu, Keeranur, Kudimiyanmalai and Pudhukottai district. Twenty-three accessions were conserved, among them 14 accessions are in bearing stage and 9 genotypes are in pre-bearing stage. Accessions AH-1 recorded the maximum height (7.80 m) and AH-2 recorded the maximum numbers of fruits (48).

Lembucherra: During the reporting period 20 local jackfruit accessions were identified and evaluated their physico- chemical characters. In-situ evaluation resulted that, out of 20 genotypes, maximum number of fruit (53), fruit length (38.90 cm), fruit diameter (25.35 cm), flake weight per kg fruit (0.72 kg) was recorded in TJS-1 and minimum fruits (6) in TJS-4. Maximum TSS (28.2°B) was found in TJS-20 (Table 42)

Table-42: Variation in fruit characteristics (quantitative) of jackfruit at different centres

Quantitative parameters	Lower (Minimum)	Higher (Maximum)
Fruit weight (kg)	2.05 (TJS-3)	17.80 (KJ-39/19).
Flake: fruit	0.09 (KJ-27/19)	0.88 (AH-2)
Flake thickness (mm)	0.19 (BCJ-20)	0.76(BCJ-5)
Flakes/ kg fruit	5.54 (BCJ-30)	61.0(S. Manohar)
TSS (°B)	12.5 (TJS-3).	39.1(M. Varikka),
Fruit rind thickness (cm)	0.10 (TJS-3).	1.83 (Boduluru-2)
Flake length (cm)	3.5 (TJS-8).	11.08 (AH-5)
Flake width (cm)	2.02 (AH-4)	6.07 (BRP2)

Note: Lembucherra- TJS-3 & 8, Kannara-KJ-27/19 & KJ-39/19, Mohanpur-BCJ-5, BCJ-20 & BCJ-30, Periyakulam -AH-4, AH-2 & AH-5-, Kannara- Swarna Manohar, M. Varikka & Boduluru-2, Jorhat- BRP2

1.5.2 J. Varietal trial in Jack fruit

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

Kovvur: Among the evaluated varieties maximum canopy volume (609.8 m³) was recorded in Velipala. Maximum number of fruits (59.5) with average yield of 43.7 kg/tree was recorded in Palur-1 (Table 43).

Kannara: Pechiperai has recorded maximum canopy volume (1477 m³). Maximum fruits per tree was recorded in Singapore (127.0) with yield of 165.2 kg/tree (Table 43).

Jorhat: Muttam Varrikka has recorded the maximum number of fruits per tree (30.00) and yield (23.80 kg/tree).

Periyakulam: Variety Singapore Jack has recorded significantly maximum values for canopy volume (524.9 m³) whereas maximum number of fruits per tree (26.1) and yield (62.4 kg/tree) was recorded by Palur-1 (Table 43).

Mohanpur: Maximum number of fruits per tree (13.4) and yield (7.3 kg/tree) was noticed in Palur-1.

Table-43: Growth and yield of jack fruit varieties at different centres

Varieties	Yield (kg/tree)					Fruits/tree				
	Kovvur	Jorhat	PKM	Kannara	Mohanpur	Kovvur	Jorhat	PKM	Kannara	Mohanpur
M.Varikka	12.3	23.8	13.2	150.9	6.9	15.8	30.0	12.1	122.0	12.4
Gumless Jack	33.0	8.9	-	14.4	3.4	43.7	13.0	-	28.0	10.2
Palur-1	43.7	13.0	62.4	32.1	7.3	59.5	20.7	26.1	35.0	13.4
Pechiparai-1	30.0	15.1	7.2	96.4	7.1	42.7	23.7	6.2	97.0	10.7
Singapore	29.4	8.6	9.8	165.2	4.5	30.2	18.7	11.4	127.0	8.8
Velipala	3.7	12.1	5.1	17.7	4.2	6.3	17.3	4.5	25.0	6.7
Burliar-1	7.5	8.0	7.1	-	6.5	11.3	15.3	6.3	-	9.9
CD at 5%	10.5	4.7	-	-	2.1	12.4	5.7	-	-	4.4

Note: Tree age at Kovvur: 15 years, Kannara: 14 years, Jorhat: 9 years, Periyakulam (PKM): 8 years and Mohanpur: 11 years

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

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

Roving survey

Jorhat: Surveys were conducted in Jorhat, Sibsagar and Golaghat districts. Fruit borer was the major insect pest of jackfruit with an incidence of 28-34 per cent. During the survey period mealy bug was reported from Golaghat and Jorhat districts with an incidence ranges from 15-18 per cent (Fig. 14).

Kannara: Infestations of large xylophagous and phytophagous cerambycid beetles viz., *Macrochenus isabellinus* Aurivillius and *Epepeotes uncinatus* Gahan (Coleoptera: Cerambycidae), which were recorded as a new pest and pest of concern in the surveyed areas. Severe defoliation in adult stage by reducing the leaves to veins and grubs by feeding heavily on woods is recorded from senile or unattended orchards. High incidences of *Glenea multiguttata*, cerambycid defoliator was reported from Kasargod, Ernakulam, Idukki, Wayanadu, Palakkad, Kottayam and Alappuzha districts which damage young flushes and shoots. Very low infestations of Jackfruit shoot and fruit borer *Margaronia caesalis* were recorded

from Thrissur, Wayanadu, Kottayam districts. Young plantations were infested by *Oberea artocarpi*, leading to shoot death, from Thrissur and Palakkad districts. *Olenecamptus bilobus* was observed across the surveyed areas during the monsoon period. Bud weevil (*Ochyromera artocarpi*) infestation was sporadic which was heavily fed on young and tender jack fruits. Jack fruit aphid (*Greenidia artocarpii*), tingid bug and spittle bug (*Clovioa lineaticollis*), were observed as mild but regular pests on growing young shoots and causes crinkling of leaves. Defoliation by Long horned Grasshoppers/Katydid and leaf caterpillars were of sporadic occurrence.

Kovvur – Surveys were conducted in East Godavari and West Godavari Districts of Andhra Pradesh. Infestation of fruit borer, mealy bug and leaf webber was observed in jack fruit during the survey. Among them, fruit borer was found to be the major pest of Jackfruit and its infestation ranged between 1.0 to 21.5 per cent (Fig. 14).

Mohanpur: Survey conducted in Nadia and Hoogly, infestation of fruit borer (*Glyphodes caesalis*) was recorded (20 & 15% respectively) during March-May. Bark eating caterpillar (*Indarbela tetraonis*) was also recorded (4 & 2% respectively) on the plants. A species of *Eriophyid* mite has been recorded as

new incidence and the species confirmation is in progress. However, the pest infestation was low.

Periyakulam: Roving survey was conducted in various districts of Tamil Nadu in which the shoot and fruit borer incidence (10.12%) and Mealybug infestation (9.78%) was maximum in Manjalar. Both in fixed plot survey and roving survey the stem borer (8.70%) and aphids infestation (11.15%) was maximum. It was high during the month of August. In addition, natural enemies (3 – 8) viz., spiders, praying mantids, green lacewings, Coccinellids, *Spalgis epius* and reduvid bugs were also observed in surveyed areas.

Fixed plot surveys

Kannara: Infestation of Fruit and shoot borer was conspicuously very low in the fixed plot. Sporadic incidences of gregarious leaf caterpillar (*Margaronia bivitalis*) closely followed the attack of cerambycid defoliators. Breadfruit mealy bugs (*Icerya aegyptica*) were attacked by red ants for the honey dew they secrete and protected them from predators and

parasitoids meanwhile, red ants acts as dispersal of these pests to other parts of the orchard. The stem borer, *Batocera rufomaculata* and *Mactochenus isabellinus* were noticed on older primary branches respectively, during monsoon season (June-September) and adult beetles are known as defoliators of tender leaves and grubs tunnel in to the heartwood killing the branches. Gregarious chrysomelid beetles infested the leaves during the monsoon months of June and July. Severe denuding of shoots by long horned grasshopper was sporadic in the monsoon season.

Mohanpur: Shoot and fruit borer, *Glyphodes caesalis* was recorded as major pest of jackfruit and causes medium to high damage on shoots and young fruits during March-May. The pest was active up to June. Mealy bug incidence was also observed in the month of August and September (2-3%) and attack was confined in twig parts.

Periyakulam: Shoot and fruit borer (10.12%) and aphid infestations (11.15%) were maximum during survey.

Kannara: Increasing incidence of Algal rust (*Cephaleuros* spp) was recorded. Fruit rot caused by *Rhizopus* was increased (20%). Leaf spot caused by *Colletotrichum gloeosporioides* was predominant disease in Thrissur District of Kerala. Apart from this, Seedling blight, Algal rust, Pink disease were recorded from the district.

Kovvur: Jackfruit wilt was recorded as emerging disease.

Mohanpur: Jackfruit wilt was recorded as emerging disease. Post-harvest rot or storage rot (*Diplodia/Lasiodiplodia* sp.) was recorded during transport, storage and marketing particularly in hot and humid weather. Severity of the disease ranges from 03.95 to 18.50 per cent and reaches its peak during July.

Periyakulam: Increasing incidence of Algal rust (*Cephaleuros* spp) was recorded. Leaf spot incidence was maximum and fruit drop due to *Rhizopus* fruit rot incidence was maximum in Pudhukottai. Foot rot/collar rot (wilt) disease (02.70 to 08.50%) of jackfruit (*Phytophthora* sp) was recorded a complex with infestation of trunk borer.

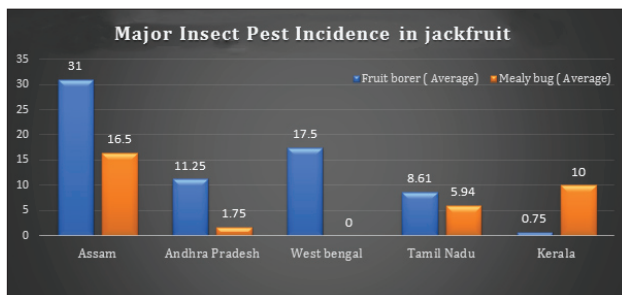


Fig.14 Roving survey for the infestation of major insect pests in jack fruit

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. The changes in the incidences of different diseases with respect to previous years have been given in fig. 15.

Jorhat: Algal rust (*Cephaleuros* spp) incidence (3.5%) was increased during survey. leaf spot (*Phyllosticta* sp, *Colletotrichum* spp) and Red rust (*Cephaleuros* spp) were recorded, of which *Rhizopus* fruit rot was found to be the most severe disease.

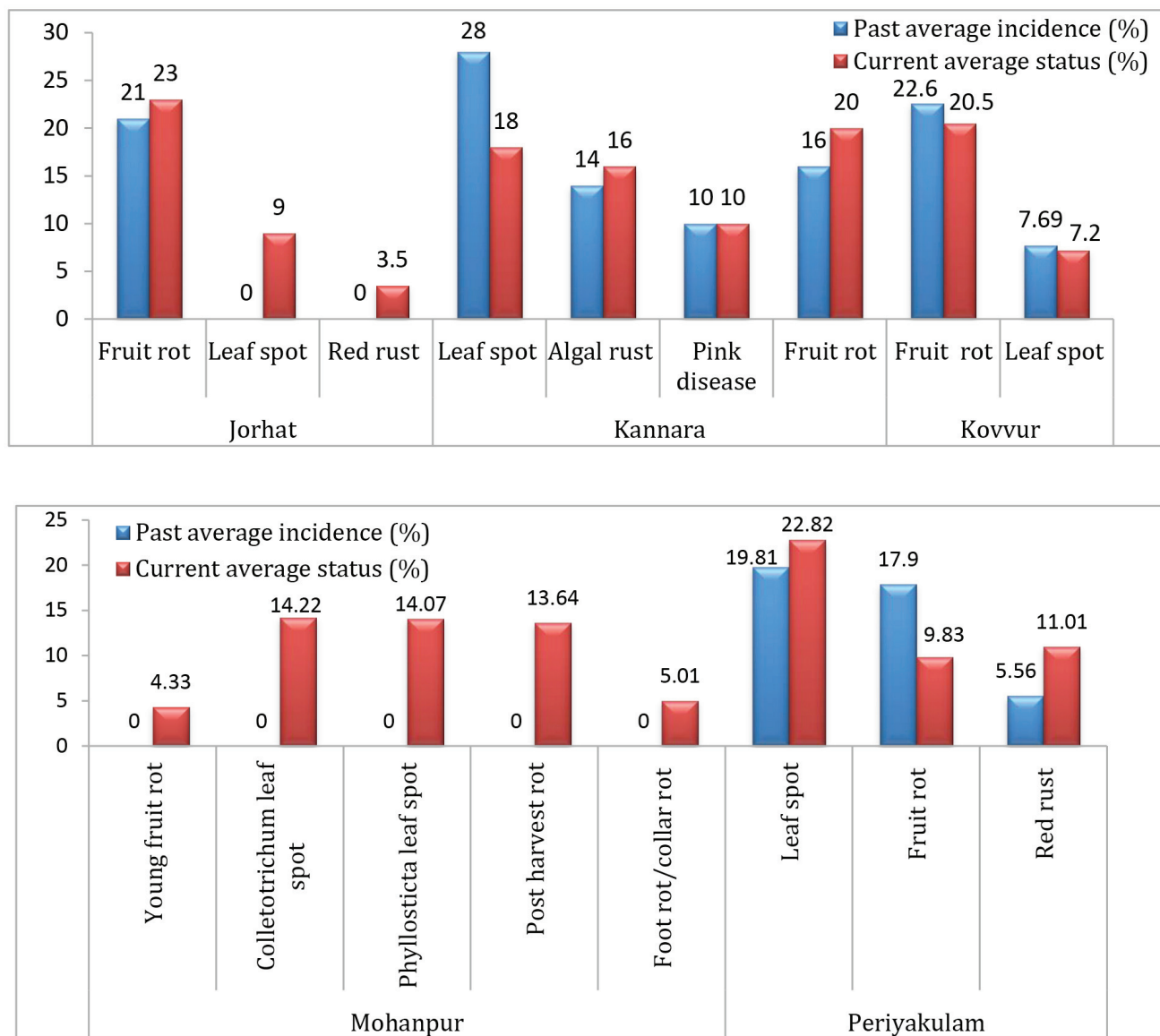


Fig.15 Status of new and emerging diseases of jackfruit

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: Root rot/ collar rot was observed at experimental block of jackfruit, Venkataramana gudem of West Godavari District. Infected plants showed gummosis or reddish-brown ooze on the trunk region and partial or complete wilting of the plants. Rotting of the roots with loose skin was observed. Ganoderma bracket was also observed on the infected plant. Root bits from infected plants were collected and kept for isolation and characterization. While, *Fusarium* sp. isolated from earlier surveys has not produced any disease symptoms in inoculated jack seedlings and further studies are in progress.

Mohanpur: The two fungi were identified as *Fusarium* sp and *Phytophthora* sp were isolated from infected roots and rhizospheric soil. Root injury and wilt symptom was recorded with inoculation of *Phytophthora* as soil drenching. Pathogenicity confirmation of *Fusarium* sp is in progress. Symptoms recorded after 3-4 weeks in potted seedlings has recorded dull coloured leaves losing turgidity and drooping of leaves and pathogenicity of the fungus species was identified and confirmed as *Phytophthora artocarpi*.

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 will be raised and evaluated as per litchi descriptor.

Gangian: Seedling population of Dehradun has been transplanted.

Medziphema: Seedling population of Shahi has been developed and maintained in protected nursery.

Mohanpur: Seedling population of Bombai has been transplanted.

Muzaffarpur: Seedling population of Shahi has been developed and maintained in protected nursery.

Pantnagar: Seedling population of Rose scented has been developed and maintained in protected nursery.

Ranchi: Seedling population of Bedana has been developed and maintained in protected nursery.

Sabour: Seedling population of Mandraji has been transplanted.

2.3.4. L. High Density Planting in Litchi

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

Mohanpur: Seven years old litchi cv. Bombai has recorded maximum yield per plant in the spacing of 4×4 m which was on par with 6×6 and 5×5 m. However, maximum fruit weight, fruit size, pulp weight, TSS and least acidity were recorded in 6×6 m which was on par with 4×4 m (Table 44).

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

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

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

Table-44: Effect of planting densities on fruit yield & quality in litchi cv. Bombai at Mohanpur

Planting density (Plants/ha)	Plant age at 1 st fruiting (Year)	Fruit weight (g)	Pulp weight (g)	Stone weight (g)	Fruit length (cm)	Fruit diameter (cm)	TSS (°B)	Acidity (%)	Yield (kg/plant)
2×2 m (2500 plants/ha)	7	18.06	11.23	3.83	3.23	2.90	17.63	0.38	0.77
3×3 m (1111 plants/ha)	7	18.17	11.37	3.77	3.37	2.90	17.67	0.37	1.23
4×4 m (625 plants/ha)	7	18.53	11.60	3.73	3.57	3.03	17.80	0.36	3.07
5×5 m (400 plants/ha)	7	18.70	11.67	3.57	3.67	3.06	18.06	0.34	2.53
6×6 m (278 plants/ha)	7	18.83	11.73	3.63	3.77	3.13	18.10	0.34	2.56
CD at 5 %	-	0.36	0.23	0.13	0.23	0.16	0.27	0.020	1.07

2.3.5. L. Development of plant canopy architecture in litchi.

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

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

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

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

Neri: Treatments has been imposed and plants are in vegetative phase.

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

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

Sabour: Treatments has been imposed and plants are in vegetative phase.

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.

Gangian: The trial has been initiated in cv. Dehradun

Mohanpur: The trial has been initiated in cv. Bombai

Neri: The trial has been initiated in cv. Dehradun

Pantnagar: The trial has been initiated in cv. Rose Scented

Ranchi: Old plantations of litchi cv. Purbi rejuvenated in the previous year produced 52-64 shoots/plants. Of these, 50 per cent were thinned out and the remaining 50 per cent is allowed to develop further which will again be thinned out to the desired number of branches.

Sabour: The trial has been initiated in cv. Purbi

3.3.3.L: Irrigation (Drip) scheduling in litchi

The trial consisting of irrigation at 50% ER, 75% ER, 100% ER and control (calender schedule) was laid out to determine the optimum irrigation requirement in litchi. A spacings of 8×8 m (Muzaffarpur), 5×5 m (Ranchi) and 10×10 m (Mohanpur and Pantnagar) were followed as per the standard practice of the region.

Muzaffarpur: There is no significant variations among the treatments has recorded for vegetative parameters.

Pantnagar: Irrigation at 75% ER with plastic mulch (T_3) results in maximum fruit weight (23.91 g), TSS (18.89°B) and ascorbic acid (24.19 mg/100ml) and minimum acidity (0.40%). However, plants irrigated at 100% ER with plastic mulch gave maximum number of fruits per tree and yield (27.08 kg) owing to least minimum (60.75) fruit drop.

Mohanpur: Irrigation at 50% ER with mulching results in maximum TSS (24.40°B), fruit weight (24.50 g) and yield (91 kg/tree) while lowest fruit cracking (10%) was recorded in treatment involving 75% ER with mulch.

Ranchi: Fifteen years old litchi cv. Shahi planted at 5 x5 m spacing. The result showed that all mulching treatments were significantly superior over the non-mulching treatments. Fruit quality parameters such as TSS (25.53°B) and total sugar (15.12 mg/100g) were significantly higher with mulching plus drip irrigation with 75% ER. Whereas, maximum yield (36.03 kg/tree) was obtained in mulching plus 100% ER.

4.3.3. L: Improving Bearing Potential of Litchi through Girdling of branches

The effect of girdling on 25 and 50 per cent of the primary branches with different girdling size (2 mm, 4 mm and 6 mm width) on flowering in litchi was investigated. Treatments were imposed at 5 to 6 months (August– September) before the anticipated flowering.

Neri: Treatment involving 4mm girdling performed in 50% primary branches has recorded minimum initial fruit drop (70.24%), maximum fruit weight (19.80 g), fruit set (13.90%) and yield (29.70 kg/tree) compared to control (13.50 g, 10.50% & 21.80 kg/tree respectively).

Chettalli: Maximum per cent flowering shoot (74.29) and fruit set (51.11%) was recorded by 2mm girdling in 50% primary branches.

Medziphema: Girdling at 4 mm width in 75% primary branches has recorded maximum flowered shoot (15.50%). However, maximum fruit weight (17.85 g) and yield (20.50 kg/tree) was recorded in 6 mm girdling performed on 50% primary branches compared to control (14.40 g & 12.00 kg/tree respectively).

Gangian: Maximum fruit set (13.10%) was recorded with 4 mm girdling on 25% primary branches. However, maximum fruit weight (19.90 g) and yield (72 kg/tree) was recorded in 2 mm girdling in 25 per cent of primary branches (Table 45 & 46).

Table-45: Effect of girdling on per cent flowering shoot, number of fruits set and fruit drop in litchi at different centres

Treatments	Flowered shoot (%)		Fruit set (Fruits/panicle)				Initial fruit drop (%)		
	CHE	MED	CHE	GAN	MED	NERI (%)	CHE	MED	NERI
2mm 25% PB	65.59	-	38.34	12.00	-	-	87.26	-	-
4mm 25% PB	44.28	-	32.34	13.10	-	-	86.26	-	-
6mm 25% PB	35.22	-	31.00	10.30	-	-	86.07	-	-
2mm 50% PB	74.29	11.16	51.11	12.80	111.66	11.30	88.13	27.61	73.60
4mm 50% PB	71.33	11.66	39.38	11.30	150.00	13.90	89.32	25.75	70.24
6mm 50% PB	46.29	8.83	23.13	11.10	101.66	11.60	78.16	38	75.40
2mm 75% PB	-	11.16	38.34	10.00	150.00	12.20	-	31.79	78.60
4mm 75% PB	-	15.5	-	-	120.00	11.80	-	24.47	74.60
6mm 75% PB	-	9.66	-	-	112.66	11.40	-	27.61	79.65
Control	38.48	4.66	-	-	48.00	10.50	87.20	34.83	85.80
CD at 5%	NS	-	NS	0.84	-	-	NS	-	-

* CHE: Chettalli, MED: Medziphema, GAN: Gangian

Table-46: Effect of girdling on fruit quality and yield of litchi at different centres

Treatments	Fruit weight (g)			TSS/acid ratio		Yield (kg/tree)		
	GAN	MED	NERI	GAN	MED	GAN	MED	NERI
2mm 25% PB	19.90	-	-	59.80	-	72.00	-	-
4mm 25% PB	19.10	-	-	57.50	-	66.50	-	-
6mm 25% PB	18.50	-	-	64.70	-	61.10	-	-
2mm 50% PB	15.10	14.58	17.80	63.20	36.20	47.90	16.60	23.30
4mm 50% PB	14.10	15.00	19.80	59.00	35.03	49.70	20.00	29.7
6mm 50% PB	19.60	17.85	17.50	56.60	36.30	56.30	20.50	23.90
2mm 75% PB	-	15.75	18.30	-	31.10	-	18.24	24.75
4mm 75% PB	-	15.38	17.60	-	39.13	-	20.42	26.20
6mm 75% PB	-	17.25	18.60	-	36.85	-	18.00	24.50
Control	16.80	14.40	13.50	61.70	33.23	44.00	12.00	21.80
CD at 5%	1.79	-	-	12.59	-	4.32	-	-

* MED: Medziphema, GAN: Gangian

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.

Ranchi: In 36 years old Shahi litchi, spraying KNO_3

(1%), K_2HPO_4 (1%) + KNO_3 (1%) and KH_2PO_4 (1%) + KNO_3 (1%) resulted significantly higher flowering intensity (75.57 - 78.02%) and yield (71.02 - 76.47 kg/plant). Similarly, the advancement in flowering (8 days) and harvesting (9 days) were also recorded in trees receiving the same foliar sprays. However, there was no significant effect of foliar spray on fruit quality parameters.

Mohanpur: Spraying of K_2HPO_4 (1%) + KNO_3 (1%)

was most effective in advancing flowering (6 days), increasing flowering intensity (95%), hastening fruit maturity and harvesting period (5 days) with maximum fruit yield (34.16 kg/plant) and TSS (19.13°B) in cv. Bombai, which was on par with T₈ [Ethrel (400ppm)].

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 and Ranchi), Rose Scented (Pantnagar), Purbi (Sabour), Bombai (Mohanpur) and Dehradun (Gangian) were bagged at 15, 25 and 30 days after fruit set, using polypropylene pink and white bags.

Ranchi: Irrespective of treatments, there was significant reduction in incidence of fruit borer, sunburn and fruit cracking in bunch bagging trees as compared to control (Table 48 & 49). Maximum fruit weight (22.22 g) was recorded in bunches bagged at 25 DAFS with Polypropylene Pink bags (T₅), however, TSS remains unaffected by bagging. Pericarp anthocyanin content was highest (74.72 mg/100g) in bunches bagged with pink polypropylene bags at 15 DAFS. However, the anthocyanin content of fruits bagged with white polypropylene bags was lower than control (Table 50).

Pantnagar: The maximum fruit weight (23.07 g) and anthocyanin (26.24 mg/100g) was obtained in bunches bagged with Polypropylene Pink bags at 30 DAFS (Table 47). Bunch bagging significantly reduce total acidity of fruits over control. The incidence of fruit borer was absolutely nil in bagged fruits while the rate of fruit cracking increases as the date of bagging increases but was lower than control (Table 48 & 49). Bagging of litchi bunches with bagged with Polypropylene Pink bags at 30 DAFS also produced highest (59 kg/tree) yield (Fig. 16).

Muzaffarpur: The rate of fruit cracking and sunburn increases as the date of bagging increases while, bunches bagged before 25 days after fruit set escapes from incidence of fruit borer. Fruit acidity was higher in bagged fruits compared to control while TSS remains unaffected by bagging. Anthocyanin content (39.27 mg/100g) as well as yield (62.15 kg/tree) was highest in fruit bunches bagged at 30 days after fruit

set irrespective of bag colour (Table 50 & Fig. 16). Bagged fruits also registered high 'L' and 'a' values compared to control.

Sabour: Bagged fruits were free from cracking and sunburn, however the incidence of fruit borer was noted in fruits bagged with PPW & PPP at 30 days of fruit set (1.70 & 1.30% respectively). The maximum fruit weight (23.82 g) and TSS (21.27°B) was recorded in bunches bagged with (T₆) Polypropylene Pink bags + 30 DAFS. Bunch bagging significantly reduce total acidity of fruits over control and also improves colour development in fruit as compared control.

Gangian: Bunches bagged with Polypropylene Pink bags + 30 DAFS has resulted in maximum fruit weight (25.55 g) and TSS (21.07°B), however the effect on total acidity was insignificant. Bunch bagging was promising in minimizing incidence of fruit borer and bunches bagged at 15-25 DAFS were free from fruit borer (Table 49). Bagging markedly improve fruit colour and fruit bagged with T2 (Polypropylene White bags at 25 DAFS) recorded maximum 'a' values (Table 50).

Mohanpur: Bunch bagging with PPP at 25 DAFS has recorded minimum fruit cracking (0.63%) and fruit borer infestation (3.53%) in litchi cv. Bombai (Table 48 & 49). Whereas no significant difference on fruit weight was recorded. Under bunch bagging, fruit develops bright carmine red as compared to dull carmine red colour in control.

Medziphema: Bagging of bunches with Polypropylene Pink bags at 25 DAFS (T₅) has recorded maximum fruit weight (17.85 g) and yield (21.30 kg) per tree (Table 47 & Fig. 16). Whereas, maximum TSS (17.60°B) and minimum fruit cracking (0.83%) was recorded by bagging with PPP at 15 DAFS (Table 48). Similarly, bunch bagging improves colour development in fruits and bagged fruits has recorded higher anthocyanin content (14.3–22.3 mg/100g) compared to control (13.0 mg/100g).

Ambikapur: Promising effect of bunch bagging in improving fruit colour, reducing per cent incidence of fruit borer, sunburn and fruit cracking was recorded in bagged fruits. However, the effect on fruit weight and TSS did not differ significantly.

Table-47: Effect of bunch bagging on fruit weight of litchi at different centres

Treatments	Fruit weight (g)							
	SAB	MFP	AMB	GAN	MED	MHP	PANT	RAN
T1 (PPW at 15 DAFS)	23.23	21.45	21.15	23.13	14.58	22.67	17.86	17.25
T2 (PPW at 25 DAFS)	21.73	23.13	21.85	22.65	15.75	23.00	21.71	19.11

Treatments	Fruit weight (g)							
	SAB	MFP	AMB	GAN	MED	MHP	PANT	RAN
T3 (PPW at 30 DAFS)	20.30	24.61	23.14	22.15	15.00	22.03	21.93	17.11
T4 (PPP at 15 DAFS)	22.07	21.30	20.36	21.50	15.38	22.20	18.56	21.04
T5 (PPP at 25 DAFS)	22.20	22.75	20.87	22.85	17.85	22.96	22.32	22.22
T6 (PPP at 30 DAFS)	23.82	23.05	22.36	25.55	17.25	22.70	23.07	19.10
T7 (Control)	20.07	19.97	19.55	-	14.40	20.90	19.22	16.59
CD at 5%	0.34	1.04	NS	0.25	-	NS	0.54	2.63

* SAB: Sabour, MFP: Muzaffarpur, AMB: Ambikapur, MED: Medziphema, GAN: Gangian, MHP: Mohanpur, PANT: Pantnagar, RAN: Ranchi

Table-48: Effect of bunch bagging on fruit cracking (%) in litchi at different centres

Treatments	MFP	AMB	GAN	MED	MHP	PANT	RAN
T1 (PPW at 15 DAFS)	2.03	2.75	3.20	1.30	0.80	3.76	7.23
T2 (PPW at 25 DAFS)	3.99	1.80	5.80	1.67	0.67	6.04	6.98
T3 (PPW at 30 DAFS)	6.37	1.05	4.10	2.00	0.93	6.77	4.06
T4 (PPP at 15 DAFS)	2.18	3.12	5.90	0.83	0.87	4.29	5.08
T5 (PPP at 25 DAFS)	4.28	2.55	4.30	2.84	0.63	5.90	6.26
T6 (PPP at 30 DAFS)	6.16	1.30	7.50	1.41	0.77	6.96	4.81
T7 (Control)	12.44	20.74	-	2.69	0.93	12.37	23.82
CD at 5%	1.07	2.27	NS	-	0.23	0.41	1.13

*MFP: Muzaffarpur, AMB: Ambikapur, MED: Medziphema, GAN: Gangian, MHP: Mohanpur, PANT: Pantnagar, RAN: Ranchi

Table-49: Effect of bunch bagging on fruit borer infestation at different centers

Treatments	SAB	MFP	AMB	GAN	MED	MHP	PANT	RAN
T1 (PPW + 15 DAFS)	0.00	0.00	0.00	0.00	0.31	4.70	0.00	1.33
T2 (PPW + 25 DAFS)	0.00	0.00	0.00	1.20	0.74	4.23	0.00	0.67
T3 (PPW + 30 DAFS)	1.70	3.13	1.22	2.70	0.51	4.63	0.00	0.33
T4 (PPP + 15 DAFS)	0.00	0.00	0.08	0.00	0.82	5.13	0.00	1.67
T5 (PPP + 25 DAFS)	0.00	0.00	2.14	0.00	1.10	3.53	0.00	1.33
T6 (PPP + 30 DAFS)	1.30	2.56	4.33	1.90	1.77	4.80	0.00	0.33
Control	8.70	26.28	21.50	-	25.53	10.50	11.02	18.72
CD at 5%	-	-	-	NS	-	2.30	-	0.75

* SAB: Sabour, MFP: Muzaffarpur, AMB: Ambikapur, MED: Medziphema, GAN: Gangian, MHP: Mohanpur, PANT: Pantnagar, RAN: Ranchi

Table-50: Effect of bunch bagging on anthocyanin content and hunter colour values of litchi at different centers

Treatments	Anthocyanin (mg/100g)						Hunter colour values				
	SAB	MFP	MED	MHP	PANT	RAN	GAN			MFP	
							L*	*a	b*	L*	*a
T1 (PPW at 15 DAFS)	23.57	34.45	14.35	23.3	23.06	65.79	41.8	24.4	19.3	35.17	20.64

Treatments	Anthocyanin (mg/100g)						Hunter colour values				
							GAN			MFP	
	SAB	MFP	MED	MHP	PANT	RAN	L*	*a	b*	L*	*a
T2 (PPW at 25 DAFS)	23.17	38.6	16.1	23.7	21.02	60.99	41.1	26.0	17.2	38.44	23.17
T3 (PPW at 30 DAFS)	22.85	39.06	10.55	22.73	25.88	68.74	37.1	23.7	14.9	42.27	24.29
T4 (PPP at 15 DAFS)	26.2	34.1	17.35	23	19.66	75.31	44.8	26.2	17.2	36.68	20.67
T5 (PPP at 25 DAFS)	23.9	35.92	21.9	23.63	23.01	74.72	46.3	24.3	20.5	40.45	22.22
T6 (PPP at 30 DAFS)	23.32	39.27	22.3	23.03	26.24	74.2	44.2	22.8	20.1	41.51	24.93
T7 (Control)	21.84	25.62	13	20.2	21.51	73.05	-	-	-	30.03	18.16
CD at 5%	2.28	2.53	-	5.98	0.62	5.87	1.8	2.17	0.23	2.87	3.12

* SAB: Sabour, MFP: Muzaffarpur, MED: Medziphema, MHP: Mohanpur, PANT: Pantnagar, RAN: Ranchi

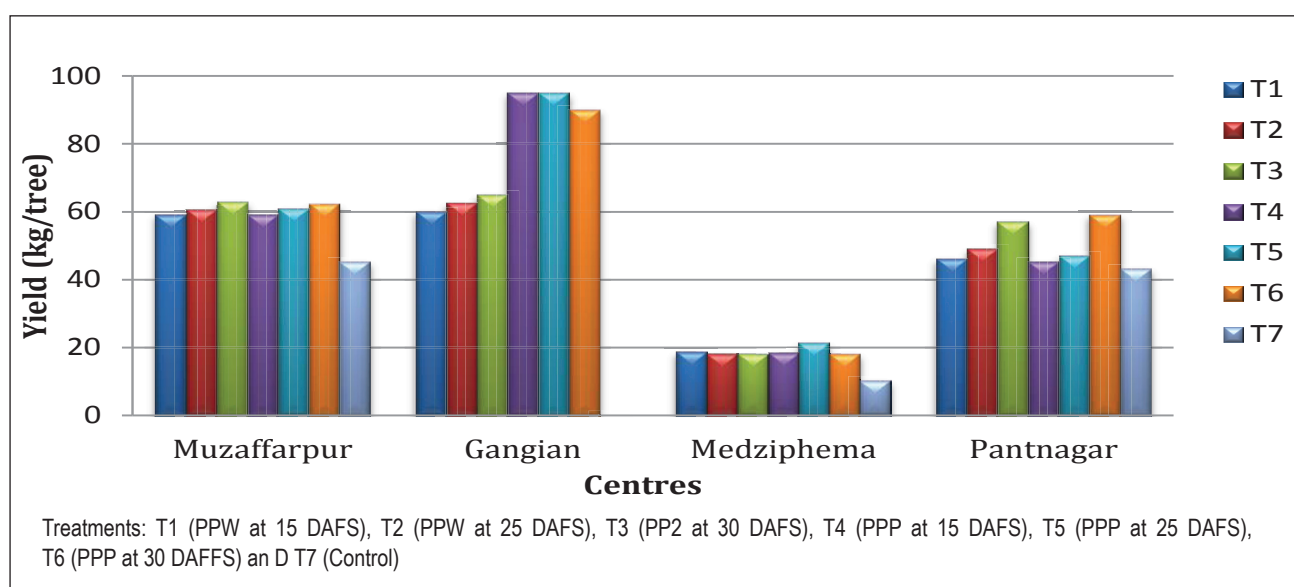


Fig. 16. Effect of bunch bagging on yield of litchi

5.3.1. L: Survey and surveillance of pest complex and their natural enemies

Weekly observations for recording the diversity and activity of litchi pollinators during flowering periods in surveyed orchards, was undertaken considering 10 panicles per tree from 5 randomly selected trees from all the directions.

Pantnagar: Fruit borer and leaf curl mite were recorded as major pests. Besides, other insects pests like leaf roller, beetles, weevils, mango mealy bug, defoliating larvae and coccids were also recorded. Among natural enemies, coccinellid beetle, spiders, lace wing, canthoconid bugs, preying mantid and ants were recorded during the period. A high population of litchi bug, *Tessartoma javanica* was also observed. However, no new insect pest was observed.

Muzaffarpur: The major pests viz., fruit and shoot borer, leaf folder, litchi looper, ash weevil, red weevil, litchi mite and bark eating caterpillar were

observed while, mango mealy bug was noted as pest of minor significance. Among natural enemies two coccinellids, one predatory bug, lace wing, *Cotesia* spp., preying mantid and spiders were recorded. However, no new emerging insect pest was recorded during the period.

Gangian (PAU): Fruit borer, *Anarsia* sp. (Lepidoptera: Gelechiidae) were reported as new insect-pests of litchi. In litchi plantations at Patiala District, a large population of Spider, *Oxyopes shwetha* Tikader was also observed.

Mohnapur: Leaf cutting weevil, *Myllocerus* sp., litchi bug, *Tessarotoma* sp., litchi looper, *Perixera* sp., was recorded as emerging pests of litchi in the region. Litchi leaf roller, *Platyepala aprobola* observed throughout the year with maximum infestation during June-September and reaching its peak during August. The peak infestation of fruit borer, *Conopomorpha cramerella* in mature fruits was observed in May. The

attack of *Conogethes punctiferalis* was also observed. Infestations of bark eating caterpillar, *Indarbela quadrinotata* and litchi eryiophid mite, *Aceria litchi* were found relatively low. Of these, leaf cutting weevil was found most prevalent followed by litchi bug, *Tessarotoma* sp. Infestation of litchi looper, *Perixera* sp. coincides with vegetative flushing stage thereby destroying the young shoots. The litchi white rust mite, *Notacaphylla chinensiae* occurs throughout the year and mostly preferred the shaded portion of the plants. The natural enemies recorded from the litchi ecosystem include spiders, reduvid bugs, dragonfly, damselfly and praying mantis.

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.

Bengaluru: New germplasm of mango was not added in the field gene bank. A total of 1382 accessions of mango are being conserved in field gene bank across 8 centres of AICRP on Fruits. Efforts have been made to eliminate the duplicates of secondary collections among the centres which suggests that a total of 475 duplicates are existing and 272 accessions/varieties are most often repeated/duplicated.

Lembucherra: During the reporting period the centre has surveyed the major mango growing areas, collected 10 local mango germplasm within Tripura and evaluated their physico-chemical parameters.

Mohanpur: Twenty-four mango germplasm were evaluated pertaining to yield and physicochemical characters. Higher yield was recorded in Naba Bhog (101.52 kg/pl) followed by Durgabhog, Khota Lagga and Sinduria.

Paria: A total of 157 mango germplasm were maintained in field. During reporting period no new promising germplasm were collected. Previously collected germplasm were planted in field for further evaluation.

Pantnagar: Maximum number of fruits per plant (140.00) and yield (28.60 kg/tree) were recorded in Lemon. The significantly higher fruit weight (575.61), fruit length (12.31 cm) pulp weight (452.07 g), peel weight (64.55 g), stone weight (58.97 g) and acidity (0.89%) were observed in cv. Sukul.

Rahuri: The maximum fruit weight (635.22 g) and pulp weight (354.28 g) was recorded in cv. Swamini. The range of stone per cent was in between 13.53 (cv. Neeleshan) and 34.13 (cv. Animadura). The TSS content was found to be ranged from 14.47°B (cv. Totapuri) to 20.54°B (cv. Dilpasand). The total sugar content was maximum (16.23%) in cv. Aalampur and minimum (9.23%) in cv. Sameer Basti. The reducing sugars were in the range of 2.07 to 7.57 per cent. The maximum reducing sugars were observed in cultivar Pairi (7.57%) and minimum in cv. Salem (2.07%). The non-reducing sugars were found maximum in cultivar Salem Badam (11.82%) and were minimum in cultivar Bombay Yellow (4.40%).

Rewa: A total of 235 accessions were collected from India and abroad are maintained. Out of 235 accessions, fifty-two accessions have been evaluated for vegetative and 32 varieties for yield parameters.

Sabour: The fruit weight was recorded maximum (621.00g) in Banglora and higher fruit yield 240.00 kg/tree) was observed in Hansraj. The TSS ranged from (13.34°B) in Barmasia- Ranchi and (26.65°B) in Chapraha.

Sangareddy: A total number of 477 mango varieties have been maintained. A total of 15 mango accessions were characterized as per the IBPGR descriptors and a total 18 mango accessions were evaluated during the reported period. A total of 435 mango accessions were characterized so far. Dashehari-35 which has recorded consistently highest yield due to its more than average size of fruit has been utilized for the commercialization in Telangana region. Among the eighteen mango accessions evaluated, maximum number of fruits per tree (290) and yield (89.9 kg/tree) was recorded in CISH M1 collected from CISH, Lucknow. Further, cumulative yields for 12 bearing years (2007-19) revealed, CISH M1 (1049.7 kg/tree) to be superior over other seventeen varieties. With regard to quality, Yerra Arati was found to record maximum fruit length (11.40 cm) and TSS (22.1°B) when compared to other varieties.

Udaipur: A total 45 secondary germplasms of mango are being maintained. During reporting period 23 germplasms were evaluated for fruiting and yield and quality attributes. Maximum yield reported in Amarpali (51.73 kg/tree) followed by Dashehari (45.47 kg/tree).

Vengurle: During reporting period, no accessions with specific traits have been found. A total 17 accessions have been evaluated. Maximum flowering percentage (62%) was recorded in 'Hybrid 352'. Mysore maharaja recorded the highest fruit weight (854.6 g) and yield (29.68 kg/tree) in Naliyaro.

The highest TSS (27.0°B) was recorded in Delicious. The maximum shelf life (13.0 days) was observed by Naliyaro and Neelum X Panchdarkalsha.

1.1.7 M. Varietal trial in mango

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 8m X 8m. 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).

Udaipur: The vegetative growth characteristics were recorded and found that maximum plant height was Langra (4.84 m) followed by Kishan Bhog (4.56 m) while minimum in Fernandin (2.90 m). Further, the maximum canopy volume was found in Langra (178.84 m³) and minimum in Suvarnrekha (2.74 m³). Among all varieties, the highest number of fruits per tree (228) was recorded in Neelum (Table 1 & 2) while, the maximum fruit yield per tree (45.47 kg/tree) was found in Dashehari. The highest content of TSS (24.10°B) with lowest acidity (0.21%) was noted in Chousa. Whereas maximum fruit weight (390 g) was found in Fazli. The maximum pulp content was found in Langra (72.00%) followed by Mallika (71.50%), while minimum peel per cent in Kesar (12.40%) and stone weight was found in Bangalora (10%).

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 IHR, Bengaluru; Suvarna (Alphonso x Neelum), Hybrid-314 (Alphonso x Neelum), Hybrid-360 (Neelum x Alphonso) from Vengurle and GMH-1 (Sonapari) from Paria.

Mohanpur: The highest fruit weight (346.33 g) was registered in H-1084 followed by H-949 (345 g).

Pantnagar: Highest yield (9.69 kg/tree and 3.87 t/ha) and TSS (19.07) was registered in hybrid H-1739 followed by H-314 (8.92 kg/tree and 3.56 t/ha) (Table 51).

Paria: The grafts of all hybrids were planted and trees are in pre-bearing stage.

Periyakulam: The highest fruit weight (320.55 g) was recorded in hybrid H-360 (320.55) followed by H-2-6 (215 g).

Ranchi: Plants are in vegetative stage.

Sabour: Maximum fruit weight was recorded in H-360 (508 g) followed by H-311 (314.33 g). However, highest TSS was observed in H-949 (23.37°B).

Sangareddy: Plants are in vegetative stage.

Neri: Trial planted during February 2020.

Malda: Trial planted during February 2020. (Plate 6)

Vengurle: The crop is in pre-bearing stage. Maximum plant height (2.90 m) were recorded in the hybrid H-1-6 followed by hybrid H-360 (2.55 m). The tree circumference was recorded maximum in the H-360 (0.30 m) followed by H-2-6 (0.28 m).

Table-51: Yield performance of F₁ hybrids at Pantnagar

Hybrids	Fruits /tree	Fruit weight (g)	Yield (kg/tree)	Yield (t/ha)	Yield efficiency (kg/m ³)	Shelf life (days)	TSS (°B)	Acidity (%)
H-949 (Amrapali x Vanraj)	16.67	215.14	3.59	1.44	0.24	11.67	15.13	0.16
H-1084 (Amrapali x Janardan Pasand)	27.33	176.20	4.83	1.93	0.38	12.33	11.47	0.83
H-1739 (Neelum x Tommy Atkins)	33.33	268.32	9.69	3.87	0.42	16.00	19.07	0.82
Pusa Pratibha [H-1-1 (Amrapali x Sensation)]	9.67	157.20	1.52	0.61	0.48	12.67	18.87	0.14
Pusa Shreshta [H-1-6 (Amrapali x Sensation)]	9.67	161.97	1.56	0.62	0.13	15.67	14.00	0.21

Hybrids	Fruits /tree	Fruit weight (g)	Yield (kg/ tree)	Yield (t/ha)	Yield efficiency (kg/m ³)	Shelf life (days)	TSS (°B)	Acidity (%)
Pusa Pitambar [H-2-6 (Amrapali x Lal Sundari)]	40.33	167.80	6.77	2.70	0.44	15.67	18.67	0.16
Arka Udaya [Hybrid-12 (Amrapali x Arka Anmol)]	15.33	189.53	2.95	1.17	0.69	19.33	13.90	0.36
Suvarna [Hybrid-311 (Alphonso x Neelum)]	23.33	175.03	4.16	1.66	0.78	9.67	15.97	0.19
Hybrid-314 (Alphonso x Neelum)	52.67	166.97	8.92	3.56	0.70	12.00	17.40	0.10
Hybrid-360 (Neelum x Alphonso)	3.00	1059.00	3.11	1.24	0.66	13.67	19.53	0.25
Sonpari (GMH-1)	3.00	138.30	0.35	0.14	0.21	11.67	15.23	0.13
Dashehari	34.00	153.56	5.07	2.02	0.13	10.33	18.67	0.10
Langra	12.33	247.78	3.09	1.24	0.77	8.00	18.07	0.15
CD at 5%	10.42	79.11	3.80	1.52	0.52	2.23	1.41	1.13



Lucknow



Mohanpur



New Delhi



Paria



Sangareddy



Vengurle

Plate 6: Improvement of mango through half-sibs

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.

Lucknow: Five hundred half-sibs seedling population of Ambika (Amrapali x Janardhan Pasand) and Arunika (Amrapali x Vanraj) is established in the field and population is still in juvenile phase.

Malda: Two fifty half sib of Ambika and Arunika variety have been planted in the field during the September, 2019.

Mohanpur: Five hundred seedling progenies of Amrapali have been established in the field with the spacing of 2m X 2m since 2014-15 and are in vegetative stage.

New Delhi: Among Amrapali half-sibs planted in 2016, twenty-eight plants showed precocious flowering. Maximum number of panicles (21) and number of fruits (45) was recorded in plant No. 47 in first row. Physico-chemical analysis of fruits from 25 half-sibs revealed that fruit weight ranged from 65 to 212 g. Pulp content ranged 54 to 65 per cent. Fruit peel firmness ranged from 622 to 1036 g/cm² and pulp firmness ranged between 113 to 601 g/cm². TSS ranged between 18.9 to 23.8°B. Pulp β-carotene ranged between 4721 to 10326 µg/100 g pulp.

Paria: 500 seedlings from the stones of Sonpari were raised, which are in vegetative stage.

Sangareddy: Five hundred seedlings of KMH-1 were raised in the nursery and planted in the field. The plants are in juvenile stage.

Vengurle: Sixty-five seedlings from Ratna were raised and planted in the field during 2017-18. Hundred

seedlings of Ratna were raised in the nursery but due to excessive rainfall only 15 seedlings survived which were planted in field for further evaluation. All the plants are in juvenile stage.

1.1.14 M. Scion breeding in mango

Cross combination of Amrapali with Vanraj were attempted to develop F₁ progenies.

Bengaluru: A total of 7605 flowers from 1428 panicles of Amrapali were crossed with pollens of Vanraj and raised 29 F₁ progenies.

Sabour: A total of 2000 crosses were made. But due to the incidence of hailstorm during marble stage the generated crosses could not be saved.

Vengurle: During the period 28th January to 20th February 2019 a total of 2007 crosses have been made. Among these 20 seedlings have been evolved.

1.1.15 M. Root stock breeding in mango

Cross combination of Olour with Turpentine and Turpentine with Vellaikolumban were attempted to increase the variability in rootstocks.

Bengaluru: A total of 4210 flowers of Vellaikolumban were crossed with Turpentine and 440 flowers of Olour were crossed with Turpentine. Raised 46 F₁ progenies from both the combination.

Vengurle: Trees were not flowered. The flowering of germplasm varieties has not recorded till December (for the year 2019) due to extended rain fall up to 1st week of November 2019.

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 with pH 8.67 was selected and Bappakai, Kurukkan, Terpentine and 13-1 seedlings were used as rootstocks. Grafted plants were planted and data has to be collected.

Imphal: Trial is yet to be initiated due to non-availability of rootstock.

Paria: The rootstocks were grafted with Kesar scion and the grafts were planted in the field. The plants are in vegetative stage.

Periyakulam: The crop is in vegetative stage (2 years 4 months) in saline soli and morphological parameters observations is in progress. The treatment R_3V_1 (Neelum on 13-1) recorded maximum plant height 4.32 m followed by R_4V_1 (Neelum on Terpentine).

Sangareddy: The site with problematic soils has been identified at Ibrahimpatnam. The rootstock has been procured. The plantation has been done during 2019.

Udaipur: The trial is laid out with five rootstock viz., 13/1, Kurkan, Bappakai, Terpentine, and open pollinated own seedling root stock (check) and scion of variety Amrapali has been used for grafting during September month of last year. Some of graft union established well after grafting in last year but mostly graft union failed to join properly and scion become dried later-on hence this year recently such rootstocks are grafted again with scion of Amrapali.

3.1.1.a M. Evaluation of substrate dynamics for IPNM in mango

To study the influence of varius 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 (Table-52).

Rewa: Application of half of the RD along with 50 kg FYM and 250 g *Trichoderma* was effective in getting higher fruit yield (65.72 kg/tree) which was on par with application of 250 g of *Azotobacter* along with 50 kg FYM and half dose of RD (yield 50.04 kg/ tree) when compare to control (30.04 kg /ha) (Fig. 17 & 18)

Mohanpur: Application of half of the RD along with 50 kg FYM and 250 g *Azospirillum* has recorded maximum fruit yield (626 fruits / tree and 187.76 kg/tree). The same treatment has given highest shelf life of 11.3 days and TSS of 190B which was correlated with high soil and leaf K content (198.33 kg/ha & 0.95%).

Sabour: Application of half of the RD along with 50 kg FYM and 250 g *Psuedomonas floescence* has recorded maximum yield (279.82 kg/tree).

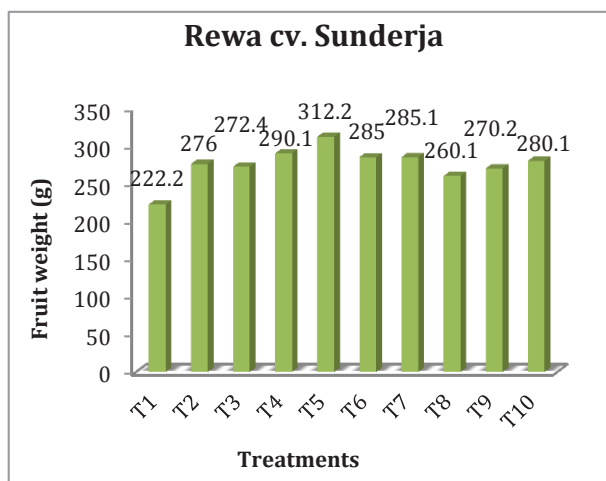
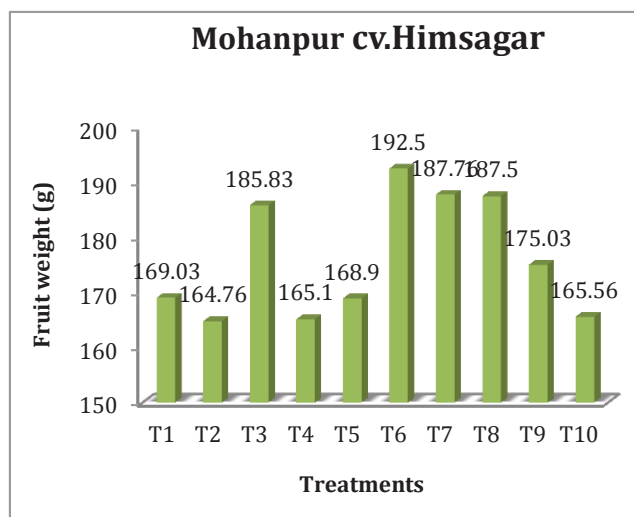
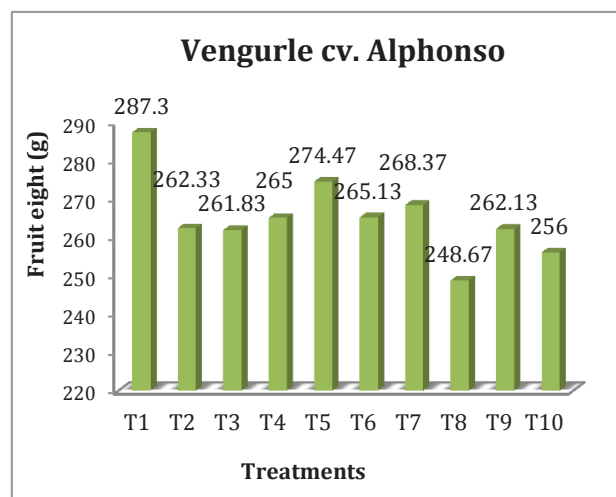
Sangreddy: Application of 250 g of *Azotobacter* along with 50 kg FYM and half dose of RDF resulted in higher fruit yeild (190 fruits / tree and 79.8 kg/tree) and cost benefit ratio (6.65) with maximum shelf life (14.33 days) when compare to control (42.24 kg/ tree; 132 fruits /tree & 10.33 days)

Vengurle: Application of 1000:1000:1000g of N, P_2O_5 , K_2O / tree + Zn (0.5%) + B (0.2%) + Mn (1%) + Ca (0.6%) as 2 foliar application (August & October) + Organic mulching 10cm thick resulted in getting higher yield (40.44 kg/tree) and TSS (18.50B) when compare to control (30.53 kg/tree & 17.90°B).

Table-52: Effect of various substrate dynamics treatments on fruit yield (kg/tree) of mango

Treatments	Sangareddy	Vengurle	Mohanpur	Sabour	Rewa
T ₁	42.24 ^c	30.53 ^b	169.03 ^c	268.75 ^b	30.04 ^b
T ₂	43.71 ^c	30.25 ^b	164.76 ^c	203.44 ^e	46.98 ^b
T ₃	46.25 ^a	26.54 ^c	185.83 ^a	216.67 ^d	57.86 ^a
T ₄	51.48 ^a	40.44 ^a	165.10 ^c	179.91 ^f	49.67 ^a
T ₅	48.64 ^a	31.19 ^b	168.90 ^c	179.32 ^f	65.72 ^a
T ₆	59.25 ^b	26.77 ^c	192.50 ^a	240.40 ^c	59.99 ^a
T ₇	79.8 ^a	26.42 ^c	187.76 ^a	219.93 ^d	50.04 ^a
T ₈	52.2 ^a	25.88 ^c	187.50 ^a	113.26 ^g	48.17 ^a
T ₉	48.65 ^a	33.12 ^b	175.03 ^b	279.82 ^a	46.15 ^a
T ₁₀	43.86 ^c	33.66 ^b	165.56 ^c	163.19 ^g	52.07 ^a
CD at 5%	13.01	4.06	7.71	7.35	17.26

Treatments	Sangareddy	Vengurle	Mohanpur	Sabour	Rewa
Sangareddy cv. Banganpalli, Vengurle cv. Alphonso, Mohanpur cv. Himsagar, Sabour cv. Langra, Rewa cv. Sunderja					
# T ₁ : 1000:1000:1000 g of N, P ₂ O ₅ , K ₂ O 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 10 cm thick; T ₅ : ½ RDF + 50 kg FYM + 250 g <i>Trichoderma</i> ; T ₆ : ½ RDF + 50 kg FYM + 250 g <i>Azospirillum</i> ; T ₇ : ½ RDF + 50 kg FYM + 250 g <i>Azotobacter</i> ; T ₈ : ½ RDF + 50 kg FYM + 5 kg vermicompost; T ₉ : ½ RDF + 50 kg FYM + 250 g <i>Pseudomonas florescence</i> ; T ₁₀ : ½ RDF + 50 kg FYM + 250 g <i>Trichoderma</i> + 250 g <i>Pseudomonas florescence</i>					



Treatment details:

T₁ : 1000:1000:1000 g of N, P₂O₅, K₂O per tree (control)

T₂ : T₁ + Zn (0.5%) + B (0.2%) + Mn (1 %) + Ca (0.6%) as 2 foliar applications in August and in October

T₃ : T₁ + Organic mulching 10 cm thick

T₄ : T₂ + Organic mulching 10 cm thick

T₅ : ½ RDF + 50 kg FYM + 250 g *Trichoderma*

T₆ : ½ RDF + 50 kg FYM + 250 g *Azospirillum*

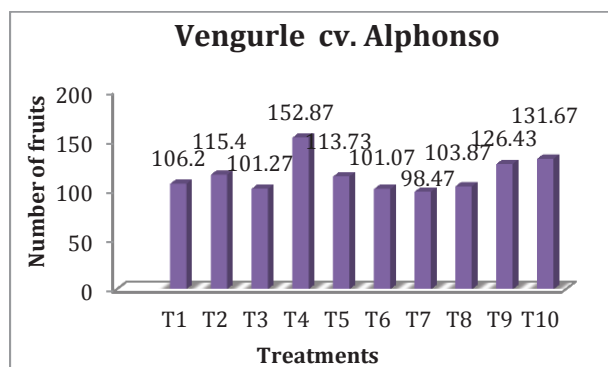
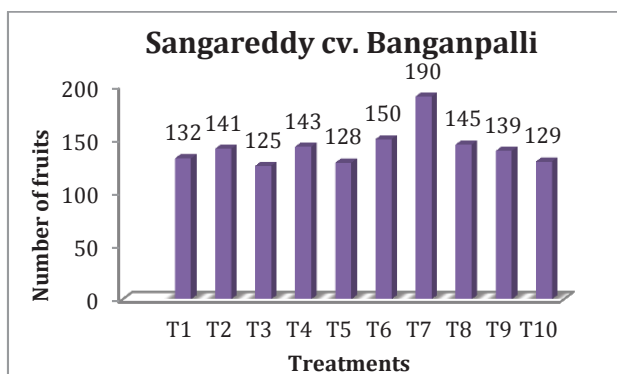
T₇ : ½ RDF + 50 kg FYM + 250 g *Azotobacter*

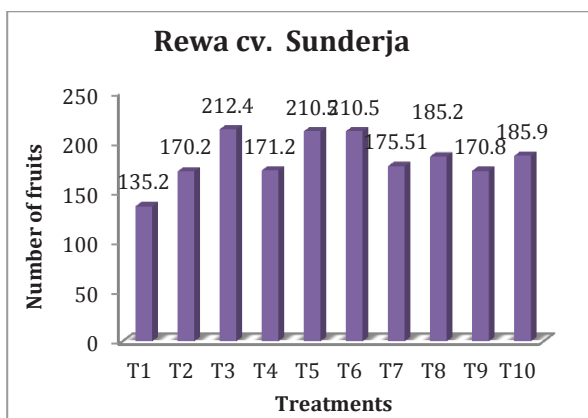
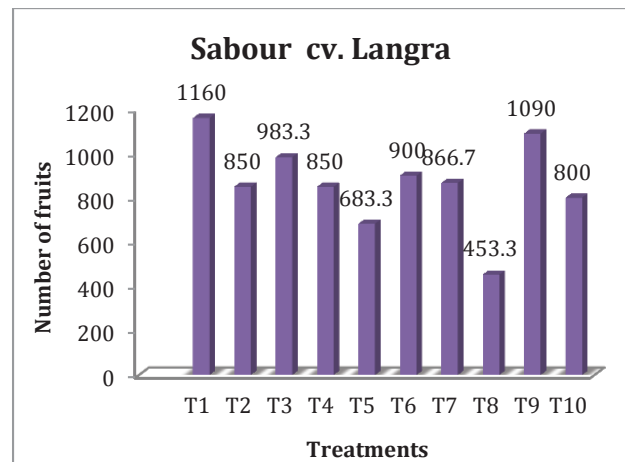
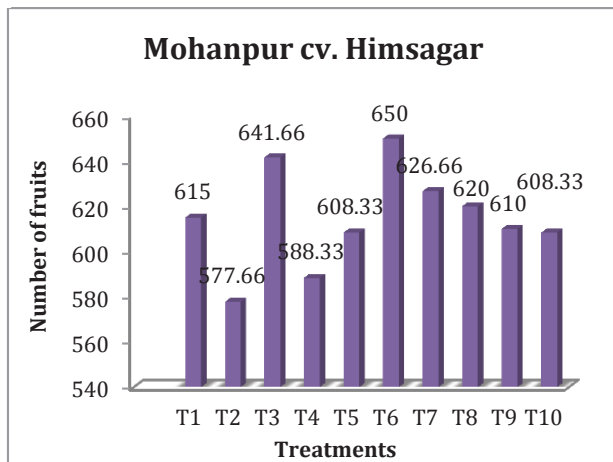
T₈ : ½ RDF + 50 kg FYM + 5 kg vermicompost

T₉ : ½ RDF + 50 kg FYM + 250 g *Pseudomonas florescence*;

T₁₀ : ½ RDF + 50 kg FYM + 250 g *Trichoderma* + 250 g *Pseudomonas florescence*

Fig. 17: Effect of various substrate dynamics treatments on fruit weight (g) of mango





Treatment details:

T₁ : 1000:1000:1000g N, P₂O₅, K₂O/tree (control)

T₂ : T₁ + Zn (0.5%) + B (0.2%) + Mn (1%) + Ca (0.6%) as foliar application (August & October)

T₃ : T₁ + Organic mulching 10 cm thick

T₄ : T₂ + Organic mulching 10 cm thick

T₅ : ½ RDF + 50kg FYM + 250g *Trichoderma*

T₆ : ½ RDF + 50 kg FYM + 250 g *Azospirillum*

T₇ : ½ RDF + 50 kg FYM +250g *Azotobacter*

T₈ : ½ RDF + 50 kg FYM + 5 kg Vermicompost

T₉ : ½ RDF + 50 kg FYM + 250 g *Pseudomonas*

T₁₀ : ½ RDF + 50 kg FYM + 250g *Trichoderma* + 250 g *Pseudomonas florescence*.

Fig. 18: Effect of various substrate dynamics treatments on number of fruits per tree 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.

Imphal: The yield potential of high yielding orchards was 10.43 tonnes per hectare when compared to 7.43 tonnes per hectare in low yielding orchards of cv. Alphonso. The high yielding orchards recorded highest N (1.46%), K (0.61%), Fe (93.91%), Mn (33.9%), Zn (17%) and Cu (14.4%) content compared to low and medium yielding orchards thus indicating nitrogen, potassium, iron, manganese, zinc and copper are the limiting factor for yield in mango cv. Alphonso.

Sangareddy: The mean yield of high yielding orchard of cv. Banganpalli was recorded as 13.05

tonnes per hectare when compared with low yielding orchard of 3.97 tonnes per hectare. Further, high yielding orchards have highest leaf N (1.13%) and K (0.69%) and other micronutrient Fe (109.4 ppm) and Zn (78.3%) compared to low yielding orchards (N-0.87%, K-0.41% and Fe-72.8 ppm, Zn-45.1 ppm).

Vengurle: High yielding orchard of cv. Alphonso recorded 6.34 tonnes per hectare yield compared to low yielding orchard of 4.08 tonnes per hectare (Table 54).

Periyakulam: High yielding orchard of cv. Neelum recorded 7.44 tonnes per hectare compare to low yielding orchard of 3.92 tonnes per hectare. Further, high yielding orchard have higher leaf N (2.03%), K (1.03%) and other micronutrient Fe (104.9 ppm), Zn (42.23 ppm) respectively when compared to low yielding orchard (N-1.53 %, K-1.03 % and Fe-104.99 ppm, Zn-42.23 ppm) indicating nitrogen, potassium, Fe and Zn are the limiting factors for the yield in mango cv Neelum (Table 53).

Table- 53: Fruit yield and quality, soil physicochemical properties and leaf nutrient content of low, medium and high yielding orchard of mango

Parameter	Sangareddy cv. Banganpalli			Periyakulam cv. Neelum		
	Low	Medium	High	Low	Medium	High
Yield (kg/tree)	15.91	32.9	52.2	40.4	50.21	67.58
Yield (t/ha)	3.97	8.25	13.05	3.92	5.82	7.44
Fruit weight (g)	333	359	378	318	324.00	332.00
TSS (°B)	19.0	19.5	20.5	17.01	16.80	16.25
Acidity (%)	0.23	0.31	0.31	0.22	0.27	0.27
Soil physico-chemical properties						
pH	6.50	6.50	7.00	6.81	7.00	7.25
N (kg/ha)	290	320	386	160.00	170.00	182.00
P (kg/ha)	34.11	37	35.5	28.44	31.85	30.26
K (kg/ha)	319	453	480	167.21	188.09	208.62
Fe (ppm)	5.76	6.64	9.72	6.20	7.13	9.20
Mn (ppm)	8.87	12.35	13.8	10.12	12.07	12.61
Zn (ppm)	0.7	1.68	1.72	0.90	1.28	1.62
Cu (ppm)	1.72	1.93	1.71	2.85	2.30	2.42
Leaf nutrient content						
N (%)	0.87	0.91	1.13	1.53	1.62	2.03
P (%)	0.15	0.16	0.19	0.14	0.15	0.15
K (%)	0.41	0.58	0.69	0.62	0.87	1.03
Fe (ppm)	72.8	74.7	109.4	70.50	71.91	104.99
Mn (ppm)	46.0	51.0	87.2	50.44	65.48	68.32
Zn (ppm)	45.1	47.0	78.4	30.55	31.47	42.23
Cu (ppm)	20.0	23.1	38.2	19.11	21.98	22.08

A total of 10 orchards in each category were surveyed and each data point is the mean of 10 orchards

Table-54: Fruit yield and quality, soil physicochemical properties and leaf nutrient content of low, medium and high yielding orchard of mango

Parameter	Vengurle cv. Alphonso			Imphal cv. Alphonso		
	Low	Medium	High	Low	Medium	High
Yield (kg/tree)	40.8	50.6	63.4	36.9	43.42	52.31
Yield (t/ha)	4.08	5.06	6.34	7.43	8.75	10.43
Fruit weight (g)	248	250	259	310	340	398
TSS (°B)	17.3	16.99	17.13	12.95	12.62	13.3
Acidity (%)	0.20	0.20	0.20	0.40	0.35	0.36
Pulp content (g)	162	163.85	165.25	-	-	-
Soil physico-chemical properties						
pH	5.56	5.32	5.33	5.42	5.37	5.46
N (kg/ha)	273.72	250.5	276.8	305.8	345.92	354.88
P (kg/ha)	12.99	11.85	9.14	16.61	31.72	18.57
K (kg/ha)	482.9	464.3	431.19	236.7	232.6	264.01
Fe (ppm)	66.97	68.72	74.01	103.3	123.6	135.9
Mn (ppm)	9.96	10.66	9.95	45.11	43.58	37.88
Zn (ppm)	1.12	1.17	1.07	1.84	1.05	4.88
Cu (ppm)	3.87	4.02	4.0	0.46	1.00	1.14
Leaf nutrient content						
N (%)	2.12	1.75	1.96	1.12	1.31	1.46
P (%)	0.106	0.09	0.09	0.14	0.16	0.18
K (%)	1.475	1.58	1.44	0.57	0.60	0.61
Fe (ppm)	65.6	74.74	61.4	74.98	88.6	93.91
Mn (ppm)	108.6	123.04	101.0	24.5	30.7	33.9
Zn (ppm)	10.81	10.69	9.23	11.68	14.6	17.0
Cu (ppm)	17.61	19.67	15.35	9.78	11.3	14.4

A total of 10 orchards in each category were surveyed and each data point is the mean of 10 orchards.

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.

Lucknow: Application of vermicompost (50 kg/tree) + *Azospirillum* culture @ 250 g/tree + PSB @ 50 g/tree + vermiwash (T₇) had significantly increased the yield (493 fruits/tree & 146.22 kg/tree).

Paria: Application of vermicompost (50 kg/tree) + *Azospirillum* culture @250 g/tree + PSB @ 50 g/tree + vermiwash (T₇) had significantly produced higher yield (54.51 kg/tree).

Rahuri: Application of vermicompost (50 kg/tree) + *Azospirillum* culture @250 g/tree + PSB @250 g/tree (T₅) had significantly increased the yield (305 fruits/

tree & 66.36 kg/tree).

Sabour: Application of vermicompost (50 kg/tree) + *Azospirillum* culture @250 g/tree + PSB @ 50 g/tree + vermiwash (T₇) had significantly resulted in increased the yield (236.59 kg/tree) (Fig 20).

Sangareddy: Application of vermicompost (50 kg/tree) + *Azospirillum* culture @250 g/tree + PSB @250 g/tree (T₅) had significantly increased the yield (176 fruits/tree & 68.74 kg/tree). The same treatment has increased the quality (TSS 20.3°B) with a cost benefit ratio of 2.82 (Table 55) (Fig 19).

Vengurle: Application of FYM (50 kg/tree) + *Azospirillum* culture @250 g/tree + PSB @250 g/tree (T₂) has increased the yield (26 fruit/tree and 8.05 kg/tree) and is correlated with increased *Azospirillum* population (33.33 X 10⁻⁶ CFU/g).

Table-55: Effect of various organic source of nutrients on yield (kg/tree) of mango

Treatments	Sangareddy Banganpalli	Vengurle Alphonso	Paria Kesar	Sabour Langra	Rahuri Kesar	Lucknow Dashehari
T ₁	41.67 ^c	6.30 ^b	38.72 ^c	102.22 ^c	55.65 ^b	84.95 ^b
T ₂	59.55 ^b	8.05 ^a	43.12 ^b	238.23 ^a	56.98 ^b	69.83 ^b
T ₃	54.86 ^b	5.03 ^a	39.85 ^c	89.09 ^c	60.78 ^b	86.03 ^b
T ₄	45.5 ^c	3.79 ^d	38.40 ^c	95.64 ^c	56.73 ^b	65.75 ^b
T ₅	68.74 ^a	3.97 ^c	48.28 ^b	101.96 ^c	66.36 ^a	64.62 ^b
T ₆	59.49 ^b	4.26 ^c	44.54 ^b	140.76 ^b	69.32 ^a	100.55 ^a
T ₇	43.78 ^c	5.44 ^c	54.51 ^a	236.59 ^a	78.88 ^a	146.22 ^a
CD at 5%	8.35	1.69	4.91	14.71	16.03	46.74

Treatment details: T₁: FYM (50 kg/tree); T₂: FYM (50 kg/tree) + *Azospirillum* culture @ 250 g/tree + PSB @250 g/tree; T₃: FYM (50 kg/tree) + *Azotobacter* @ 250 g/tree + PSB @ 250 g/tree; T₄: Vermicompost (50 kg/tree); T₅: Vermicompost (50 kg/tree) + *Azospirillum* culture @ 250 g/tree + PSB @250 g/tree; T₆: Vermicompost (50 kg/tree) + *Azotobacter* @ 250 g/tree + PSB @250 g/tree; T₇: Vermicompost (50 kg/tree) + *Azospirillum* culture @250 g/tree + PSB @50 g/tree + vermiwash

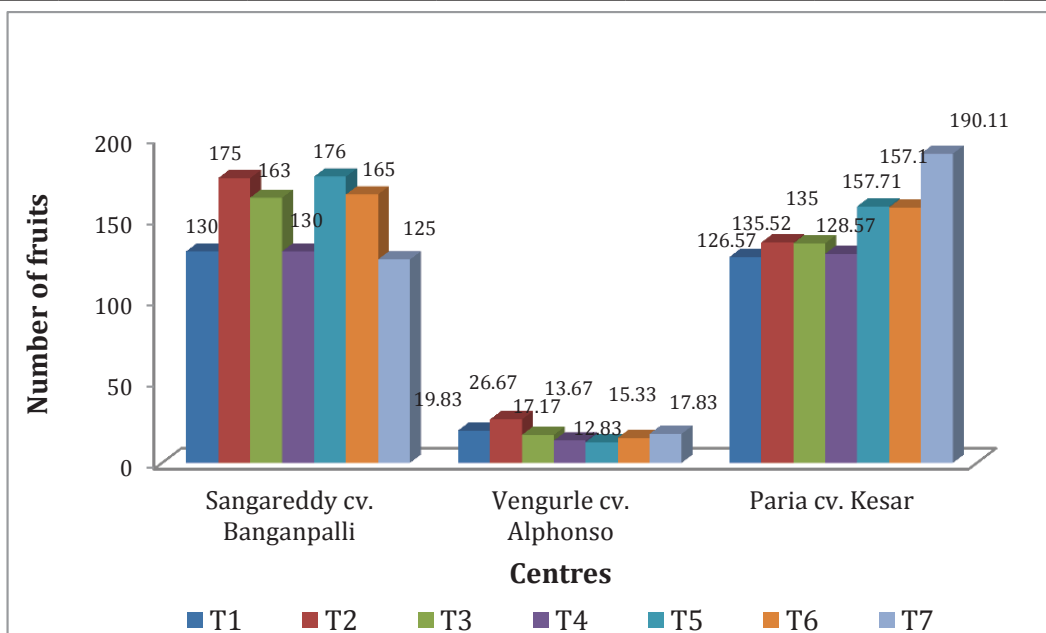


Fig 19: Effect of various organic package of practices on number of fruits of mango at different centre

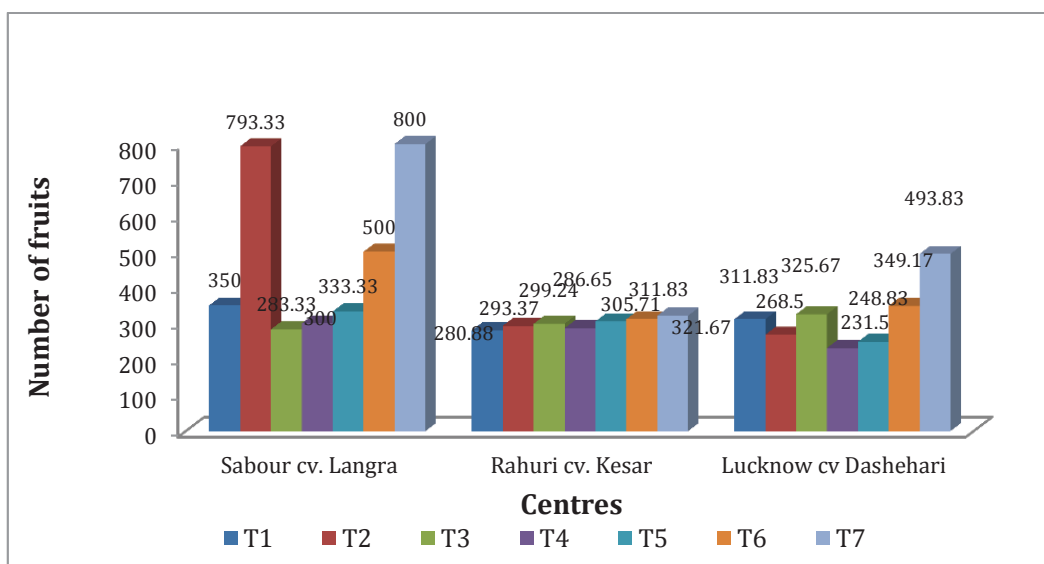


Fig 20: Effect of various organic package of practices on number of fruits of mango at different centre

3.1.5 M. Fertilizer scheduling for high density planting in mango

The experiment was laid out in RBD with two varieties and different levels of nutrients of the recommended dose of fertilizers viz., 120:75:100 g N:P₂O₅:K₂O per tree per year. Drip irrigation was installed on 100% pan evaporation and scheduled with 70% pan evaporation scheduling, which was split into 6 doses and applied at weekly intervals at four different stages of plant growth.

Lucknow: The yield parameters revealed that application of 90 per cent RDF through fertigation in var. Dashehari recorded the highest yield (8.57 kg/tree and 3.43 t/ha) and fruit weight (210.36 g). However, the highest TSS content (21.75°B) with less acidity (0.18%) was registered in the same treatment.

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. (Plate 7).

Pantnagar: The result revealed that maximum fruits per tree (84) and yield (10.85 kg/tree) was recorded in plants supplied with 70 per cent RDF through fertigation. However, application of 80 per cent RDF with fertigation recorded maximum TSS content (19.93°B).

Mohanpur: Plants are in vegetative stage.

Paria: Plants are in vegetative stage.

Periyakulam: Plants are in vegetative stage.

Rewa: Plants are in vegetative stage.

Sabour: Plants are in vegetative stage.

Sangareddy: Plants are in vegetative stage.

Udaipur: Plants are in vegetative stage.

Vengurle: Plants are in vegetative stage.

Anantharajupet: Application of RDF + 100 g Zinc sulphate + 50 g Copper sulphate + 50 g Borax (Soil application) in basin after harvest + Foliar spray of 0.2% Zinc sulphate + 0.1% Copper sulphate + 0.1% Boric acid (two sprays at just before flowering and again at marble stage) recorded higher flowering intensity (58.54%) and fruit yield (6.23 t/ha) when compared to control (50.58% & 4.31 t/ha) (Table 56 & 57). While, maximum shelf life (12.36 days) was noted in application of RDF + Mango special (IIHR) at 5g/l (2 months before flowering and again when the fruits are of 2-4 cm diameter stage) it was 9.2 days in control (Fig 21).

Bhubaneswar: No data recorded due to Fani cyclone.

Lucknow: The significantly higher flowering intensity (45.42%) and fruit yield (9.30 t/ha) was registered in the plants supplied with 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 (two sprays at just before flowering and again at marble stage)] as compared to control (30.72% & 4.99 t/ha).

Mohanpur: Application of RDF + 100 g Zinc sulphate + 50 g Copper sulphate + 50 g Borax (Soil application) in basin after harvest + Foliar spray of 0.2% Zinc sulphate + 0.1% Copper sulphate + 0.1% Boric acid (two sprays at just before flowering and again at marble stage) recorded significantly higher fruit yield (25.70 t/ha) when compared to control (23.28 t/ha). Maximum shelf life (11.70 days) was observed in application of RDF + Foliar spray of 0.2% Zinc sulphate + Copper sulphate (0.1%) + Boric acid (0.1%) [2 sprays at just before flowering and marble stage)].

Pantnagar: Application of RDF + 100 g Zinc sulphate + 50 g Copper sulphate + 50 g Borax (Soil application) in basin after harvest + Foliar spray of 0.2% Zinc sulphate + 0.1% Copper sulphate + 0.1% Boric acid (two sprays at just before flowering and again at marble stage)] recorded significantly maximum flowering intensity (63.44%) and fruit yield (13.51 t/ha) when as compared to control (58.75% & 7.17 t/ha). Availability of phosphorus (80.61 kg/ha & 0.18%), zinc (0.86 & 73.58 ppm), copper (3.82 & 59.17 ppm) in both soil and leaf recorded maximum in the same treatment (Fig 22-25). While maximum shelf life (14.33 days) was registered in application of RDF + Foliar spray of 0.2% Zinc sulphate + Boric acid (0.1%) [2 sprays at just before flowering and marble stage) shown in fig 21.

Paria: Application of RDF + 100 g Zinc sulphate + 50 g Copper sulphate + 50 g Borax (Soil application) in basin after harvest + Foliar spray of 0.2% Zinc sulphate + 0.1% Copper sulphate + 0.1% Boric acid (two sprays at just before flowering and again at marble stage) recorded maximum fruit yield (7.22 t/ha) and shelf life (12.67 days) when compared to control (3.45 t/ha).

Periyakulam: Application of RDF + 100 g Zinc sulphate + 50 g copper sulphate + 50 g Borax (Soil application) in basin after harvest + Foliar spray of 0.2% Zinc sulphate + 0.1% Copper sulphate + 0.1% Boric acid (two sprays at just before flowering and again at marble stage) recorded significantly higher fruit yield (8.32 t/ha) and shelf life (12.52 days) as

compared to control (fruit yield- 3.90 t/ha and shelf life- 7.10 days, respectively). However, the same treatment recorded the maximum availability of N (146 kg/ha & 1.82%), P_2O_5 (32.42 kg/ha & 1.32%) and K_2O (1.32 kg/ha & 370%) content in both soil and leaf (Fig. 29-32).

Rewa: The 2019 was the off season

Sabour: The maximum fruit yield (254.80 kg/tree) was recorded in the plants supplied with RDF + Foliar spray of 0.2% Zinc sulphate + Copper sulphate (0.1%) + Boric acid (0.1%) (two sprays at just before flowering and again at marble stage)] as compared control (241.57 kg/tree).

Sangareddy: The fruit yield (11.81 t/ha) was observed significantly maximum in the plants supplied with RDF + Mango special (IIHR) at 5g/l (2 sprays at 2 months before flowering & fruits of 2-4cm diameter stag) as compared to control (9.15 t/ha).

Udaipur: Application of RDF + 100 g Zinc sulphate + 50 g Copper sulphate + 50 g Borax (Soil application) in basin after harvest + Foliar spray of 0.2% Zinc sulphate + 0.1% Copper sulphate + 0.1% Boric acid (two sprays at just before flowering and again at marble stage) were observed significantly higher flowering intensity (68%), fruit yield (13.90 t/ha) and shelf life (8.33 days) as compared to control (55.50% & 7.80 t/ha). However, the maximum availability of N (162.75 kg/ha & 1.38%), P_2O_5 (22.51 kg/ha & 0.18%), K_2O (248.80 kg/ha & 0.95%), Zn (0.55 ppm & 16ppm), Fe (3.57 ppm & 86 ppm) and Mn (2.78 ppm & 45 ppm) in both soil and leaf was recorded in the same treatment (Fig 26-29).

Vengurle: The fruit yield (2.03 t/ha) and shelf life (16.83 days) was found significantly maximum in the plants supplied with RDF + Foliar spray of 0.2% Zinc sulphate + Copper sulphate (0.1%) + Boric acid (0.1%) [2 spray at just before flowering and marble stage] as compared to control (1.55 t/ha).

On the basis of results obtained during the year 2018-19 at various centre, it may be concluded that 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, two sprays at just before flowering and marble stage)] has been found most effective to increase the yield without impairing the quality of mango fruits.


 Best treatment (T₇)

 Control (RDF) T₁
Plate7: Effect of micronutrient on flowering and yield of mango
Table-56: Effect of micronutrients on flowering intensity in different cultivars of mango at various centres

Treatments	PNT	VNG	PRI	LKO	ANP	PKM	SNG	UDP
	Flowering intensity (%)							
T ₁	58.75	67.33	54.00	30.72	50.58	43.52	58.3	55.50
T ₂	58.64	56.00	54.67	28.75	51.69	41.28	53.6	56.75
T ₃	60.53	70.67	56.11	32.54	52.46	43.50	58.0	65.00
T ₄	60.06	57.00	56.36	36.12	54.01	55.12	60.0	64.20
T ₅	59.34	76.17	53.07	35.24	54.36	51.54	65.2	65.75
T ₆	62.14	59.17	54.03	38.18	55.48	60.82	59.6	64.00
T ₇	63.44	63.33	58.07	45.42	58.54	70.82	59.3	68.00
T ₈	51.97	62.33	56.98	31.45	57.63	59.48	59.3	60.50
CD at 5%	2.29	NS	NS	8.01	4.04	-	NS	8.03

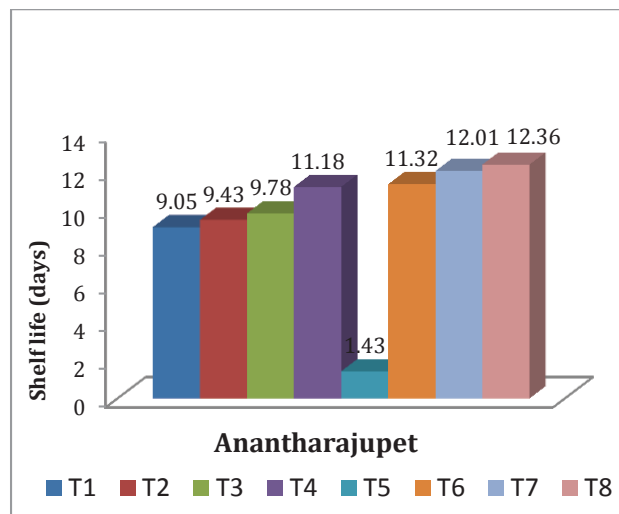
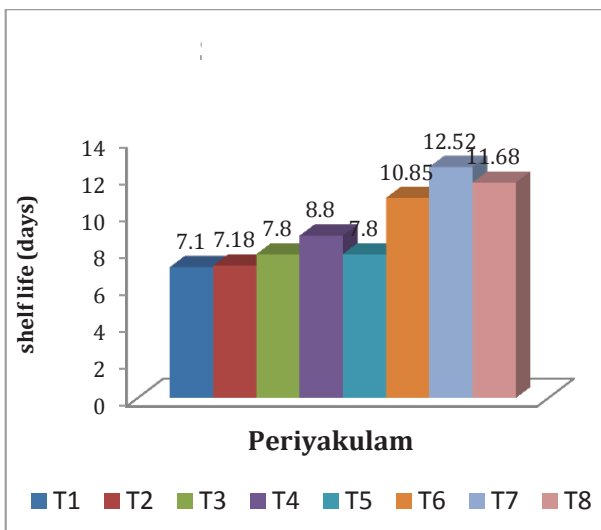
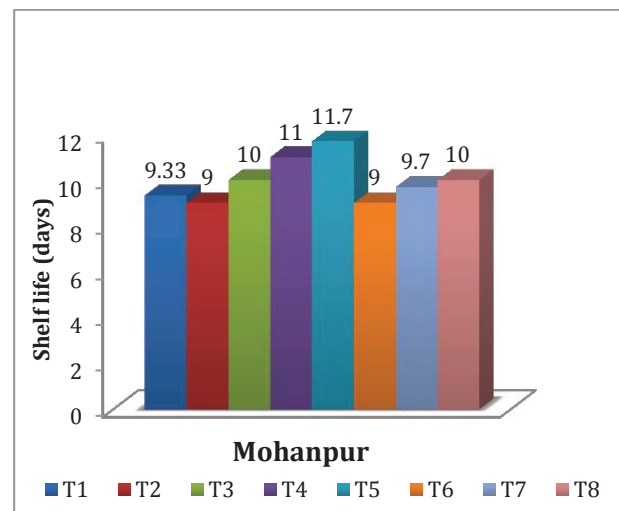
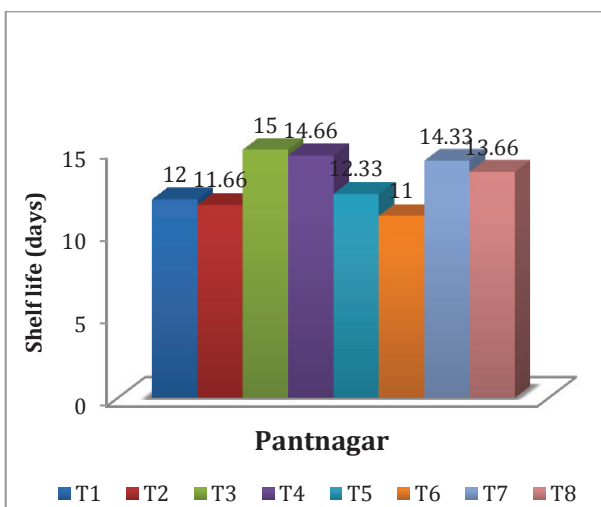
PNT– Pantnagar (Dashehari), VNG–Vengurle (Alphonso), PRI– Paria (Kesar), LKO– Lucknow (Dashehari), ANP– Anantharajupet (Baneshan), PKM– Periyakulam (Imam pasand), SNG–Sangareddy (Banganpalli) and UDP–Udaipur (Dashehari),

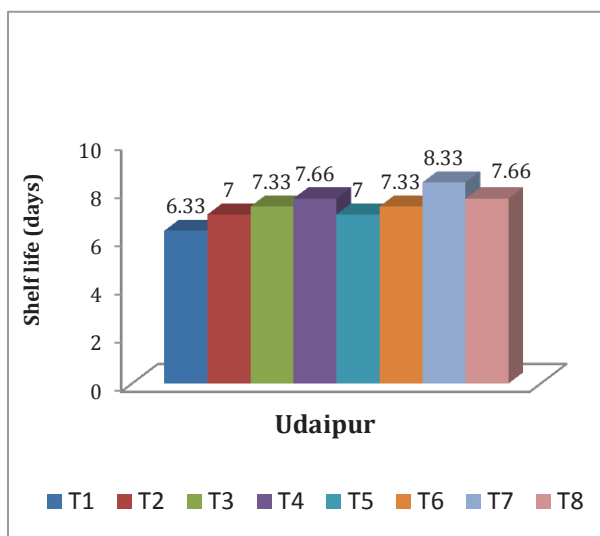
Treatment details: T₁ - Control as per RDF (Region specific) in basin after harvest; T₂ - RDF + 200 g ZnSO₄+ 100 g Borax (Soil application) in basin after harvest; T₃ - RDF + 200 g ZnSO₄+ 100 g CuSO₄+ 100 g H₃BO₃ (Soil application) in basin after harvest; T₄ - RDF + Foliar spray of 0.2% ZnSO₄ + H₃BO₃ (0.1%) [2 sprays at just before flowering and marble stage]; T₅ - RDF + Foliar spray of 0.2% ZnSO₄+ CuSO₄ (0.1%) + H₃BO₃ (0.1%) [2 sprays at just before flowering and marble stage]; T₆ - RDF + 100 g ZnSO₄+ 50 g CuSO₄+ 50 g H₃BO₃ (soil application) in basin after harvest + Foliar spray of 0.2 % ZnSO₄+ 0.1% H₃BO₃ (2 sprays at just before flowering and marble stage), T₇ - RDF + 100 g ZnSO₄+ 50 g CuSO₄+ 50 g H₃BO₃ (Soil application) in basin after harvest + Foliar spray of 0.2% ZnSO₄+ 0.1% CuSO₄+ 0.1% H₃BO₃ (2 sprays at just before flowering and marble stage); T₈ - RDF + Mango special (IIHR) (2 months before flowering & fruits of 2-4 cm diameter stage) at 5g/l

Table-57: Effect of micronutrients on fruit yield (kg/plant) in different cultivars of mango at various centres.

Treatments	Pantnagar (Dashehari)	Vengurle (Alphonso)	Sabour (Langra)	Periyakulam (Imam Pasand)	Lucknow (Dasheshari)	Udaipur (Dasheshari)
T ₁	71.70	15.50	241.57	39.91	14.99	78.0
T ₂	101.49	12.72	275.65	41.67	20.60	84.0
T ₃	102.04	17.33	240.20	45.64	19.65	88.0
T ₄	111.33	12.94	252.60	51.10	20.32	86.0
T ₅	105.07	20.30	254.80	50.59	20.92	118.0
T ₆	114.57	14.37	223.40	57.66	27.02	115.0
T ₇	135.11	13.33	250.53	83.24	27.95	139.0
T ₈	133.85	15.94	238.27	66.02	26.98	132.0
CD at 5%	6.48	1.83	8.44	2.98	10.14	11.95

Treatment details: T₁ - Control as per RDF (Region specific) in basin after harvest; T₂ - RDF + 200 g ZnSO₄+ 100 g Borax (Soil application) in basin after harvest; T₃ - RDF + 200 g ZnSO₄+ 100 g CuSO₄+ 100 g H₃BO₃ (Soil application) in basin after harvest; T₄ - RDF + Foliar spray of 0.2% ZnSO₄ + H₃BO₃ (0.1%) [2 sprays at just before flowering and marble stage]; T₅ - RDF + Foliar spray of 0.2% ZnSO₄ + CuSO₄ (0.1%) + H₃BO₃ (0.1%) [2 sprays at just before flowering and marble stage]; T₆ - RDF + 100 g ZnSO₄ + 50 g CuSO₄ + 50 g H₃BO₃ (soil application) in basin after harvest + Foliar spray of 0.2 % ZnSO₄ + 0.1% H₃BO₃ (2 sprays at just before flowering and marble stage); T₇ - RDF + 100 g ZnSO₄+ 50 g CuSO₄+ 50 g H₃BO₃ (Soil application) in basin after harvest + Foliar spray of 0.2% ZnSO₄+ 0.1% CuSO₄+ 0.1% H₃BO₃ (2 sprays at just before flowering and marble stage); T₈ - RDF + Mango special (IIHR) (2 months before flowering & fruits of 2-4 cm diameter stage) at 5g/l

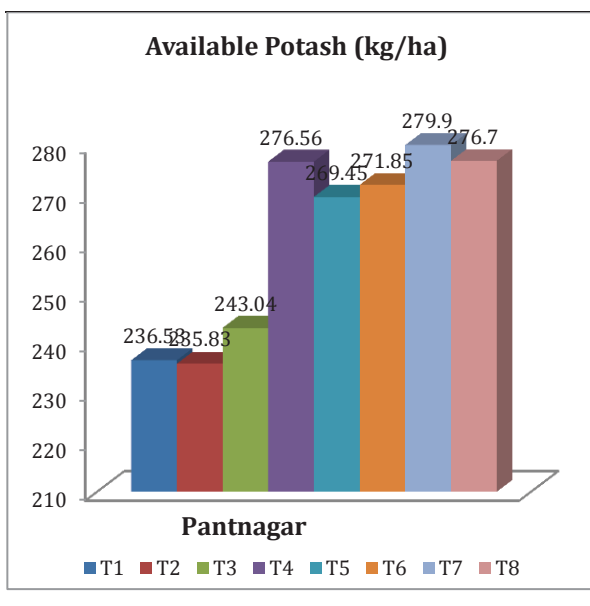
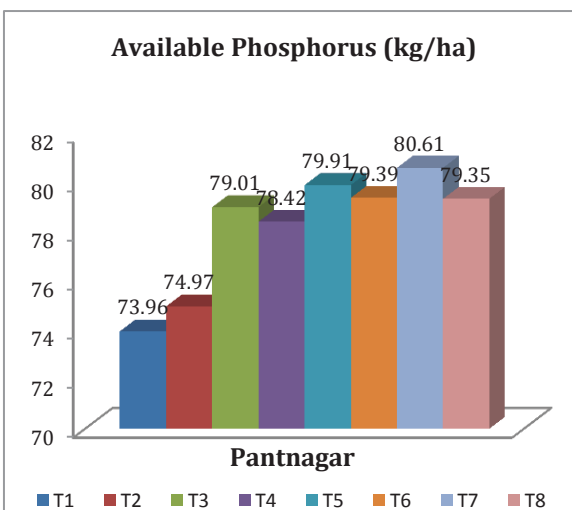
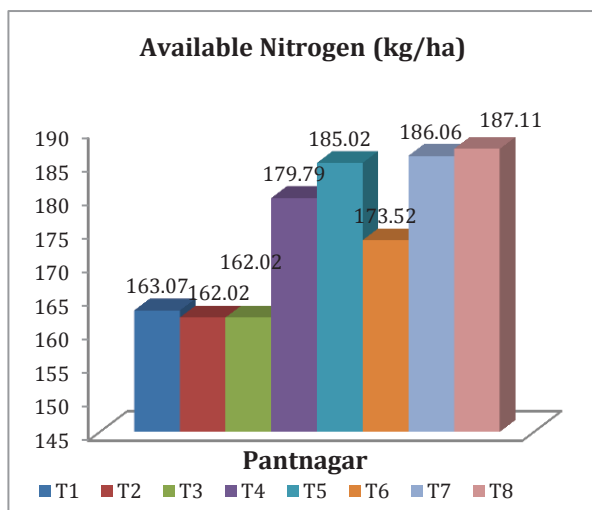




Treatment details:

- T₁ : Control as per RDF (Region specific) in basin after harvest
- T₂ : RDF + 200 g ZnSO₄+ 100 g Borax (Soil application) in basin after harvest
- T₃ : RDF + 200 g ZnSO₄+ 100 g CuSO₄+ 100 g H₃BO₃ (Soil application) in basin after harvest
- T₄ : RDF + Foliar spray of 0.2% ZnSO₄ + H₃BO₃ (0.1%) [2 sprays at just before flowering and marble stage]
- T₅ : RDF + Foliar spray of 0.2% ZnSO₄+ CuSO₄ (0.1%) + H₃BO₃ (0.1%) [2 sprays at just before flowering and marble stage]
- T₆ : RDF + 100 g ZnSO₄+ 50 g CuSO₄+ 50 g H₃BO₃ (soil application) in basin after harvest + Foliar spray of 0.2 % ZnSO₄+ 0.1% H₃BO₃ (2 sprays at just before flowering and marble stage)
- T₇ : RDF + 100 g ZnSO₄+ 50 g CuSO₄+ 50 g H₃BO₃ (Soil application) in basin after harvest + Foliar spray of 0.2% ZnSO₄+ 0.1% CuSO₄+ 0.1% H₃BO₃ (2 sprays at just before flowering and marble stage)
- T₈ : RDF + Mango special (IHR) (2 months before flowering & fruits of 2-4 cm diameter stage) at 5g/l

Fig. 21: Effect of micronutrients on shelf life in different cultivars of mango at various centres.



Treatment details:

- T₁ : Control as per RDF (Region specific) in basin after harvest
- T₂ : RDF + 200 g ZnSO₄+ 100 g Borax (Soil application) in basin after harvest
- T₃ : RDF + 200 g ZnSO₄+ 100 g CuSO₄+ 100 g H₃BO₃ (Soil application) in basin after harvest
- T₄ : RDF + Foliar spray of 0.2% ZnSO₄ + H₃BO₃ (0.1%) [2 sprays at just before flowering and marble stage]
- T₅ : RDF + Foliar spray of 0.2% ZnSO₄+ CuSO₄ (0.1%) + H₃BO₃ (0.1%) [2 sprays at just before flowering and marble stage]
- T₆ : RDF + 100 g ZnSO₄+ 50 g CuSO₄+ 50 g H₃BO₃ (soil application) in basin after harvest + Foliar spray of 0.2 % ZnSO₄+ 0.1% H₃BO₃ (2 sprays at just before flowering and marble stage)
- T₇ : RDF + 100 g ZnSO₄+ 50 g CuSO₄+ 50 g H₃BO₃ (Soil application) in basin after harvest + Foliar spray of 0.2% ZnSO₄+ 0.1% CuSO₄+ 0.1% H₃BO₃ (2 sprays at just before flowering and marble stage)
- T₈ : RDF + Mango special (IHR) (2 months before flowering & fruits of 2-4 cm diameter stage) at 5g/l

Fig. 22. Effect of different macronutrients on availability of nutrient contents in soil at Pantnagar.

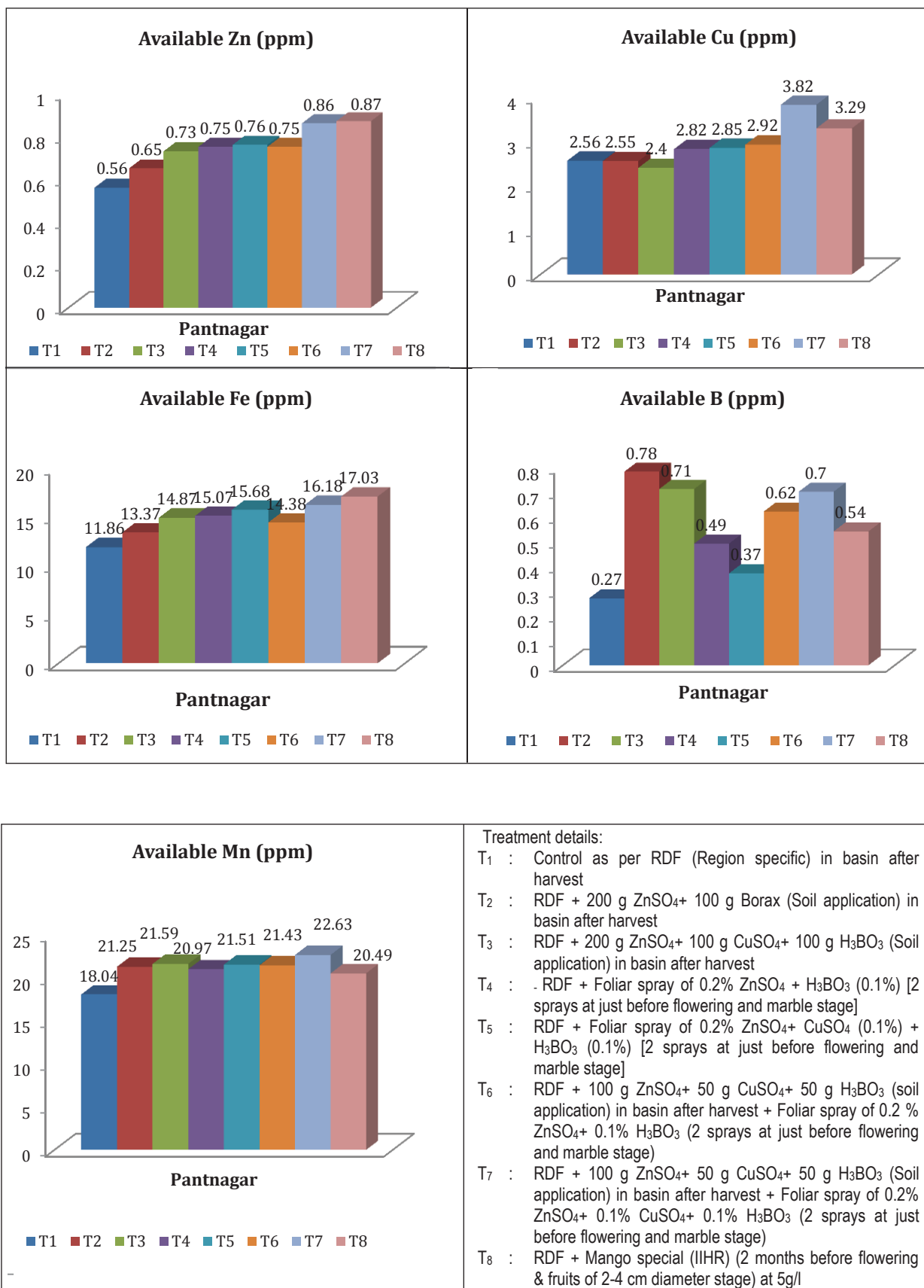


Fig. 23. Effect of different macronutrients on availability of nutrient contents in soil at Pantnagar

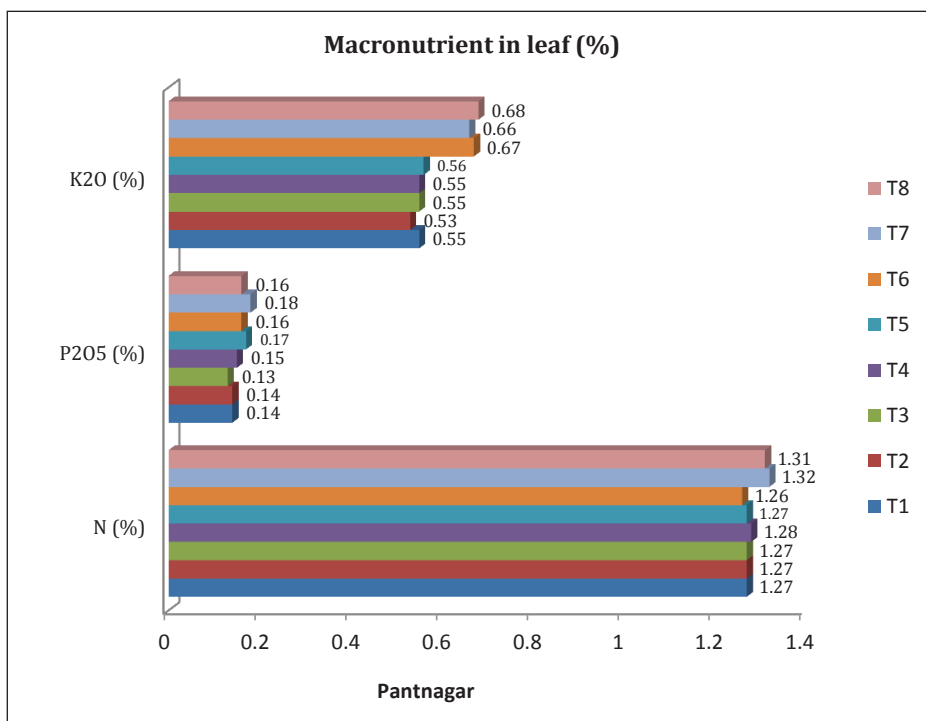


Fig. 24. Effect of different macronutrients on availability of nutrient contents in soil at Pantnagar.

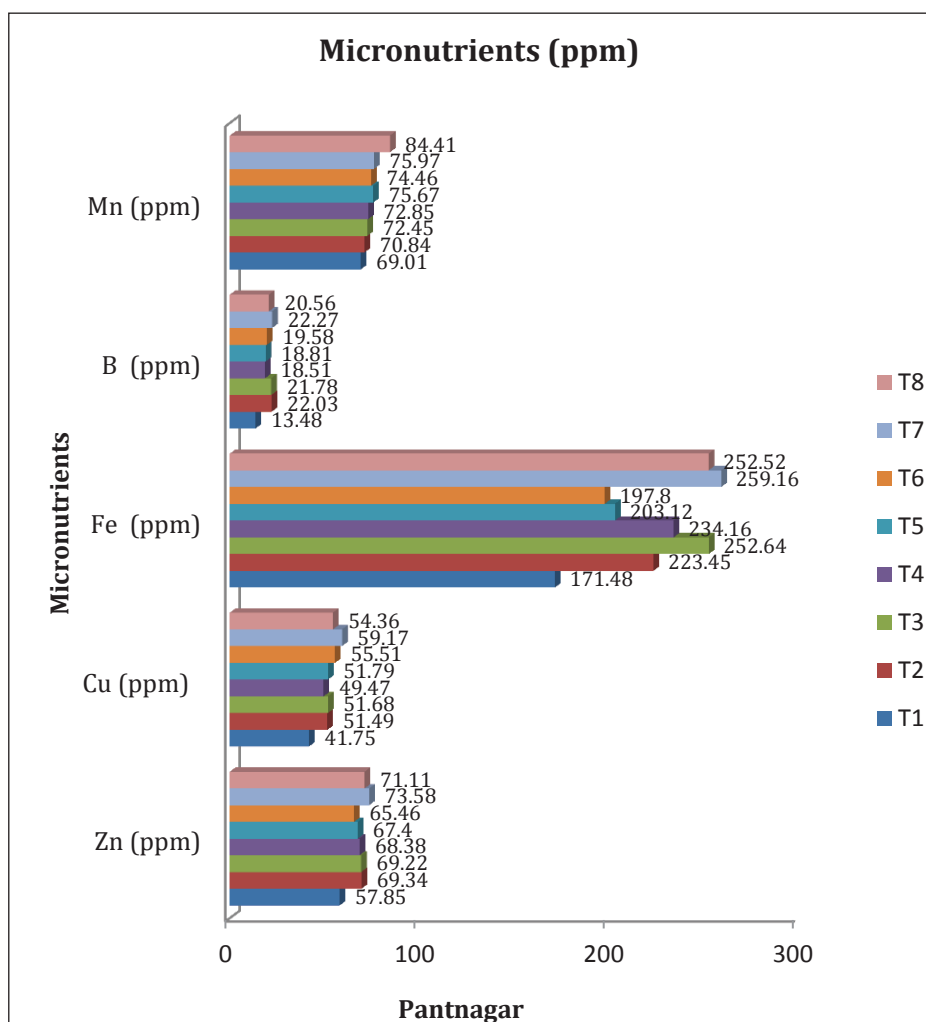


Fig. 25. Effect of different macronutrients on availability of nutrient contents in soil at Pantnagar.

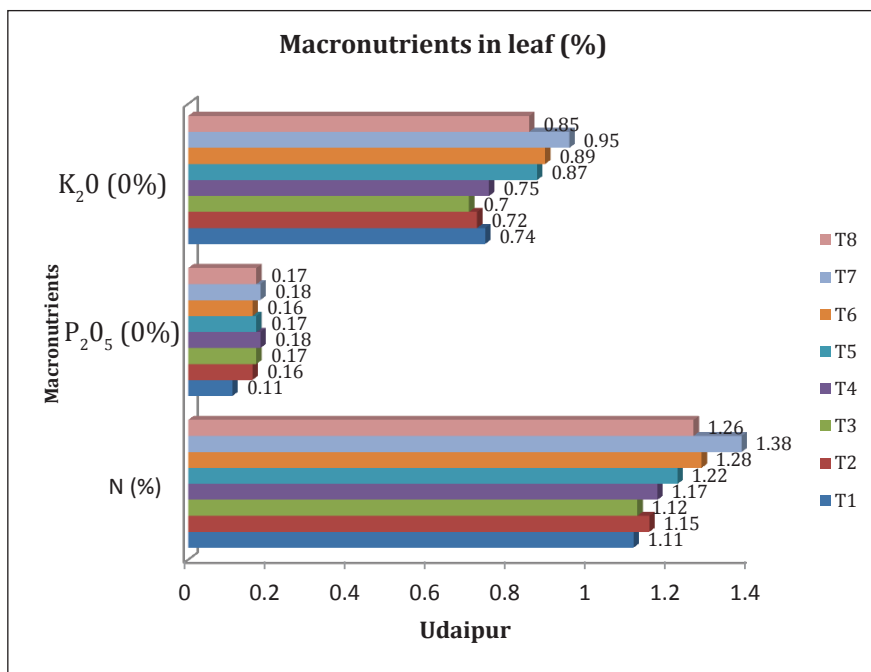


Fig. 26. Effect of different macronutrients on availability of nutrient contents in leaves at Udaipur

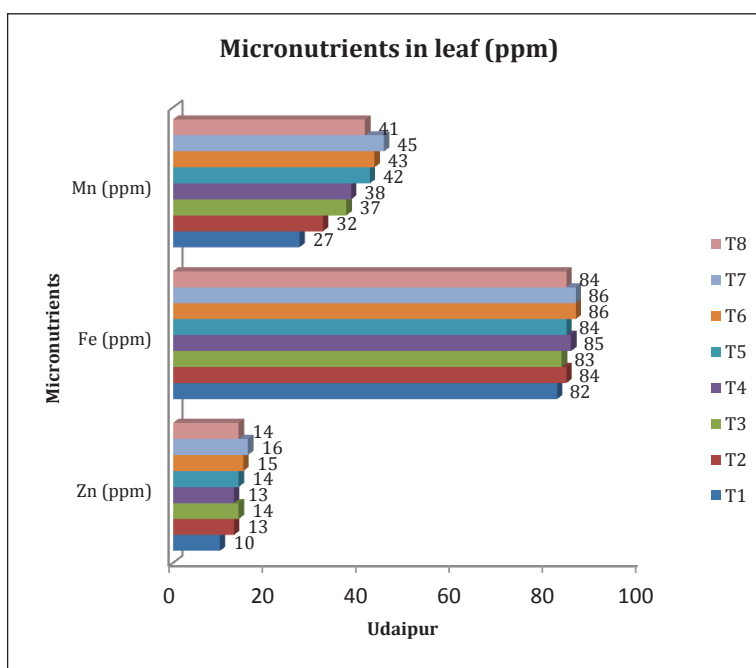
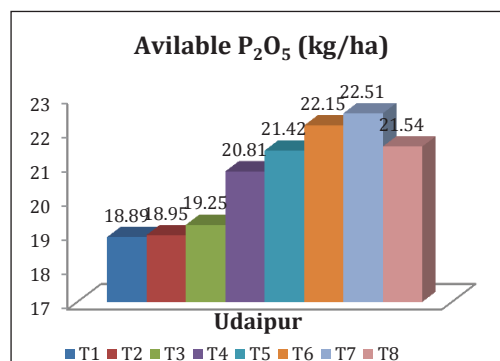
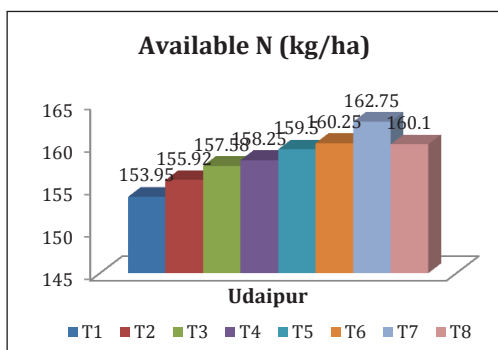


Fig. 27. Effect of different macronutrients on availability of nutrient contents in leaves at Udaipur



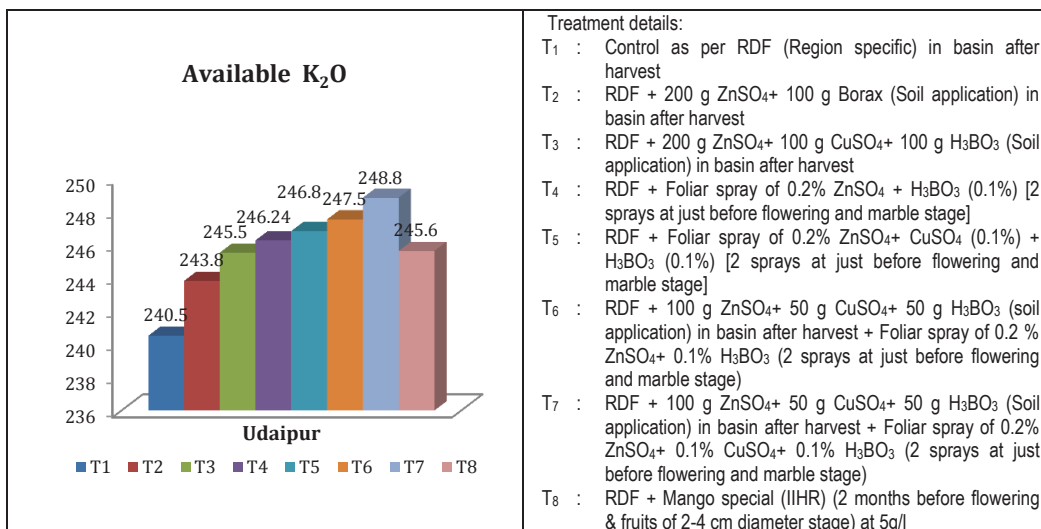


Fig. 28. Effect of different macronutrients on availability of nutrients contents in leaves at Udaipur

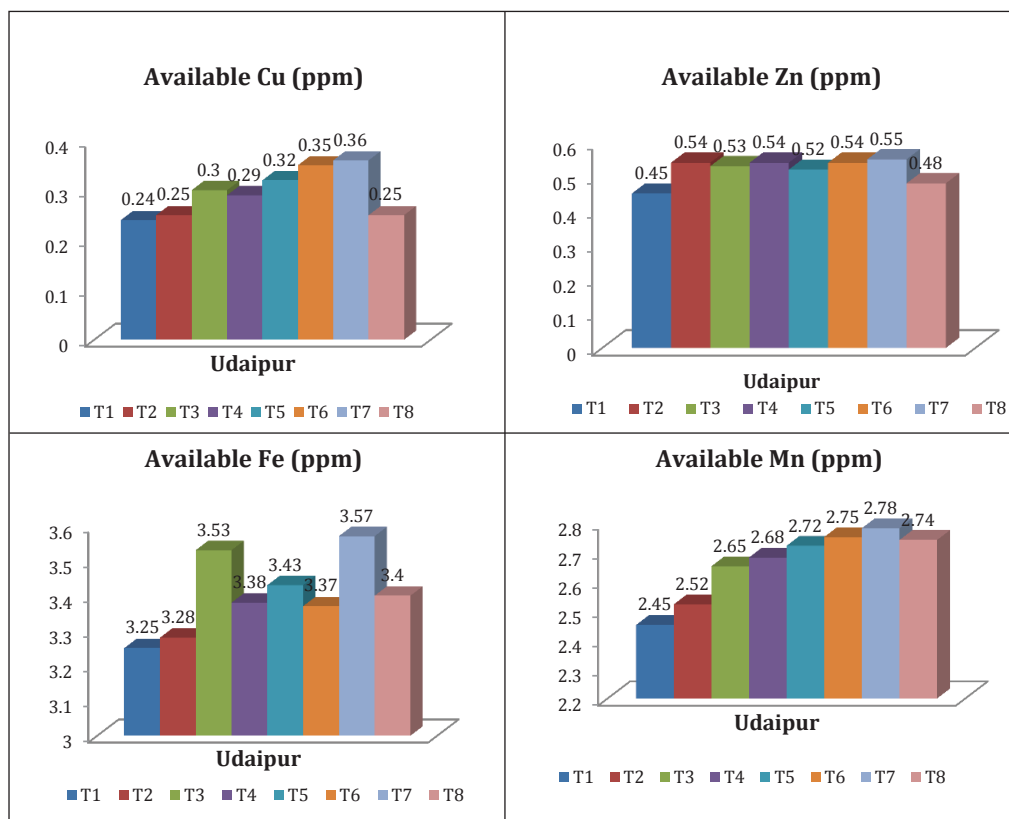
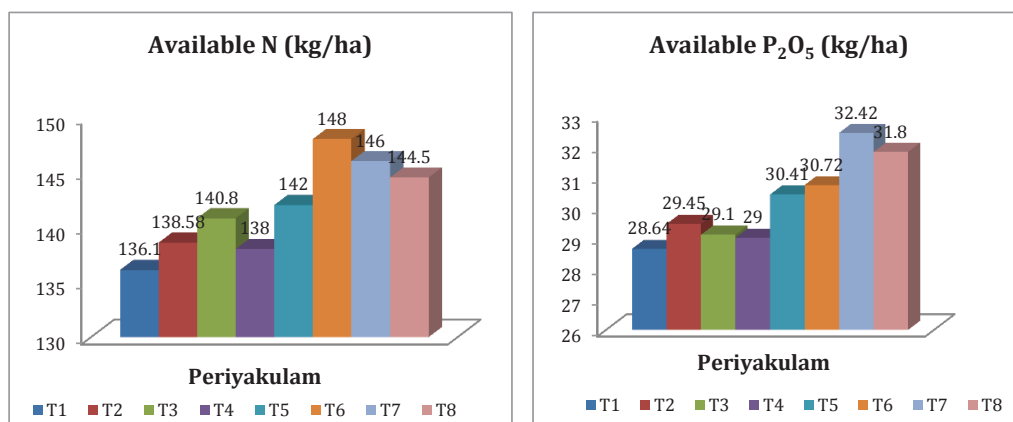
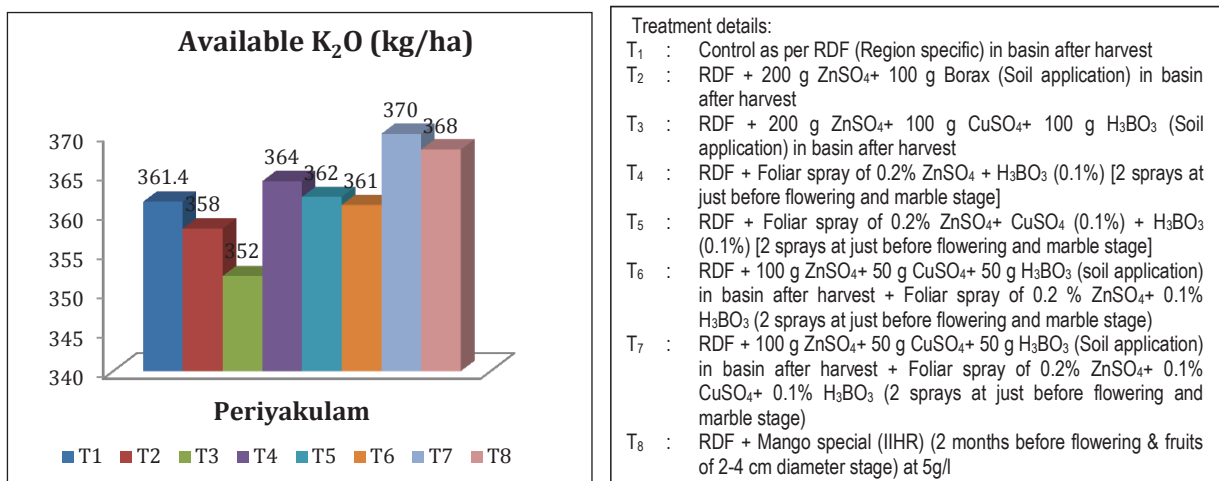


Fig. 29. Effect of different macronutrients on availability of nutrients contents in Soil at Udaipur





Treatment details:
 T₁ : Control as per RDF (Region specific) in basin after harvest
 T₂ : RDF + 200 g ZnSO₄+ 100 g Borax (Soil application) in basin after harvest
 T₃ : RDF + 200 g ZnSO₄+ 100 g CuSO₄+ 100 g H₃BO₃ (Soil application) in basin after harvest
 T₄ : RDF + Foliar spray of 0.2% ZnSO₄ + H₃BO₃ (0.1%) [2 sprays at just before flowering and marble stage]
 T₅ : RDF + Foliar spray of 0.2% ZnSO₄+ CuSO₄ (0.1%) + H₃BO₃ (0.1%) [2 sprays at just before flowering and marble stage]
 T₆ : RDF + 100 g ZnSO₄+ 50 g CuSO₄+ 50 g H₃BO₃ (soil application) in basin after harvest + Foliar spray of 0.2 % ZnSO₄+ 0.1% H₃BO₃ (2 sprays at just before flowering and marble stage)
 T₇ : RDF + 100 g ZnSO₄+ 50 g CuSO₄+ 50 g H₃BO₃ (Soil application) in basin after harvest + Foliar spray of 0.2% ZnSO₄+ 0.1% CuSO₄+ 0.1% H₃BO₃ (2 sprays at just before flowering and marble stage)
 T₈ : RDF + Mango special (IHR) (2 months before flowering & fruits of 2-4 cm diameter stage) at 5g/l

Fig. 30. Effect of different macronutrients on availability of nutrients contents in soil at Periyakulam

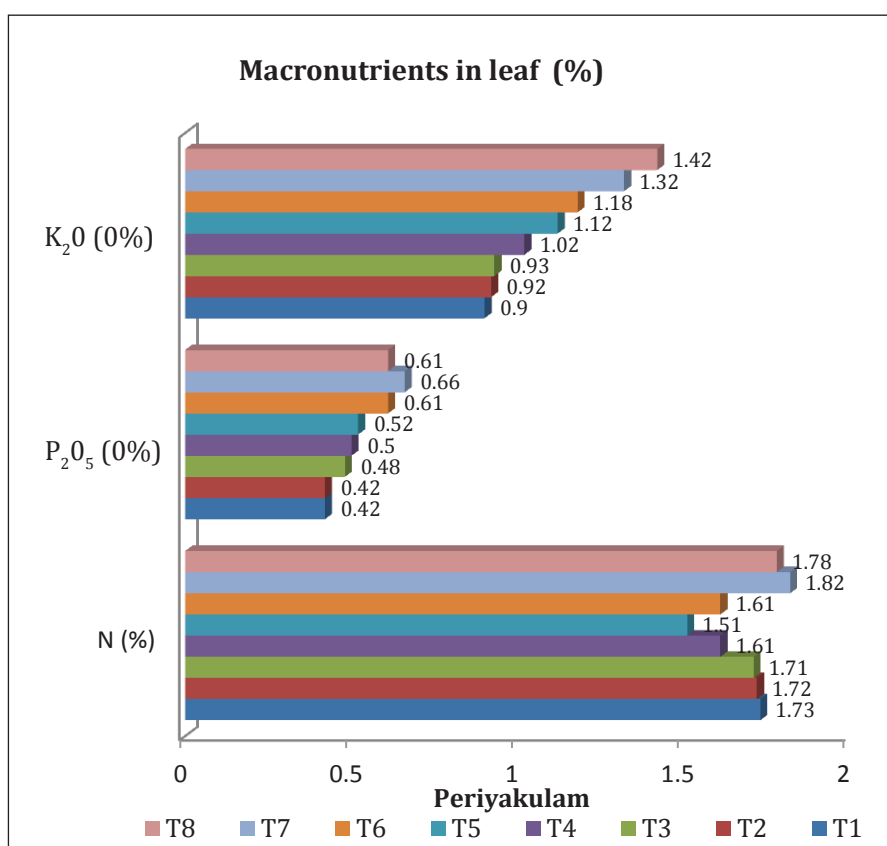


Fig. 31. Effect of different macronutrients on availability of nutrients contents in soil at Periyakulam

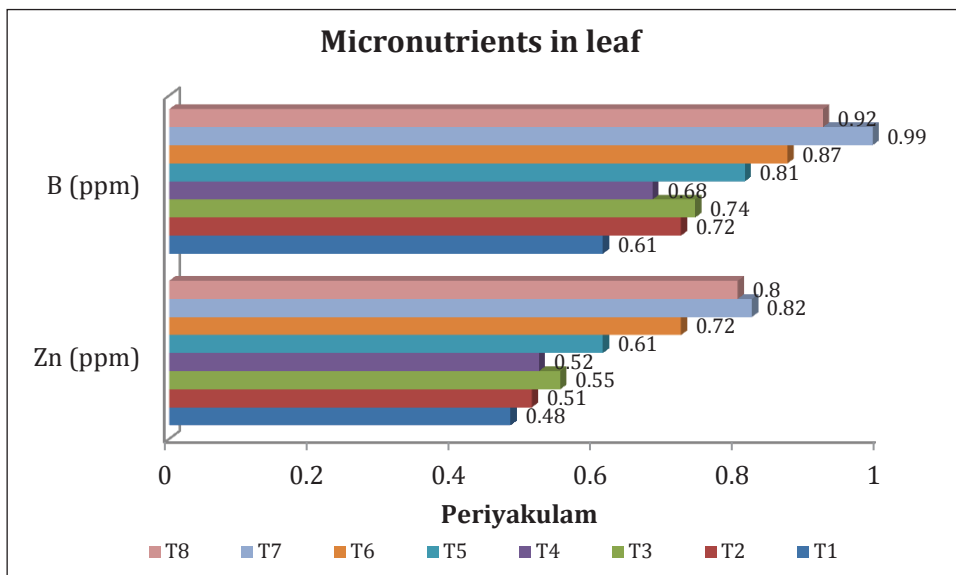


Fig. 32. Effect of different macronutrients on availability of nutrients contents in soil at Periyakulam

3.1.3 M. Fertigation scheduling for quality fruit production of mango

The experiment is laid out in RBD comprising five treatments and five replications with various treatments and yield and yield parameters were recorded.

Paria: Application of $N:P_2O_5:K_2O$ in the ratios of 40:60:20, 40:40:20 and 20:0:60 at after harvest, during fruit set and at marble size stage respectively recorded highest yield in Kesar (54.34 kg/tree). Data regarding quality parameters showed non-significant relation among different treatments.

Sabour: Application of $N:P_2O_5:K_2O$ in the ratios of 20:30:10, 20:20:10 and 10:0:30 at after harvest, during fruit set and marble size stage respectively gave maximum fruit yield (580 fruits/tree and 160.40 kg/tree) in comparison to other methods in cv. Langra.

Sangareddy: Application of $N:P_2O_5:K_2O$ in the ratios of 25:50:15, 20:25:15 and 30:0:45 at after harvest, during fruit set and marble size stage respectively on cv. Banganpalli had given significantly higher yield (115 fruits/tree and 39.10 kg/tree) when compared to other treatments. Data regarding quality parameters showed non-significant relation among different treatments (Table 58).

Vengurle: Application of $N:P_2O_5:K_2O$ applied in the ratios of 25:50:15, 20:25:15 and 30:0:45 at after harvest, during fruit set and marble size stage respectively on cv. Alphonso had given significantly higher yield (126.40 fruits/tree and 32.73 kg/tree). Further, highest potassium content of both soil (597.40 kg/ha) and leaf (0.65%) was recorded in the same treatment and data regarding quality parameters showed non-significant relation among different treatments.

Table-58: Effect of fertilizer schedules on yield and yield parameters of mango at various locations

Treatment	Paria		Sabour		Sangareddy		Vengurle	
	Fruits /tree	Yield (kg/ tree)	Fruits /tree	Yield (kg/tree)	Fruits /tree	Yield (kg/tree)	Fruits/ tree	Yield (kg/tree)
T ₁	123.60	34.91	454.00	112.34	96	30.72	86.40	22.04
T ₂	172.40	54.34	452.00	110.27	-	-	112.20	28.58
T ₃	168.10	49.18	330.00	82.62	115	39.10	126.40	32.73
T ₄	137.20	45.35	580.00	160.40	93	33.48	99.80	24.52
T ₅	150.90	45.88	165.50	143.99	88	29.04	98.60	23.45
CD at 5%	NS	9.57	48.64	13.51	19.33	5.93	10.71	2.13

Paria cv. Kesar; Sabour cv. Langra; Sangareddy cv. Banganpalli; Vengurle cv. Alphonso

Treatment details: T₁: Control as per RDF (after harvest) in basin through drip; T₂: 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; T₃: 25:50:15, 20:25:15 and 30:0:45 $N:P_2O_5:K_2O$ respectively at after harvest, during fruit set and marble size stage; T₄: 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; T₅: 10:20:5, 10:5:5 and 5:0:15 $N:P_2O_5:K_2O$ respectively at after harvest, during fruit set and marble size stage.

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 the varieties evaluated for phenological variability, the lowest number of days recorded in Neelum for 50 per cent flowering (8 days) and for 100 per cent flowering in Pulihora (14 days). Interestingly, the lowest sex ratio was recorded in Neelum (3.05) but with highest number of fruits per panicle (8.85 fruits). With regard to yield, the highest fruit weight (301.89 g), fruits per tree (266.58) and fruit yield (12.90 t/ha) was recorded in Banglora while the lowest yield was recorded in Baneshan (5.32 t/ha). Among the cultivars, Baneshan recorded highest TSS content (18.8°B).

Bengaluru: The phenological trait, first appearance of flower bud was recorded from 3rd week of November (Amrapali) to 1st week of December (Banganapalli) and the duration of flowering varied from 38 days (Banganapalli) to 56 days (Amrapali). With respect to days to 50 per cent flowering, Amrapali recorded lowest and Alphonso highest. Similar observations were recorded for sex ratio (male/hermaphrodite); Amrapali recorded low (2.43) and Alphonso recorded high (5.14). Highest fruit set at marble stage was recorded in Amrapali (6.6) and least was in Banganapalli (2.58). The maximum number of fruits per panicle at harvest was observed in Amrapali (1.23) and least in Alphonso (0.62). Totapuri gave maximum fruit yield followed by Banganapalli and Amrapali during the current year.

Bhubaneswar: The days taken for 50 per cent flowering was lowest (14 days) in Arka Neelachal Kesari followed by Amrapali (16 days) and Dashehari (19 days). The flowering intensity was highest in Amrapalli (58.92%) followed by Arka Neelachal

Kesari (50.33%) and Dashehari (34.83%). Maximum flowering duration (44.17 days) was observed in Amrapali and minimum duration of flowering (34.83 days) was recorded for Arka Neelachal Kesari. Number of male flowers per panicle was lowest in Dashehari (492) and was highest (836) in Amrapali. Similarly, number of perfect flowers per panicle was observed maximum (109) in Amrapali and lowest number of perfect flowers per panicle (86) was recorded in Dashehari.

Lucknow: The flowering intensity 42 per cent was noticed in Dashehari and 78 per cent in Mallika. The cultivar Dashehari took 22-26 days and Mallika 24-29 days for 50 per cent flowering. Fruit yield ranged between 30-35 kg per tree in Dashehari and 35-50 kg per tree in Mallika.

Mohanpur: It was observed that cv. Himsagar took maximum days (14.31 days) from first flowering to 50 per cent flowering but it was minimum (12.33 days) in cv. Langra. The flowering percentage was observed maximum in cv. Bombai (60.67%) and it was found minimum in cv. Fazli (52.33%) followed by Himsagar (52.66%) during 2019. The maximum number of fruits was noted in cv. Himsagar (207.13) during 2019 and minimum was recorded in cv. Fazli (133.13). The highest fruit yield was recorded in Fazli (64.49 kg/plant) while it was found lowest in cv. Bombai (34.17 kg/plant).

Paria: The difference between maximum and minimum days to reach 100 per cent flowering in different mango varieties was 6.6 days, while the duration of flowering ranges between 31.80

to 38.40 days, as minimum duration of flowering was recorded with Amrapali (31.80 days). On the average basis minimum days taken for 50 per cent of flowering was recorded with cv. Amrapali (10.20 days). Maximum and minimum sex ratio of 3.24 and 0.50 was recorded in Amrapali and Langra varieties, respectively. The average maximum percentage of fruit set (per panicle) at marble stage *i.e.* 2.59 per cent and fruit retention at maturity from fruit set (50.90%) was noted with cv. Amrapali. However, on the average basis highest no. of fruits per tree (132.20) and yield (46.16 kg/tree) was obtained in cv. Kesar. The average fruit weight (627.44 g) was obtained within cv. Mallika. The highest TSS (19.87°B) and ascorbic acid (30.70 mg/100 g) was obtained with cv. Amrapali and Langra, respectively. The minimum acidity (0.21%) was observed with Kesar cultivar.

Periyakulam: The effect of climatic variability on mango pertaining to flowering and yield were recorded. During the year the weather parameter was favourable for the yield and quality of mango varieties *viz.*, Neelum, Bangalora and Banganapalli. The data clearly indicated that the prevailing favourable condition for flowering, fruit set, fruiting and yield. The average temperature (29.68°C), relative humidity (66.62%) and total rainfall (63.03 mm) were recorded. The flowering and fruiting behavior have been registered for three varieties and observed that variety Neelum exhibited late in 50% flowering and harvesting stage (34.88). The variety Bangalora harvest period was observed up to May 2019. However, the early flowering, fruiting and harvest period were recorded in the variety Banganapalli 25.76 days (50% flowering). In variety Neelum, recorded the highest number of fruits (642.50). However, the yield per tree recorded with the highest value in variety Bangalora (215.18 kg/tree). The biochemical parameters were also recorded, the highest TSS and carotenoid content registered in the variety Banganapalli (20.16°B and 3.28 mg/100 g respectively) and the same variety also recorded the lowest acidity content of 0.25 per cent where as Neelum recorded the TSS content of 18.12°B.

Rahuri: The earliest flowering initiation was observed in cultivar Alphonso (12th December 2018) while days for 50 per cent 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 Kesar (60) and highest in Mallika (81). The sex ratio was highest in Kesar (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 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 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 (70.15 kg/tree, 7.08 t/ha). 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: During reporting period, the maximum yield was recorded in Totapuri (61.29 kg/plant) followed by Mallika (57.12 kg/plant). Maximum fruit weight in Mallika (320.9 g) The Maximum TSS were noted in Langra (21.34°B) and minimum in Totapuri (13.52°B).

Sangareddy: During reporting period, the flower initiation was 2 days earlier in Suvernakha (27-12-18) when compared to Banganapalli (27th December 2018). The early fruit set (21st February 2018) in Suvernakha was recorded when compared to Mallika (10th March 2019). Significantly maximum yield of 62.40 kg per tree was obtained in mango Mallika due to maximum number of fruits per tree (430) when compared with 320 in Suvernakha. Mallika is giving consistently higher yield during the past two years.

Udaipur: Among all five varieties, early panicle emergence was recorded in variety Amrapali (27th November 2018) with highest flowering intensity (66%) while, late panicle emergence in January was observed in Langra (18th January 2019) and Dashehari (10th January 2019) with the flowering intensity of 62 per cent and 61 per cent, respectively. Both Mallika and Dashehari took maximum 34 days to 50 per cent flowering while; Langra took minimum of 30 days to 50 per cent flowering. Dashehari proved best as compared to other varieties with highest number of fruits per tree (587) and yield per tree (112 kg) but, in Mallika maximum average fruit weight (255 g) and in Amrapali yield per hectare (25.6 t/ha) was recorded. Hopper population during flowering was observed maximum in Dashehari whereas, malformation was observed maximum in Kesar. In case of powdery mildew low to moderate infection was observed in all five varieties.

Vengurle: Due to extent in monsoon up to first week

of November, 2019, there was delay in flowering in all varieties under study. The flowering will be initiated in the month of January, 2020. All the yield and yield contributing characteristics also varied significantly. Significantly the highest fruit weight (589.20 g), yield (100.20 kg/tree) and (10.02 t/ha) were observed in Totapari. The chemical parameters were found to be significant. However, TSS, acidity and ascorbic acid were found highest in the variety Alphonso.

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., T₁ Spraying on the fruits with Arka Saka Nivarak @ 100 ml/l; T₂ - Dipping the fruits with Arka Saka Nivarak @ 100 ml/l; T₃ - Water spray (standard check) and T₄ - Unsprayed control.

Paria: There was no incidence of spongy tissue in any treatment during experimental period. Furthermore, TSS, Fruit weights and yield parameter were not significant with respect to treatments.

Sangareddy: The experiment was not initiated during the year 2018-19 as the yield of Alphonso is very low. The variety Alphonso is alternate bearer in Telangana conditions.

Vengurle: The result indicated that the extent of spongy tissue was non-significant. However, maximum TSS (19.78°B) was recorded in the treatment involved dipping of fruits with Arka Saka Nivarak @ 100 ml/l as compared to the unsprayed control (18.79°B). Fruit weight and yield parameter were not significant with respect to treatments.

5.1.5 M. Survey and surveillance for new and emerging pest 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 2019.

Diversity and incidence of insect fauna associated with various centres are presented.

Lucknow: A higher incidence (25-30%) of Semilooper, *Hyposidra talaca* was recorded during the 23rd SMW with 6.5 larvae per twig which caused severe damage on new leaves.

Ludhiana: Three new pests and 4 sporadic pests were recorded in the various region of Punjab. Fruit fly parasitoid, *Diachasmimorpha (Biosteres) longicaudata* (Ashmead), Mango black predatory beetle, *Chilocorus nigrata* (Fabricius) was found to feed on scale, *Aulacapsis tubercularis*, *Plyctes* sp. (Braconidae: Doryctinae). Parasitoid, *Thomsonisca*

pakistanensis (Ahmad) (Encyrtidae) were reared in large number from mango scales. Beetles, *Sasajiscymnus murreensis* (Ahmad) (Coleoptera: Coccinellidae) were collected in large number from mango trunks and a new species of wasp recorded from mango orchards, probably a natural enemy of mango hoppers.

Mohanpur: Apart from mango hoppers, mango red banded caterpillar or fruit borer, *Deanolis sublimbalis* was found the most destructive pest in different places of West Bengal in early developing stage of the fruit, where the stone remained soft. The pest was not observed in mature stage. Another insect, mango leaf cutting weevil was also caused serious damage in the nursery and young orchards when new vegetative flush comes preferably during monsoon months (July-Sept). The mango fruit fly incidence was also recorded higher in all the mango growing parts of Nadia district during May-June and another peak in September- October in parts of Hoogly district. Three new insect pest viz., thrips flea beetle (Chrysomelidae), flower webber were found as new emerging pest.

Pantnagar: A total of 31 pest species were recorded on mango trees at different stages (Table 59). Among the natural enemies, spiders and ladybird beetle significantly performed the role of efficient predators by showing their abundance and regulating the sucking pests that caused considerable damage. Spiders were seen feeding on mango hoppers, ladybird beetle species viz. *Chilocorus nigratus* (Leach) was seen attacking on coccids whereas, both grub and adult of *Rodolia fumida* (Mulsant) was seen feeding voraciously on mango mealy bug.

Paria: 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 Palan, Tighra and Atgam village of Valsad district (8.2 thrips/panicle and up to 24% fruits infestation) in second fortnight of Feb. and April, 2019, respectively. Fruit fly infestation was also recorded higher in Pardi taluk of Valsad district (15%).

Periyakulam: A low incidence of stem borer and thrips were recorded on mango.

Sangareddy: Besides, major insect pest heavy infestation of leaf webber was observed on mango.

Vengurle: It was found that the intensity of mango fruit borer, *Citripestis eutrapphera* increased during this year (2 to 3%). Also, a new species of fruit borer, *Deanolis albizonalis* was recorded in Sindhudurg district of Maharashtra.

Table-59: Diversity of pest fauna associated with mango at different centres (2019)

Pest	Average number of insect/panicle/leaf/tree or % incidence						
	PRI	PNT	LDH	SNG	VNG	MHR	LKO
Mango Hopper: 1. <i>Amritodus atkinsoni</i> Leth. 2. <i>Idioscopus clypealis</i> Leth. 3. <i>I. niveosparsus</i> Leth. 4. <i>I. nagpurensis</i> Pruthi 5. <i>I. nitidulus</i> Walker 6. <i>Amrasca splendens</i> Ghauri	0.1-9.7	0.25-15.5	5-10	1.46-4.8	5-10	5-10	5-10
Mealy Bug: 1. <i>Drosicha mangiferae</i> G. 2. <i>Rastrococcus iceryoides</i> G. 3. <i>Rastrococcus invadens</i> Williams	0.05	2.5-10.25	1-5	5-10	1-5	1-5	1-5
Shoot Gall Psylla , <i>Apsylla Cistellata</i> (Buckton)	-	5.25-9.75	-	-	-	-	5-10
Mango Fruit fly: 1. <i>Bactrocera dorsalis</i> (Hendel) 2. <i>B. correcta</i> (Bezzi) 3. <i>B. Zonata</i> (Saunders)	5-10	2.14-28.5	>10	5-10	>10	>10	5-10
Leaf Cutting Weevil , <i>Eugnamptus marginellus</i> (Faust) [<i>Deporaus marginatus</i> (Pascoe)]	-	1.75-3.5	1-5	-	-	5-10	>10
Leaf Gall midge , <i>Procontarinia matteriana</i> (Kieffer & Cecconi, 1906)	0.05-0.25	0.25-1.25	5-10	-	-	1-5	5-10
Leaf mining weevil , <i>Rhynchaenus mangiferae</i> Mshel.	-	0.25-0.75	-	-	-		5-10
Inflorescence Midge , <i>Erosomyia indica</i> Grover.	-	0.5-1.25	-	>10	5-10		>10
Leaf Webber: 1. <i>Orthaga</i> sp. 2. <i>O. euadrusalis</i> Walker 3. <i>O. exaginacea</i> Hamp.	0.05-0.10	4.25-6.75	1-5	5-10	-		>10
Termite , <i>Odontotermes obesus</i> (Rambur)	-	5.25-10.75	-	-	-		>10
Bark eating caterpillar , <i>Indarbela quadrinotata</i> Walker	1-2	0.24-2.25	1-5	5-10	-		1-5
Stem borer , <i>Batocera rufomaculata</i> (De Geer) Aeolesthes holosericea (Fabricius)	0.5	1.3-5.6	1-5	5-10	1-5		>10
Coccids: 1. <i>Chloropulvinaria</i> sp. 2. <i>C. polygonata</i> Cockerell 3. <i>Aspidiotus destructor</i> Signoret 4. <i>Pulvinaria psidi</i> Mask. 5. <i>Parlatoria crypta</i> Mekenzen	0.05-0.10	0.35-0.55	1-5	1-5	1-5	1-5	5-10
Leaf eating caterpillar , <i>Euthalia garuda</i> Moore	-	0.3-0.5	-	5-10	-	-	1-5
Leaf Miners: 1. <i>Acrocercops</i> sp. 2. <i>Acrocercops syngamma</i> M.	0.05-0.65	0.25-0.85	1-5	5-10		-	1-5
Fruit borer: 1. <i>Conogathes punctiferalis</i> L. 2. <i>Deanolis albizonalis</i> (Hampson) 3. <i>Autocharis</i> (=Noorda) <i>albizonalis</i> Hampson 4. <i>Citripestis eutrapphera</i> Meyrick	5-15	5.75-14.75	- - -	>10	2-3 >10	>10	1-5
Red ant , <i>Oecophylla smaragdina</i> Fab.	<1	<1	-	-	-		-

Pest	Average number of insect/panicle/leaf/tree or % incidence						
	PRI	PNT	LDH	SNG	VNG	MHR	LKO
Grey weevil , <i>Mylocerous discolor</i> Boh.	0.05-0.65	0.15-0.33	-	-	-		1-5
Shoot borer , <i>Chlumetia transversa</i> Walker	0.05-0.35	3.25-5.65	-	-	-		1-5
Thrips: 1. <i>Scirtothrips dorsalis</i> Hood 2. <i>Thrips flavus</i> Schrank 3. <i>Thrips hawainsis</i> (Morgan) 4. <i>S. mangiferae</i> (Fab.) 5. <i>Rhipiphorotherips cruentatus</i> Hood 6. <i>Exothrips hemavarna</i> (Ramakrishna & Margabandhu) 7. <i>Haplthrips ganglbaueri</i> Schmutz 8. <i>Bathrips jasminae</i> Ananthakrishnan 9. <i>Thrips florum</i> Schmutz	1-10	0.26-1.65	1-5	>10	1-10	5-10	>10
Mite: 1. <i>Oligonychus mangiferae</i> (Rahman and Sapra) 2. <i>Aceria mangiferae</i> (Sayed)	-	< 1	1-5	1-5	-	1-5	-
Hairy caterpillar , <i>Euproctis fraternal</i> (Moore)	< 1	< 1	-	-	-	-	1-5
Stone weevil , <i>Sternochetus mangiferae</i> Fab.	-	-	-	-	1-5	-	-
Inflorescence eating caterpillars , Unidentified sp.	-	-	-	1-5	-	-	-
Blossom midge , Unidentified sp.	-	-	-	1-5	-	-	-
Semilooper: 1. <i>Thalassodes</i> spp. 2. <i>Trichoplusia</i> spp. 3. <i>Achaea janata</i> (Linnaeus) 4. <i>Hyposidra talaca</i> Walker	>1	1-2	-	-	-	-	5-10
Citrus Black fly , <i>Aleucanthus woglumi</i> Ashby	-	< 1	-	-	-	1-5	-
Tussock Moth , Unidentified sp.	-	< 1	-	-	-	-	-
Common baron butterfly , <i>Euthalia aconthea</i>	-		-	-	-	-	-
Gall midge , <i>Oligotrophus mangiferae</i> Keiffer	-	1.45-2.33	-	-	-	-	-
Pleasing fungus beetles, <i>Episcapha quadrimaculata</i>	-	-	1-5	-	-	-	-
Tiger moth , <i>Arctia caja</i> (Linnaeus)	-	< 1	-	-	-	-	-
Short horned grasshopper , <i>Hieroglyphus banian</i> (Fabricius)	-	< 1	-	-	-	-	-
PRI-Paria; PNT-Pantnagar; LDH-Ludhiana; SNG-Sangareddy; VNG-Vengurle; MHR-Mohanpur; LKO-Lucknow							

5.17.M Module based pest management in mango

The mango tree 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: The treatment of dichlorvos injection 20-25 ml per live hole against steam borer was applied in the month of November 2019 and other treatments as per allotted cluster will be applied during ensuring flowering season January 2020.

Pantnagar: The trial is under progress

Periyakulam: The trial is under progress

Paria: Experiment was revised in sixth group discussion meeting held at AAU, Jorhat. Hence, it will be conducted in ensuring season.

Vengurle: The module I recorded least hopper population (0.69 hoppers/panicle as against 6.27 hopper/panicle in untreated control. The treatment T₁ (module I) was found to be the most effective (3.13 thrips/panicle) against thrips, mealy bug (1.47 mealy bug/ panicle) and Midge (2.86% of infested shoots). Module II was found most effective against fruit flies with only 0.29 per cent fruit fly incidence, 1.57 per cent incidence against fruit borer and 97.14 per cent recovery of stem borer infested tree (Table 60).

Table-60: Incidence of different pests of mango in different modules at Vengurle

Treatment	Incidence of different foliage pests				Per cent incidence at harvest		Per cent trees recovered
	Hopper (No. panicle)	Thrips (No. panicle)	Mealy bug (No. panicle)	Midge (% infested shoots)	Fruit fly (% fruits infested)	Fruit borer (% fruits infested)	Stem borer (% Recovery)
T ₁	0.69 (1.31)*	3.13 (2.03)*	1.47 (1.56)*	2.86 (8.81)**	1.43 (5.73)**	2.43 (8.92)**	94.28 (82.41)
T ₂	0.77 (1.33)	3.74 (2.17)	1.49 (1.57)	3.00 (9.86)	0.29 (1.64)	1.57 (6.63)	97.14 (86.21)
T ₃	6.27 (2.69)	9.70 (3.27)	9.21 (3.17)	12.29 (20.46)	14.57 (22.40)	4.29 (11.91)	0 (0.00)
CD at 5%	0.11	0.12	0.16	3.44	2.84	2.44	11.69

*Figures in parenthesis are square root transformed values
 **Figures in parenthesis are aresine transformed values

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 sooty mould (20-25%) was severe during pre-monsoon season (Fig. 34).

Bhubaneswar: Anthracnose (14.7%) disease severity was recorded during monsoon season (Fig. 35).

Lucknow: Among the major diseases shoulder browning (36.5%) was severe during monsoon season.

Malda: Blossom blight (30%) was severe during pre-monsoon season.

Mohanpur: Among the major diseases sooty mould (17.5%) was severe during monsoon season

Paria: Anthracnose (7.6%) and black banded (7.6%) severity was observed during monsoon season

Periyakulam: Anthracnose disease severity was observed to the tune of 20.8 per cent during monsoon season

Rahuri: Anthracnose (18.7%) disease severity was recorded during monsoon season

Rewa: Among the major disease, stem end rot (46.7%) severity was recorded during monsoon season

Sangareddy: Gummosis (25%) was severe during pre-monsoon season

Sabour: Among the major diseases red rust (15.05%) was severe during post-monsoon season (Fig. 33).

Vengurle: Powdery mildew (56.5%) was recorded during pre-monsoon season.

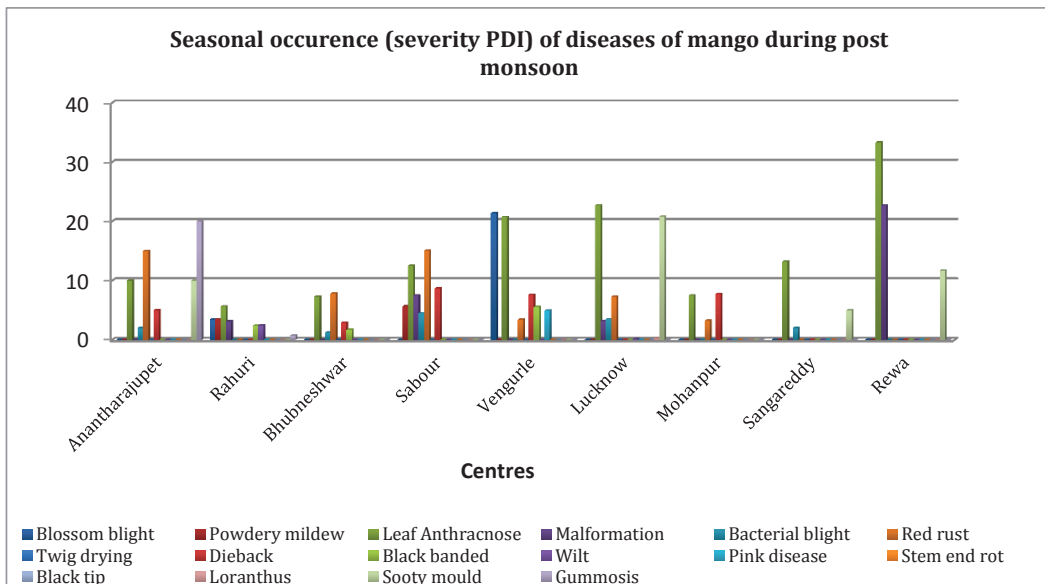


Fig. 33. Seasonal occurrence (severity PDI) of diseases of mango during post-monsoon

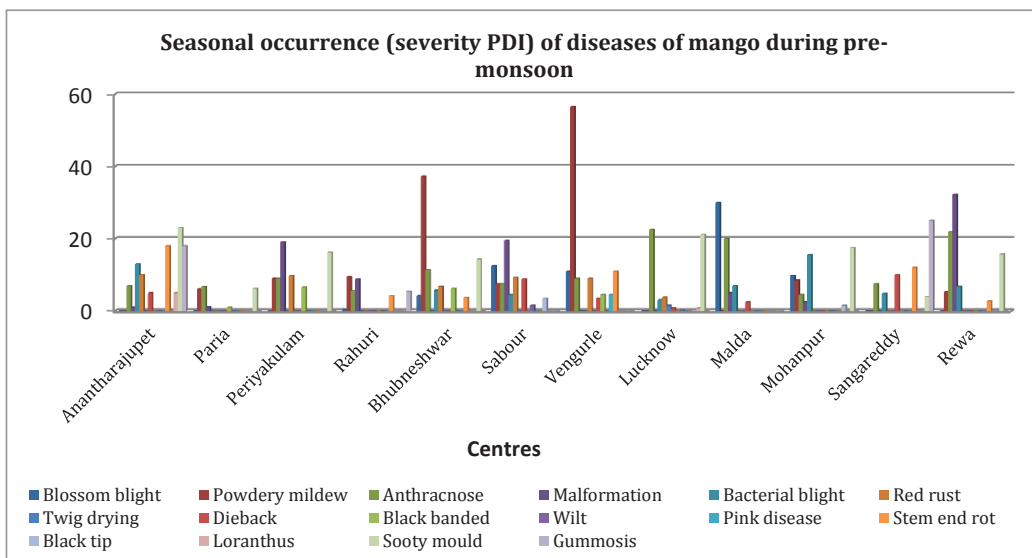


Fig. 34. Seasonal occurrence (severity PDI) of diseases of mango during pre-monsoon

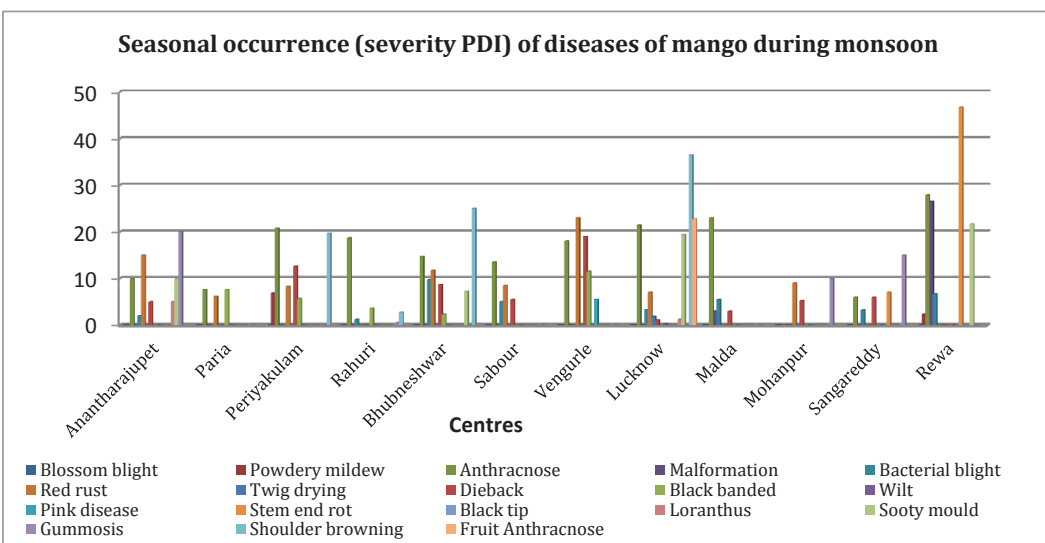


Fig. 35. Seasonal occurrence (severity PDI) of diseases of mango during monsoon

6.1.9 M. Identification and characterization of pathogens associated with stem end rot in mango

The matured fruits infected with stem end rot pathogen were collected and the pathogen was isolated from infected mango by using potato dextrose agar media. The cultural characterization of the isolated pathogen was done by using different media viz., potato dextrose agar media, Czapek-Dox agar medium, Cornmeal agar medium and Richards Agar medium and the result obtained on mycelia radial growth.

Sabour: *Botryodiplodia theobromae* was the major pathogen isolated from mango cv. Langra causing stem end rot. The effect of temperature and different carbon sources viz., Glucose, Glycerol and Sucrose on growth of the pathogen were studied and observed that 25°C temperature and Glucose as a good source of carbon (Fig. 36 & 37).

Rahuri: *Lasiodiplodia theobromae* was grown on potato dextrose agar at three temperature levels viz., 15°C, 25°C and 35°C and found that the temperature range of 25 to 30°C is optimum for the growth of *L. theobromae*.

Mohanpur: Effect of different temperatures on *Diplodia*

sp. growth was studied and the results indicated that the pathogen growth was faster at 35°C. Its cultural characterization on different carbon sources revealed that sucrose followed by dextrose and fructose were found good as carbon source (Fig 38).

Vengurle: *D. natelansis* was grown on potato dextrose agar at three temperature levels viz., 25°C, 30°C and 35°C. Among the different media used, PDA was found to be best supported medium for the growth of *D. natelansis*. However, the maximum (90.00 mm) mycelium growth of *D. natelansis* was recorded at 30°C and minimum (75.00 mm) at 35°C.

All the centres isolated the pathogen associated with the stem end rot of mango (Table 61). After isolation the pathogen was identified as *Botryodiplodia theobromae* (Sabour), *Lasiodiplodia theobromae* (Rahuri and Sangareddy), and *Diplodia sp.* (Anantharajupet, Mohanpur and Vengurle) based on the morphology, cultural characterization on different media and effect of different temperature were studied. Among the various cultural media used, Potato Dextrose Agar (PDA) found to be best supportive medium for growth of the pathogen followed by Richard's agar and Mango leaf extract Agar medium after 120 hrs of incubation (Table 62).

Table-61: Pathogen associated with stem end rot of mango at different centres

Centre name	Associated micro-organism with stem end rot	Secondary infection
Anantharajupet	<i>Diplodia sp.</i>	<i>Aspergillus niger, Alternaria spp</i>
Mohanpur	<i>Diplodia sp.</i>	
Rahuri	<i>Lasiodiplodia theobromae</i>	<i>Colletotrichum gloeosporoides, Alternaria alternata, Aspergillus niger</i>
Sabour	<i>Botryodiplodia theobromae</i>	<i>Aspergillus spp</i>
Sangareddy	<i>Lasiodiplodia theobromae</i>	<i>Alternaria alternate, Aspergillus niger,</i>
Vengurle	<i>Diplodia natelansis</i>	<i>Colletotrichum gloeosporoides, Aspergillus niger</i>

Table-62: Effect of different solid media on growth of the pathogen (mm/hr) at different centres.

Medium	Radial growth rate (mm/hr)					
	Anantharajupet	Mohanpur	Rahuri	Sabour	Sangareddy	Vengurle
	<i>Diplodia sp.</i>		<i>Lasiodiplodia theobromae</i>	<i>Botryodiplodia theobromae</i>	<i>Lasiodiplodia theobromae</i>	<i>Diplodia natelansis</i>
PDA	1.73	1.86	0.96	0.88	0.986	0.84
MLEM	0.98	1.3	0.79	0.68	-	-
RSAM	-	0.83	0.75	0.46	-	0.73

PDA: Potato dextrose medium; MLEM: Mango leaf extract agar medium; RSAM: Richard's synthetic agar medium

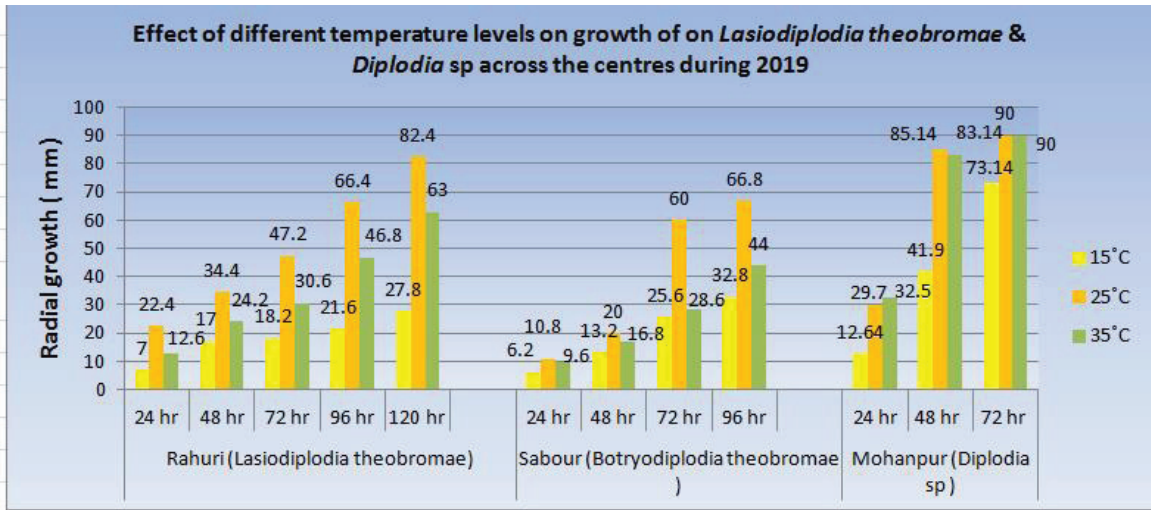


Fig. 36. Effect of different temperature levels of growth of *Lasiodiplodia theobromae* and *Diplodia* sp across the centres

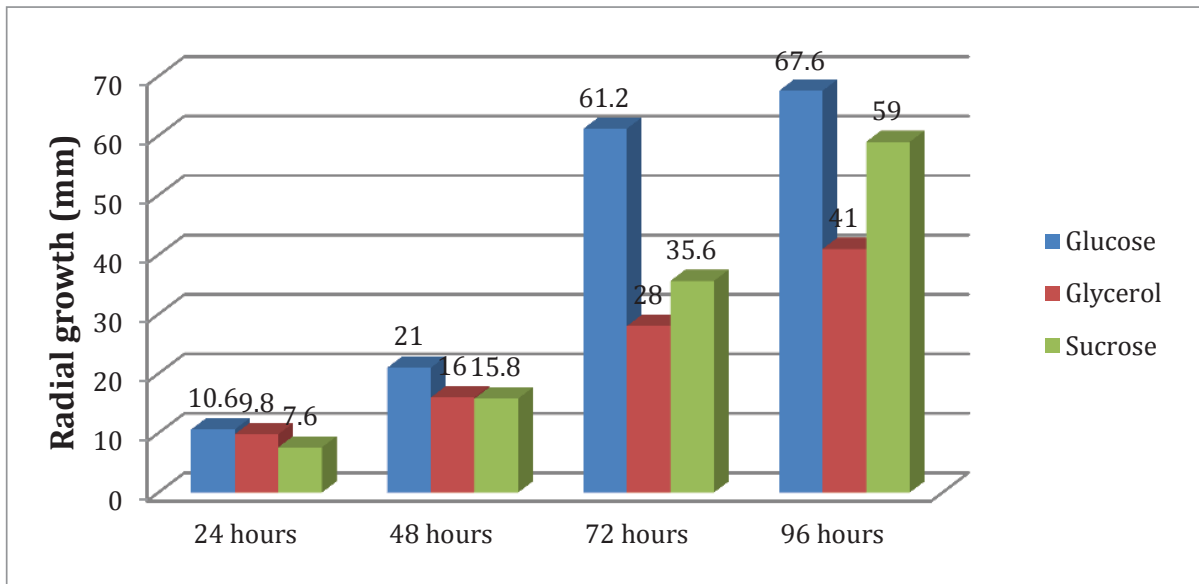


Fig. 37. Effect of different carbon source on the radial growth of *Botrydiploia theobromae* at Sabour

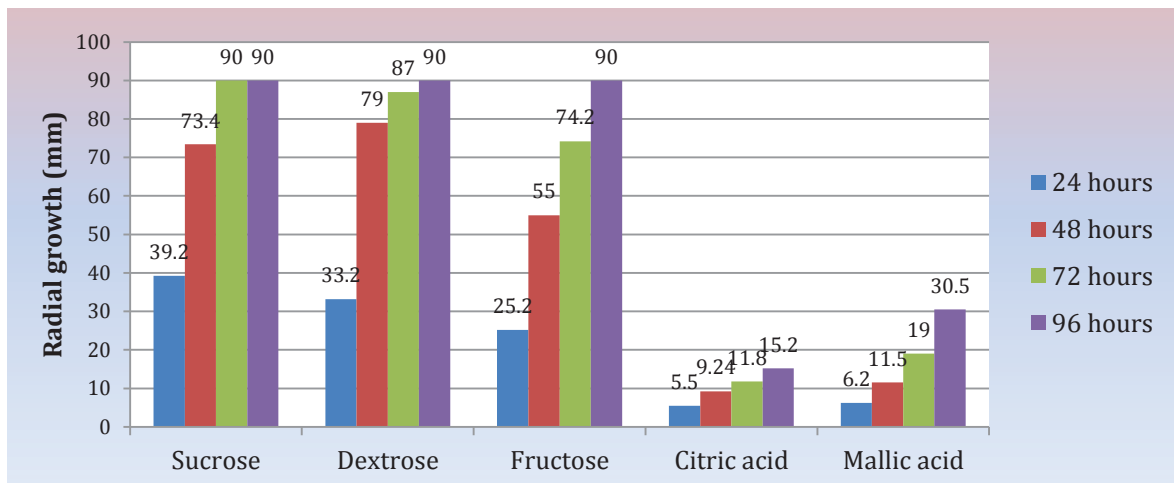


Fig. 38. Effect of different carbon source on the radial growth of *Diplodia* sp on different carbon source at Mohanpur

PAPAYA

1.3.4.P. Multilocation testing of new papaya selection (MLT-1)

Anantharajupet: Planting was done in second fortnight of December, 2019.

Ranchi: The seed of all varieties (PS-1, PS-3, Red Lady and Ranchi Local) were sown in nursery during mid-July and planting was done during first week of September. All the plants were virus free till date (2 MAP).

Coimbatore: The transplanting was done during second fortnight of October, 2019.

Gandevi: The seedlings of all four varieties are prepared and will be planted in October, 2019.

2.3.1.P Validation of protocol for extending papaya seed viability in storage

Seeds of papaya (cv. Arka Prabhath) dried to 6 to 8 per cent moisture level, then sealed in airtight in poly lined aluminium pouches and stored at 15°C and at room temperature (RT) has to be tested in comparison with the local practice (to be defined while presenting) so as to assess the duration of seed viability using this protocol under RT and at low temperature (15°C).

Anantharajupet: The germination (per cent) at 20 days after incubation and seedling vigour index for all the three modules of seeds incubated for germination did not reveal any significant difference during second (15th June 2019) and third (16th September 2019) sets of germination among the modules. Whereas, the seeds subjected to germination at December 2019, (fourth set) which was stored for one year, exhibited significant difference in germination and vigour index among the three modules indicating that method of seed storage affects seed viability in due course of time. The germination (per cent) at 20 days after incubation (in fourth set) was significantly higher in the module I (79.89) which was on par with the module II (77.65) as against the low germination (59.45) in module III. As regards vigour index, similar trend was observed for all the three sets of seeds. In fourth set (December, 2019) significantly high value was recorded in Module I (1605.95), followed by Module II (1539.75) as against control (1147.38).

Bengaluru: Seeds of second (15th June 2019) and

third (16th September 2019) sets did not reveal any significant difference among the modules. While seeds incubated during December 2019, (fourth set) which was stored for one year, exhibited significant difference in germination and vigour index among the three modules. The germination (per cent) at 20 days after incubation was significantly higher in the module I (82.00) which was on par with the module II (77.43) as against the low germination (60.57) in module III. Similar result was obtained for vigour index also (1284.96, 1185.78 and 745.01 respectively, in module I, II and III).

Coimbatore: Seeds of second (15th June 2019) and third (16th September 2019) sets did not reveal any significant difference among the modules. The seeds incubated during December 2019, (fourth set) revealed significant difference in germination and vigour index by registering higher germination (per cent) at 20 days after incubation in the module I (70.00) which was on par with the module II (61.71) as against the low germination (44.29) in module III. The vigour index also, (699.18, 592.0 and 537.83 respectively, in module I, II and III) exhibited similar results (Table 63).

Gandevi: Seeds of second (15th June 2019), third (16th September 2019) and fourth sets (15th December 2019) subjected to germination revealed significant difference in germination per cent and vigour index among all the three modules. In all the three sets, the Module I and Module II registered significantly high germination and vigour index compared to control. In the fourth set (December, 2019) maximum germination (58.29) and vigour index (728.17) was observed in Module I (and on par with Module II) as against local practice, where the seeds lost viability and did not germinate after one year of storage.

Pune: Seeds of second (15th June 2019) and third (16th September 2019) sets did not reveal any significant difference among the modules. While the seeds incubated during December 2019, (fourth set) revealed significant difference in germination and vigour index among the three modules. The Module I registered high (48.62) germination (per cent) at 20 days after incubation which was on par with the module II (48.62) as against the low germination (30.44) in module III. The vigour index also, (1028, 1031 and 388 respectively, in module I, II and III) exhibited similar results.

Table-63: Comparison of seed germination (%) and seedling vigour index among different modules of seed storage in papaya variety Arka Prabhath

Treatment	Germination % (After 20 days)					Seedling Vigour index				
	ANP	BLR	COB	GND	PNG	ANP	BLR	COB	GND	PNG
2nd set (15 th June 2019)										
Module I	78.53	82.86	68.37	70.57	74	1490.42	1291.914	1087.67	1360.86	841
Module II	78.12	83.14	67.19	68.57	72	1579.616	1287.486	1007.18	1323.14	935
Module III	76.14	81.14	67.01	60	67	1362.06	1286.714	939.48	1106.00	837
CD at 5 %	NS	NS	NS	4.2	NS	NS	NS	NS	97.86	NS
3rd set (16 th September 2019)										
Module I	79.59	86.57	67.22	69.43	81	1573.434	1333.49	1065.44	1320.11	1498
Module II	78.57	86.29	66.79	70.57	79	1436.277	1155.31	1001.18	1342.20	1280
Module III	77.86	78.86	64.86	57.43	71	1480.061	1211.34	972.25	1052.11	1255
CD at 5 %	NS	NS	NS	3.75	NS	NS	NS	NS	71.03	23.59
4 th set (15 December 2019)										
Module I	79.89	82.00	70.00	58.29	48.62 (56)	1605.95	1284.96	699.18	728.17	1028
Module II	77.76	77.43	61.71	53.71	48.62 (56)	1539.75	1185.78	592.60	679.31	1031
Module III	59.45	60.57	44.29	0.00	30.44 (26)	1147.38	745.01	537.83	0.00	388
CD at 5 %	6.38	7.33	15.1	5.42	0.66	50.26	30.95	94.7	108.96	24.4

ANP: Anantharajupet, BLR: Bengaluru, COB: Coimbatore, GND: Gandevi, PNG: Pune

3.3.4. P. Evaluation of Arka Microbial Consortium (AMC) for growth and yield of papaya

Existing papaya orchard with two months old plants are taken as the experimental material and 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 biofertilization. Application of microbial consortium was done two -three weeks after application of chemical fertilizers.

Anantharajupet: Plant yield parameters viz., number of fruits (35.26), fruit weight (1.16 kg), yield (40.90 kg/plant) and TSS (12.18°B) were recorded maximum in 75 per cent recommended dose of N and P Fertilizers + AMC application @ 5 kg/acre twice a year along with FYM.

Coimbatore: The second trial was initiated with the variety TNAU papaya CO-8 during August, 2019 and the crop is in flowering stage.

Ranchi: The second trial was taken up with the

variety Red Lady during July, 2019 and the crop is in vegetative phase.

Pune: The first trial was taken up with the variety, Pune Selection 3. The treatment, 75 per cent recommended dose of N and P Fertilizers + AMC application @ 5 kg/ acre twice a year through biofertilization performed better for number of fruits per plant (28.22), however, no significant difference in yield parameters was observed. The second trial has been initiated during mid-August, 2019 as per revised technical programme (Table 64 & 65).

Gandevi: The first trial initiated during September, 2017 with the variety Red Lady was vitiated due to heavy rainfall (June-July, 2018) at maturity stage of crop. Therefore, new trial was initiated with the variety Red Lady during October, 2018. The results indicated that among the treatments, 100 per cent RDF + *Azospirillum* (20 g) twice at planting and 6 MAP + PSB (20 g/plant) twice at planting and 6 MAP was recorded maximum number of fruits (42.00), yield (40.02 kg/plant), pulp thickness (2.47 cm) and TSS (11.07°B).

Table-64: Effect of Arka Microbial Consortium (AMC) on yield and its attributes of papaya

Treatments	Fruits/plant			Fruit weight (g)			Yield (kg/plant)		
	ANP	Gandevi	Pune	ANP	Gandevi	Pune	ANP	Gandevi	Pune
T ₁	32.89	27.00	23.97	1.09	0.98	1.15	35.85	26.30	27.80
T ₂	34.46	36.13	28.22	1.11	0.94	1.06	38.25	33.87	29.59
T	35.26	35.88	24.56	1.16	0.99	1.20	40.90	35.62	29.62
T ₄	35.98	41.13	-	1.19	0.83	-	42.81	33.91	-
T ₅	35.09	42.00	-	1.17	0.95	-	41.05	40.02	-
CD at 5%	1.27	2.15	1.097	0.06	NS	NS	1.84	4.63	NS

Anantharajupet (ANP)(Red Lady); Gandevi (Red Lady); Pune (Pusa Selection 3)

Treatments	Fruits/plant			Fruit weight (g)			Yield (kg/plant)		
	ANP	Gandevi	Pune	ANP	Gandevi	Pune	ANP	Gandevi	Pune
Treatment details: T ₁ : 100 % Recommended Dose of Fertilizers; T ₂ : 75% Recommended Dose of N and P Fertilizers + AMC application @ 5 kg/acre twice a year through biofertiligation ; T ₃ : 75% Recommended Dose of N and P Fertilizers + AMC application @ 5 kg/acre twice a year along FYM; T ₄ : 100% RDF along + AM fungi (50g/plant) + PSB (25g/plant) + Azospirillum (50g/plant) + Trichoderma harzianum (50g/plant); T ₅ : 100% RDF + Azospirillum (20 g) twice at planting and 6 MAP + PSB (20 g/plant) twice at planting and 6 MAP AMC application can be done at the onset of S. W. and N. E. monsoons that prevail in Coimbatore conditions.									

Table-65: Effect of Arka Microbial Consortium (AMC) on quality attributes of papaya

Treatments	Cavity index (%)		Pulp thickness (cm)			TSS (°B)		
	ANP	Pune	ANP	Gandevi	Pune	ANP	Gandevi	Pune
T ₁	28.35	23.36	2.78	2.10	3.02	11.01	10.20	8.15
T ₂	25.68	22.76	2.91	2.23	3.18	11.63	9.92	8.16
T ₃	26.72	22.41	2.89	2.00	3.11	12.18	10.10	8.36
T ₄	27.52	-	2.95	1.97	-	12.01	10.43	-
T ₅	28.10	-	3.00	2.47	-	11.98	11.07	-
CD at 5%	1.42	NS	NS	0.24	NS	0.48	0.52	NS

Anantharajupet (ANP)(Red Lady); Gandevi (Red Lady); Pune (Pusa Selection 3)

Treatment details: T₁: 100 % Recommended Dose of Fertilizers; T₂: 75% Recommended Dose of N and P Fertilizers + AMC application @ 5 kg/acre twice a year through biofertiligation ; T₃: 75% Recommended Dose of N and P Fertilizers + AMC application @ 5 kg/acre twice a year along FYM; T₄: 100% RDF along + AM fungi (50g/plant) + PSB (25g/plant) + Azospirillum (50g/plant) + Trichoderma harzianum (50g/plant); T₅: 100% RDF + Azospirillum (20 g) twice at planting and 6 MAP + PSB (20 g/plant) twice at planting and 6 MAP AMC application can be done at the onset of S. W. and N. E. monsoons that prevail in Coimbatore conditions.

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 second trial was taken up with the variety Red Lady. Raised bed cultivation + drip irrigation (80% ER) + fertigation (75% RDF) + micro nutrient spray ZnSO₄ 0.5% + boric acid (0.2%) at alternate months was found to be superior for fruit weight (1.17 kg), number of fruits (36.52), fruit length (16.54 cm), yield (42.74 kg/plant ; 128.22 t/ha), TSS (12.32°B) and pulp thickness (3.08 cm) and highest B:C ratio (1.95) compare to control (0.78 kg, 34.68, 13.89 cm, 34.33 kg/plant and 2.12 cm respectively)

Coimbatore: The third trial was taken up with the variety TNAU papaya CO.8. Among the treatments, fruit yield, fruit weight, number of fruits per tree, pulp thickness and TSS was highest (62.78 kg/plant ; 174.50 t/ha, 1.72 kg, 37.90, 2.51 cm and 13.01 °B respectively) in raised bed cultivation + drip irrigation (80% ER) + fertigation (75% RDF) +

micro nutrient spray ZnSO₄ 0.5% + boric acid (0.2%) at alternate months compare to control (41.70 kg/plant, 1.39 kg, 30 and 2.30 respectively).

Pusa: The third and confirmation trial was taken up with the variety Red Lady. Among the treatments imposed, highest yield (62.38 kg/plant ; 176.52 t/ha), number of fruits per plant (32.40), fruit weight (1.96 kg), cavity index (41.36), pulp thickness (2.96 cm) and BC ratio (2.81) 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 and the treatment T₄ (raised bed cultivation + drip irrigation (80% ER at all stages) + micronutrient spray (ZnSO₄ (0.5%) + boric acid (0.2%) alternate months from second month) recorded lesser days to flowering from date of transplanting (114.00 days) (Fig. 39).

At all the three centres viz., Anantharajupet, Coimbatore and Pusa, the treatment T₃ (Raised bed cultivation + Drip irrigation (80% ER) + Fertigation (75% RDF) + micro nutrient spray ZnSO₄ 0.5% + boric acid (0.2%) at alternate months) recorded the highest yield along with favourable fruit attributes (Table 66 & 67).

Table-66: Effect of input treatments on yield and quality attributes of papaya variety at different centres

Treatments	Fruits /plant			Yield (kg/plant)			TSS (°B)		
	ANP	COB	Pusa	ANP	COB	Pusa	ANP	COB	Pusa
T ₁	36.01	34.80	30.16	40.33	57.42	52.06	12.2	12.58	15.61
T ₂	35.83	32.20	26.32	39.05	52.16	43.61	12.0	12.35	12.84

Treatments	Fruits /plant			Yield (kg/plant)			TSS (°B)		
	ANP	COB	Pusa	ANP	COB	Pusa	ANP	COB	Pusa
T ₃	36.52	37.90	32.40	42.74	62.78	62.38	12.3	13.01	13.72
T ₄	36.33	31.10	21.54	36.69	44.47	31.72	11.2	12.08	12.40
T ₅	34.68	30.00	18.16	34.33	41.70	26.20	11.8	11.98	12.51
CD at 5%	1.02	7.83	1.25	2.24	22.14	1.37	-	0.40	0.21

Anantharajupet (ANP) (Red Lady), Coimbatore (COB) (CO-8), Pusa (Red Lady)

Treatment details: T₁: Raised Bed cultivation (RBC) + 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. Prepare separately and mix the micro nutrient solution (MN Spray); T₂: Raised Bed cultivation (RBC) + Drip irrigation (80% ER at all stages) + Fertigation (75% RDF) + Mulching with 100-micron UV stabilized black polyethylene; T₃: Raised Bed cultivation (RBC) + Drip irrigation (80% ER at all stages) + Fertigation (75% RDF) + Micronutrient spray {(ZnSO₄ (0.5%) + Boric acid (0.2%)) alternate months from second month. Prepare separately and mix the micro nutrient solution (MN Spray); T₄: Raised Bed cultivation (RBC) + Drip irrigation (80% ER at all stages) + Micronutrient spray {(ZnSO₄ (0.5%) + Boric acid (0.2%)) alternate months from second month. Prepare separately and mix the micro nutrient solution (MN Spray); T₅: Control

Table-67: Effect of input treatments on fruit attributes of papaya variety at different centres

Treatments	Fruits weight (kg)			Pulp thickness (cm)			Cavity index (%)		
	ANP	COB	Pusa	ANP	COB	Pusa	ANP	COB	Pusa
T ₁	1.12	1.65	1.80	3.10	2.41	2.51	27.44	41.66	45.31
T ₂	1.09	1.62	1.72	2.97	2.32	2.42	28.86	38.18	54.29
T ₃	1.17	1.72	1.96	3.08	2.51	2.69	30.52	34.42	41.36
T ₄	1.01	1.43	1.46	2.65	2.32	2.27	29.58	42.34	48.43
T ₅	0.78	1.39	1.28	2.12	2.30	2.31	26.32	43.67	57.21
CD at 5%	0.083	0.31	0.12	0.55	0.18	1.24	2.88	7.49	0.61

Anantharajupet (Red Lady), Coimbatore (CO-8), Pusa (Red Lady)

Treatment details: T₁: Raised Bed cultivation (RBC) + 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. Prepare separately and mix the micro nutrient solution (MN Spray); T₂: Raised Bed cultivation (RBC) + Drip irrigation (80% ER at all stages) + Fertigation (75% RDF) + Mulching with 100-micron UV stabilized black polyethylene; T₃: Raised Bed cultivation (RBC) + Drip irrigation (80% ER at all stages) + Fertigation (75% RDF) + Micronutrient spray {(ZnSO₄ (0.5%) + Boric acid (0.2%)) alternate months from second month. Prepare separately and mix the micro nutrient solution (MN Spray); T₄: Raised Bed cultivation (RBC) + Drip irrigation (80% ER at all stages) + Micronutrient spray {(ZnSO₄ (0.5%) + Boric acid (0.2%)) alternate months from second month. Prepare separately and mix the micro nutrient solution (MN Spray); T₅: Control

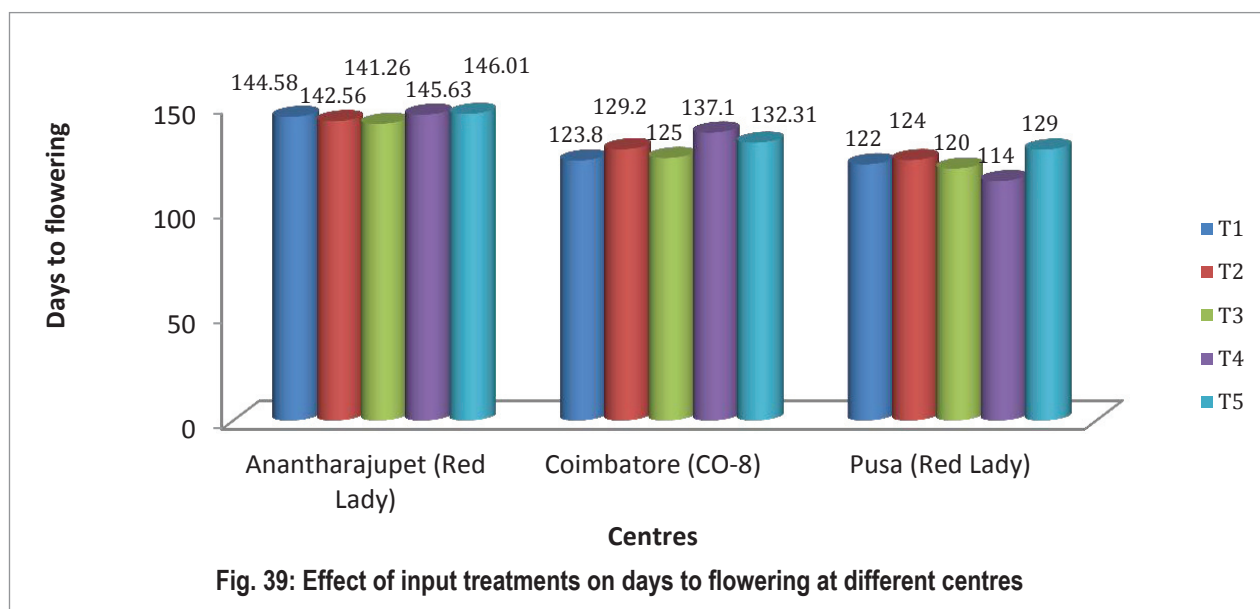


Fig. 39: Effect of input treatments on days to flowering at different centres

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 but for the total rainfall which was high during August, 2019 (221.3 mm) and October, 2019 (246.9 mm). 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 TNAU Papaya Co 8, days to flower was recorded as 122-135 days from transplanting in main field and fruit yield in the range of 34-37 kg per plant, TSS as 11-12°B and acidity as 0.14 - 0.16 per cent. PRSV incidence was recorded as 74-80 per cent.

Pune: Maximum fruit yield was obtained in Co.2 (26 kg/plant) and the lowest in Pusa Dwarf (8 kg/plant). Average number of fruits per plant was highest in Pusa Delicious (24) and lowest in Pusa Dwarf (7). Average fruit weight was the lowest in Pusa Delicious (865 g) and the highest in Co 6 (1312 g). Pulp thickness was highest in Pusa Delicious (3.50 cm) and minimum in red Lady (2.50 cm). The highest TSS (9.67°B) was found in Pusa Nanha and the lowest in Pusa Dwarf (7.50°B)

Pusa: Days to flower from transplanting was recorded as 174.1 days, days to fruit maturity from fruit set recorded as 123.7 days and fruit yield was in the

range of 15-35 kg per tree, fruit quality parameters were recorded as TSS 13.7-18.2°B, acidity as 0.59 per cent and shelf life as 4-7 days.

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.

Anantharajupet: Cultivar Red Lady grown under net house condition performed better for yield (Table 68 & 69) characters viz., number of fruits (60.15) and yield (45.90 kg/plant; 137.70 t/ha) as compared to open field conditions (57.38 and 32.21 kg/plant; 96.63 t/ha).

Coimbatore: The trial was taken with the variety TNAU Papaya CO8. Plants are in flowering phase. In all the three locations, it is observed that net house is able to significantly protect the plants from PRSV incidence (Fig 40).

Gandevi: The second trial was taken up with the cv. Red Lady. The plants grown under net house recorded maximum number of fruits (53.64) and yield (43.30 kg/plant; 98.20 t/ha) when compared to open cultivation (Table 70).

The results of the first trial from all the three centres and second trial in Anantharajupet and Gandevi indicated that PRSV incidence could be prevented under net house condition. The plants under net house performed better for yield and quality attributes. The second trial is in progress at Coimbatore [Plate 8-10].



Plate : 8 PRSV management through Net house cultivation



Plate .9 : Open field view



Plate .10 : Net house view

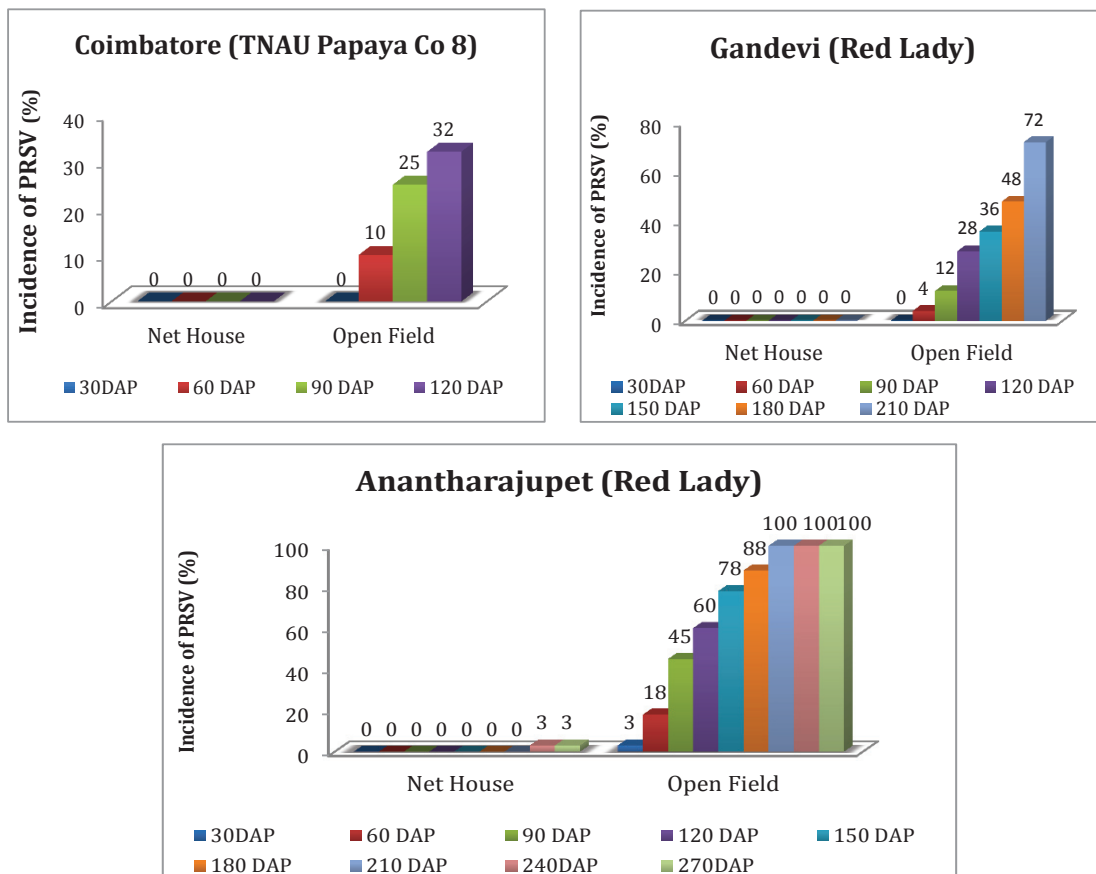


Fig. 40 Incidence of PRSV under net house and open field cultivation (%)

Table-68: Performance of papaya under net house and open filed cultivation for yield attributes at Anantharajupet

Treatments/ Character	Fruits/ tree	Fruit weight (kg)	Number of marketable fruits	Number of un marketable fruits	Marketable yield (kg/tree)
T ₁ : Net house	60.15	1.22	37.63	22.52	45.90
T ₂ : Open field	57.38	0.97	33.21	25.59	32.21
Two sample t-test	2.12*	0.54*	3.26*	2.89*	11.28*

*Significant at 5% level

Table-69: Performance of papaya under net house and open filed cultivation for yield attributes at Anantharajupet

Treatments/ Character	Total yield (t/ha)	Pulp thickness (cm)	Cavity index (%)	TSS (°B)	Acidity (%)
T ₁ : Net house	137.70	3.10	28.58	12.28	0.25
T ₂ : Open field	96.63	2.90	26.45	10.96	0.38
Two sample t-test	21.86*	NS	1.89*	0.98*	NS

*Significant at 5% level

Table-70: Performance of papaya under net house and open field cultivation for yield attributes at Gandevi

Treatment	Fruits/tree	Fruit weight (kg)	Yield (kg/tree)	Yield (t/ha)	TSS (°B)
T ₁ : Net house	53.64	0.81	43.30	98.20	6.8
T ₂ : Open field	37.96	0.80	30.58	69.36	6.2
Two sample t-test	12.34**	NS	7.53**	7.30**	NS

* Significant at 5% level

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: No new disease was recorded during period under report. Among fungal diseases collar rot (5-15%), fruit rot (10-15%) were recorded. Powdery mildew disease was also observed but incidence was very low (1%). Among viral disease PRSV incidence was 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 papaya leaf curl incidence was observed which were already reported. In all the places irrespective of variety, PRSV incidence ranged from 20 - 90 per cent. Papaya leaf curl incidence varied between 5 and 10 per cent in cv Red lady in Arachaloor of Erode district. *Cercospora* leaf spot intensity ranged from 10.15 - 25.50 PDI and it was observed in cv CO 8 and Red Lady during reporting period. *Phytophthora* rot (5%), Bacterial crown rot (5%) and Black leaf spot were also recorded in CO 8. Black leaf spot of Papaya was observed in Coimbatore district with 5 per cent incidence and 2 per cent incidence in Erode district. Isolation of causal agent was carried out. Pathogenicity test was confirmed. Culture identification by molecular

methods was done.

Gandevi: No new / 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 severity of fruit rot (5-8%) and collar rot (5-6%) was low and occurred infrequently. The incidence of fruit rot and collar rot was low in severity and occurred infrequently. There is no major change in incidence of diseases in current year as compare 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 reporting period. Highest incidence was observed in case of root rot (70-80%) while fruit rot and collar rot showed less than 15 per cent incidence in area under survey. The incidence of PRSV was found between 70 to 100 per cent; while leaf curl showed less than 1-2 per cent incidence only. Fruit rot, collar rot and leaf curl showed decreasing trend whereas PRSV and root rot showed increasing trend in comparison to previous year (Table 71 & 72).

Table-71: 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	-	70-100 (80-100)
Powdery mildew	1 (2-5)	-	-	1-2 (0-1)
PRSV	45-100 (100)	20-90 (60-90)	85-90 (91-100)	-
Leaf curl	1-20 (10-20)	5-10 (1.0)	-	-

Table-72: 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

1.4.4. S Widening the genetic base in sapota

In order to widen the genetic base of sapota, selfing the flowers of important commercial varieties (Cricket Ball for Arabhavi, Kalipatti for Gandevi, Pala for Kovvur and PKM-1 for Periyakulam) was undertaken. The seedlings of these half-sibs were

planted for further evaluation to select superior types.

Half-sibs were raised and planted during June to October, 2014 in all the four centres for further evaluation to select superior types. The plants are still in vegetative stage and plant morphological parameters were observed (Table 73).

Table-73: Plant morphological characters of Sapota half sibs

Parameters	Arabhavi (Cricket Ball)	Gandevi (Kalipatti)	Kovvur (Pala)	Periyakulam (PKM 1)
Plant height (m)	0.82 to 1.52	1.6 to 3.6	1.77 to 3.86	0.87 to 2.90
Stem girth (cm)	18 to 24	14 to 30	28 to 41	14 to 20
Internodal length (cm)	10 to 21	12 to 36	24.10 to 65.12	11 to 25
Canopy volume (m ³)	0.25 to 0.54	1.22 to 9.18	1.20 to 10.54	0.64 to 5.56

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 7m x 7m spacing. The trial was carried out using RBD with 3 replications.

Arabhavi: The planting was done during August to September, 2017.

Kovvur: Planting material were collected from respective centres and the trial was initiated during June 2017. The experiment is in initial stage.

Gandevi: New hybrid grafts were prepared and planted during June-July, 2017. Plants are in vegetative stage.

Periyakulam: All the four varieties were planted in the main field during September, 2017 and maintained as per the recommendations given in the TNAU crop production guide. The experiment is in initial 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 not imposed on trees since their canopy is far apart. However, higher yield of 70.5 kg per tree having 795 fruits per tree was observed in S_1P_3 (10 x 10m spacing).

Gandevi: The variety used for the trial is Kalipatti. Trees are in vegetative stage and showed significant differences for plant height and canopy volume. Highest plant height (3.4m) and canopy volume (10.6m³) was recorded in S_1P_3 (10 X10m spacing).

Kovvur: The variety used for the trial is Kalipatti. Higher yield of 25.4 kg/tree having 369.4 fruits/tree were observed in S_1P_2 (10 X10m spacing). Based on

the number of trees per hectare maximum yield of 5.4 t/ha was observed in 6 x 6m spaced trees pruned to a gap of 1m between the trees.

Periyakulam: The variety PKM-1 spaced at 10 X 10 m recorded maximum yield of 83.5 kg/tree with 1025.4 fruits per tree. Pruning has not been initiated so far since the tree canopy is far apart.

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 1) higher yield (60.52 kg/tree with 852 fruits/tree having 80 g fruit weight) on 42 years old sapota cv. Cricket ball (10 x 10 m spacing) over control (32.20 kg tree with 519 fruits/tree having 68.00 g fruit weight).

Gandevi: Center opening along with cutting of cross branches at 10x10 m spacing (Table 1) has recorded higher yield (156.70 kg/tree with 1587.3 fruits/tree having 99.70 g fruit weight) on 37 years old sapota cv. Kalipatti (10 x 10 m spacing) compared to control (80.24 kg tree with 1067.96 fruits/tree having 75.20 g fruit weight)

Periyakulam: Center opening along with cutting of cross branches at 10x10 m spacing has recorded higher yield (262.93 kg/tree with 3240. fruits/tree having 81.15 g fruit weight) on sapota cv. PKM-1 compared to control (191.62 kg yield/tree with 2438.00 tree having 78.60 g fruit weight) (Table 74).

Table-74: Effect of rejuvenation on yield of sapota at normal spacing

Treatments*	Fruits/ tree			Yield (kg/tree)			Fruit weight (g)		
	ARB	GND	PKM	ARB	GND	PKM	ARB	GND	PKM
T ₁	815.0 ^b	1068.4 ^b	2415 ^b	52.64 ^b	91.87 ^b	191.27 ^{ba}	76.0 ^a	85.84 ^b	79.20 ^a
T ₂	805.0 ^c	1515.8 ^a	2385 ^b	48.20 ^b	135.83 ^a	182.45 ^c	74.0 ^b	88.96 ^b	76.50 ^c
T ₃	852.0 ^a	1587.3 ^a	3240 ^a	60.52 ^a	156.70 ^a	262.93 ^a	80.0 ^a	99.70 ^a	81.15 ^b
T ₄	519.0 ^b	1067.0 ^b	2438 ^b	32.20 ^c	80.24 ^b	191.62 ^b	68.0 ^c	75.20 ^c	78.60 ^d
CD at 5%	8.32	419.57	76.85	4.45	36.80	10.25	4.17	6.98	2.16

*T₁: Topping Terminal Growth of 0.5 m; T₂: Topping Terminal Growth of 1.0 m; T₃: Center opening along with cutting of cross branches; T₄: Control.

#ARB: Arabhavi (Cricket ball - 10x10 m), GND: Gandevi (Kalipatti - 10x10 m) and PKM: Periyakulam (PKM-1-10x10 m).

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 $1/8^{\text{th}}$ 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. The yield attributes recorded were non-significant. (Table 75).

Gandevi: The experiment was initiated with cv. Kalipatti during January 2012. The trees under

experiment are 8 years old and non-significant results were observed at early stage of growth.

Kovvur: The trees under experiment are 9 years old and non-significant results were observed at early fruit bearing stage in cv. Kalipatti (Table 75).

Periyakulam: The trial was initiated in end of 2007 with cv. PKM-1. Higher yield number of fruits (1162.50) and fruit yield (98.85 kg/tree/year) was recorded with $1/8^{\text{th}}$ RDF with 100% application to 12 years old trees (Table 75).

Table-75: Effect of residual and cumulative nutrients on yield parameters of sapota

Treatments	Fruits/ tree			Fruit Yield (kg/ tree)			Mean fruit weight (g)		
	ARB	KVR	PKM	ARB	KVR	PKM	ARB	KVR	PKM
T ₁ : A ₁ B ₁	830.33 ^a	362.55 ^a	1053.13 ^b	60.12 ^a	26.33 ^a	86.96 ^b	74.00	73.85	82.57
T ₂ : A ₁ B ₂	828.00 ^a	470.00 ^a	883.47 ^f	61.24 ^a	34.76 ^a	71.47 ^f	75.00	76.96	80.90
T ₃ : A ₁ B ₃	836.00 ^a	511.11 ^a	784.96 ^h	61.18 ^a	38.80 ^a	62.47 ^h	75.00	75.64	79.59
T ₄ : A ₂ B ₁	909.33 ^a	508.33 ^a	1012.60 ^c	67.72 ^a	46.33 ^a	81.98 ^c	76.00	92.10	80.96
T ₅ : A ₂ B ₂	903.66 ^a	563.89 ^a	959.50 ^d	68.42 ^a	40.89 ^a	75.50 ^d	77.00	71.64	78.70
T ₆ : A ₂ B ₃	912.00 ^a	383.33 ^a	845.42 ^g	68.82 ^a	27.40 ^a	67.87 ^g	77.00	71.13	80.28
T ₇ : A ₃ B ₁	953.00 ^a	548.89 ^a	1162.50 ^a	78.76 ^a	35.76 ^a	98.85 ^a	84.00	67.84	85.12
T ₈ : A ₃ B ₂	910.66 ^a	511.66 ^a	915.13 ^e	71.14 ^a	34.28 ^a	73.90 ^e	80.00	69.52	80.75
T ₉ : A ₃ B ₃	870.66 ^a	516.66 ^a	835.12 ^g	62.42 ^a	33.08 ^a	62.07 ^h	74	64.12	74.32
CD at 5%	NS	NS	20.73	NS	NS	1.88	NS	NS	1.58

ARB: Arabhavi (Kalipatti – 10x10 m), GND: Gandevi (Kalipatti – 10x10 m), KVR: Kovvur (Kalipatti – 10x10 m) and PKM: Periyakulam (PKM-1 - 8x8 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.

Per cent nutrients of RDF				
Treatments	Stages of crop growth			
	I Vegetative flush (July)	II Fruit set (September)	III Fruit growth (November)	IV Fruit growth (February)
	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

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 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 (10^8 cfu/mg) applied during the months of July, September, November and February recorded (Table 2) significantly higher yield 50.83 (kg/tree) and 47.78 kg/tree during summer and winter crop respectively.

Whereas, fruits per tree was non-significant for both season crops.

Gandevi: No significant differences were observed for growth and yield parameters among the treatments for summer crop. However, significant higher yield /tree (189.25 kg/tree) was recorded in winter crop when sapota trees applied 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. (Table 77).

Kovvur: No significant differences were observed for growth and yield parameters among the treatment. However, significant highest number of fruits (1783.06 fruits/tree) were recorded in trees applied with NPK in the ratio of 20-40-32, 20-0-16, 20-40-16 and 20-0-16 during summer crop. (Table 76).

Periyakulam: Application of N-P₂O₅-K₂O 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 has recorded (Table 76) highest number of fruits per tree (1192) and fruit yield (98.01 kg/tree) in summer crop and 975 fruits/tree and 80.19 kg/tree in winter crop respectively. However, the Fruits per tree for winter crop was non-significant.

Table-76: Effect of stage wise application nutrients in sapota at different AICRP (Fruits) centres

Treatments	Kovvur				Periyakulam			
	Summer crop (Mar-July)		Winter crop (Sept-Feb)		Summer crop (Mar-July)		Winter crop (Sept-Feb)	
	Fruits/tree	Yield (Kg/tree)	Fruits/tree	Yield (Kg/tree)	Fruits/tree	Yield (Kg/tree)	Fruits/tree	Yield (Kg/tree)
T ₁	1131.58	82.85	405.49	29.69	1192	98.01	975	80.19
T ₂	1783.06	64.65	989.18	35.86	1162	92.95	950	76.07
T ₃	943.60	81.90	271.71	23.58	1065	83.2	872	68.07
T ₄	1117.81	94.83	315.65	26.78	1125	89.30	921	73.06
T ₅	1005.97	76.72	472.34	36.02	1105	84.47	905	69.11
CD at 5%	513.07	NS	NS	NS	79.98	79.98	NS	2.63

Table-77: Effect of stage wise application nutrients in sapota at different AICRP (Fruits) centres

Treatments	Gandevi				Arabhavi			
	Summer crop (Mar-July)		Winter crop (Sept-Feb)		Summer crop (Mar-July)		Winter crop (Sept-Feb)	
	Fruits/tree	Yield (Kg/tree)	Fruits/tree	Yield (Kg/tree)	Fruits/tree	Yield (Kg/tree)	Fruits/tree	Yield (Kg/tree)
T ₁	1244.90	131.90	2268.00	189.25	604	41.97	576.25	41.24
T ₂	946.50	85.20	2020.00	142.94	611	44.79	585.25	43.43
T ₃	1189.60	105.82	2028.70	163.78	667	50.83	613	47.78
T ₄	1129.60	107.89	2292.70	177.33	673	50.4	583	43.4
T ₅	1222.80	110.35	2093.5	139.87	585.5	41.36	523	36.27
CD at 5%	NS	NS	NS	21.99	NS	5.81	NS	4.85

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, evapotranspiration 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: The PDI of Phaeophleospora leaf spot was maximum in October 2018 (30.16) but during May 2019, least incidence was noticed. With regard to leaf webber incidence, it was maximum (3.50%) during September, 2019 however, least incidence of 1.00% was observed during October, December in 2018 and May 2019. The budworm incidence was maximum (4.50%) in April, 2019. The maximum incidence of bark eating caterpillar was 2.60%, during October, 2018. The occurrence of ash weevil was also noticed which was maximum (2.50%) during July, 2019. The

fruitfly incidence was maximum (4.00%) during April and August, 2019.

Gandevi: The highest new flush emergence and flowering (62.77%) was found during December, 2018 and later during March, 2019 (54.44%). There was no flowering during July and August months. Whereas, the highest TSS (20.0) was recorded during April, 2019. During the observation period, the sapota trees go through flowering and fruiting period. There were no extreme weather conditions occurred during flowering and fruiting stages of the tree.

Kovvur: Rugose whitefly incidence started in the month of August 2018 was peak during Jan-Feb 2019 and then started receding once temperatures started to rise from March 2019 onwards. With the onset of monsoon, the complete washout of rugose whitefly was observed and only remnants of rugose and sooty mould is observed during Sept 2019.

Periyakulam: Maximum flowering percentage was observed during April (48%) followed by May (34%).

Regarding emergence of new flushes, February (65.4) followed by August (55.5) month registered higher values over other months. The major sapota growing areas in Tamil Nadu was surveyed for the identification of emerging pest and natural enemies in sapota ecosystem and it was found that the sapota leaf webber damage was noticed to the extent of 17.55%, bud borer damage observed up to 11.20% and the seed borer incidence as (8.17%) which was low. In the 20 randomly selected trees the sapota chiku moth damage was observed in the range of 6.12 to 23.25 per cent and it was higher during the months of April and September 2019. The overall mean damage due to budworm was 8.89 per cent. The sapota seed borer damage was noticed to the extent of 8.57%. The fruit fly adults catch per trap was ranged from 3.0 to 9.8.

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 (Fig. 41) 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.

Gandevi: Fixed plot survey results indicated that bud borer (*Anarsia achrasella*), infestation was high during June 2019 (15.63%). Chiku moth infestation was observed during December (12.44%) in high and low in August (2.92%). Peak activity of seed borer was registered in December (11.0%). Midrib folder was noticed high during December (11.85%). Chiku moth infestation indicated negative influence of relative humidity. The parasitization of *Apanteles taragamae* was reported up to 10-25% from the early instar larvae of midrib folder on sapota (Table 78). Natural enemies like dragonfly, damselfly and lady bird beetle were also observed during the cropping season.

Periyakulam: Fixed plot survey results indicated bud borer infestation was peak in August (13.27%) and chiku moth infestation was severe during April – August (15.67 – 23.25%). Moderate infestation of seed borer was registered during July with 8.57 per cent infestation (Table 78). Activities of natural enemies like dragonfly, damselfly and lady bird beetle were also observed on sapota.

Ludhiana: Sapota bud borer, *Anarsia* sp., sapota leaf roller, mealy bug, fruit mite and leaf miner, fruit flies, *Bactrocera dorsalis* and *B. zonata* incidence were found in sapota growing areas. *Podagrion* sp. (Hymenoptera: Torymidae), parasitoid was reared from larva of Sapota leaf webber. Parasitoid, *Xanthopimpla* sp. was recovered from larvae of sapota leaf webber. *Apanteles* sp. has been recorded as a natural enemy of sapota fruit borer (Table 78).

Table-78: Status of sapota insect pests incidence at different centres under roving survey (April to December, 2019)

Insect pests	Insect pests infestation (%)					
	Gandevi		Ludhiana		Periyakulam	
	Past incidence reported	Current status	Past incidence reported	Current status	Past incidence reported	Current status
New and Emerging pest	-	-	-	-	-	-
Major pests:						
Bud borer [<i>Anarsia achrasella</i> Bradley]	15-20	18-22	-	1.0	15.32	11.20
Chiku moth [<i>Nephopteryz eugraphella</i> (Ragonot)]	10-15	15-18	-		25.15	17.55
Seed borer [<i>Trymalitis margariae</i> Meyrick]	10-12	15-18	-		7.15	8.17
Fruit fly [<i>Bactrocera dorsalis</i> , <i>B. zonata</i> and <i>B. correcta</i>]	4-6	4-7	2.25	<1.0	1.45	1.65
Midrib folder [<i>Banisia myrsusales elearalis</i> (Walker)]	15-20	15-18	-		1.47	1.75
Minor Pests:						
Leaf miner [<i>Acrocerops gemoniella</i> Stainton]	2-5	2-3	-	5.0	5.45	1.51

Insect pests	Insect pests infestation (%)					
	Gandevi		Ludhiana		Periyakulam	
	Past incidence reported	Current status	Past incidence reported	Current status	Past incidence reported	Current status
Mealy bug [<i>Ferrisia virgata</i>] & mango mealybug, <i>Drosicha</i> sp.]	-	-	-	Low	2.15	1.27
Fruit borer [<i>Phycita erythrophia</i> Hampson & <i>Conogethes</i> spp.]	5-6	4-5	-	1.0	Low	Low

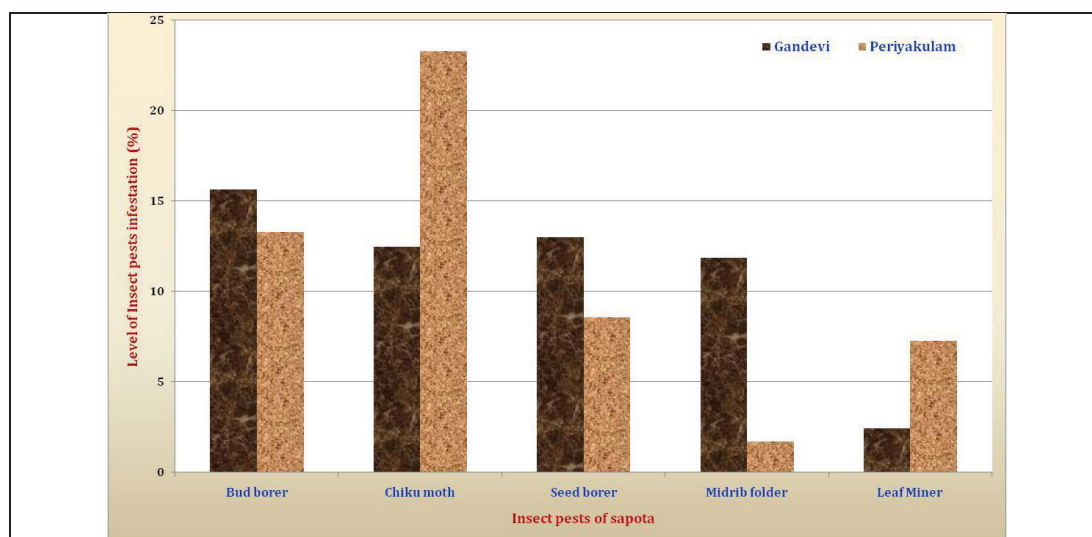


Fig 41. Peak activity of various insect posts of sapota at different centres under fixed plot survey (April 2019 to December 2019)

5.4.7.S: Assessment of losses due to seed borer in different varieties of sapota seed borer

Trial was evaluated to assess the extent of fruit losses caused by seed borer, *Trymalitis margarias* at harvest in 13 varieties/hybrids of sapota.

Gandevi: The loss of marketable fruits due to seed borer fruit infestation was maximum during December at commencement of new fruiting season in Kalipatti, Cricket ball and Kirthibarathi, whereas it was higher during February in DHS-2 at middle fruit harvesting stage. However, lower fruit infestation was recorded in CO-1 that was on par with CO-3, PKM-3 and PKM-4.

Periyakulam: The fruit loss due to seed borer was maximum in Kirthibarathi during November, while it was also higher in DHS-1 and DHS-2 during December. However, lower infestation of seed borer was observed in PKM-2, Kalipatti, PKM-1, CO-3 and CO-1.

5.4.8. S: Management of seed borer in sapota

Experiments were carried out in randomized block design comprising three treatments with seven replications planted at 10 x 10 m spacing at Gandevi and 8 x 8 m at Periyakulam. The new management schedule was compared with local practice against

seed borer to know the extent of damage and to identify effective module for their management.

Gandevi: Four alternate applications of profenophos @ 1.5 ml/l followed by indoxacarb @ 0.5 ml/l (Local practice) during October showed minimum fruit damage by seed borer (2.48%), which was statistically comparable with application of deltamethirn @ 1 ml/l followed by *Bt* @ 1 g/l with 2.54 per cent fruit damage of cv. Kalipatti (Table 79) compared to control with higher fruit damage (7.38%). The yield of healthy fruits and yield of damaged fruits was found non-significant.

Periyakulam: The alternate application of deltamethirn @ 1 ml/l followed by *Bt* @ 1 g/l showed minimum fruit damage (0.97%) by seed borer and less damaged fruits (2.66 kg/tree), which was statistically comparable with application of profenophos @ 1.5 ml/l followed by indoxacarb @ 0.5 ml/l (Local practice) with 1.17% fruit damage and 3.04 kg/tree damaged fruits of cv. PKM-1 (Table 79) compared to control (6.84% fruit damage and yielding 9.53 kg/tree damaged fruits). The higher marketable fruits yield was recorded in deltamethrin and *Bt* application (204.21 kg/tree) 2.79 BC ratio over application of profenophos and indoxacarb (182.42 kg/tree) 2.95 BC ratio and control

Table-79: Efficacy of different treatments against seed borer in sapota

Treatment	Fruit damage (%)*		Yield of healthy fruits (kg/tree)		Yield of damage fruits (kg/tree)		BC ratio	
	GND	PKM	GND	PKM	GND	PKM	GND	PKM
T ₁	2.54 (8.89) ^a	0.97 (6.06) ^a	180.33 ^a	204.21 ^a	5.34 ^a	2.66 ^a	3.48	2.79
T ₂	2.48 (8.76) ^a	1.17 (7.09) ^a	181.42 ^a	182.42 ^b	5.51 ^a	3.04 ^a	3.21	2.95
T ₃	7.38 (15.67) ^b	6.84 (16.94) ^b	156.91 ^b	151.62 ^c	12.66 ^b	9.53 ^b	3.22	1.21
CD at 5%	1.16	1.05	NS	0.89	NS	0.75		

T₁: Deltamethrin (0.018) @ 1 ml/l followed by *Bt* @ 1 g/l; T₂: Profenophos (0.075%) @ 1.5 ml/l followed by indoxacarb (0.007%) @ 0.5 ml/l (Local practice) and T₃: Control.

* Figures in parenthesis are arc sin transformed values.

GND-Gandevi and PKM-Periyakulam

Transfer of technology

A. Seminars/Symposium/Workshop/Group meeting attended

Akola

- Paithankar DH attended Training cum Interface Meeting on Project Appraisal and Research Data Management of ICAR-AICRP, on Fruits held at ICAR-IIHR, Bengaluru (19th to 21st August 2019).
- Paithankar DH and Ingle YV attended World Orange Festival, held at Nagpur (21st January 2019).
- Ingle YV participated Two Days Training Programme on “Increase Teaching Effectiveness” held at Department of Renewable Energy, Dr. PDKV, Akola (14th to 15th January 2019).
- Ingle YV participated Brain Storming Workshop on Organic Farming Research held at MPKV, Rahuri (28th January 2019).
- Ingle YV participated Biowaste Resources management One day workshop held at S. Khandelwal College, Akola (23rd February 2019).
- Paithankar DH and Ingle YV attended and participated in Global Organic Convention, “Natural Resource Management for Sustainable Agriculture, Soil Health and Quality Food” held at College of Agriculture, Nagpur (15th to 17th September 2019).
- Ingle YV attended and participated Online training two days programme on “Disease map preparation” organized by ICAR-NRC for Grapes, Pune (26th to 27th September 2019).

Anantharajupet

- Naga Lakshmi T participated in “Training cum Interface Meeting on Project Appraisal and Research Data Management of ICAR-AICRP on Fruits” held at IIHR, Bengaluru (19th to 21st August 2019).
- Naga Lakshmi T and Sharath Kumar Reddy YS conducted a training programme to popularize the technology released under ICAR- AICRP on Fruits project on “Integrated management of papaya diseases” held at Harijanwada, Obanpalli village of Kodur (18th June 2019).
- Naga lakshmi T and Sharath Kumar Reddy YS conducted a training programme on “INM and IPM in Mango Cultivation” under ICAR-AICRP on Fruits held at KR Kandriga village in Kodur division (11th July 2019).

Arabhavi

- Kantharaju V participated in “Training cum Interface Meeting on Project Appraisal and Research Data Management of ICAR-AICRP on Fruits” held at ICAR-IIHR, Bengaluru (19th to 21st August 2019).
- Kantharaju V and Suhasini Jalawadi participated in training on “Advanced production and Post-harvest Technologies in Banana and utilization of natural fibres for value addition in Textile Industry” held at KRCCH, Arabhavi (3rd December 2019).
- Kantharaju V participated in “National Symposium (IPS - Southern zone) on Transdisciplinary approaches to Plant Pathology Research, Education and Extension in response to changing climate: The way Ahead” held at UAS, Raichur (6th to 7th December 2019).
- Kantharaju V and Suhasini Jalawadi participated in National conference on “Horticulture for Sustainability and Nutritional Security” held at KRCCH Arabhavi (19th to 20th December 2019).
- Siddanna Thoke participated in Mid-Term Review meeting of grape programmes under ICAR-AICRP on Fruits held at ICAR-NRC for Grapes, Pune (14th November 2019).
- Siddanna Thoke participated in National conference on “Horticulture for Sustainability and Nutritional Security” held at KRCCH, Arabhavi (19th to 20th December 2019).

Bhubaneswar

- Saudamini Swain participated in National Seminar on “Science and Technology: Rural Development” held at Indian Science Congress Association Bhubaneswar (13th to 14th December 2019).
- Saudamini Swain and Bipin Kumar Pradhan participated in ZREAC meeting held at OUAT, Bhubaneswar (27th April 2019).
- Saudamini Swain participated in training on Business opportunities in Plant Health Management Technologies of ICAR-IIHR held at CHES, Bhubaneswar (12th September 2019).

Coimbatore

- Kavitha C attended training on “Advanced Techniques: Photosynthetic Efficiency and water relations in crops” organised by the Dept. of Crop Physiology, TNAU, Coimbatore (21st & 22nd March 2019).

- Manoranjitham SK and Kavitha C attended one day workshop on Krishi Portal organised by ICAR – AICRP on Fruits held at ICAR-NRCB, Tiruchirapalli (25th March 2019).
- Manoranjitham SK attended training on Quarantine Pathogens: Seed Health Testing Methods and Molecular diagnostic techniques held at NIPHM, Hyderabad (6th to 10th May 2019).
- Paramaguru P and Kavitha C attended the “Training cum Interface Meeting on Project Appraisal and Research Data Management of ICAR-AICRP on Fruits” held at ICAR-IIHR, Bengaluru (19th to 21st August 2019).
- Manoranjitham SK and Kavitha C attended online training on “Disease map preparation” organized by ICAR-NRC for grapes, Pune (26th & 27th September 2019).
- Manoranjitham SK attended National seminar on Mushroom Rise of research and retreats for humanity (30th September 2019).

Gandevi

- Bisane KD participated in International Conference on “Plant Protection in Horticulture (ICPPH-2019) - Advances and Challenges” held at ICAR-IIHR, Bengaluru (24th to 27th July 2019).
- Bisane KD attended “A Training-cum-Interface Meeting on Project Appraisal and Research Data Management of ICAR-AICRP on Fruits” held at ICAR-IIHR, Bengaluru (19th to 21st August 2019).
- Bisane KD participated in State Level Seminar on “*Kruishi ane Bagayati pakoma pravartman pak sanrakshan na prashno ane nirakaran*” held at Anand Agricultural University, Anand Gujarat (8th November 2019).
- Bisane KD participated in International Seminar on “Agriskills for Convergence in Research, Industry & Livelihood (ACRIL)” held at Farmers' Academy & Convention Centre (FACC), BCKV, Kalyani, Nadia, West Bengal (28th November to 1st December 2019).

Jalgaon

- Pawar KB attended the training cum interface meet on appraisal and research data management of ICAR-AICRP on Fruits held at ICAR-IIHR, Bengaluru (19th to 20th August 2019).

Jorhat

- Borthakur PK, Inee Gogoi and Popy Bora attended Technical Committee Meeting, Rabi,

held at Assam Agricultural University, Jorhat (22nd October 2019).

- Borthakur PK, Inee Gogoi and Popy Bora attended Technical Committee meeting, Kharif held at Assam Agricultural University, Jorhat (23rd March 2019).
- Borthakur PK attended DBT review meeting held at New Delhi (19th October 2019).
- Inee Gogoi attended DBT review meeting held at Jorhat (4th July 2019).
- Popy Bora attended the training cum interface meet on appraisal and research data management of ICAR-AICRP on Fruits held at ICAR-IIHR, Bengaluru (19th to 20th August 2019).

Kannara

- Pushpalatha PB, Vimi Louis, Manju PR and Gavas Ragesh participated in the state level ZREAC Central Zone meeting held at RARS Pattambi (13th July 2019).
- Gavas Ragesh participated in the National level training on “Online tools for plant protection” held at National Institute of Plant Health Management, Rajendranagar, Hyderabad (2nd to 4th March 2020).

Kovvur

- Bhagavan BVK, Mamatha K, Naga Lakshmi R, Ravindra Kumar K, Kishore Kumar Ch. S and Nandini MLN presented respective technical programme of work for 2019-20 and Work done report of 2018-19 (24th to 26th April 2019).
- Bhagavan BVK, Ravindra Kumar K and Kishore Kumar Ch. S participated integrated crop management in spices organized by MIDH at HRS Chintapalli and educated the farmers on different aspects of spices cultivation in Visakhapatnam District (16th to 17th May 2019).
- Bhagavan BVK, Mamatha K, Naga Lakshmi R, Ravindra Kumar K and Kishore Kumar Ch. S participated in the Awareness programme on “Turmeric and Ginger cultivation” at Horticultural Research Station, Kovvur, West Godavari (2nd July 2019).
- Bhagavan BVK, Mamatha K, Naga Lakshmi R, Ravindra Kumar K, Kishore Kumar Ch. S and Nandini MLN attended the Diploma in Agricultural Extension Services for Input Dealers (DAESI) programme at Horticultural Research Station, Kovvur, West Godavari (11th July 2019).
- Bhagavan BVK participated as a resource person

in the workshop on Conservation of ground water technologies in horticulture and delivered a lecture on water management in Horticulture crops.

- Bhagavan BVK and Ramanandam G inaugurated the seminar and released two technical leaflets about 'Agrotechniques of tuber crops' in Telugu and English. He also distributed soil health cards to the farmers.
- Snehalatha Rani A and Kishore Kumar Ch. S participated in the online training programme on "Disease Map preparation".
- Ramanandam G and Bhagavan BVK attended 3rd meeting of Multi- Disciplinary committee of Polavaram Irrigation Project.
- Ramanandam G and Bhagavan BVK organised farmers interaction meeting on improved technologies/varieties demonstration on banana, acid lime and mango with tribal farmers under TSP in the agency area of ITDA, T.R. Puram, West Godavari district.
- Ravindra Kumar K and Snehalatha Rani A attended a training programme on "Export oriented banana cultivation and disease management" as resource persons organized by Department of Horticulture, Krishna district at Chekkapalli village of Musunuru mandal. Sri. Srinivas, ADH, Nuzuveedu and Saratschandra, HO, Musunuru attended the programme. Various issue with respect to banana cultivation, tissue culture plant materials, diseases etc. were discussed with farmers.
- Ramesh Babu B participated in the training programme on creating awareness to the nursery growers to produce quality planting material at Jangareddygudem of West Godavari district.

Ludhiana

- Rattanpal HS, Sandeep Singh, Anita Arora, Krishan Kumar and Manveen Kaur participated in "Research & Extension Specialist Workshop for Horticultural Crops" held at Punjab Agricultural University, Ludhiana (27th to 28th May 2019).
- Sandeep Singh participated in "Sensitization workshop on impending insect threats in Punjab" held at Punjab Agricultural University, Ludhiana (20th June 2019).
- Sandeep Singh and Anita Arora participated in "State Level Litchi Show-cum-Seminar" held at District Pathankot, Punjab (21st June 2019).
- Sandeep Singh participated in 9th International Conference on Agriculture, Horticulture and

Plant Science at Dharamshala, HP (27th to 28th June 2019).

- Sandeep Singh participated in International Conference on Plant Protection in Horticulture (ICPPH-2019) at ICAR-IIHR, Bengaluru (24th to 27th July 2019).
- Anita Arora participated in International Dialogue on "Indian Viticulture: Way Forward" at Pune (15th November 2019).
- Sandeep Singh participated in Workshop of Project ICT based E-Pest Surveillance and advisory Services for Horticultural Crops in Haryana, at Haryana Agricultural University, Hisar (26th November 2019).
- Sandeep Singh and Anita Arora participated in Seminar on "Horticultural Crops" held at Punjab Agricultural University, Fruit Research Station Bahadurgarh, District Patiala, Punjab (9th December 2019).

Medziphema

- Maiti CS conducted farmers training on improved of litchi production (bagging & girdling) and quality.

Mohanpur

- Misra DK and Bauri FK participated in International symposium organized by Crop and Weed Science Society at BCKV, Kalyani (West Bengal).

Pantnagar

- Singh AK, Pooman Srivastava, Satish Chand, Rajesh Shukla and Pratibha participated in International conference on "Innovation Horticulture and Value Chain Management-Shaping Future Horticulture" at Pantnagar (28th to 31st May 2019).

Paria

- Solanki PD participated in 21day training on "Application of ICT in Agricultural Extension and Market Linkage" organised by CAFT, Department of Extension Education, BAU, Sabour, Bhagalpur, Bihar.
- Patel CR, Solanki PD and Bana JK participated in 7th Group Discussion of AICRP-Fruits at Punjab Agricultural University, Ludhiana (16th to 19th January 2020).

Pasighat

- Training programme conducted at Mebo village, East Siang District covering 25 farmers and farm women (21st December 2019).
- Training programme on "Quality planting material

production Technology of Khasi Mandarin" was conducted at College of Horticulture and Forestry, CAU, Pasighat, East Siang District covering 20 Horticulture field assistants from different Districts of Arunachal Pradesh (21st February 2020).

Periyakulam

- Manonmani K attended third grantmanship workshop at the Directorate of Research, TNAU, Coimbatore (10th to 13th June 2019)
- Rajangam J and Kavino M attended training cum interface meeting on Project Appraisal and Research Data Management of ICAR – AICRP on Fruits at ICAR-IIHR, Bengaluru (19th to 21st August 2019).
- Manonmani K attended workshop on 'Skill empowerment in milky mushroom production technology, oyster mushroom production, antimicrobial biomolecules for plant health and protoplasmic fusion technology for strain improvement in mushroom' at the Department of Plant Pathology, TNAU, Coimbatore (1st October 2019).
- Kavino M attended seminar on "Postharvest management and value addition of horticultural crops" by Department of Fruit Science and Coffee Board (15th November 2019).
- Irulandi S attended International Conference on "Extension for strengthening Agricultural Research and Development at ICAR JSS Krishi Vigyan Kendra, Suttur, Mysuru, Karnataka (14th to 16th December 2019)
- Manonmani K attended 'National conference on 'Mitigation of emerging plant diseases under changing climate scenario' organized by INSOPP, Ludhiana and Department of Plant Pathology, TNAU, Coimbatore (16th to 17th December 2019).
- Rajangam J, Subesh Ranjith Kumar C, Kavino M, Irulandi S and Manonmani K participated in the 7th Group Discussion of ICAR-AICRP on Fruits at Punjab Agricultural University, Ludhiana (16th to 18th January 2020).

Pune (ARI)

- Sujata Tetali participated in 59th Annual conference of Maharashtra Rajya Draksha Bagaitdar Sangh at Pune (03rd to 05th August 2019).
- Sujata Tetali participated in the training cum interface meeting on Project Appraisal and

Research Data Management of ICAR-AICRP on Fruits at ICAR-IIHR, Bengaluru (19th to 21st August 2019).

- Sujata Tetali, Karkarmkar SP and Phalake SV poster presented on 'Mutation breeding for genetic improvement of ARI 516'-at International Dialogue on Indian Viticulture: Way Forward by ICAR-NRC for grapes and Society for Viticulture and Oenology (15th to 16th November 2019).

Pune (NRCG)

- Roshini S attended Training cum Interface Meeting on Project Appraisal and Research Data Management of ICAR-AICRP on Fruits held at ICAR-IIHR, Bengaluru (19th to 21st August 2019).

Sriganganagar

- Bairawa SK attended One day Workshop on Academic Ethics and Integrity at DHRD (SKRAU), Bikaner (18th May 2019).
- Bairawa SK attended ZREAC meeting Rabi – 2019 (Zone 1B of Rajasthan) held at Agricultural Research Station (SKRAU), Sriganganagar (5th to 6th September 2019)
- Bairawa SK attended International Conference on "Environmental Ethics, Resource Management and Regional Development: Issues, Challenges and Prospects" organized by Department of Geography, Dr. BR Ambedkar Govt College, Sriganganagar (29th to 30th November 2019).
- Bairawa SK attended Seminar on Sustainable Agriculture and Organic Farming organized by Sarswati Siksan Sadan Agriculture College, Sriganganagar (11th to 12th April 2019).

Tinsukia

- Kakoti, RK and. Sikha Deka attended the Annual Technical Committee Meeting at AAU, Jorhat (30th September 2019).

Tirupati

- Venkataramana KT, attended the 10th REC Meeting at Administrative Office, Dr YSRHU, V R Gudem (1st April 2019).
- Dilip Babu J attended pre ZREAC meeting of Rayalaseema Zone at Citrus Research Station, Tirupati and presented the technical programme of work (3rd April 2019).
- Rajasekharam T attended ZREAC-2019 (Costal zone) Meeting as crop specialist at Dr.YSRHU, V.R Gudem (15th April 2019).
- Venkataramana KT, Mukunda Lakshmi L, Srinivas

Reddy D and Rajasekharam T, attended ZREAC-2019 (Rayalaseema Zone) Meeting at HRS, Anantharajupet (18th April 2019).

- Srinivas Reddy D attended meeting regarding Ag Tech Project with ADB Collaboration by Department of Horticulture at O/o Commissioner of Horticulture, Guntur, Andhra Pradesh (23rd May 2019).
- Ramana KTV, Mukunda Lakshmi L, attended the meeting on Buyers & Sellers Meet for Export of Mangoes at Hotel Bliss, Tirupati (15th June 2019).
- Srinivas Reddy D attended as resource person for training on Awareness cum training programmes by the APMIP to the farmers on Horticultural Crops at Pulivendala, Kadapa district (25th July 2019).
- Srinivas Reddy D attended as resource person for training on constituency level training programmes to the farmers on latest protection technology at Pulivendala, Kadapa district (30th July 2019).
- Mukunda Lakshmi L attended training programme on Production Technology of Tuber crops at RARS, Tirupati (4th August 2019).
- Srinivas Reddy D attended as resource person for training on "Pest and Disease management of Mango" at RHTI, Kadapa (14th August 2019).
- Srinivas Reddy D attended as resource person for training on "Pest and Disease management in Lime and Sweet orange" at RHTI, Kadapa (21st August 2019).
- Rajasekharam T attended training programme on Pest and Disease Management in Vegetable crops at RARS, Tirupati (25th August 2019).
- Venkata Ramana KT attended Training cum Interface Meeting on Project Appraisal and Research Data Management of ICAR-AICRP on Fruits -2019 at ICAR-IIHR, Bengaluru (19th to 21st August 2019).
- Venkata Ramana KT attended Bi-monthly "Training & Visit (T & V) programme" (2019-20) to the officers of Department of Horticulture at KVK, Dr.YSRHU, Venkataramannagudem (13th September 2019).
- Rajasekharam T attended as resource person for training on Production and Protection technology - Banana at Baireddipalle, Chittoor district (18th September 2019).
- Srinivasa Reddy D attended as resource person

for training on pest management in papaya at RHTI, Chittoor organized by Department of Horticulture (28th September 2019).

- Srinivasa Reddy D attended workshop on Mango fruit fly and Nut weevil conducting by Department of Horticulture at O/o Commissioner of Horticulture, Guntur (30th September 2019).
- Srinivasa Reddy D attended as resource person for training on Nut weevil management and package of practices in mango at Nethakuppam Village of Ramachandrapuram Mandal, Chittoor district organized by Department of Horticulture (6th December 2019).

Udaipur

- Lakhawat SS participated in Interface Meeting of AICRP on Fruits at ICAR-IIHR, Bengaluru (19th to 21th August 2019)
- Lakhawat SS participated in 7th Group Discussion of ICAR-AICRP on Fruits held at Punjab Agricultural University, Ludhiana (16th to 19th February 2020).

B. AIR/Doordarshan Programme

Akola

- Paithankar DH has presented TV programme on Doordarshan, Nagpur- Ambia bahar management in mandarin (7th October 2019) Reliance Foundation - Summer cropping in Acidlime (15th November 2019), Management of mandarin nutrition in Mrug bahar (15th November 2019), Ambia bahar management in mandarin (15th November 2019).
- Ingle YV has presented TV programme on Doordarshan, Mumbai Management of Citrus canker (15th May 2019).

Anantharajupet

- Naga lakshmi T attended Phone-In-Live programme in Doordarshan on "*Boppai lo tegulla samagra yajamanym*" (15th August 2019).
- Naga lakshmi T attended a television programme in 'E TV Annadata' E TV on "*Boppai lo virus tegulla yajamanym*" (15th August 2019).

Bhubaneswar

- Saudamini Swain delivered radio talk (Akashbani / Puri) on *Kadali bagichara jatna* (4th June 2019).
- Saudamini Swain has given TV programme (Doordarshan/ Bhubaneswar) on Improved cultivation practices of tissue culture banana (3rd April 2019).

Coimbatore

- Paramaguru P attended the programme “Velan Neram” phone in live agri Programme on improved technologies in fruit crop cultivation (22nd April 2019).
- Paramaguru P has given a talk on “*Vazhayil Uyar Sagupadi Nutpangal*” in All India Radio, Coimbatore (4th September 2019).
- Manoranjitham SK has delivered a talk on Papaya diseases and their management in TNAU, Community radio.
- Kavitha C has delivered a talk on Hitech cultivation practices in papaya in TNAU Community radio.
- Kavitha C has delivered a talk on “High density planting in fruit crops in All India Radio, Coimbatore (24th December 2019).

Jalgaon

- Shaikh NB has delivered radio talk on winter care for banana.

Kannara

- Pushpalatha PB has delivered radio talk (AIR, Thrissur) on *Vazhayude janithakasappathum avayude upayodavum* (23rd September 2019)
- Vimi Louis has delivered radio talk (AIR, Thrissur) on “Emerging diseases of banana” (23rd August 2019).
- Pushpalatha PB attended TV programme (Doordarshan, Thiruvanthapuram) - Live phone-in Programme on “Value added products from Banana” (15th November 2019)
- Vimi Louis and Gavas Ragesh gave an interview on pitting disease of Banana for Mathrubhumi news channel exclusively (22nd August 2019)
- Gavas Ragesh prepared 10 short video documentaries on various pests of banana and their management for the benefit of farmers of Kerala under the aegis of Agricultural Technology Information Centre (ATIC), Directorate of Extension, Kerala Agricultural University.

Kovvur

- Ramesh Babu has given Live phone in programme (Doordarshan, Saptagiri) on rainy season Guava management (4th July 2019).
- Bhagavan BVK has given TV programme (Doordarshan kendra, Vijayawada) on Tissue culture *Aratilo poshaka yajamanyam* (6th June 2019).
- Snehalatha Rani has delivered radio talk on (Vijayawada) on Diseases of banana and their management (5th December 2019).

Ludhiana

- Anita Arora has delivered radio talk (AIR, Jalandhar) on *Nimboo jaati ch phallan da kera* (9th May 2019).
- Sandeep Singh has delivered radio talk (AIR, Jalandhar) on Management of insect-pests of fruit crops during summer season (15th May 2019).
- Sandeep Singh has given Tv programme (PAU, Ludhiana) on *Phaldar butian de kerian di suchaji roktham (Mera Pind Mere Khet)* (16th October 2019).

Mohanpur

- Misra DK has delivered radio talk on “Farmers’ question-answer programme of KrishiVibhag” in Akashvani, Kolkata (3rd August 2019).
- Misra DK has delivered radio talk on “Farmers’ question-answer programme of KrishiVibhag” on in All India radio, Akashvani, Kolkata (8th August 2019).
- Misra DK has delivered radio talk (AIR, Kolkata) on *Chithipatreruttar* (Answer of farmers problem) (28th December 2019).
- Misra DK and Chakraborti K participated in KrishiDarshan TV programme of DD Bangla for the discussion of Banana Cultivation with Advance Technology (13th August 2019).

Mandsaur

- Soni N has delivered TV programme in Krishi darshan live in programme as guest in Doordarshan Madhya Pradesh and Chhattisgarh on topic Madhya Pradesh *main angoor ke khati ki sambabnai* (27th November 2020).

Pnatnagar

- Singh AK has delivered radio talks (Janvani Radio) on “Essential works for management of fruit trees” (18th February 2019), “Testing of harvesting grading & packing of mature mango” (21st May 2019), “Use of fertilizers in fruit crops” (19th June 2019), High density Planting in fruit crops” (15th July 2019), Use of plastic in orchards (17th July 2019), Protection of fruit plants from frost (21st October, 2019) and Rejuvenation of senile orchards (19th November 2019).

C. Extension and other activities

Akola

- Ingle YV participated in workshop organized by DSAO, Amravati for mandarin growers at Amravati, Yerla Taluk, Morshi District (23rd April 2019).
- Paithankar DH and Ingle YV participated in State Level Mega Agril Exhibition at Dr. PDKV, Akola (28th December 2019), Technology day and demonstrations of technology at Dr. PDKV, Akola (5th to 7th November 2019).
- Ingle YV attended farmers training on acid lime production and protection technology Wadegaon Taluk, Balapur District, Akola 7th September 2019).
- Ingle YV attended one day farmers training on citrus protection technology at Mungla Taluk, Malegaon District, Washim (11th September 2019).
- Paithankar DH and Ingle YV attended field day for the disseminated citrus production and protection technology at Khandala Taluk, Telhara District, Akola (25th July 2019).
- Paithankar DH and Ingle YV conducted one day farmers training for citrus production and protection technology at Bopapur Taluk, Achalpur District, Amravati (21st September 2019).
- Paithankar DH and Ingle YV conducted one day farmers training for acid lime production and protection technology at Chandur Taluk, Akola (12th December 2019).
- Paithankar DH and Ingle YV arranged farmers training and tour for mandarin production and protection technology at Akola Mungala vilage and Bopapur village (28th and 29th December 2019).

Anantharajupet

- Naga Lakshmi T conducted survey in papaya fields of Mudivemula, Vempalli, Doopadu villages of Tripurantakam mandal in Prakasam district and observed that PRSV incidence was low (25%) and fruit quality is good (13th to 14th May 2019).
- Sharat Kumar Reddy YS participated in an exhibition conducted at Jammalamadugu on the eve of Andhra Pradesh Raitu Dinostavam. Exhibited different varieties and technologies released and displayed different varieties of Guava and mango in the stall for the benefit of the farmers (8th July 2019).

- Naga Lakshmi T and Sharat Kumar Reddy YS explained about different ongoing research activities to the thirty trainees and Project director DESI programme as a part of an exposure visit organized by ANGRAU (14th August 2019).
- Naga Lakshmi T attended a training program as resource person on production and protection technology of mango at Yerravari palem village, Bhakrapet mandal of Chittoor district organized by KVK, Periyavaram in collaboration with SERP FPOs training program (5th September 2019).
- Naga Lakshmi T conducted survey in papaya nurseries grown in Gangararajupodu and Raghavarajupuram of Kodur division to observe the growing conditions for the production of disease-free material.

Arabhavi

- Kantharaju V did farm advisory work for about 171 farmers they brought their field problems along with diseased specimen and suggested the suitable remedies for management of diseases.
- Kantharaju V has visited 25 farmers filed and suggested the suitable remedies for management of diseases.
- Suhasini Jalawadi has visited 04 farmers filed and suggested the suitable remedies for management of diseases.
- Siddanna Thoke has visited 12 farmers filed and suggested the suitable remedies for management of diseases.

Bhubaneswar

- Pradhan Bipin Kumar has given skill development training on tissue culture banana (Grand Naine) disease management' to 25 precision farming farmers at BTCC office O.U.A.T Bhubaneswar (30th March 2019).

Coimbatore

- Paramaguru P delivered lecture on high density orchards – status & outlook, techno economic parameters and recommendations organized by Bankers Institute of Rural Development (BIRD), Mangalore at Hotel CAG Pride, Coimbatore (21st October 2019).
- Manoranjitham SK served as resource person in District level farmers training -Banana conference by SSEPERS at Anthiyur-Erode district (June 2019).
- Kavitha C was involved in the exhibition arrangement during Field Day for

Commercialization of TNAU Hybrids at College orchard, TNAU, Coimbatore (1st October 2019).

Gandevi

- Bisane KD delivered lectures on plant protection in fruits crops of the south Gujarat under 'Mahila Diwas' programme organized by ATMA project, Gandevi at Nani Desad, Tal. Gandevi, Dist.-Navsari held (6th August 2019).
- Naik BM, Bisane KD and Patel AR participated and delivered lectures on technologies of ICAR-AICRP (Fruits) and exhibited different samples of fruits crops in State Government sponsored Krishi Mahotsav cum exhibition at Gadat Village of Navsari district (17th June 2019).

Gangian

- Amrendra Kumar has visited farmer field and conducted technology demonstration at Gurdaspur, Pathankot and Hoshiarpur districts of Punjab (13th to 14th June 2019).

Kannara

- Vimi Louis and Gavas Ragesh handled two classes on "IPM in Banana" for about 48 farmers from various parts of Kannara (25th October 2018).
- Pushpalatha PB, Vimi Louis, Manju PR and Gavas Ragesh participated in AICRP technology meet 2019 at BRS, Kannara (23rd September 2019).
- Pushpalatha PB conducted training on "Post-harvest loss management and doubling farmer's income in banana cultivation" at BRS Kannara.
- Pushpalatha PB conducted training to banana farmers on improved production technology" at Pattikkad Farmer's Producers company, Thrissur (8th March 2019).
- Pushpalatha PB, Vimi Louis, Manju PR and Gavas Ragesh conducted training to banana farmers on 'scientific banana cultivation" at BRS Kannara (16th March 2019).
- Vimi Louis and Gavas Ragesh conducted survey on various districts of Kerala for the study of disease incidence of blast and pitting disease which emerge as a new threat in Nendran and other banana varieties due to climate changes in Kerala.
- Gavas Ragesh conducted field inspection in four banana farmer's fields at in Mookkannoor and Karukutty panchayaths in Angamali Block along with officials of Central Integrated Pest Management Centre, Govt. of India and Agricultural Department officials (18th March 2019).

- Gavas Ragesh conducted field inspection as team leader, Multi-Disciplinary Diagnostic Team and did diagnostic inspections of the pest related problems in the banana plots under the jurisdiction of Cherpu KrishiBhavan, Cherpu Block (28th March 2019).

Kovvur

- Ashok P conducted diagnostic survey for low yield of guava gardens at Mathagudem of Lingapalem mandal of W.G. Dist (10th December 2019).
- Ramesh Babu conducted diagnostic survey for damage of guava gardens at Kunchanapalli of tadepalli gudem mandal, West Godavari District (11th June 2019) and low yield of guava gardens at Mathagudem of Lingapalem (mandal of Krishna District (10th November 2019).
- Bhagavan BVK participated in the ZREAC meeting of Rayalaseema Zone (18th April 2019)

Ludhiana

- Sandeep Singh delivered lecture on "Insect-pests of fruit crops and their non-chemical management during training at skill development centre, PAU, Ludhiana (15th April 2019).
- Sandeep Singh and Anita Arora delivered lecture on "Integrated Management of termites in horticultural crops" to the farmers during field day at village Jindawala, District Tarn Taran (25th April 2019).
- Sandeep Singh delivered lecture on "IPM for horticultural crops" during STRY on "Integrated Nutrient Management and Integrated Pest Management" at PAMETI, PAU Campus, Ludhiana (10th May 2019).
- Anita Arora delivered lecture on "Major diseases of fruit nursery plants; their identification and management" in the Skill Development Programme (Gardener training course) sponsored by Hindustan Insecticides Ltd. held at College orchard, PAU, Ludhiana (16th May 2019).
- Anita Arora delivered lecture on "Diseases of fruit crops and their management" during Horticultural Supervisory Training Course", Department of Fruit Science held at College Orchard, PAU, Ludhiana (20th May 2019).
- Anita Arora and Sandeep Singh delivered lecture on "Innovations in fruit disease management" to HDOs during Research and Extension Specialist's Workshop for Horticultural Crops, held at PAU, Ludhiana (27th May 2019).

- Anita Arora delivered lecture on "Management of diseases of litchi" during Litchi Show-cum-Seminar at Pathankot (21st June 2019).
- Sandeep Singh delivered lecture on "Management of insect-pests of litchi" during Litchi Show-cum-Seminar at Pathankot (21st June 2019).
- Anita Arora delivered lecture on "New techniques for disease management in fruit crops" to HDOs/DESS/KVK Scientists (Hort) in training course on "Latest Production, Protection & Post-Harvest Techniques for Fruits and Vegetable Crops" held at KKG, PAU, Ludhiana (27th June 2019).
- Sandeep Singh delivered lecture on "Application of PAU fruit fly traps for management of fruit flies in fruit crops" at village Nabipur, District Tarn Taran (27th June 2019).
- Sandeep Singh delivered lecture on "Insect-pest menace in fruit crops" during Refresher Course on Plant Protection Practices for major kharif crops in Punjab" (30th July 2019).
- Sandeep Singh delivered lecture on management of fruit flies in guava with Eco-friendly PAU fruit fly traps, during field Day on PAU fruit fly traps at Govt. Garden and Nursery, Wazidpur, Patiala (8th August 2019).
- Sandeep Singh delivered lecture on pests of fruit crops and their control during three months skill development integrated crop production training course for young farmers, PAU, Ludhiana (26th August 2019).
- Sandeep Singh participated in discussion on IPM in fruit crops as expert with chairman, Punjab State Farmers' Commission, Mohali (28th August 2019).
- Anita Arora delivered lecture on "Major diseases and disorders in fruit crops and their management" in the Skill Development Programme (Gardener training course) sponsored by Hindustan Insecticides Ltd. held at College orchard, PAU, Ludhiana (29th August 2019).
- Anita Arora delivered lecture on "Citrus, mango, grapes, ber and guava fruit plants diseases and their control measures" in "Three months skill development integrated crop production training course for young farmers of Punjab" held at Skill Development Centre, PAU, Ludhiana (30th August 2019).
- Sandeep Singh delivered lecture on Eco-friendly ways for management of insect-pests of fruit crops, to farmers from Kinnaur, Himachal Pradesh during Training-cum-Exposure visit (30th August 2019).
- Sandeep Singh delivered lecture on Management of insect-pests of fruit crops, during Young Farmers Training Class, PAU, Ludhiana (9th September 2019).
- Sandeep Singh delivered lecture on "Identification of biological agents in orchards, during Young Farmers Training Class, PAU, Ludhiana (9th September 2019).
- Sandeep Singh delivered lecture on management of insect-pests of fruit crops, during Farmers Scientist Interaction on Field Problems in Fruit Crops, at village Nabipur, District Tarantaran (14th October 2019).
- Anita Arora delivered lecture on "Management of diseases of fruit crops" to SC/ST candidates in training course on "Phaldar bootyan di sambh-sambhal at nursery paida karan bare sikhilai course", held at Fruit Research Farm, PAU, Ludhiana (24th September 2019).
- Anita Arora delivered lecture on "Management of citrus diseases" to the farmers during field day held at Village Churriwala Dhanna, District Fazilka (5th November 2019).
- Sandeep Singh delivered lecture on "Management of fruit flies with PAU fruit fly traps in Kinnow" to the farmers during field day on "Management of fruit flies with PAU fruit fly traps" held at Village Churriwala Dhanna, District Fazilka (5th November 2019).
- Anita Arora delivered lecture on "Disease management in fruit crops" to the farmers in Seminar on "Horticultural Crops" held at PAU Fruit Research Station, Bahadurgarh, District Patiala (9th December 2019).
- Anita Arora delivered lecture on "Diseases of citrus and their management" in "Training course on kinnow growers for farmers of District Hanumangarh (Rajasthan)" held at Skill Development Centre, PAU, Ludhiana (13th December 2019).
- Sandeep Singh delivered lecture on "Pests of citrus and their management" in "Training course on kinnow growers for farmers of District Hanumangarh (Rajasthan)" held at Skill Development Centre, PAU, Ludhiana (13th December 2019).

Mohanpur

- Misra DK, Bauri FK, and Chakraborti K organized workshop on fruit cultivation with improved

technologies with SCSP Farmers at Gaighata Block, 24 Pgs (North) District.

- Misra DK, Bauri FK, and Chakraborti K organized a workshop on fruit cultivation with improved technologies with students of Bethun College (Botany/Plant pathology) of Kolkata (20th September 2019).

Pantnagar

- Singh AK conducted one day training programme on “Fruit cultivation, demonstration and transfer of technologies related to mango, litchi and guava under AICRP-Fruits” at Gaughat, Kiccha, U.S. Nagar (24th October 2019).
- Singh AK and Poonam Srivastava conducted one day training programme on “Demonstration and transfer of technologies related to mango, litchi, guava and banana under AICRP-Fruits” at Village-Saweldey, Block- Ramnagar, District – Nainital (28th November 2019) & at Village-Gujrora, Block- Haldwani, District-Nainital (5th December 2019).
- Singh AK conducted one day training programme on “Demonstration and transfer of technologies related to mango, litchi, guava and banana under AICRP-Fruits” at Village -Kamola, Block- Kota Bagh, District-Nainital (11th December 2019).
- Singh AK, Poonam Srivastava and Satish Chand 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 in the year 2019 at HRC, Pattharchatta and Kisan Goshthi at Pantnagar to the farmers of Uttarakhand and adjoining states.
- Singh AK, Poonam Srivastava, Satish Chand, and Rajesh Kumar given regular advisement to the farmers through Agricultural Technology Information Centre (ATIC) of University Help Line Service, mobile and what’s App.

Paria

- Patel CR delivered lecture on mango cultivation in FTC, Pardi, Valsad (27th September 2019)
- Patel CR conducted training programme on demonstration of pruning technology in mango in Ambach, Ta. Pardi, Valsad (15th November 2019).
- Patel CR conducted training programme on mango cultivation under SCSP in Motapondha Ta. Pardi, Valsad (29th November 2019).

- Solanki PD delivered lecture on mango cultivation in FTC, Pardi, Valsad (4th December 2019).
- Bana JK delivered lecture on pest management in mango at farmer training, AES, Paria , Valsad (14th and 17th October 2019).
- Bana JK delivered lecture on integrated pest management in mango at farmer training, AES, Paria, Valsad (26th November and 16th December 2019).

Periyakulam

- Rajangam J and Kavino M attended farmers grievances meeting at Theni Collectorate (19th July 2019).
- Rajangam J, Subesh Ranjith Kumar C, Kavino M, Irulandi S and Manonmani K organized HDP mango training (13th August 2019).
- Rajangam J, Subesh Ranjith Kumar C, Kavino M, Irulandi S and Manonmani K organized on campus: field day conducted for acid lime INM (26th August 2019).
- Rajangam J, Subesh Ranjith Kumar C, Kavino M, Irulandi S and Manonmani K organized and participated training for extension functionaries about guava UHDP.
- Rajangam J, Subesh Ranjith Kumar C, Kavino M, Irulandi S and Manonmani K organized and participated in the training programme for SCSP (11th January 2020).

Pune (ARI)

- Phalake disseminated information on grape varieties developed at ARI, Pune to farmers Mela at Hol, Tal. Baramati (23rd August 2019).

Pune (NRCG)

- Online training programme on ‘Disease map preparation’ was organized by ICAR-NRCG, Pune using ‘Google hangout’ (<http://hangouts.google.com>) web application. Total 25 persons participated in the training programme (24th to 27th September 2019).

Rahuri

- Garande VK, Jadhav SB, Pawar PS, Palande AL, Shete MH and Bhalerao VK participated in Kisan Adhar Exhibition (October 2019).

Raipur

- Sharma GL attended Farmer Training Programme on Organic Farming: Package of Practices of

Organic Production of Horticulture Crop & their safe storage and preservation (13th February 2019).

- Sharma GL delivered lecture in Farmer Training Programme On, Cultivation of major Fruits Crops for DAESI (Diploma in Agricultural Extension Services for Input dealers) (12th January 2019).
- Sharma GL delivered lecture in Farmer Training Programme on, Doubling Farmers' Income at SAMETI, Raipur (25th January 2019).
- Sharma GL delivered lecture in Farmer Training Programme on, Doubling Farmers' Income at SAMETI, Raipur (22nd February 2019).
- Sharma GL delivered lecture in Training Programme on, Successful Production of Fruits: Important Point at Prakriti ki or Society, Raipur (22nd July 2019).

Sabour

- Sanjay Sahay, Muneshwar Prasad, Samik Sengupta attended mango diversity show-2019 in Patna, Bihar (19th to 20th June 2019).
- Sanjay Sahay attended 31st Mango Show in Dilli Hat Janakpuri, Delhi (5th to 7th July 2019).

Tirupati

- Mukunda Lakshmi L, Srinivasa Reddy D and Gopi V attended and displayed the AICRP recommended technologies and exhibits on eve of 1st Andhra Pradesh Rythu Dinosthavam at Jammalamadugu, Kadapa district and Honble Chief Minister of Andhra Pradesh Sri. Y S Jagan Mohan Reddy visited Dr. YSR Horticultural University Stall and interacted with scientists (on 8th July 2019).

Vengurle

- Munj AY delivered lecture on mango blossom protection at various parts of vengurle (26th November to 23rd December 2019).
- Munj AY and Raut RA delivered lecture on mango blossom protection at Jamsande, Deogad (28th November 2019).

D. Special Programmes

D1. Achievements under SCSP Programme

The Schedule Caste Sub Plan is being undertaken at Akola, Anantharajupet, Arabhavi, Coimbatore, Gandevi, Jalgaon, Jorhat, Kannara, Ludhiana, Mandasaur, Mohanpur, Paria, Periyakulam, Ranchi, Tirupati, and Tinsukia centres. At Akola had organized three training programmes in which 75 farmers from the identified districts of Akola, Washim, Amaravati, had attended to whom various agriculture inputs were supplied. At Anantharajupeta, 24 papaya growing

farmers were selected from Rallacheru, Kottapalle and Obanapalle villages of Kodur division of Kadapa district and inputs were supplied as per the recommended technological practices for the cultivation. Gandevi centre had distributed 7,900 tissue culture banana plants to the selected tribal farmers in the villages under the Navsari district. At Jalgon, three acres of banana plantation with Grand Naine cultivar has been created in the villages of Jalgon district. The Ludhiana centre had distributed 352 PAU fruit fly traps were supplied to Kinnow growers. The 35 beneficiaries in the villages of Lalpura, Dabla and Parada in Mandasaur districts were given farm inputs by the Mandasaur districts. Kannara centre had planted Manjeri Nendran II in the field for demonstration and inputs and macro-propagation plants were supplied to the beneficiaries. In their fields and in the demo plantation, all the plant protection measures were demonstrated in the Thrissur district. Ranchi centre had organised two field days for the 60 farmers from Ranchi and Lohardaga districts. Mohanpur centre had organized one training programme and two exposure visits, besides supplying planting materials and fertilizers to the 70 farmers. The Periyakulam centre had organised three training programmes and one demonstration in the Pullikodu village under the Theni district. Tinsukia centre had conducted two training programmes of three days duration to the farmers in the Tinsukia district. The Tirupati centre under the SCSP plan, surveyed the orchards of the beneficiaries in Kadapa district for pests and diseases and suitable recommended plant protection measures were taken up.



Farmers meeting at Obanapalle, Harijanwada, Kadapa to popularize the integrated disease management in papaya



Distribution of farm inputs to farmers of Munjla village at Washim district



Demonstration of macro propagation technology for rapid multiplication of elite banana clones/varieties at Kannara Centre

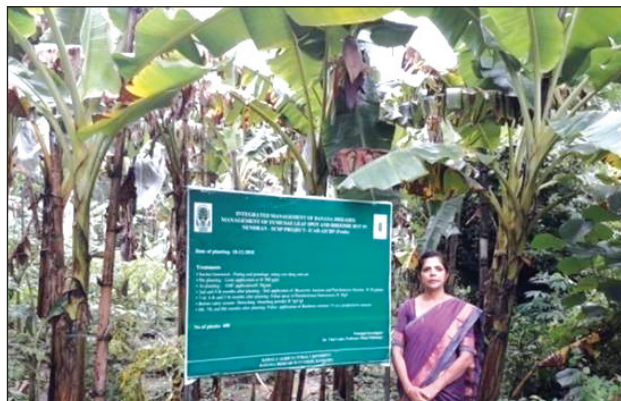


Interaction meeting with farmers in Koiribeda, Namum, Ranchi

D2. Achievements under TSP Programme

Six centres viz., Bhubaneswar (OUAT), Gandevi, Jalgoan, Kovvur, Ranchi and Udaipur were identified to undertake activities under the Tribal Sub Plan (TSP). In Nadurbar district, 15 acres of banana plantation with Grand Naine was established by the Jalgaon centre. It also organised trainings as well as field visits, exposure visits and demonstrations which resulted in increasing the yield to the tune of 72 t/ha and net profit of 2.64 lakhs per hectare. Kovvur centre had identified few beneficiaries in the agency area of ITDA, KR Puram in West Godavari District

who are growing acid lime, banana and mango and had distributed inputs like fertilizers, bio-inoculants, micronutrient mixtures besides organising a training programme. Ranchi centre had organised exposure visits and field days to 110 tribal farmers from Gumla, Lohardaga on cultivation, propagation and management of mango, Litchi, guava, papaya, at ICAR-RCER, Research Centre Ranchi. Udaipur centre had distributed mango grafts, papaya plants and intercultivation implements along with the agriculture inputs to the tribal farmers and had also conducted five trainings on papaya cultivation.



General Information

A. Monitoring of the project

A1. Monitoring of Project by Project Coordinator and Review Meeting

The following are the details of the visit by Project Coordinator (Fruits) to review the programmes being implemented at different centres of ICAR-AICRP on Fruits including the headquarters:

Tirupati and Anantharajupet (2nd April 2019):

Reviewing the programmes on Citrus at Tirupati and mango, guava and papaya at Anantharajupet. Discussed with the scientist associated for ICAR-AICRP on Fruits of both the centre. Planned for the FLDs of the recommended technology under this project to reach the end-users. Accordingly, it has been planned for consolidating the technologies on water and nutrient management along with pest management in sweet orange for implementation in farmers field. Similarly, for Anantharajupet it has been planned for papaya crop to include the technology of PRSV management coupled with efficient input use technologies for demonstration. To facilitate this process, it has been suggested to link with the KVKs of the region. The matter relating to posting of positions as against the approved cadre strength at both the centres was discussed and suggested to approach the university authorities to fill up the vacant positions. The performance of both the centre is Very Good.

Venkataramannagudem (24th & 25th April 2019):

Attended the State Level Technical Programme meeting as an Expert Member in Horticulture, at Dr. YSRHU, University Head Quarters, Venkataramannagudem and also visit was made to the experimental plots of sapota and jackfruit. The centre has implemented all the programmes. In sapota, the response on the canopy management in sapota has been encouraging and needs mid-term corrections as the canopy of normal spacing has not been overlapping. Accordingly, it has been planned to revisit the programme during the ensuing group discussion.

Bhubaneswar (17th & 18th May 2019): Visit was made to Bhubaneswar centre of CHES along with the Director, ICAR-IIHR. It was observed that most of the trees of the station are uprooted due to FANI cyclone. Due to the impact of the cyclone, the nursery structure and boundary wall has also been collapsed. The team on ICAR-IIHR has submitted the report of the entire station, which has been submitted to the DDG (HS & CS). In view of this request has been made to

initiate the fresh planting wherever necessary. Also, requested to submit the additional fund required to this task. In the later part of the day, visit was made to Bhubaneswar centre of OUAT. The trials of banana have been entirely damaged due to the cyclone effect. However, in fresh planting the damage was partial. Therefore, it has been suggested for replanting of all the ten trials during the ensuing season. Further, also requested to replant the germplasm accessions with the planting material from NAGS wherever required. It has been suggested to work out the additional funds required for this purpose. In both the centres, it has been requested to document the phenology of mandate crops to understand the performance due to extreme climatic event.

Coimbatore (5th & 6th May 2019): Participated in the 28th Annual Group Meeting of the ICAR-AICRP on Palm as a Panel expert for the session on “**Variety Release Proposal**”, reviewed the proposals of oil palm and coconut. Also visited the Coimbatore centre of ICAR-AICRP on Fruits and discussed with the scientist concerned. The centre has implemented all the allotted experiments although some of the trials are in the process of replanting in the ensuing season. To bring the visibility of the technologies recommended under this project, it has also been suggested for taking appropriate action in inclusion of ICAR-AICRP on Fruits under KVKs annual action plan. Further, also suggested for FLDs utilising the SCSP funds.

Vengurle (25th & 26th May 2019): Visited the experimental plots and reviewed the observations recorded. Necessary guidelines were suggested for maintaining uniformity across centres. The efforts made by the centre is very good and all the experiments have been implemented except the trial on rootstock breeding in mango, as there was no flowering in Terpentine rootstock. It has also been suggested for taking appropriate action in inclusion of ICAR-AICRP on Fruits recommended technologies under KVKs annual action plan.

Sabour and Mohanpur (19th to 21st June 2019):

On 20th June 2019, visited the experimental plots of mango, guava and litchi along with the concerned scientist of Sabour centre. The progress made for the allotted experiments were discussed with the scientists concerned and necessary suggestions were made for achieving the desired results. A total of 27 experiments has been reviewed and experiment wise targets have been fixed. In the afternoon met the Vice Chancellor to brief the progress of the

centre and future plans in meeting the technological needs of the region. In addition, the major emphasis has been given to the centres for inclusion of the technological module for different mandate crops as per the recommendations approved in various Group Discussion. On 21st June 2019, visit was made to experimental plots of mango, litchi, guava, banana and jackfruit and interacted with the scientists associated with the project. Necessary suggestions were made for each experiment and in some cases, it was noticed that, the programmes are not implemented as per the technical programme. In this regard, a clear instruction has been given that, Also, met the Vice Chancellor to brief the progress of the centre and emphasized to fill up the vacant positions. Further, also discussed on the modalities of the technologies spread through respective KVKs of the region. Accordingly, he has assured the necessary support and directives in implementing these tasks.

Periyakulam (27th & 28th June 2019): The centre has tried in implementation of the programmes of the ICAR-AICRP on fruits. However, in few trials the populations are not uniform and suggested for the new planting of the experiment wherever possible. In order to show the visibility of the programmes of ICAR-AICRP on Fruits, it has been suggested to ensure that the recommended technologies are passed on to ATARI for inclusion in the annual action plan of the KVKs of the region. On 28th June 2019, visit was made to farmers plot who has been growing mango and jackfruit with the technical advice on the scientist of ICAR-AICRP on Fruits

Rahuri (21st to 23rd July 2019): Met the scientist of the centre and visited the various experimental plots of Citrus, mango, guava and grapes. The field maintenance for Citrus is satisfactory, however, for other crops it is average. Necessary suggestions have been made for its improvement. It was also observed that due to severe water stress the acid lime trees have been totally dried, hence, suggested to wait for completion of the rainy season in identifying the dead trees. Verified the data book and interacted with the scientist concerned for different trials. Issues relating to naming of the varieties, impact studies of recommended programme and steps for transferring the technologies to different KVKs through ATARIs was discussed and requested to ensure its implementation.

Nagpur (8th to 10th August 2019): Participated ICAR Regional Committee VII meeting held at ICAR-NBSS&LUP. On 10th August 2019 visit was made to CCRI and visited the different plots of AICRP on Citrus along with concerned scientists. Also seen the plots of HDP in acid lime for considering its MLT

under AICRP. Discussed with the scientists on the progress made for the information compiled towards the ensuing meeting at Bengaluru.

Jalgaon (11th to 13th October 2019): Discussed on the activities being undertaken at Jalgaon centre with Officer-In charge. On 12th October 2019 visit was made to the Banana Research Centre, Jalgaon and interacted with all staff members of the centre. The centre has implemented all the allotted 11 trials and is in good condition. Necessary guidelines pertaining to various trials were made and suggested for its implementation. Later, travelled to Nandurbar district for interaction with the TSP communities. Visit was made to banana orchards being established through the TSP funding by Jalgaon centre in coordination with KVK of Nandurbar. During this visit, attended an interactive meeting with all beneficiaries of TSP along with scientists of Jalgaon centre and KVK, Nandurbar. The farmers of the TSP beneficiaries are happy with the support under this programme and many new farmers are also eager to utilize this benefit in the coming years. To spread the success of this programme it has been suggested to organize a field day involving other members of TSP community so as to appreciate the support of TSP.

Medziphema (09th to 11th November 2019): Attended "Awareness Programme on Impact of TR-4 on Banana Crop" held at CIH, Medziphema on 9th November 2019. On 11th November 2019 visit was made to the centre and reviewed the programmes of litchi being implemented besides attending the 34th School Board Meeting of SASRD, (Nagaland University), Medziphema as an external expert.

Pune (14th to 16th November 2019): On 14th November 2019 attended the meeting for the Midterm review programmes of grapes under ICAR-AICRP on Fruits. Various issues pertaining to implementation of the programmes of grapes and technologies available for adoption have been discussed. Later co-chaired the technical session on climate resilience-strategies and tools.

Pantnagar (25th & 26th November 2019): On 25th November 2019 travelled to Pantnagar and met the Vice Chancellor along with the Director of Research and Officer In-charge of the centre. The purpose of the meet was briefed and has agreed to provide all support in successful conduct of the Group Discussion. On 26th November 2019 visit was made to experimental plots of ICAR-AICRP on Fruits and interacted with the scientists associated with various programmes of mango, litchi and guava. Accordingly, necessary guidelines were made wherever necessary. The centre has implemented all

the allotted programmes and is in good condition.

Lucknow (07th & 08th December 2019): Participated in the Progressive Horticulture Conclave 2019 for Futuristic Technologies in Horticulture. Thereafter, had a brief discussion with the Nodal Officer of ICAR-CISH, Lucknow centre. Suggested in documenting the observations pertaining to varietal trial in guava being implemented at ICAR-CISH, Lucknow. Also interacted with other scientists of the centre in assessing the progress of the coordinated programmes. Further, request was made to the Director to provide the information pertaining to PGR of mango as per the format being circulated by the Project Coordinator.

Bengaluru (10th December 2019): Reviewed the programmes of mango, papaya and guava being implemented by different scientists. Discussed on the online data management tool for effective sharing of the data and PGR related matters.

Thrissur/Kannara (21st December 2019): Chaired the technical session on Physiology of Horticultural Crops, Post-harvest Physiology and Plant Nutrition and Development in the National Conference on Plant Physiology. Later visit was made to Kannara centre. During my visit, detailed discussion was held on each trial followed by visit to the experimental fields. Necessary guidelines were made and suggested for its implementation wherever needed. The centre has taken all care in implementation of the allotted programmes besides maintaining the relevant records. The scientist associated with jackfruit varietal evaluation has expressed that, the trees have not started bearing though sufficient canopy has been established. Hence, it has been suggested to verify with another farmers field in Kerala.

Ludhiana (6th January 2020): Discussed with concerned university authorities for the arrangements towards 7th Group Discussion of ICAR-AICRP on Fruits at PAU, Ludhiana (16th to 19th January 2020). Discussed with the scientists on the programmes of Kinnow mandarin, guava and grapes being implemented at the centre. Planned for the field visit for the delegates.

Vijayapura (18th February 2020): Visited the Horticulture Research Station, Tidagundi and reviewed the programmes of grape being implemented. The centre has implemented all the programmes and saw first bearing of the varietal trials. Discussed with the scientists of the centre with respect to the programmes of acid lime and grape.

A2. Monitoring of banana research activities at different centres under ICAR-AICRP (Fruits) by Crop Coordinator for banana

Kannara (6th April 2019): Dr. P. Suresh Kumar reviewed the activities of Kannara centre and suggested modifications in the implementation of the technical programme

Kovvur (9th to 13th July 2019): Dr. P. Durai, STO, ICAR -NRCB visited germplasm block for morphotaxonomic characterization. He advised the Nodal Officer to mark the duplicates and its removal.

Coimbatore (13th to 16th October 2019): Dr. P. Durai, STO, ICAR - NRCB visited germplasm block for morphotaxonomic characterization. He advised the Nodal Officer to mark the duplicates and its removal.

A3. Monitoring of Citrus research activities at different centres under ICAR-AICRP (Fruits) by Crop Coordinator for Citrus

Akola (17th May 2019): Dr. M.S. Ladaniya, Director, ICAR-CCRI, Nagpur & Crop Coordinator, Dr. I.P. Singh, Pr. Scientist (Hort.) & Dr. A.K. Das, Pr. Scientist (Pl. Path.) and Nodal Officer, AICRP (F) visited and reviewed the work progress of the centre.

A4. Monitoring of grapes research activities at different centres under ICAR-AICRP (Fruits) by Crop Coordinator for grapes

There are nine centres conducting trials on AICRP Grapes viz; Rahuri, Ludhiana, New Delhi, Pune-ARI, Pune (ICAR-NRCG), Periyakulam (Theni), Vijayapura, Mandasaur and Rajendranagar. Out of these the following centres were visited by the Crop Coordinator during April, 2019 to December, 2019.

Vijayapura (6th September, 2019): Dr. R.G. Somkuwar and Dr. Ajay Kumar Sharma visited Vijayapura centre. They interacted with the scientists to review the progress of the AICRP trials. Scientists discussed with Crop Coordinator about the water unavailability, gap filling and vine training. Centre was suggested to follow the advisories issued by ICAR-NRCG for managing insect-pests and diseases and stage specific assurance of water supply was advocated.

Rajendranagar (4th December, 2019): Visited the experimental plots of AICRP (Grapes) and reviewed the progress of grape trials and interacted with the scientists. Crop coordinators suggested the nutrient management strategies and attended the problem in functioning of online advisory system for crop management.

Rahuri (24th December, 2019): Visited AICRP Grape centre, reviewed progress made under various trials and technical guidance was given to the scientists. Crop load was affected due to disease incidence.

Disease management practice for powdery mildew was advised to the centre.

A5. Monitoring of litchi research activities at different centres under ICAR-AICRP (Fruits) by Crop Coordinator for litchi

Gangian - PAU (20th January 2019): The Crop Coordinator interacted with Head, Department of Fruit Science and associated scientists of the centre. Proper follow-up of the technical layout in implementation of trial and record of observation was stressed. During field visit, suggestion was made to collect fruit cracking tolerant germplasm with good bearing potential identified at Pathankot, followed by characterization as per descriptors proforma developed for litchi. This germplasm can be multiplied with a set of material to be deposited to NAGS.

Ambikapur (18th January 2019): This is the maiden visit of Crop Coordinator (CC) to the centre. Since it is a new centre, only 4 trials were allotted which will be initiated in the coming seasons. There are 21 genotypes at the centre which needs maintenance. The follow-up of technical program while implementing trials were emphasized and the preparation and communication of AICRP (F) reports was highlighted.

Pantnagar (27th to 30th May & 09th & 10th September 2019): There are 7 experiments on litchi at the centre and has been laid out as per the technical programme. For imparting knowhow on practical aspects of canopy management, a hand on training and pruning of young litchi plants was imparted to the centre. The procedure for rejuvenating of old plantations was also demonstrated as per the technical programme and inclusion of seasonal intercrops was suggested. In high density planting, mortality of plant during rainy season was observed owing to water logging. Accordingly, gap filling during post rainy periods along with provision of sufficient drainage was suggested.

Chettalli (24th & 25th August 2019): The experiment on girdling of branches has shown good impact at the centre, and this needs to be further disseminated to farmers' field. The experiment on canopy architecture needs to be initiated in fresh plantation after realizing the impact of centre opening and pruning in established plants.

Sabour (27th & 28th September 2019): The centre has implemented all the experiments as per technical programme and the performance of the centre is good. In canopy architecture management, the first level treatment for retaining the desired number

of primary branches has been imposed. Half-sib's seedling population needs to be established in the field.

Medziphema (01st & 02nd November 2019): The Crop Coordinator (CC) made a maiden visit to the centre. As this was recently included, only 3 trials were allotted. The experiment on girdling of branches and bagging of fruit bunches has shown visible impact. Training on canopy architecture management was also imparted at the centre. More emphasis should be laid on establishing seedlings population of litchi.

Mohanpur (04th & 05th November 2019): The performance of newly raised seedlings population of litchi is very satisfactory whereas at other centres, seedlings population has yet to be transplanted. In high density planting, particularly at 2x2 m, there is plant mortality which needs to be replanted. Other experiments have been implemented as per the technical programme.

B. Research papers

Akola

- Ingle YV, Bhosale DB, Paithankar DH, Mane SS and Lande GK (2019) Natural occurrence of *Aschersonia aleyrodalis* on citrus black fly in Vidarbha region of Maharashtra. *J. Plant Disease Sci.*, **14**(2):147-150.
- Mohod YN, Giri GK, Ingle YV and Meena Koche (2019) Management of pre-harvest fungal fruit drop in Nagpur mandarin. *J. Plant Disease Sci.*, **14**(2):129-132.

Bhubaneshwar (OUAT)

- Nayak PK, Patel MK, Panda CM and Swain S (2019) Yield performance of commercial banana cultivars propagated through different methods. *The Pharma innovation Journal.* **8**(10): 61-63.

Coimbatore

- Bowiya KS, Soorianathasundaram K, Kavitha C and Hemaprabha K (2019) Effect of pre-soaking treatments on *in vitro* seed germination of papaya to facilitate axenic explant production. *Int. J. Chem. Stud.*, **7**(4): 50-55.
- Shreedeevasena S, Manoranjitham SK, Rajendran L and Parimaladevi R (2019) Detection and molecular characterization of black spot disease of papaya (*Carica papaya* L.) incited by *Asperisporium caricae* (Speg.) Maubl. *Int. J. Curr. Microbiol. Appl. Sci.*, **8**(6): 2319-7706.

Gandevi

- Bisane KD, Shinde BD, Saxena SP and Patil

P (2019) Management of sapota seed borer (*Trymalitis margarias Meyrick*) with some newer pesticides. *Pesticide Res. J.*, **31**(1): 48-53.

- Bisane KD (2019) Seasonal variability of chiku moth, *Nephoteryx eugraphella* (Ragonot) in relation to ecological parameters and crop phenology of sapota. *Pest Mgt. Hortl. Ecosys.*, **25**(1): 37-43.
- Bisane KD and Naik BM (2019) Consequences of ecological factors and crop phenological stages on seasonal incidence of bud borer, *Anarsia achrasella* Bradley on sapota. *J. Entomol. Res.*, **43**(3): 295-300.
- Bisane KD and Naik BM (2019) Population Dynamics of Midrib Folder, *Banisia myrsusales elearalis* (Walker) in sapota and its Rootstock, Khirnee. *Indian J. Eco.*, **46**(4): 733-739.

Gangian

- Shilpa, Mahajan BVC, Singh NP, Sharma S and Kaur S (2019) Hydrocooling delays pericarp browning, enzymatic activities and maintains quality of litchi fruits under cold chain conditions. *Ind. J. Hort.*, **76**(1):162-167.
- Singh J, Singh NP, Sagwan AK, Gill PPS, Gill BS, Kaur S, Singh N, Singh D and Singh S (2019) Standardization of Litchi Leaf Nutrient Composition for Tissue Analysis in Sub Tropics of India. *Communications in soil Science and plant analysis*, **50**(22):2889-2898.

Jalgaon

- Pardeshi SR, Shaikh NB and Deshmukh PL (2019) Management of rhizome rot/tip over disease of banana. *J. Pharmacognosy and Phytochemistry*: 608-610.

Jorhat

- Sayed Yusuf Muzafary, Borthakur PK and Syed Wasifur Rahman (2019) Physico- chemical changes of Khasi mandarin (*Citrus reticulata*. Blanco) fruits as influenced by plant extracts, essential oils and natural coatings. *Int. J. chem. stud.*, **7**(2):1273-1276.

Kannara

- Dhanyasree K, Sobhana A, Suma A and Pushpalatha PB (2019) Evaluation of clones of banana Musa spp. Rasthali (AAB Group). *Tropical J. Agri.*, **57**(1):35-39.
- Lakshmi KS, Jyothi Bhaskar, Suma A and Pushpalatha PB (2019) Induction of multiple shoots through in vitro male bud culture in

banana Musa (AA) cv. Kadali. *Tropical J. Agri.*, **57**(1):66-70.

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C. Planting material produced during 2019

Crops	Centres	Quantity	Total
Banana	Arabhavi	12000	165992
	Bhubaneswar	736	
	Gandevi	1900	
	Jorhat	5700	
	Kannara	53688	
	Kovvur	86818	
	Mohanpur	5150	
Citrus	Akola	50000	172299
Acid lime	Kovvur	617	
	Ludhiana	400	
	Periyakulum	5334	
	Rahuri	13938	
	Sriganganagar	7070	
	Tirupati	94940	
Grape	Mandsaur	2400	15320
	Pune (ARI)	12330	
	Rajendranagar	590	
Guava	Udaipur	1000	1515
	Vengurle	515	
Jackfruit	Kannara	44	2779
	Kovvur	1790	
	Mohanpur	255	
	Periyakulum	690	
Litchi	Medziphema	350	1432
	Mohanpur	1082	
Mango	Kannara	102	25135
	Kovvur	17733	
	Mohanpur	1642	
	Periyakulum	5200	
	Udaipur	50	
	Vengurle	408	
Sapota	Gandevi	1380	7986
	Kovvur	3500	
	Periyakulum	3106	
Papaya	Coimbatore	7.805 kg	7.805 kg

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

Sl. No.	Centre name	Location of the centre	Mandate crops
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
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
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), Muzaffarpur-842002, Bihar	Litchi
37.	Nagpur	ICAR- Central Citrus Research Institute (CCRI), Nagpur-440010, Maharashtra	Citrus
38.	New Delhi	Division of Fruits and Horticultural Technology, ICAR- IARI, New Delhi-110012	Citrus, Grapes, Mango
39.	Port Blair	Division of Horticulture and Forestry, ICAR-Central Island Agricultural Research Institute (CIARI), Port Blair-744101, Andaman & Nicobar Islands	Banana
40.	Pune (IARI-RS)	ICAR-IARI Regional Station, Survey No. 125 A, ITI Road, Aundh, Pune-411007, Maharashtra	Papaya

Sl. No.	Centre name	Location of the centre	Mandate crops
41.	Pune (NRCG)	ICAR- National Research Centre for Grapes (NRCG), Pune-412307, Maharashtra	Grapes
42.	Ranchi	ICAR Res Complex for Eastern Region-Research Centre (RCER-RC), Tata Road, Plandu, Ranchi-834010, Jharkhand	Guava, Litchi & Papaya
43.	Tiruchirappalli	ICAR-National Research Centre for Banana (NRCB), Tiruchirappalli-620102, Tamil Nadu	Banana
44.	Lembucherra	ICAR Research Complex for NEH Region (ICAR-RC for NEH), Tripura Centre, Lembucherra, Tripura-799210, Tripura	Guava & Mango
C.	CAU based centres		
45.	Imphal	Department of Horticulture, College of Agriculture (CAU), Imphal-795004, Manipur	Mango
46.	Medziphema	Department of Horticulture, SASRD, Nagaland University, Medziphema Campus, Medziphema -797106, Nagaland	Litchi & Mango
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.

Sl. 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	3	3	4	4	1	1	3	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	4	4	4	1	-	4	-	13	8
7	Jalgaon	3	3	3	2	1	1	3	2	10	8
8	Jorhat	3	3	3	3	1	1	4	4	11	11
9	Kannara	4	4	4	2	1	1	5	3	14	10
10	Kovvur	4	4	4	2	1	-	4	4	13	10
11	Ludhiana	5	5	5	5	1	1	6	6	17	17
12	Mandsaur	1	1	1	-	-	-	1	-	3	1
13	Mohanpur	7	7	7	2	1	1	7	7	22	17
14	Pantnagar	3	3	4	2	-	-	2	-	9	5
15	Paria	3	3	4	2	1	1	2	-	10	6
16	Pasighat	1	-	2	2	1	1	1	1	5	4
17	Periyakulam	5	5	5	4	1	1	5	5	17	15
18	Pune (ARI)	1	1	1	1	-	-	1	1	3	3
19	Rahuri	7	6	7	7	1	1	6	4	21	18
20	Rajendranagar	3	3	3	1	1	1	2	1	9	6
21	Rewa	3	2	3	3	1	-	2	2	9	7
22	Sabour	3	3	3	3	1	-	3	3	10	9
23	Sangareddy	4	4	5	3	1	-	2	-	12	7
24	Sriganganagar	1	1	1	1	1	1	2	1	5	4
25	Tinsukia	3	3	3	3	1	1	3	2	10	9
26	Tirupati	4	4	4	4	1	-	4	1	13	9
27	Udaipur	2	1	2	1	1	-	2	2	7	4
28	Vengurle	4	4	4	3	1	-	3	3	12	10
	Total	92*	87	97*	74	25	16	90*	63	304	240

S = Sanctioned, F = Filled, 304 posts sanctioned (Conveying the approval of 3 posts pending)

Annexure-III

The allocation and expenditure for ICAR-AICRP on Fruits (ICAR and State shares) during 2019-20.
Expenditures are based on the information received from centres`

I. SAU/CAU/ DBT Institute based centre

(Amount in Rupees- ICAR+State share)

Sl. No.	Centre	Heads	Grant in aid Salary	Grant in aid General	Grants in aid Capital	Grand Total
1	Akola	Allocation	36,99,750	13,78,500	1,65,000	52,43,250
		Expenditure	34,53,745	13,83,157	11,48,483	59,85,384
2	Anantharajupet	Allocation	46,50,000	6,09,750	3,90,750	56,50,500
		Expenditure	31,75,023	4,99,503	3,88,799	40,63,325
3	Arabhavi	Allocation	67,50,000	13,76,250	12,52,500	93,78,750
		Expenditure	60,72,006	12,48,829	59,424	73,80,259
4	Bhubaneswar	Allocation	35,49,750	5,48,250	1,50,000	42,48,000
		Expenditure	19,62,038	6,09,398	0	25,71,436
5	Coimbatore	Allocation	1,02,00,000	10,38,000	1,87,500	1,14,25,500
		Expenditure	93,29,632	9,99,643	1,82,604	1,05,11,879
6	Gandevi	Allocation	45,99,750	7,29,000	4,08,750	57,37,500
		Expenditure	42,78,656	6,94,191	3,17,483	52,90,329
7	Gangian	Allocation	0	3,78,750	0	3,78,750
		Expenditure	0	3,78,926	0	3,78,926
8	Imphal	Allocation	0	9,53,250	4,12,500	13,65,750
		Expenditure	0	8,60,815	0	8,60,815
9	Jalgaon	Allocation	45,99,750	13,05,750	66,750	59,72,250
		Expenditure	47,11,754	12,84,098	66,146	60,61,997
10	Jorhat	Allocation	72,99,750	18,56,250	16,14,750	1,07,70,750
		Expenditure	1,00,77,580	13,01,086	9,48,431	1,23,27,096
11	Kalimpong	Allocation	0	2,10,000	0	2,10,000
		Expenditure	0	1,13,243	0	1,13,243
12	Kannara	Allocation	95,00,250	14,31,750	0	1,09,32,000
		Expenditure	84,72,081	14,31,750	0	99,03,831
13	Kovvur	Allocation	95,00,250	11,83,500	1,12,500	1,07,96,250
		Expenditure	77,08,227	10,82,037	74802.75	88,65,067
14	Ludhiana	Allocation	1,11,00,000	17,18,250	0	1,28,18,250
		Expenditure	1,06,07,429	15,64,716	0	1,21,72,145
15	Mandsaur	Allocation	8,00,250	5,57,250	1,50,000	15,07,500
		Expenditure	5,92,799	5,35,622	1,50,000	12,78,421

Sl. No.	Centre	Heads	Grant in aid Salary	Grant in aid General	Grants in aid Capital	Grand Total
16	Medziphema	Allocation	0	8,58,000	0	8,58,000
		Expenditure	0	4,40,250	0	4,40,250
17	Mohanpur	Allocation	1,08,00,000	18,96,750	4,12,500	1,31,09,250
		Expenditure	98,62,915	19,53,864	4,12,050	1,22,28,829
18	Neri	Allocation	0	4,65,000	0	4,65,000
		Expenditure	0	4,32,175	0	4,32,175
19	Pantnagar	Allocation	81,00,000	5,68,500	4,08,750	90,77,250
		Expenditure	59,89,100	5,52,566	4,07,164	69,48,830
20	Paria	Allocation	48,00,000	5,89,500	0	53,89,500
		Expenditure	35,08,623	5,69,140	0	40,77,763
21	Pasighat	Allocation	7,50,000	13,97,250	13,12,500	34,59,750
		Expenditure	14,81,466	10,00,427	3,34,721	28,16,615
22	Periyakulam	Allocation	1,40,00,250	14,03,250	3,91,500	1,57,95,000
		Expenditure	1,05,05,986	17,79,966	3,87,527	1,26,73,479
23	Pune (ARI)	Allocation	20,25,000	2,85,000	60,000	23,70,000
		Expenditure	20,30,801	3,01,970	57,914	23,90,684
24	Pusa (CAU)	Allocation	0	5,50,500	5,25,000	10,75,500
		Expenditure	0	7,14,235	8,17,958	15,32,193
25	Rahuri	Allocation	1,59,50,250	13,84,500	1,87,500	1,75,22,250
		Expenditure	90,78,996	14,59,105	5,65,546	1,11,03,647
26	Raipur	Allocation	0	3,96,750	0	3,96,750
		Expenditure	0	3,97,978	0	3,97,978
27	Rajendranagar	Allocation	47,00,250	5,43,750	0	52,44,000
		Expenditure	56,82,209	5,71,612	0	62,53,820
28	Rewa	Allocation	39,99,750	8,67,000	1,83,750	50,50,500
		Expenditure	41,80,371	8,37,344	1,80,252	51,97,967
29	Sabour	Allocation	90,00,000	7,15,500	5,24,250	1,02,39,750
		Expenditure	98,29,584	8,74,577	0	1,07,04,161
30	Sangareddy	Allocation	50,00,250	5,55,000	2,44,500	57,99,750
		Expenditure	64,78,989	5,03,029	2,43,552	72,25,570
31	Sriganganagar	Allocation	17,00,250	3,36,750	37,500	20,74,500
		Expenditure	14,62,500	3,13,500	7,500	17,83,500
32	Tinsukia	Allocation	77,00,250	18,31,500	18,85,500	1,14,17,250
		Expenditure	86,98,790	12,98,976	10,64,888	1,10,62,654

Sl. No.	Centre	Heads	Grant in aid Salary	Grant in aid General	Grants in aid Capital	Grand Total
33	Tirupati	Allocation	1,14,99,750	12,80,250	2,25,000	1,30,05,000
		Expenditure	88,44,114	12,52,124	2,19,930	1,03,16,168
34	Udaipur	Allocation	39,99,750	3,72,750	0	43,72,500
		Expenditure	37,89,651	3,62,502	0	41,52,153
35	Vengurle	Allocation	48,00,000	14,35,500	1,50,000	63,85,500
		Expenditure	50,67,538	13,78,493	1,02,893	65,48,924
36	Yachuli	Allocation	-	6,77,250	1,50,000	8,27,250
		Expenditure	-	2,19,750	-	2,19,750

II. ICAR based centre

(Amount in Rupees- ICAR share)

Sl. No.	Centre	Heads	Grant in aid General	Grants in aid Capital	Grand Total
1	Bengaluru (PC Unit)	Allocation	38,33,250	6429000	1,02,62,250
		Expenditure	38,33,250	6429000	1,02,62,250
2	Bengaluru (IIHR)	Allocation	6,67,500	0	6,67,500
		Expenditure	6,67,500	0	6,67,500
3	Bhubaneswar (CHES)	Allocation	2,25,000	0	2,25,000
		Expenditure	2,06,759	0	2,06,759
4	Chettalli (CHES)	Allocation	1,75,500	0	1,75,500
		Expenditure	1,75,321	0	1,75,321
5	Lucknow (CISH)	Allocation	2,81,250	0	2,81,250
		Expenditure	2,90,212	0	2,90,212
6	Malda (CISH-RS)	Allocation	1,12,500	0	1,12,500
		Expenditure	98,888	0	98,888
7	Muzaffarpur (NRCL)	Allocation	6,00,000	0	6,00,000
		Expenditure	6,00,254	0	6,00,254
8	Nagpur (CCRI)	Allocation	5,37,000	0	5,37,000
		Expenditure	5,37,000	0	5,37,000
9	New Delhi (IARI)	Allocation	1,61,250	0	1,61,250
		Expenditure	1,58,603	0	1,58,603
10	Port Blair (CIARI)	Allocation	1,98,750	0	1,98,750
		Expenditure	2,05,009	0	2,05,009
11	Pune (IARI RS)	Allocation	1,65,000	0	1,65,000
		Expenditure	1,28,435	0	1,28,435
12	Pune (NRCG)	Allocation	4,32,750	0	4,32,750
		Expenditure	4,32,236	0	4,32,236
13	Ranchi (RCER RC)	Allocation	4,40,250	0	4,40,250
		Expenditure	4,37,210	0	4,37,210
14	Tiruchirapalli (NRCB)	Allocation	8,77,500	0	8,77,500
		Expenditure	8,77,373	0	8,77,373
15	Lembucherra (ICAR-RC)	Allocation	9,23,250	3,75,000	12,98,250
		Expenditure	11,46,857	3,73,481	15,20,338

III. TSP programme

Sl. No.	Centre	Heads	Grant in aid General	Grants in aid Capital	Grand Total
16	Bhubaneswar (Rayagada)	Allocation	5,62,500	1,50,000	7,12,500
		Expenditure	0	0	0
17	Gandevi (The Dangs/ Valsad)	Allocation	8,25,000	75,000	9,00,000
		Expenditure	7,81,267	68,242	8,49,509
18	Jalgaon (Nandorebar)	Allocation	8,62,500	75,000	9,37,500
		Expenditure	59,801	43,191	1,02,992
19	Kovvur (ITDA area of West Godavari Dist.)	Allocation	9,37,500	1,50,000	10,87,500
		Expenditure	14,40,080	0	14,40,080
20	Medziphema (NU)	Allocation	6,37,500	1,50,000	7,87,500
		Expenditure	2,07,750	0	2,07,750
21	Ranchi (Ranchi)	Allocation	6,37,500	1,50,000	7,87,500
		Expenditure	4,97,014	0	4,97,014
22	Udaipur (Udaipur/ Dungarpur & Banswara)	Allocation	7,87,500	1,50,000	9,37,500
		Expenditure	7,87,141	1,49,999	9,37,140

IV. SCSP programme

Sl. No.	Centre	Heads	Grant in aid General	Grants in aid Capital	Grand Total
1	Akola	Allocation	2,40,000	18,750	2,58,750
		Expenditure	4,23,662	0	4,23,662
2	Anantharajupet	Allocation	1,12,500	75,000	1,87,500
		Expenditure	1,72,280	74,250	2,46,530
3	Arabhavi	Allocation	4,27,500	75,000	5,02,500
		Expenditure	3,69,581	27,000	3,96,581
4	Coimbatore	Allocation	1,95,000	37,500	2,32,500
		Expenditure	1,95,008	37,492	2,32,500
5	Gandevi	Allocation	1,87,500	0	1,87,500
		Expenditure	1,83,118	0	1,83,118
6	Jalgaon	Allocation	1,98,750	26,250	2,25,000
		Expenditure	32,183	10,798	42,980
7	Jorhat	Allocation	63,750	18,750	82,500
		Expenditure	63,750	18,750	82,500
8	Kannara	Allocation	1,50,000	75,000	2,25,000
		Expenditure	1,50,000	75,000	2,25,000
9	Ludhiana	Allocation	1,50,000	37,500	1,87,500
		Expenditure	93,750	37,500	1,31,250
10	Mandsaur	Allocation	1,65,000	75,000	2,40,000
		Expenditure	1,64,404	75,000	2,39,404
11	Mohanpur	Allocation	1,87,500	1,04,250	2,91,750
		Expenditure	1,87,500	1,04,207	2,91,707
12	Paria	Allocation	1,50,000	37,500	1,87,500
		Expenditure	1,49,842	37,500	1,87,342
13	Periyakulam	Allocation	3,37,500	75,000	4,12,500
		Expenditure	3,14,705	74,065	3,88,769
14	Ranchi	Allocation	1,50,000	37,500	1,87,500
		Expenditure	1,34,867	0	1,34,867
15	Tirupati	Allocation	1,87,500	37,500	2,25,000
		Expenditure	1,49,984	36,383	1,86,367
16	Tinsukia	Allocation	97,500	19,500	1,17,000
		Expenditure	1,09,583	0	1,09,583

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.	
April 19	13.50	1	42.10	22.20	41.00	22.00	10.50
May	0.0	0	43.10	26.40	39.00	19.00	15.20
June	89.60	6	40.10	24.70	60.00	33.00	13.10
July	285.70	16	32.10	20.90	84.00	61.00	5.60
August	179.50	12	29.20	20.00	90.00	73.00	4.20
September	263.10	13	29.90	19.90	92.00	72.00	2.80
October	85.10	7	30.50	17.90	91.00	60.00	3.70
November	11.80	1	30.50	14.70	90.00	46.00	3.50
December	14.20	2	27.90	15.20	86.00	45.00	3.40

Anantharajupet

Month	Rainfall (mm)	Rainy days	Temperature (°C)		Relative Humidity (%)		Evaporation (mm/day)
			Max.	Min.	Morn.	Even.	
April 19	27.00	2	40.63	21.50	69.10	35.90	-
May	10.00	1	41.82	24.60	75.50	33.90	-
June	143.20	4	35.83	25.37	77.80	34.70	-
July	240.60	9	35.65	23.80	77.10	51.80	-
August	117.10	11	33.90	20.20	83.60	46.20	-
September	120.80	13	33.58	19.90	84.70	46.70	-
October	210.30	17	32.83	20.06	84.60	43.00	-
November	65.40	5	29.93	17.76	82.40	51.30	-
December	125.00	6	28.29	16.64	88.80	46.80	-

Arabhavi

Month	Rainfall (mm)	Rainy days	Temperature (°C)		Relative Humidity (%)		Evaporation (mm/day)
			Max.	Min.	Morn.	Even.	
April 19	0.0	0	37.40	15.80	74.30	36.10	2.90
May	11.60	2	42.80	14.40	90.20	46.10	3.10
June	211.20	7	35.90	11.70	82.90	57.70	2.20
July	101.60	12	30.80	13.30	79.30	74.40	1.10
August	338.60	10	30.70	12.30	87.10	75.80	1.50
September	65.20	10	32.80	13.40	85.70	78.80	1.80
October	356.20	13	34.00	15.50	87.50	77.80	1.20
November	0.0	0	32.40	15.40	86.80	71.40	2.90
December	12.30	1	32.70	15.90	84.20	68.10	3.00

Bengaluru

Month	Rainfall (mm)	Rainy days	Temperature (°C)		Relative Humidity (%)		Evaporation (mm/day)
			Max.	Min.	Morn.	Even.	
April 19	28.70	3	35.50	20.40	69.90	33.70	7.30
May	153.50	10	34.30	21.70	78.80	47.60	6.30
June	86.70	3	30.90	21.30	82.40	62.20	5.80
July	47.70	5	29.70	20.90	83.40	63.10	5.20
August	198.90	13	28.00	20.50	87.50	75.40	4.40
September	207.50	12	28.60	20.60	89.20	70.80	3.60
October	324.20	15	28.90	19.70	89.90	72.50	4.10
November	15.20	2	28.70	18.10	87.00	60.60	3.80
December	2.70	0	27.20	16.70	88.30	67.20	3.10

Bhubaneswar (OUAT)

Month	Rainfall (mm)	Rainy days	Temperature (°C)		Relative Humidity (%)		Evaporation (mm/day)
			Max.	Min.	Morn.	Even.	
April 19	29.60	5	38.00	25.30	91.00	45.00	7.50
May	197.70	2	37.10	27.40	92.00	54.00	8.10
June	144.60	13	35.50	26.60	91.00	64.00	6.50
July	341.70	20	32.90	26.00	92.00	74.00	3.40
August	319.40	21	32.10	26.00	95.00	78.00	3.10
September	406.50	15	32.10	25.70	94.00	78.00	2.90
October	312.60	13	32.60	24.20	94.00	70.00	3.10
November	5.30	1	30.20	20.00	94.00	55.00	3.30
December	0.0	0	28.30	16.20	92.00	56.00	3.60

Bhubaneswar (CHES)

Month	Rainfall (mm)	Rainy days	Temperature (°C)		Relative Humidity (%)		Evaporation (mm/day)
			Max.	Min.	Morn.	Even.	
April 19	29.60	5	38.00	25.30	91.00	45.00	7.50
May	197.70	2	37.10	27.40	92.00	54.00	8.10
June	144.60	13	35.50	26.60	91.00	64.00	6.50
July	341.70	20	32.90	26.00	92.00	74.00	3.40
August	319.40	21	32.10	26.00	95.00	78.00	3.10
September	406.50	15	32.10	25.70	94.00	78.00	2.90
October	312.60	11	32.60	24.20	94.00	70.00	6.30
November	4.00	1	30.20	20.00	94.00	55.00	5.90
December	0.0	0	28.30	16.20	92.00	56.00	5.60

Chettali (CHES)

Month	Rainfall (mm)	Rainy days	Temperature (°C)		Relative Humidity (%)		Evaporation (mm/day)
			Max.	Min.	Morn.	Even.	
April 19	92.20	10	33.20	18.23	93.57	39.43	-
May	112.30	11	31.86	19.58	91.84	51.71	-
June	143.20	20	27.98	19.85	92.33	68.93	-
July	187.20	25	25.56	19.37	91.87	76.35	-
August	654.40	30	24.58	19.16	93.16	79.48	-
September	244.10	24	26.29	18.79	93.77	73.80	-
October	0.40	1	27.08	18.55	90.90	64.13	-
November	0.20	1	26.52	15.07	42.07	30.52	-
December	-	-	-	-	-	-	-

Coimbatore

Month	Rainfall (mm)	Rainy days	Temperature (°C)		Relative Humidity (%)		Evaporation (mm/day)
			Max.	Min.	Morn.	Even.	
April 19	23.60	2	36.70	24.50	85.00	8.80	43.00
May	77.80	6	35.80	24.90	85.00	8.60	51.00
June	21.00	3	33.50	24.80	79.00	7.10	55.00
July	8.50	0	31.80	23.60	82.00	4.90	58.00
August	221.30	7	29.90	23.00	84.00	4.20	66.00
September	57.30	9	30.90	23.40	84.00	5.40	65.00
October	246.90	13	30.70	22.70	87.00	62.00	4.90
November	167.10	9	29.60	22.20	87.00	60.00	4.70
December	36.00	5	27.80	21.20	86.00	62.00	4.10

Gandevi

Month	Rainfall (mm)	Rainy days	Temperature (°C)		Relative Humidity (%)		Evaporation (mm/day)
			Max.	Min.	Morn.	Even.	
April 19	0.0	0	32.40	19.70	71.10	65.90	6.30
May	0.0	0	33.10	24.20	74.90	56.20	6.50
June	454.00	8	33.20	26.10	81.30	70.20	4.10
July	491.50	19	30.80	24.50	90.40	83.70	0.30
August	613.50	19	29.00	24.20	90.50	85.00	0.60
September	705.00	22	30.30	24.50	91.00	87.00	2.50
October	145.10	5	33.40	22.80	85.70	79.00	1.60
November	31.00	1	33.30	21.30	88.60	77.20	1.90
December	0.0	0	27.10	17.80	86.00	78.40	2.40

Imphal

Month	Rainfall (mm)	Rainy days	Temperature (°C)		Relative Humidity (%)		Evaporation (mm/day)
			Max.	Min.	Morn.	Even.	
April 19	2.59	7	29.41	15.25	84.37	47.60	-
May	2.81	10	29.85	19.50	81.16	54.71	-
June	6.05	13	30.74	21.71	87.43	66.10	-
July	6.54	18	29.66	22.35	89.35	70.94	-
August	2.03	11	30.69	22.45	87.10	67.45	-
September	8.46	14	29.48	21.62	90.63	68.00	-
October	5.15	9	28.40	19.28	93.77	67.29	-
November	1.29	3	26.30	13.54	93.47	56.23	-
December	0.44	2	22.49	6.40	92.65	46.39	-

Jalgaon

Month	Rainfall (mm)	Rainy days	Temperature (°C)		Relative Humidity (%)		Evaporation (mm/day)
			Max.	Min.	Morn.	Even.	
April 19	0.0	0	42.00	25.40	57.00	25.00	10.60
May	0.0	0	42.30	27.40	66.00	27.00	12.40
June	81.80	5	39.20	27.60	74.00	37.00	8.70
July	196.70	14	32.90	24.90	89.00	63.00	4.60
August	357.10	12	30.10	24.00	89.00	82.00	4.50
September	106.90	10	31.30	24.10	89.00	81.00	5.20
October	159.60	9	31.50	21.60	86.00	72.00	5.60
November	28.50	2	31.40	18.20	83.00	62.00	7.60
December	1.50	0	28.80	15.90	78.00	57.00	6.80

Jorhat

Month	Rainfall (mm)	Rainy days	Temperature (°C)		Relative Humidity (%)		Evaporation (mm/day)
			Max.	Min.	Morn.	Even.	
April 19	184.60	7	28.90	19.80	92.00	70.00	2.50
May	327.60	19	27.80	21.70	95.00	80.00	2.50
June	328.60	13	32.60	25.20	90.00	73.00	2.90
July	403.50	8	31.90	25.90	92.00	80.00	2.80
August	194.40	8	33.80	26.20	91.00	72.00	2.90
September	370.10	17	31.80	24.50	96.00	76.00	2.60
October	-	-	-	-	-	-	-
November	-	-	-	-	-	-	-
December	-	-	-	-	-	-	-

Kannara

Month	Rainfall (mm)	Rainy days	Temperature (°C)		Relative Humidity (%)		Evaporation (mm/day)
			Max.	Min.	Morn.	Even.	
April 19	76.40	3	36.20	25.50	86.40	54.20	4.70
May	48.80	4	34.60	24.90	86.00	59.40	4.20
June	324.40	15	32.10	23.60	92.70	73.20	2.80
July	654.40	21	30.40	22.80	95.20	75.90	2.40
August	977.50	24	29.50	21.80	96.20	82.40	1.90
September	419.00	19	31.20	22.00	95.40	74.60	2.50
October	418.40	16	32.40	21.40	91.00	68.00	2.70
November	205.00	5	32.90	21.70	83.00	60.00	3.40
December	4.40	1	32.30	22.10	73.00	52.00	4.50

Kovvur

Month	Rainfall (mm)	Rainy days	Temperature (°C)		Relative Humidity (%)		Evaporation (mm/day)
			Max.	Min.	Morn.	Even.	
April 19	14.00	2	38.50	25.50	90.86	19.00	3.57
May	5.60	2	40.90	28.03	85.78	27.41	3.44
June	40.40	9	38.16	28.00	84.23	21.96	2.57
July	126.20	16	33.90	26.12	93.06	26.80	2.20
August	197.20	15	32.45	25.38	92.16	35.83	2.73
September	205.40	20	31.73	25.56	95.43	45.43	3.04
October	161.20	7	32.03	23.74	97.70	27.93	3.52
November	-	-	33.56	22.76	89.73	19.00	4.18
December	-	-	31.41	20.48	84.06	19.00	3.62

Lembucherra

Month	Rainfall (mm)	Rainy days	Temperature (°C)		Relative Humidity (%)		Evaporation (mm/day)
			Max.	Min.	Morn.	Even.	
April 19	146.20	6	33.40	20.50	91.00	59.00	3.60
May	251.60	11	34.10	23.20	92.00	67.00	3.90
June	446.30	11	33.70	23.80	92.00	74.00	3.30
July	485.20	16	32.70	24.10	93.00	79.00	2.90
August	220.50	19	33.70	24.20	94.00	72.00	3.40
September	199.50	8	33.30	23.60	94.00	73.00	3.30
October	216.60	12	31.40	21.20	96.00	77.00	2.40
November	44.20	3	30.30	16.50	98.00	67.00	1.90
December	5.40	1	25.30	11.30	98.00	61.00	1.30

Lucknow

Month	Rainfall (mm)	Rainy days	Temperature (°C)		Relative Humidity (%)		Evaporation (mm/day)
			Max.	Min.	Morn.	Even.	
April 19	16.40	1	37.70	18.20	93.20	48.10	8.10
May	0.0	0	41.50	19.90	93.60	37.50	9.40
June	61.80	1	39.70	25.20	94.40	46.50	9.00
July	442.20	10	34.20	25.50	95.40	67.20	7.40
August	244.60	8	33.60	25.80	95.50	69.80	6.20
September	267.60	6	32.00	24.80	94.60	71.80	5.20
October	0.0	0	31.10	19.20	93.90	72.90	4.50
November	0.0	0	28.50	12.50	93.30	72.60	4.00
December	22.40	1	20.00	7.40	88.50	70.90	3.00

Ludhiana (PAU campus)

Month	Rainfall (mm)	Rainy days	Temperature (°C)		Relative Humidity (%)		Evaporation (mm/day)
			Max.	Min.	Morn.	Even.	
April 19	41.60	3	35.10	19.50	71.00	30.00	170.30
May	20.00	3	38.00	22.10	52.00	22.00	243.50
June	29.90	2	40.40	26.80	55.00	30.00	291.40
July	218.40	10	34.00	26.70	79.00	64.00	174.10
August	331.40	8	33.80	26.10	85.00	76.00	131.40
September	264.80	8	33.10	25.50	86.00	68.00	100.00
October	0.0	0	30.60	18.40	90.00	46.00	76.70
November	35.20	2	25.60	13.40	90.00	47.00	56.80
December	46.80	3	15.80	7.50	93.00	64.00	30.50

Ludhiana (Abohar station)

Month	Rainfall (mm)	Rainy days	Temperature (°C)		Relative Humidity (%)		Evaporation (mm/day)
			Max.	Min.	Morn.	Even.	
April 19	47.40	3	35.30	18.20	90.30	23.20	6.50
May	45.80	4	38.30	21.10	79.10	17.80	9.20
June	35.60	3	41.30	25.10	77.00	21.70	12.30
July	141.50	7	36.50	27.30	91.70	47.90	9.20
August	86.60	3	35.50	26.60	100.00	53.30	5.90
September	10.00	1	35.50	25.60	100.00	50.50	5.50
October	0.0	0	32.00	17.60	99.90	36.00	4.10
November	33.80	2	25.60	12.60	100.00	42.00	3.30
December	22.40	1	16.60	5.40	100.00	56.10	1.90

Mandsaur

Month	Rainfall (mm)	Rainy days	Temperature (°C)		Relative Humidity (%)		Evaporation (mm/day)
			Max.	Min.	Morn.	Even.	
April 19	-	-	40.96	23.40	39.64	-	-
May	-	-	41.52	26.05	38.18	-	-
June	-	-	35.10	26.83	53.73	-	-
July	381.00	7	33.40	24.47	75.43	-	-
August	840.00	12	28.69	22.48	88.34	-	-
September	680.50	10	30.69	23.45	91.28	-	-
October	55.00	2	31.72	20.41	70.94	-	-
November	-	-	-	-	-	-	-
December	-	-	-	-	-	-	-

Medziphema

Month	Rainfall (mm)	Rainy days	Temperature (°C)		Relative Humidity (%)		Evaporation (mm/day)
			Max.	Min.	Morn.	Even.	
April 19	73.30	-	30.80	18.50	92.00	58.00	-
May	185.80	-	32.00	21.70	90.00	64.00	-
June	195.00	-	33.50	24.10	91.00	69.00	-
July	271.30	-	33.00	24.90	93.00	72.00	-
August	56.40	-	33.90	24.80	92.60	72.20	-
September	42.30	-	26.10	23.90	93.70	72.50	-
October	48.90	-	30.30	21.30	95.40	72.20	-
November	39.40	-	28.30	15.60	97.50	64.00	-
December	36.70	-	23.20	11.70	98.20	67.00	-

Mohanpur

Month	Rainfall (mm)	Rainy days	Temperature (°C)		Relative Humidity (%)		Evaporation (mm/day)
			Max.	Min.	Morn.	Even.	
April 19	142.50	5	34.68	24.12	89.80	56.87	3.51
May	94.40	5	36.06	26.48	87.48	60.32	4.47
June	108.80	7	35.28	27.10	89.27	66.47	3.69
July	104.00	11	34.06	26.89	89.61	71.81	3.03
August	331.20	20	32.22	26.34	94.65	79.35	2.37
September	184.20	12	32.16	25.83	94.67	75.07	2.24
October	98.80	11	30.85	23.33	94.52	72.71	1.92
November	70.00	3	29.24	18.31	92.27	61.87	1.36
December	20.40	1	24.39	12.91	91.94	61.55	0.96

Muzaffarpur

Month	Rainfall (mm)	Rainy days	Temperature (°C)		Relative Humidity (%)		Evaporation (mm/day)
			Max.	Min.	Morn.	Even.	
April 19	2.95	4	33.68	19.85	76.75	50.00	5.55
May	0.25	2	38.65	24.30	75.25	49.00	6.53
June	6.65	3	37.93	25.65	79.75	54.00	6.35
July	61.08	15	35.08	26.60	84.25	69.00	4.55
August	48.65	9	33.95	26.63	87.75	74.50	4.08
September	27.23	14	34.03	26.78	89.00	73.50	4.43
October	102.40	1	30.05	24.18	93.50	83.75	2.43
November	0.00	0	29.48	21.48	91.25	81.50	2.70
December	0.00	2	28.15	15.85	92.75	66.50	1.75

Nagpur

Month	Rainfall (mm)	Rainy days	Temperature (°C)		Relative Humidity (%)		Evaporation (mm/day)
			Max.	Min.	Morn.	Even.	
April 19	15.30	05	42.06	26.77	-	-	-
May	0.0	0	44.38	30.79	-	-	-
June	130.60	11	41.74	28.62	-	-	-
July	283.60	21	30.44	23.59	-	-	-
August	316.40	24	30.45	23.81	-	-	-
September	383.90	28	30.53	24.09	-	-	-
October	64.80	07	32.19	21.37	-	-	-
November	0.10	01	31.79	16.57	-	-	-
December	23.10	05	29.09	14.21	-	-	-

Neri

Month	Rainfall (mm)	Rainy days	Temperature (°C)		Relative Humidity (%)		Evaporation (mm/day)
			Max.	Min.	Morn.	Even.	
April 19	75.80	-	36.64	12.76	96.23	12.21	-
May	22.20	-	38.97	14.44	95.00	4.96	-
June	127.60	-	38.58	17.72	97.01	22.79	-
July	325.40	-	34.99	20.32	97.66	43.04	-
August	407.80	-	32.75	20.57	97.97	53.95	-
September	291.60	-	32.74	16.81	97.98	45.03	-
October	11.40	-	30.23	10.09	97.22	21.46	-
November	20.00	-	25.21	7.79	96.84	30.68	-
December	4.60	-	21.36	1.56	96.57	22.14	-

Pantnagar

Month	Rainfall (mm)	Rainy days	Temperature (°C)		Relative Humidity (%)		Evaporation (mm/day)
			Max.	Min.	Morn.	Even.	
April 19	14.40	2	34.50	18.30	71.00	35.00	7.00
May	0.0	0	37.00	21.20	58.00	20.00	10.10
June	257.00	5	37.00	25.30	70.00	44.00	9.10
July	239.50	13	32.30	25.90	85.00	69.00	4.70
August	332.30	12	32.00	25.50	88.00	69.00	4.60
September	290.60	7	31.60	24.30	89.00	67.00	3.80
October	0.0	0	30.90	18.60	89.00	51.00	2.80
November	29.20	1	28.00	13.40	90.00	48.00	2.30
December	79.80	2	24.00	8.50	95.00	66.00	1.90

Paria

Month	Rainfall (mm)	Rainy days	Temperature (°C)		Relative Humidity (%)		Evaporation (mm/day)
			Max.	Min.	Morn.	Even.	
April 19	0.0	0	37.39	26.08	71.33	38.15	6.28
May	0.0	0	35.42	27.69	73.20	47.90	6.83
June	371.70	6	34.87	28.06	79.14	61.10	5.67
July	1025.50	15	31.35	26.40	90.50	81.63	2.80
August	675.30	15	29.93	25.75	92.10	86.84	3.43
September	838.30	18	31.03	25.58	93.57	84.86	2.68
October	43.80	4	33.55	25.23	88.20	71.47	3.17
November	82.40	2	34.00	22.73	89.79	60.70	2.80
December	0.0	0	32.42	19.23	86.23	60.70	3.02

Pasighat (CAU)

Month	Rainfall (mm)	Rainy days	Temperature (°C)		Relative Humidity (%)		Evaporation (mm/day)
			Max.	Min.	Morn.	Even.	
April 19	173.50	12	23.70	29.50	81.70	78.60	3.70
May	458.50	18	23.60	27.40	91.60	86.60	2.10
June	-	-	-	-	-	-	-
July	1405.00	21	26.10	29.70	93.30	89.80	2.60
August	261.00	09	28.80	34.40	84.10	79.90	4.60
September	660.00	16	26.70	30.10	91.80	90.00	3.60
October	132.00	09	24.10	28.30	86.60	87.10	3.30
November	22.00	03	22.70	27.90	84.90	80.80	3.00
December	7.00	02	17.90	23.10	87.20	80.50	3.90

Periyakulam

Month	Rainfall (mm)	Rainy days	Temperature (°C)		Relative Humidity (%)		Evaporation (mm/day)
			Max.	Min.	Morn.	Even.	
April 19	123.80	3	38.11	27.51			-
May	42.00	4	38.07	28.08			-
June	9.00	1	37.15	27.36			-
July	12.80	1	35.34	26.80			-
August	137.20	5	33.00	25.33			-
September	102.40	8	33.68	25.92			-
October	192.40	14	31.90	25.04			-
November	125.40	7	31.82	24.17			-
December	34.20	3	30.01	22.44			-

Port Blair

Month	Rainfall (mm)	Rainy days	Temperature (°C)		Relative Humidity (%)		Evaporation (mm/day)
			Max.	Min.	Morn.	Even.	
April 19	17.90	2	33.10	25.40	67.00	73.00	-
May	336.60	17	32.40	25.60	79.00	82.00	-
June	691.00	23	29.90	24.20	89.00	89.00	-
July	165.60	16	30.80	25.10	84.00	84.00	-
August	1098.80	29	28.80	24.00	92.00	92.00	-
September	540.00	23	29.10	24.10	88.00	89.00	-
October	270.20	10	31.60	24.90	75.00	83.00	-
November	194.50	10	31.00	24.70	73.00	82.00	-
December	1.80	01	30.30	24.90	68.00	72.00	-

Pune (ARI)

Month	Rainfall (mm)	Rainy days	Temperature (°C)		Relative Humidity (%)		Evaporation (mm/day)
			Max.	Min.	Morn.	Even.	
April 19	4.00	1	39.48	20.86	68.78	24.95	-
May	-	-	39.50	23.00	66.43	23.73	-
June	59.10	6	35.04	23.86	80.48	52.35	-
July	193.40	12	29.77	22.53	89.12	72.74	-
August	49.70	6	29.43	21.94	90.08	75.29	-
September	142.00	4	30.20	21.58	91.34	70.49	-
October	371.00	14	29.78	20.96	96.01	71.01	-
November	34.00	3	30.30	17.98	95.35	63.13	-
December	-	-	29.10	17.15	91.87	56.72	-

Pune (NRCC)

Month	Rainfall (mm)	Rainy days	Temperature (°C)		Relative Humidity (%)		Evaporation (mm/day)
			Max.	Min.	Morn.	Even.	
April 19	55.60	3	36.89	19.94	69.81	22.32	8.30
May	0.0	0	37.91	22.59	76.34	27.96	8.80
June	41.50	3	32.75	23.78	87.93	53.11	6.00
July	193.40	16	28.83	22.76	96.38	75.73	3.20
August	77.50	7	28.91	21.66	97.84	76.15	2.90
September	174.10	7	29.91	21.62	96.83	72.10	2.80
October	202.80	12	30.61	20.75	98.34	66.13	3.20
November	64.10	4	31.36	16.93	99.74	54.23	3.00
December	12.00	2	30.23	16.42	97.77	54.00	3.30

Pusa

Month	Rainfall (mm)	Rainy days	Temperature (°C)		Relative Humidity (%)		Evaporation (mm/day)
			Max.	Min.	Morn.	Even.	
April 19	7.60	1	34.70	21.40	76.00	51.00	6.10
May	14.40	1	39.00	24.70	77.00	50.00	6.60
June	30.40	4	37.50	26.50	80.00	59.00	5.50
July	354.00	13	33.20	26.10	88.00	73.00	3.70
August	171.70	7	34.30	26.80	89.00	75.00	5.00
September	403.00	12	31.40	25.20	91.00	80.00	2.70
October	6.60	1	29.30	22.10	92.00	82.00	2.70
November	0.0	0	28.40	16.60	93.00	68.00	1.90
December	22.00	2	21.00	9.70	92.00	75.00	1.00

Rahuri

Month	Rainfall (mm)	Rainy days	Temperature (°C)		Relative Humidity (%)		Evaporation (mm/day)
			Max.	Min.	Morn.	Even.	
April 19	4.40	1	39.13	19.78	39.50	14.75	8.98
May	0.0	0	39.90	22.05	36.75	14.75	11.85
June	75.60	4	38.90	24.88	51.40	28.00	12.36
July	108.60	9	31.98	23.53	76.75	57.50	5.03
August	99.80	5	29.13	23.05	80.25	68.00	3.55
September	170.80	11	30.83	22.53	75.50	60.50	4.75
October	205.80	10	30.70	21.45	80.75	61.75	4.23
November	26.40	2	29.42	20.52	81.80	62.80	4.02
December	4.20	1	30.20	14.70	67.13	42.25	4.88

Rajendranagar

Month	Rainfall (mm)	Rainy days	Temperature (°C)		Relative Humidity (%)		Evaporation (mm/day)
			Max.	Min.	Morn.	Even.	
April 19	43.20	3	39.00	18.30	72.00	34.00	-
May	9.00	1	41.20	21.30	59.00	29.00	-
June	85.00	5	36.80	20.00	81.00	48.00	-
July	60.60	8	31.80	18.30	83.00	58.00	-
August	190.80	12	29.90	17.40	88.00	68.00	-
September	318.80	14	29.70	16.70	93.00	70.00	-
October	129.00	12	30.00	16.60	93.00	70.00	-
November	0.0	0	29.90	17.70	90.00	49.00	-
December	8.80	1	27.80	15.80	92.00	52.00	-

Ranchi

Month	Rainfall (mm)	Rainy days	Temperature (°C)		Relative Humidity (%)		Evaporation (mm/day)
			Max.	Min.	Morn.	Even.	
April 19	14.00	3	36.00	21.50	-	-	-
May	18.00	2	37.50	27.60	-	-	-
June	126.00	7	36.10	25.60	-	-	-
July	243.00	12	30.60	26.00	-	-	-
August	387.00	18	29.60	25.30	-	-	-
September	267.00	12	30.00	24.40	-	-	-
October	217.00	6	29.00	20.20	-	-	-
November	0.0	0	28.20	15.10	-	-	-
December	0.0	0	24.50	10.30	-	-	-

Rewa

Month	Rainfall (mm)	Rainy days	Temperature (°C)		Relative Humidity (%)		Evaporation (mm/day)
			Max.	Min.	Morn.	Even.	
April 19	16.40	8	39.20	19.64	41.70	19.46	-
May	1.20	3	41.62	23.73	29.90	15.92	-
June	47.00	9	41.08	27.23	36.96	26.42	-
July	289.90	15	34.85	25.79	64.42	52.45	-
August	506.90	23	30.98	24.82	84.28	79.53	-
September	268.30	13	30.99	22.60	86.89	78.67	-
October	239.30	11	34.16	20.73	69.99	51.60	-
November	0.0	0	33.40	15.21	62.03	43.81	-
December	0.0	0	29.80	10.47	64.03	54.31	-

Sabour

Month	Rainfall (mm)	Rainy days	Temperature (°C)		Relative Humidity (%)		Evaporation (mm/day)
			Max.	Min.	Morn.	Even.	
April 19	38.00	3	33.50	21.40	77.90	57.40	3.30
May	61.20	4	38.80	24.30	75.70	50.40	4.20
June	85.00	5	37.90	25.50	71.60	51.10	4.70
July	380.30	18	34.20	25.10	83.10	65.80	2.00
August	65.60	12	34.70	26.60	85.20	65.30	3.70
September	371.30	16	32.60	26.20	86.60	75.70	1.90
October	23.40	4	30.80	21.70	89.40	78.50	1.20
November	0.00	0	28.90	16.20	88.60	76.00	1.10
December	2.50	0	21.20	9.30	91.00	76.00	0.60

Sangareddy

Month	Rainfall (mm)	Rainy days	Temperature (°C)		Relative Humidity (%)		Evaporation (mm/day)
			Max.	Min.	Morn.	Even.	
April 19	0.0	-	41.22	23.18	56.67	43.38	-
May	0.26	-	43.13	25.76	54.32	41.00	-
June	4.13	-	38.67	23.74	72.40	54.60	-
July	8.65	-	32.22	21.50	82.45	74.68	-
August	8.97	-	30.36	21.46	86.65	79.77	-
September	12.40	-	30.59	20.36	89.13	82.03	-
October	4.61	-	31.38	19.77	85.42	79.90	-
November	0.07	-	31.68	16.47	79.40	69.53	-
December	0.0	-	30.04	14.44	73.32	74.94	-

Sriganganagar

Month	Rainfall (mm)	Rainy days	Temperature (°C)		Relative Humidity (%)		Evaporation (mm/day)
			Max.	Min.	Morn.	Even.	
April 19	26.90	2	36.84	22.14	59.50	31.33	5.48
May	46.80	3	40.65	28.47	49.29	26.26	7.04
June	35.80	3	43.95	27.87	53.60	30.93	8.53
July	44.70	6	39.20	30.50	68.68	53.58	6.31
August	38.10	3	38.20	28.07	76.42	59.48	5.04
September	31.20	3	38.42	26.90	80.27	56.60	4.48
October	0.0	0	34.66	19.96	77.13	48.55	1.96
November	15.30	2	26.14	14.22	85.80	62.67	1.67
December	17.70	2	16.59	6.85	89.94	74.94	0.97

Tinsukia

Month	Rainfall (mm)	Rainy days	Temperature (°C)		Relative Humidity (%)		Evaporation (mm/day)
			Max.	Min.	Morn.	Even.	
April 19	116.00	9	29.20	18.90	94.00	60.00	-
May	479.00	24	29.00	24.80	95.00	61.00	-
June	313.00	16	29.00	24.40	94.00	61.00	-
July	574.00	24	29.30	24.40	97.00	81.00	-
August	155.00	9	30.00	25.50	94.00	67.00	-
September	274.00	14	31.70	24.80	95.00	70.00	-
October	125.00	13	27.90	15.50	89.00	60.00	-
November	2.00	1	25.20	14.70	97.00	78.00	-
December	0.0	0	24.50	10.40	99.00	58.00	-

Tirupati

Month	Rainfall (mm)	Rainy days	Temperature (°C)		Relative Humidity (%)		Evaporation (mm/day)
			Max.	Min.	Morn.	Even.	
April 19	10.20(1)	1	40.10	24.40	74.70	28.30	7.00
May	22.00(3)	3	41.30	28.30	65.70	34.40	7.80
June	52.40(2)	2	39.20	28.50	62.00	35.40	8.40
July	93.40(7)	7	35.80	26.30	70.40	46.10	6.10
August	188.40(9)	9	34.10	25.70	77.00	50.90	4.40
September	277.80(9)	9	31.90	24.10	86.70	63.80	3.10
October	231.80(13)	13	30.79	23.41	90.68	66.84	3.65
November	66.40(5)	5	29.95	21.42	85.93	64.90	5.18
December	137.00(6)	6	27.94	19.85	88.81	66.45	4.13

Tiruchirapalli

Month	Rainfall (mm)	Rainy days	Temperature (°C)		Relative Humidity (%)		Evaporation (mm/day)
			Max.	Min.	Morn.	Even.	
April 19	2.00	1	40.80	27.40	41.16	-	-
May	51.00	4	40.45	28.70	37.64	-	-
June	50.40	1	39.50	28.63	34.60	-	-
July	53.00	2	37.93	27.64	56.64	54.61	-
August	47.30	4	36.45	26.83	62.64	61.25	-
September	157.20	11	35.10	25.80	70.76	72.33	-
October	166.30	10	33.25	25.29	79.19	81.29	-
November	67.40	8	31.90	24.43	80.80	82.60	-
December	71.00	3	29.80	22.90	81.80	83.38	-

Udaipur (RCA centre)

Month	Rainfall (mm)	Rainy days	Temperature (°C)		Relative Humidity (%)		Evaporation (mm/day)
			Max.	Min.	Morn.	Even.	
April 19	6.00	-	38.20	19.30	38.50	8.70	-
May	10.80	-	38.40	22.90	43.60	8.80	-
June	165.60	-	37.50	24.90	62.00	6.70	-
July	138.20	-	32.10	23.60	78.40	4.60	-
August	529.00	-	29.60	21.70	88.20	2.40	-
September	209.80	-	29.70	20.90	87.50	3.00	-
October	81.80	-	30.50	16.20	84.20	6.40	-
November	12.40	-	28.40	14.20	84.50	6.10	-
December	0.0	-	23.30	7.00	85.20	6.00	-

Udaipur (Banswara)

Month	Rainfall (mm)	Rainy days	Temperature (°C)		Relative Humidity (%)		Evaporation (mm/day)
			Max.	Min.	Morn.	Even.	
April 19	0.0	0	40.37	20.28	53.23	17.87	-
May	0.0	0	41.22	26.90	50.13	22.39	-
June	71.1	5	40.24	27.47	64.60	34.40	-
July	166.2	8	33.50	25.79	80.71	60.00	-
August	385.4	12	29.93	24.65	87.10	72.77	-
September	427.1	13	30.93	24.60	88.23	70.90	-
October	21.7	2	32.55	20.38	80.74	50.39	-
November	0.0	0	31.99	18.36	79.30	43.13	-
December	0.0	0	27.66	14.13	80.69	40.56	-

Vengurle

Month	Rainfall (mm)	Rainy days	Temperature (°C)		Relative Humidity (%)		Evaporation (mm/day)
			Max.	Min.	Morn.	Even.	
April 19	0.0	0	34.30	23.16	80.37	60.97	-
May	0.0	0	35.33	24.34	76.48	60.55	-
June	976.50	19	33.86	24.72	86.77	74.33	-
July	1588.40	29	29.71	23.85	89.13	85.58	-
August	1021.70	26	30.59	23.54	94.55	82.52	-
September	770.80	22	29.79	23.74	92.03	82.03	-
October	417.00	7	33.23	23.13	87.87	68.35	-
November	1.00	1	35.70	21.10	90.03	64.97	-
December	0.0	0	34.74	20.74	88.77	70.48	-

Max=Maximum, Min=Minimum

Morn. = Morning, Even. = Evening

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