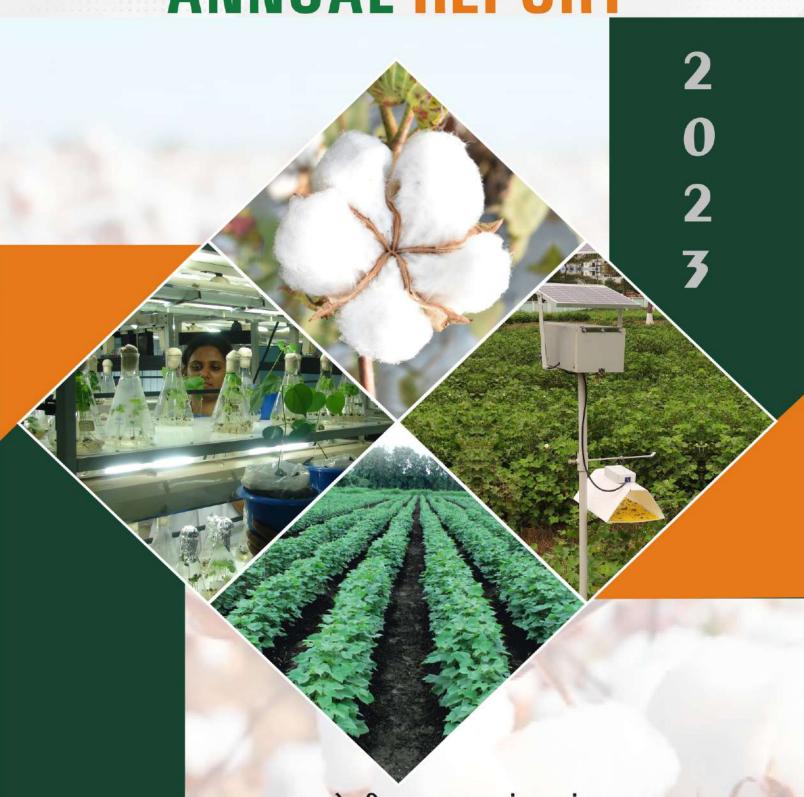




**ANNUAL REPORT** 



भा.कृ.अनु.प.–केन्द्रीय कपास अनुसंधान संस्थान, नागपुर ICAR- CENTRAL INSTITUTE FOR COTTON RESEARCH, NAGPUR







भा.कृ.अनु.प.–केन्द्रीय कपास अनुसंधान संस्थान, नागपुर ICAR- CENTRAL INSTITUTE FOR COTTON RESEARCH, NAGPUR



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# PREFACE



he cotton season during the kharif season 2023 witnessed change in rainfall pattern in onset and distribution across all the 11 cotton growing states. Central and southern zones experienced delayed onset in June and deficient rainfall in July/August months leading to dip in acreage in Andhra Pradesh, Karnataka and Tamil Nadu. Excess rains in Rajasthan led to rank outgrowth which was conducive for pest and disease incidence.

Ministry of Agriculture & Farmers Welfare and Ministry of Textiles, Govt. of India jointly launched a special project on cotton 'Targeting technologies to agro-ecological zones-large scale demonstrations of best practices to enhance cotton productivity' under National Food Security Mission (NFSM) for implementation during 2023-24 kharif season with an outlay of 41.86 crores. The project was led by the ICAR-Central Institute of Cotton Research (CICR), Nagpur in Public-Private Partnership (PPP) mode in the identified clusters in partnership with Confederation of Textile Industry (CITI), South India Mills Association (SIMA), Federation of Seed Industry of India (FSII) and National Seed Association of India (NSAI). Field extension support for technology dissemination and farmers training on best practices is extended by 42 Krishi Vigyan Kendras (KVKs) of three Agricultural Technology Research Institutes (ATARIs at Pune, Hyderabad and Bengaluru), CITI and SIMA cotton development & research associations. CICR is providing technical backstopping and knowledge support on best practices for increasing productivity. The Special Project achieved scaling up of three cotton technologies: high density planting system in shallow soils in 3033 ha, closer spacing in medium soils 3641 ha and production technology for extra-long staple cotton in 2389 ha area. The special project was implemented in 61 districts of 8 states covering a total geo-referenced area of 9064 ha involving 10418 farmers. Technology assistance to the tune of Rs 22 cr through Direct Benefit Transfer has been envisaged for beneficiary farmers registered in mobile app and web portal. Targeted technology interventions led to an yield of increase of 20.2 to 53.9% under HDPS (90 x 15 m spacing) and 27.7 to 76.0% under closer spacing interventions with canopy management through plant growth regulators.

A Pilot Project on "Awareness and Extension Services on Best Farm Practices for Cotton Farmers to Improve Quality, Yield and Sustainability" funded by Cotton Corporation of India (Rs. 2.53 crore) is also being implemented in 11 cotton growing states. Project on Insect Resistance Management (IRM): Dissemination of Pink Bollworm Management Strategies" is being implemented under NFSM-CC across 14 districts of 7 cotton growing states of India for dissemination of strategies for management of pink bollworm menace in cotton.

During the year, 6 cotton varieties were identified for release *viz.*, three naturally colored (brown) cotton varieties of *G. hirsutum viz.*, CCHC 19-1, CCHC 19-2 and CNH 18529 and two Bt cotton varieties CICR 18-Bt, CICR 20-31 Bt and one non Bt *G. hirsutum* CCH 19-2. Nine technologies of institute were certified from ICAR during the year viz., Wireless Smart Trap for Automated Pest Monitoring in Cotton, New Protocol for evaluation of transgenic cotton genotypes introgressed with protein against whitefly, Loop mediated isothermal amplification (LAMP): A new tool for



rapid diagnosis of cotton leaf curl viral disease, Technology for Management of Whitefly- *Bemisia tabaci* (Gennadius) and Cotton Leaf Curl Disease (CLCuD), Oil-based entomopathogenic fungal bio-insecticide formulation (CICR Cotpest Guard-1-3), Degree day based model for predicting pink bollworm phenology and Innovative on-plant bioassay method for genotype/ event evaluation against pink bollworm. ICAR-CICR engaged with all cotton stakeholders through interface workshops for technology dissemination and scaling up of best practices. ICAR-CICR, Nagpur organized 'Kapas Mela 2023' on 19<sup>th</sup>Dec. 2023 to showcase improved cotton technologies and facilitate farmer-scientist interaction.

Scientists from ICAR-CICR enthusiastically participated in the 81<sup>st</sup> ICAC Plenary Sessions and Ninth Asian Cotton Research and Development Network (ACRDN9) held at Mumbai during 02-05 Dec and 06-08 Dec 2023 respectively. Sixty three training programmes including virtual training programmes were organized where a total of about 6121 beneficiaries including farmers, students, field trainees, state government officials and extension functionaries participated. Linkages were fostered with sister ICAR Institutes, SAUs, other public sector Institutes, private companies, NGOs and farmer producer groups to commercialize and upscale varieties and technologies developed. Four MoUs were inked during January to December 2023.

Guidance and constant encouragement received from Dr Himanshu Pathak, Secretary, DARE and Director General, ICAR and Dr T.R. Sharma, DDG (Crop Science), ICAR enabled the institute to perform well and attain the targeted research achievements.

I am grateful for the guidance and direction by the Research Advisory Committee (RAC) Chairman Dr SA Patil (2020-23), Dr P.K. Chakrabarty (2023-25) and respected members of RAC. I am grateful for the Quinquennial Review Team chairman Dr. B. Venkateswarlu, and members of QRT. I am also grateful for the support extended by Dr R.K. Singh, ADG (CC),ICAR; Dr. D.K. Yadava, ADG (Seeds); the Heads of Divisions (HoDs) Crop Production, Crop Improvement, Crop Protection at ICAR-CICR Nagpur and Heads of regional stations Coimbatore and Sirsa, and PME for valuable support in carrying out the research programmes. Thanks are due to the Editorial Committee members for their unstinted work in bringing out this publication on time.

(Y.G. Prasad) Director, ICAR-CICR, Nagpur

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#### फसल सुधार विभाग

- दो बीटी कपास किस्मों, आईसीएआर-सीआईसीआर 18 बीटी और आईसीएआर-सीआईसीआर 20-31 बीटी का चयन रिलीज के लिए किया गया और संस्थान के सामान्य स्टेशन परीक्षणों के तहत स्थिर बीजी-॥ लाइनों की पहचान की गयी।
- हेटेरोटिक पूल विकास कार्यक्रम के तहत, विशिष्ट संयोजन क्षमता प्रभाव और सिग्मा वर्ग मूल्यों के आधार पर दो प्रमुख समूह 'ए' (सकारात्मक) और 'बी' (नकारात्मक) और चार उप-समूह 'एए1', 'एए2', 'बीबी1' और 'बीबी2' की पहचान जी. हिर्सुटम कॉटन में की गई।
- मैजिक जनसंख्या F5 से F6 पीढ़ी तक उन्नत की गई और फेनोटाइपिक स्कोर के आधार पर आशाजनक रेखाओं की पहचान की गई।
- नए जैसिड प्रतिरोध जीनोटाइप, सीआईसीआर जेएस-103 और सीआईसीआर जेएस-104 विकसित किए गए।
- कंट्रोल की तुलना में लौह नैनोकणों का हरित संश्लेषण, अंकुरण के साथ-साथ अंकुरों की जड़ की लंबाई बढ़ाने के लिए एक प्रभावी बीज प्राइमिंग उपचार पाया गया।
- सीआईसीआर द्वारा जारी किस्मों का ब्रीडर बीज उत्पादन डीएसी इंडेंट के साथ-साथ, विभिन्न हितधारकों से प्राप्त इंडेंट को पूरा करने के लिए किया गया जिसके तहत उत्पादित बीजों को विभिन्न राज्य सरकार केवीके, एफएलडी, एनएफएसएम, जैविक समूहों और गुजरात, महाराष्ट्र और मध्य प्रदेश के प्रांतिक कृषी समृह द्वारा लिया गया।

- दैहिक भ्रूणजनन के माध्यम से कपास के पौधों की कोशिकाओं के त्विरत पुनर्जनन को मानांकीत किया गया। कथित ट्रांसफॉर्मेंट्स में ट्रांसजीन एकीकरण का एक हिस्सा परिवर्तन के तौर पर मिला।
- एक अध्ययन में पाया गया कि एक वाणिज्यिक कपास बीज पैकेट में गैर-बीटी कपास बीज मिश्रण (5-10%) के आरआईबी अनुपालन को ट्रैक करने के लिए दो एलिसा प्लेटों का उपयोग करके 180 बीजों का परीक्षण किया जाना चाहिए। इस हेतु परीक्षणों को सांख्यिकीय रूप से मान्य करने के लिए विभिन्न नमूना आकारों का उपयोग किया गया।
- एक प्रयोग के तहत विकसित फेनोटाइपिक और जीनोटाइपिक डेटा,
   जल तनाव की स्थिति में कपास के जीनप्रारुपों में उपज और उसके
   घटकों को बढाने के लिए उपयोगी हो सकता है।
- एक प्रयोग के तहत, गुलाबी सुंडी के चौथे इंस्टार लार्वा से ट्रांसक्रिप्टोम डेटा का विश्लेषण किया, जिसमे महत्वपूर्ण हाउसकीपिंग जीन की पहचान की गयी और प्रमुख काइटिन बायोसिंथेसिंस जीन की अभिव्यक्ति का विश्लेषण किया गया। इसके अलावा, अध्ययन के अंतर्गत इन विट्रो डीएसआरएनए संश्लेषण के लिए एक लागत प्रभावी प्रोटोकॉल को अनुकूलित किया गया और आरएनएआई माध्यम द्वारा काइटिन संश्लेषण मार्ग के जीन को लक्षित करके गुलाबी सुंडी प्रबंधन के लिए संभावित रणनीतियों का प्रदर्शन किया गया।
- कपास एसिटोलैक्टेट सिंथेज़ जीन की पहचान और क्लोनिंग की गई, इनिवट्रो म्यूटाजेनेसिस और हर्बिसाइड इन-सेंसिटिविटी परख के लिए जीएच एएलएस जीन की पुन: संयोजक प्रोटीन अभिव्यक्ति का





अनुकूलन किया गया । एसजीआरएनए अभिव्यक्ति को बढ़ाने के लिए कपास विशिष्ट यू6 प्रमोटर अनुक्रमों की पहचान की गई। SgRNA अभिव्यक्ति के लिए कपास विशिष्ट U6-29 (Gh6-3) प्रमोटर युक्त CRISPR/Cas9 वेक्टर का निर्माण किया गया ।

- क्षेत्र प्रतिरोधी गुलाबी सुंडी आबादी के खिलाफ Cry1D प्रोटीन की जैव प्रभावकारिता की फिर से पुष्टि की गई और कस्टम संश्लेषित कोडान अनुकूलित Cry1D जीन का उपयोग करके Cry1D जीन कंस्ट्रक्ट विकसित किया गया। Cry1D जीन कंस्ट्रक्ट का उपयोग करके एग्रोबैक्टोरियम द्वारा तम्बाकू के ट्रान्सफॉरमेशन परिणामस्वरूप Cry1D सकारात्मक पौधे प्राप्त हुए।
- GhNAC9 कंस्ट्रक्ट विकसित किए गए एवं GUS जीन का उपयोग करके कपास में सोनिकेशन और वैक्यूम इनिफ्ल्टरेशन द्वारा कपास में एग्रोबैक्टीरियम ट्रान्सफॉरमेशन के लिए स्थितियां मानांकीत की गईं।

### फसल उत्पादन विभाग

- मिट्टी के कड़कपन (कठोरता का मापदंड) को कोन पेनेट्रोमीटर से मापा गया। सामान्य तौर पर, मिट्टी की गहराई के साथ प्रवेश प्रतिरोधकता में भी वृद्धि हुई। गहरी उप-मिट्टी और फसल चक्र में प्रवेश प्रतिरोधकता सबसे कम थे। इसके अलावा, नाइट्रोजन की अनुशंसित खुराक के साथ उप-मिट्टी प्रयोग की तुलना में, रोटेशन फसलों के रूप में उगाई जाने वाली लेगयुम फसलों के साथ बीज कपास की उपज अधिक पायी गयी।
- जैविक कपास उत्पादन के तहत, जी. आवॉरियम (देसी कपास) किस्मों ने कपास संकर पार्टेक 30 (15.91 किंवटल/हेक्टेयर) के बराबर बीज कपास की उपज (13.80 से 15.25 किंवटल/हेक्टेयर) पैदा की और जी. हिर्सुटम किस्मों से बेहतर उत्पादन किया। चूसक कीट प्रबंधन के लिए, एनएसकेई 5%, दशपणीं 10%, और पोंगामिया 5%, प्रभावी पाए गए और उनका प्रभाव 0.5%, नीम के तेल और अनुशंसित कीटनाशकों के प्रयोग से होने वाले नियंत्रण के बराबर था।
- आईसीएआर-सीआईसीआर के नागपुर, सिरसा और कोयंबटूर क्षेत्रीय स्टेशनों पर बीटी के साथ और बिना बीटी के कपास की किस्मों और संकरों का एचडीपीएस के तहत उनकी कॉम्पैक्टनेस और प्लांट ग्रोथ रेगुलेटर (मेपिक्वाट क्लोराइड) के साथ और उनके बिना यांत्रिक चुनाई के लिए उपयुक्तता के लिए मूल्यांकन किया गया था। यांत्रिक चुनाई से पहले पत्तियों के झड़ने के लिए आईसीएआर-सीआईसीआर डिफोलिएंट्स का उपयोग किया गया और इसकी तुलना बाज़ार में उपलब्ध डिफोलिएंट्स के विकल्पों से की गई। परीक्षण किए गए अधिकांश जीनोटाइप सभी तीन क्षेत्रों में कॉम्पैक्टनेस (ऊँचाई लगभग 100 सेमी और चौड़ाई 50 सेमी) और यांत्रिक चयन के लिए उपयुक्त पाए गए। मूल्यांकन की गई सभी संकर और किस्मों में, बुआई के बाद 45 और 65 दिन पर दो बार 25 ग्राम एआई/हेक्टेयर की दर से मेपिक्वाट क्लोराइड के छिड़काव का प्रभावशाली परिणाम मिला। आईसीएआर-सीआईसीआर किस्म सुरक्षा को जब स्पिंडल टाइप पिकर से चुना गया तो इसने बहुत अच्छा प्रदर्शन किया।
- कपास में गुलाबी बॉलवर्म (पीबीडब्ल्यू) की स्वचालित वास्तविक समय निगरानी के लिए आईसीएआर-सीआईसीआर में एआई-

आधारित स्मार्ट फेरोमोन ट्रैप विकसित किया गया है। गुलाबी बॉलवर्म के वयस्क पतंगों की संख्या का पता लगाने और उनकी गिनती करने के लिए YOLO - आधारित मशीन लर्निंग एल्गोरिदम (एक वास्तविक समय वस्तु पहचान प्रणाली) विकसित किया गया। सीएनएन आधारित उच्च पहचान और वर्गीकरण सटीकता का उपयोग, सटीक कपास बोल सड़न रोगों और वर्गीकरण का पता लगाने के लिए किया जा सकता है। नाइट्रोजन पर्यापतता सूचकांक के आधार पर, मल्टीस्पेक्ट्रल इमेजिंग के माध्यम से पौधे की नाइट्रोजन स्तर का आकलन करने के लिए एक एल्गोरिदम विकसित किया गया।

- परीक्षण की गई कपास की किस्मों में, देसी कपास ने एचडीपीएस के तहत सबसे अधिक उपज प्रदर्शित की। मिट्टी और पौधों के पोषक तत्वों के स्तर के विश्लेषण से ये पाया गया कि उच्च पैदावार और स्थिरता के लिए फसल काल की मध्य अवधि का पोषक तत्व प्रबंधन आवश्यक है।
- कैल्शियम कार्बोनेट (>20%) से समृद्ध मिट्टी में उर्वरकों की अनुशांसित खुराक की तुलना में बायोचार आधारित मिश्रित उर्वरकों ने बीज कपास की उपज को 34 से 48% तक बढ़ाया। इसके अतिरिक्त इसने पोषक तत्वों की उपलब्धता में भी वृद्धि की।
- उर्वरकों की 100% अनुशंसित खुराक (आरडीएफ) के साथ सक्रिय फास्फोरस (पीएसएपी) के पोटेशियम साल्ट के पर्णिय छिड़काव ने अन्य की तुलना में फास्फोरस और पोटेशियम के स्तर को बढ़ाया।
- जिंक म्रोतों के बीज उपचार (एसटी) और पर्णिय छिड़काव दोनों ही बीटी—कपास के लिए अप्रभावी रहे। हालाँकि, खेत की स्थितियों में, कैलकेरियस मिट्टी में नैनो जिंक ऑक्साइड के संयुक्त अनुप्रयोग (बीज उपचार और पत्तेदार स्प्रे) से संख्यात्मक रूप से उच्च बीज कपास उपज दर्ज की गयी। इसके विपरीत, नैनो जिंक ऑक्साइड के बीज उपचार अनुप्रयोग ने काली कपास मिट्टी में अन्य की तुलना में उच्च बीज कपास उपज दर्ज की।
- कैल्शियम कार्बोनेट घुलनशील जीवाणु (सीएसबी) कोन्सोर्शिया को बीज उपचार और मृदा आवेदन के रूप में प्रयोग करने से कैलकेरियस मिट्टी में कपास के पौधो की वृद्धि के साथ साथ, मैक्रो और सूक्ष्म पोषक तत्वों के घुलनशीलता में भी वृद्धि हुयी। सीएसबी फॉर्मूलेशन पर्यावरण के अनुकूल है, लागत प्रभावी है, एवं कपास के पौधों, मिट्टी जीव विज्ञान पर इसका कोई हानिकारक प्रभाव नहीं है। यह भूमि सुधार के लिए रसायनों के उपयोग को भी कम कर सकता है।
- कपास में रस चूसने वाले कीटों के प्रबंधन के लिए माइक्रोबियल-आधारित फॉर्मूलेशन एक गैर-रासायनिक दृष्टिकोण है। यह पर्यावरण के अनुकूल और लागत प्रभावी है, एवं कपास के पौधों, मिट्टी के पोषक तत्वों की स्थिति, मिट्टी जीव विज्ञान पर कोई हानिकारक प्रभाव नहीं डालता है। यह कपास में रासायनिक उपयोग और कीट पुनरुत्थान को भी कम कर सकता है।
- डिफोलिएंट से उपचारित कपास की पत्तियों की तुलना में, अनुपचारित पौधो की पत्तियां 10 दिनों के बाद भी हरी पाई गईं, जबिक डिफोलिएंट के छिड़काव के 7 दिनों के बाद 85% से अधिक हरी पत्तियां गिर गईं।

#### फसल संरक्षण विभाग

- गुलाबी सुँडी की प्रबंधन रणनीतियों को 11 राज्यों के 41 जिलों में सफलतापूर्वक लागू किया गया, जिसमें 2022-23 के दौरान 141 गांवों को शामिल किया गया और 1550 एकड़ क्षेत्र को कवर किया गया। कुल मिलाकर, 2022-23 के दौरान गैर-आईआरएम क्षेत्रों की तुलना में, आईआरएम क्षेत्रों में गुलाबी सुँडी के संक्रमण में 35.88% की कमी देखी गई।
- पीबीडब्ल्यू संक्रमण के कारण उपज में संभावित हानि बीटी में 17.4% और गैर-बीटी कपास की किस्मों में 39.5% अनुमानित की गई थी। बीआर के कारण बीटी में 15.7% और गैर-बीटी किस्मों में 13.6% उपज हानि का अनुमान लगाया गया था। प्रस्तावित विधि विश्वसनीय और मजबूत है, एवं ''कीट/रोग महामारी'' की स्थिति में त्वरित उपज हानि आकलन के लिए उपयोगी है। प्रबंधन रणनीतियों पर बेहतर बनाने के लिए पीबीडब्ल्यू फेनोलॉजी मॉडल को कीट क्षति और उपज हानि के साथ जोड़ने का एक नया आयाम जोड़ा गया है।
- नवीन कीटनाशकों की तुलना में, हेलिकोवर्पा आर्मिजेरा की आबादी इमामेक्टिन बेंजोएट के प्रति काफी अधिक संवेदनशील है, जबकि पारंपरिक कीटनाशकों में से, हेलिकोवर्पा प्रोफेनोफोस के प्रति सबसे अधिक संवेदनशील है।
- थ्रिप्स प्रजाति की संरचना निर्धारित की गई, जिससे कपास पारिस्थितिकी तंत्र में श्रिप्स टैबासी, श्रिप्स पाल्मी, स्किटोंश्रिप्स डार्सालिस, एस्प्रोथ्रिप्स बाइमाकुलैटस और थ्रिप्स हवाईएंसिस की उपस्थिति का पता चला।
- जी. हिर्सुटम, जी. रायमोंडी और जी. इंडिकम पौधो के विभिन्न ऊतकों में पाये गए यौगिकों की रूपरेखा का तुलनात्मक विश्लेषण किया गया। प्रत्येक गॉसिपियम प्रजाति के विशिष्ट भाग का भी विश्लेषण किया गया।
- तीन वर्षों की अवधि में, विभिन्न भौगोलिक स्थानों से लगभग 16,000 हरे कपास के बोल एकत्र किए गए। मृत गुलाबी सूँडी लार्वा की पहचान करने के लिए इन सारे गूलरों को विच्छेदित किया गया, जिसमें से 210 लार्वा संक्रमित पाये गए। संक्रमित लार्वा से पांच फंगल आइसोलेट्स और एंटोमोपैथोजेन के 30 बैक्टीरियल आइसोलेट्स को अलग किया गया। जांच के दौरान, संक्रमित लार्वा में कोई वायरस संक्रमण नहल देखा गया। परीक्षण किए गए तीन एंटोमोपैथोजेनिक कवक में से, एम. अनिसोप्ली, एल. लेकानी की तुलना में बी. बैसियाना के कारण गुलाबी बॉलवर्म लार्वा की मृत्यु दर काफी अधिक पायी गयी।
- कोरिनेस्पोरा कैसिकोला की विविधता और प्रादुर्भाव के लिए किए गए सर्वेक्षण के परिणामस्वरूप, 48 आइसोलेट्स का संग्रह हुआ, जिनमें से अधिकांश स्थानों पर ग्रेड 1 से 2 (2.15% प्रादुर्भाव) के लक्षण दिखाई दिए। एकत्र किए गए सी. कैसिकोला आइसोलेट्स और अन्य पौधों की प्रजातियों को संक्रमित करने वाले सी. कैसिकोला आइसोलेट्स के बीच महत्वपूर्ण संख्या आनुवांशिक समानता देखी गयी, जोकि पूरे देश में इस जीव की आनुवंशिक एकरूपता को रेखांकित करती है।
- बॉल रोट रोग कॉम्प्लेक्स में बॉल रोट रोगज़नक़ों की व्यापकता का
   फास्ट न्यूट्रान (एफएन) प्रेरित उत्परिवर्तन, एम 3 पीढ़ी में अंकुरण का सफलतापूर्वक अध्ययन किया गया और रोग के लिए एकीकृत प्रबंधन रणनीतियाँ तैयार की गई है।

- दिहया रोग की गंभीरता की जाँच के लिए चालीस अलग-अलग बीटी संकरों का परीक्षण किया गया. जिसमें 90 दिनों की फसल पर इसकी गंभीरता कम पाई गई, लेकिन 120 दिनों के बाद लगभग सभी संकरों में यह 68.0% के उच्चतम औसत पीडीआई के साथ वृद्धि हुई। दिहया रोग के प्रबंधन के लिए, आरसीएच-530 हाइब्रिड के क्षेत्रीय परीक्षण से पता चला कि 90 दिनों पर *ट्राइकोडर्मा* हर्जियानम-ट्राइकोकेश @5 ग्राम/ली+110 दिनों पर प्रोपीनेब @3एमएल /एल का पर्णिय छिड्काव करने से रोग में सबसे अधिक कमी (34.02%) आती है।
- एंटोमोपैथोजेनिक नेमाटोड के दो मूल उपभेदों, हेटेरोरेबडाइटिस इंडिका (सीआईसीआर-एचआई-सीएल और सीआईसीआर-एचआई-एमएन) को सफलतापूर्वक आइसोलेट करके उनका मूल्यांकन किया गया, जिसमे से सीआईसीआर-एचआई-सीएल ने पीबीडब्ल्यू के खिलाफ बेहतर नियंत्रण का प्रदर्शन किया। अध्ययन ने मेटारिजियम एनिसोप्लिए टीएमबीएमए1 की उल्लेखनीय प्रभावशीलता का भी प्रदर्शन किया, जिससे तीसरे इंस्टार पीबीडब्ल्यू लार्वा में मृत्यु दर 100% तक पहुंच गई। यह अध्ययन मेटारिजियम एनिसोप्लिए टीएमबीएमए। को शक्तिशाली जैव-कीटनाशक के रूप में उपयोग करने की क्षमता को उजागर करता है।
- क्रॉपसैप परियोजना के तहत, सूचना और संचार प्रौद्योगिकी (ICT) उपकरणों का उपयोग करके प्रभावी कपास कीट प्रबंधन रणनीतियों को सफलतापूर्वक लागू किया गया, और महाराष्ट्र में 2022-23 के दौरान एक प्रमुख हितधारक के रूप में योगदान दिया। 2022-23 के दौरान सभी तीन बॉलवर्म और चूसक कीट कुल मिलाकर नियंत्रण में पाये गए।

# क्षेत्रीय स्टेशन, कोयम्बट्र

- लंबी स्टेपल वाली कॉम्पैक्ट कपास किस्म सीआईसीआर-एच कॉटन 54 (नैनो) को मध्य और दक्षिण क्षेत्र के लिए अधिसूचित किया गया। जीनोटाइप सीसीएच 19-2 ने सिंचित और वर्षा आधारित परिस्थितियों में दक्षिण क्षेत्र के समन्वित विविधता परीक्षण में उत्कृष्ट फाइबर गुणवत्ता दर्शायी और इसका पहचान प्रस्ताव प्रस्तुत किया गया।
- सिंचित कपास की प्रमुख खरपतवार, ट्राइएंथेमा पोर्टुला कैस्ट्रम की तीव्रता और प्रतिस्पर्धात्मकता अधिक CO, के तहत कम पाई गयी जबिक कुछ अन्य खरपतवार जैसे डिजेरा आरवेन्सिस ने बढ़े हुए CO. के कारण अपने प्रसार को बढ़ा दिया। ऊँचे CO, के कारण एफिड्स और स्पोडोप्टेरा का संक्रमण अधिक मिला जबकि जैसिड का संक्रमण कम हुआ। अधिक CO, के कारण वाष्पोत्सर्जन दर में कमी और प्रकाश संश्लेषक दर में वृद्धि के साथ रंधों का आंशिक रूप से बंद होना पाया गया, बढ़े हुए CO, के कारण प्रकाश संश्लेषण दर में वृद्धि के परिणामस्वरूप कपास की उपज में 36% की वृद्धि प्राप्त हुई।
- एआईसीआरपी परीक्षणों के दौरान, ईएलएस कॉटन (जी.बारबार्डेस) के जीनोटाइप सीसीबी 6 और सीसीबी 29, सीवीटी बीआर 14ए ट्रायल में तथा सीसीबी 22-1 और सीसीबी 22-2, आईइटी Br12 ट्रायल में जांचे गए।
- प्रतिशत 67.8%, जीवित रहने का प्रतिशत 49.6% और चेक (सुविन) की तुलना में जीवित रहने के प्रतिशत में कमी 31.3% मिली। एम 3 में

वेरीगेटेड, क्लोरीना और ग्लैंडलेस जैसे उत्परिवर्ति के स्पेक्ट्रम देखे गए।

- फाइबर गुणवत्ता दिखाते हुए मिले वहीं हाइब्रिड MCUVT5 × ICB 284 ने दो वर्षों से उपज और स्टेपल लंबाई दोनों के लिए स्थिर प्रदर्शन दिखाया।
- कुल 2,347 प्रोटीन, प्रतिरोधी, संकर और अतिसंवेदनशील जीनोटाइप में प्राप्त किए गए। 331 विभेदित रूप से व्यक्त प्रोटीन (डीईपी) का एक सेट केवल आरपी-एलएच बनाम आरपी में पाया गया था, जिनमें केवल एक (अनियंत्रित प्रोटीन एलओसी107904777, ए०ए1यू8जे8यू7) को एलएच संक्रमण पर आरपी में काफी हद तक विनियमित (एफसी - 26.929) पाया गया।
- मेपिक्वेट क्लोराइड का उपयोग, ड्रिप फर्टिगेशन और कैनोपी प्रबंधन के साथ फाइबर की गुणवत्ता पर किसी भी हानिकारक प्रभाव के बिना ईएलएस कपास की उत्पादकता को बढ़ा सकता है।
- मानव रहित हवाई वाहन स्प्रेयर का उपयोग, उच्च घनत्व रोपण प्रणाली के तहत कपास में कैनोपी प्रबंधन के लिए मेपिकवाट क्लोराइड जैसे रसायन के अनुप्रयोग के लिए किया जा सकता है।
- सतत उपज सूचकांक (एसवाईआई) बीटी कपास किस्म मक्का
   सात जिलों में सर्वेक्षण किए गए 27 गांवों में स्टेम वेविल की प्रकोप फसल प्रणाली (0.74) की बंद रोपण प्रणाली में, कपास संकर -परती (0.62), कपास किस्म - मक्का (0.59) और कपास संकर मक्का (0.46) की व्यापक अंतर प्रणाली की तुलना में अधिक मिला। कपास-गेहूं फसल प्रणाली के बीच, बीटी कपास संकर-गेहूं (0.87) और बीटी कपास संकर-परती (0.87) फसल प्रणाली में उच्च टिकाऊ उपज सूचकांक (एसवाईआई) मान देखा गया वहीँ पोषक तत्वों के एकींत स्रोतों (एनपीके + एमजी + जेडएन + बी + एफवाईएम (10 टन/हेक्टेयर) दो साल में एक बार) के उपयोग से न केवल बीज कपास की उपज में वृद्धि हुई बल्कि कपास-मक्का (0.66) और कपास-गेहूं (0.86) फसल प्रणाली के तहत कपास के टिकाऊ उपज सुचकांक में भी सुधार हुआ।
- उर्वरक उपयोग दक्षता बढाने और उच्च कपास उत्पादकता प्राप्त करने के लिए मैक्रो, माध्यमिक और सुक्ष्म पोषक तत्वों के संतुलित रूप को एक ही गोली में पैक किया जा सकता है।
- क्षारीय मिट्टी की स्थिति में कपास की उत्पादकता बढाने के लिए नव संश्लेषित जिंक ऑक्साइड नैनो कर्णों या नैनो सस्पेंशन (ICAR & CIRCOT) के लिए सर्वोत्तम खुराक और आवेदन की विधि को मानकीकृत की गयी जिससे कपास के वर्ग गठन और फूल के चरण जैसे महत्वपूर्ण चरणों में 20 पीपीएम की दर से बीज उपचार के साथ-साथ 200 पीपीएम की दर से पर्णीय अनुप्रयोग के माध्यम से जिंक ऑक्साइड नैनो कणों के उपयोग से चेक (14.4 क्विंटल/ अधिक मिली।
- 19:19:19 (1%) + MgSO<sub>4</sub> (0.5:) + फेरस सल्फेट (0.25%) + जिंक सल्फेट (0.25%) + बोरिक एसिड (0.1%) + CuSO<sub>4</sub> (0.05%) + सोडियम मोलिब्डेट का पर्ण छिड्काव (0.01%) + Na & EDTA 0.02 mM+NAA (20 पीपीएम)+सैलिसिलिक एसिड (50 पीपीएम) +एस्कॉर्बिक एसिड (100 पीपीएम)+किनेटिन (20 पीपीएम)+एपीएसए

- 80 ने कपास की किस्म सूरज बी टी में 2450 किलोग्राम/हेक्टेयर की उच्च उपज दर्ज की।
- लगभग छह संकर (एच × बी) लगातार दो वर्षों से बेहतर उपज और डिजिटल उपकरणों जैसे वॉईस एसएमएस, मोबाइल ऐप और वेब आधारित साप्ताहिक सलाह का उपयोग करके कपास सुधार/ उत्पादन/सुरक्षा प्रौद्योगिकियों पर जानकारी प्रसारित की गई।
  - पारंपिक फेरोमोन ट्रैप की बाधाओं को दूर करने के लिए एक कृत्रिम बुद्धिमत्ता (एआई) सक्षम फेरोमोन ट्रैप विकसित किया जा रहा है जिसमे ट्रैप स्थान और मौसम डेटा जैसी अतिरिक्त जानकारी के साथ कीट जाल से पकड़े गए कीटों की संख्या सीधे उपयोगकर्ता तक पहुंचाने के लिए कॅन्फिगर किया गया है।
  - एकल ट्रैप प्रणाली का उपयोग करके कपास में जैसिड्स, थ्रिप्स, व्हाइटफ्लाई, एफिड्स और गुलाबी सुंडी पतंगों की निगरानी और प्रबंधन के लिए एक बहरंगी ग्ल-फिन ट्रैप विकसित करने का परीक्षण किया गया।
  - थियामेथोक्सम 12-60% + लैम्ब्डा-साइहलोथिन 9-50% ZC और डिनोटफ्यूरन 20 SG को एच. थीवोरा के खिलाफ अत्यधिक प्रभावी पाया गया। एक अकेले एच. थेइवोरा से कपास की उपज में 13-36% तक की अपरिहार्य हानि हो सकती है, जिसे टाला जा सकता है।
  - घटना 8 से 86% क्षति के बीच थी और गॉल की संख्या प्रति पौधा 1-7 गॉल तक थी। मदुरै और थूथुकुडी जिलों में कपास के स्टेम वेविल अधिक घटना (>70%) दर्ज की गई। बाहरी आकृति विज्ञान और जननांग लक्षणों के आधार पर, पेम्फेरुलूस ऑफिनिस को प्रमुख प्रजाति पाया गया। चार आशाजनक वाष्पशील यौगिकों का परीक्षण क्षेत्रीय परिस्थितियों में किया गया। खेत की स्थिति के तहत वाष्पशील पदार्थ स्टेम वेविल को आकर्षित करने में विफल रहे वहाँ तीन बीटी आइसोलेट्स (बीटी 41, 62 और 721) में से, बीटी 41 और बीटी 721 कपास के स्टेम वेविल/तने की घुन के खिलाफ प्रभावी पाए गए।
  - दक्षिण क्षेत्र से एकत्र किए गए सर्कोस्पोरा आइसोलेट्स का पीडीआई 11.00 से 34.0% तक था और कर्नाटक से एकत्र किए गए आइसोलेट्स तेलंगाना, आंध्र प्रदेश और तिमलनाडु की तुलना में अधिक विषैले पाए गए।
  - कवकनाशी संयोजन जैसे: एजोक्सीस्ट्रोबिन 18.2%+डिफेनोकोनाजोल 11.4% w/w SC इन-विट्रो परिस्थितियों में, यूरेडोस्पोर के खिलाफ प्रभावी मिला। सभी भंडारण स्थितियों में समय के साथ यूरेडोस्पोर की व्यवहार्यता कम पाई गई। कमरे की स्थितियों में, व्यवहाता 40 दिनों तक बनी रहती है, जबिक रेफ्रिजरेटर में संग्रहीत स्थिति में व्यवहार्यता का प्रतिशत 35 दिनों तक सबसे कम देखा गया है।
  - हेक्टेयर) की तुलना में कपास की उपज (21.3 क्विंटल/हेक्टेयर) 🔳 लेकेनिसिलियम लेकैनी और एसिनेटोबैक्टर लवोफी के साथ बायोपेस्टीसाइड के तरल फॉर्म्लेशन का छिड़काव रस चूसने वाले कीटों के खिलाफ प्रभावी मिला वहीं ये खेत की स्थिति के तहत प्राकृतिक दुश्मनों (कोकिनेलिड्स) के लिए सुरक्षित देखा गया।
    - कपास में रेनिफॉर्म निमेटोड के पर्यावरण-अनुकृल प्रबंधन के लिए पी. क्लैमाइडोस्पोरिया के टैल्क आधारित फॉर्मुलेशन से समृद्ध वर्मीकम्पोस्ट को 1 किलोग्राम/एकड की दर से मिट्टी में लगाने या



*पी.क्लैमाइडोस्पोरिया* के तरल फॉर्मूलेशन को 2.50 लीटर/एकड़ की दर से मिट्टी में आवेदन करने की सिफारिश की जा सकती है।

## क्षेत्रीय स्टेशन, सिरसा

- पत्ता मरोड़ रोग के प्रति प्रतिरोधकता हेतु, प्रजनन के स्टेशन परीक्षणों के दौरान 19 प्रतिरोधी और 7 मध्यम प्रतिरोधी जीनोटाइप की पहचान की गई, साथ ही कपास की उपज के लिए कुछ जीनोटाइप जैसे सीएसएच एनबी 4, सीएसएच एनबी 11, सीएसएच एनबी 19, सीएसएच एनबी 31 और सीएसएच एनबी 32 को गैर बीटी चेक किस्म सीएसएच 3129 की तुलना में काफी बेहतर पाया गया एवं अन्य परीक्षणों में जीवीएस 8 और जीवीएस 9 से विकसित क्रॉस की उत्तम संतानों का चयन किया गया।
- जीईएसी अनुमोदित संकरों के मूल्यांकन के दौरान, 84 प्रविष्टियों/संकरो में से, 18 प्रविष्टियों ने पत्ता मरोड़ रोग के प्रति प्रतिरोधी प्रतिक्रियाएं दर्शायी एवं प्रयोग में कुल पीडीआई रेंज 19.21% - 77.25% रही, वहीं दूसरे परीक्षण के दौरान 16 प्रविष्टियों में से, 03 ने मध्यम प्रतिरोधी प्रतिक्रियाएं दिखाई एवं प्रयोग में कुल पीडीआई रेंज 20.88% - 64.32% के बीच रही।
- हरियाणा राज्य प्रायोजित परीक्षण के तहत वर्ष 2022-23 में मूल्यांकन हुए बीस व्यवसायिक संकरों में गैर-बीटी पौधे 0.86 से 10.83 प्रतिशत के बीच पाए गए।
- बुवाई के 140-150 दिनों के पश्चात् चुनाई से प्राप्त बीजों में उच्च गुणवत्ता के पैमाने मिले एवं अन्य प्रयोग में यह पाया गया कि गोसिपियम हिर्स्टम जीनोटाइप के लिए 45 डिग्री सेल्सियस और 90% आरएच पर 72 घंटे की अवधि बढ़ने के परीक्षण का प्रयोग तुरंत बीज शक्ति परीक्षण के रूप में किया जा सकता है।
- कपास-गेहं प्रणाली के लिए संरक्षण कृषि पद्धतियों पर अनुसंधान निश्चित भूमिस्थल योजना के साथ शुरू किया गया एवं प्रयोग के पहले वर्ष/स्थापना वर्ष के दौरान, प्रभाव गैर-महत्वपूर्ण रहे क्योंकि नहीं किया जा सका, हालांकि रबी मौसम में गेहं की फसल की बुआई के दौरान इन उपचारों को क्रियान्वित किया गया।
- खराब जड़ विकास के प्रबंधन विकल्प के अध्ययन के दौरान, संकर झडप मुदा यंत्रीकरण /सामान्य जुताई /कॅम्पैक्ट मिट्टी के क्रम में प्राप्त हुए। मेपिक्वाट क्लोराइड (एस+एफ)/100 पीपीएम के साथ जड़ों के मापदंड अच्छे मिले वहीं सामान्य जुताई और सघन मिट्टी की स्थिति में मेपिक्वाट क्लोराइड (एस)/100 पीपीएम और

- सैलिसिलिक एसिड (एस+एफ)/200 पीपीएम के साथ जड़ों के मापदंड अच्छे प्राप्त हुए।
- एक प्रयोग में यह पाया गया की स्वस्थ पौधों की तुलना में पत्ता मरोड़ रोग से संक्रमित पौधों पर पली हुई सफेद मक्खी का जीव तंत्र नकरात्मक रूप से प्रभावित होता है। अन्य प्रयोगों में सेटलिंग और ओविपोजीशनल वरीयता अध्ययन के आधार पर 8 जीनोटाइप प्रतिरोधी चेक से बेहतर प्रदर्शन करते हुए पाए गए। एफिडोपाइरोपेन के बाद पायरीप्रोक्सीफेन, बुप्रोफेजिन, स्पाइरोमेसिफेन, एथियन ने सफेद मक्खी के निम्फ के खिलाफ प्रभावी मृत्यु दर दर्शायी।
- कम और उच्च तापमान सफेद मक्खी के अस्तित्व को प्रभावित करता है जहां जीवित रहने के प्रतिशत के आधार पर होस्ट पौधो की उपस्थिति और अनुपस्थिति का प्रभाव भी दर्ज किया गया था। कम और उच्च तापमान के संपर्क में आने के बाद सफेद मक्खी का जीव तंत्र नकरात्मक रूप से प्रभावित होता पाया गया।
- जड़ गलन रोग पर नियंत्रण के साथ उच्चतम बीज अंकुरण परिक्षण के दौरान, सात चयनित कपास राइजोस्फेरिक कवक (आरएफ) जिसमे आरएफ-बी/टीएच-11 (ट्राइकोडर्मा एस्पेरेलम), आरएफ-63-1 (एक्टिनोमोर्टिएरेला वोल्फी) और आरएफ-16-3-(टी. विरेन्स) मुख्य रूप से मिले। रोग प्रगति वक्र (एयूडीपीसी) के तहत सबसे कम बीमार क्षेत्र की परिस्थितियां बुआई के 150 दिनों के बाद, अनुपचारित नियंत्रण की तुलना में @ 5 ग्राम/किग्रा बीज के साथ-साथ आरएफ-बी/टीएच-11, आरएफ-60-1, आरएफ-63-1 और आरएफ-16-3 के मृदा उपचार (1 किग्रा/एकड्) पर दर्ज की गयी।

# अन्य सूचना सारांश

- इस अवधि के दौरान, कुल 58 शोधपत्र प्रकाशित हुए, जिनमें 5 NAAS स्कोर से अधिकवाले 50 शोधपत्र और 5 NAAS स्कोर से कमवाले 8 शोधपत्र और साथ ही 25 लोकप्रिय लेख प्रकाशित हुए।
- कपास की फसल पर कोई जुताई और फसल अवशेष प्रबंधन लागू आभासी प्रशिक्षण कार्यक्रमों सहित 63 प्रशिक्षण कार्यक्रम आयोजित किए गए, जहां किसानों, छात्रों, क्षेत्रीय प्रशिक्षुओं, राज्य सरकार के अधिकारियों और विस्तार पदाधिकारियों सहित कुल लगभग 6121 लाभार्थियों ने भाग लिया।
- बीटी कपास के अच्छे जड़ मापदंड और अच्छी उपज, एमबी प्लों 🔳 उन्नत किस्मों और प्रौद्योगिकियों के व्यावसायीकरण और विकास के लिए सहयोगी आईसीएआर संस्थानों, एसएयू, अन्य सार्वजनिक क्षेत्र के संस्थानों, निजी कंपनियों, गैरसरकारी संगठनों और किसान उत्पादक समूहों के साथ संबंधों को बढ़ावा दिया गया। जनवरी से दिसंबर 2023 के दौरान चार एमओयू पर हस्ताक्षर किए गए।







# **EXECUTIVE SUMMARY | 01**

## **Crop Improvement Division**

- Two bt cotton varieties ICAR-CICR 18 Bt and ICAR-CICR 20-31 Bt were identified for release for rainfed condition of central zone.
- In heterotic pools development program, based on the specific combining ability effects and sigma square values two major groups 'A' (positive) and 'B' (negative) and four sub groups 'AA1', 'AA2', 'BB1' and 'BB2' were identified in G. hirsutum cotton.
- MAGIC population is advanced from F5 to F6 generation and based on phenotypic scores promising lines were identified
- New Jassid resistance genotypes CICR JS-103 and CICR JS -104 were developed.
- Green synthesis of iron nanoparticle was an effective seed priming treatment to enhance germination as well as root length of the seedlings compared to control
- Breeder seed production of CICR released varieties was produced to meet DAC indent as well as direct indent from various stakeholders. The produced seeds were taken up by various state government KVKs, FLD, NFSM, organic groups
   and natural farming group of Gujarat, Maharashtra and MP.
- Regeneration of cotton plant cells through somatic embryogenesis was standardized. Transformation was found a part of transgene integration in the putative transformants
- The study found that 180 seeds should be tested using two ELISA plates in order to track RIB compliance of a non-Bt cotton seed mix (5–10%) in a commercial cotton seed packet. Various sample sizes were used in the trials to

- validate them statistically.
- Phenotypic and genotypic data developed will be useful to enhance yield and its components in cotton genotypes under water stress conditions.
- An analysis of raw transcriptome data from the fourth instar larva of the pink bollworm, identified vital housekeeping genes and characterizing the expression profiles of key chitin biosynthesis genes. Furthermore, the study optimized a cost-effective protocol for in vitro dsRNA synthesis and demonstrated potential strategies for pest management through RNAi mediated tageting of the chitin synthesis pathway genes in pink bollworm.
- Identified and cloned full-length coding sequence of cotton acetolactate synthase gene, optimized of recombinant protein expression of GhALS for invitro mutagenesis and herbicide in-sensitivity assays. Identified cotton specific U6 promoter sequences for increased sgRNA expression. Developed CRISPR/Cas9 vector containing cotton specific U6-29 (Gh6.3) promoter for sgRNA expression.
- Bioefficacy of the Cry1D protein against field resistant pink bollworm populations was re-confirmed and developed cry1D gene constructs using custom synthesized codon optimized cry1D gene. Agrobacterium mediated transformation of tobacco using cry1D gene construct resulted in cry1D PCR positive plants.
- Developed GhNAC9 gene constructs and standardized conditions for Sonication and vacuum infiltration aided agrobacterium mediated transformation in cotton using GUS gene construct.





## **Crop Production Division**

- Soil strength (degree of hardness) was measured with a cone penetrometer. In general, the penetration resistance values increased with soil depth. The values were the least in the deep sub-soiling treatment and the crop rotation treatments. Further, the legume crops grown as rotation crops had higher seed cotton yield than sub-soiling with the recommended dose of nitrogen.
- Under organic cotton production practices, G. arboreum (desi cotton) varieties produced seed cotton yield (13.80 to 15.25 q/ha) on par with cotton hybrid Partech 30 (15.91 q/ha) and superior over G. hirsutum varieties. For sucking pest management, NSKE 5%, Dashparni 10% and Pongamia 5%, were found effective and were on par with Neem oil 0.5% and recommended insecticides.
- Cotton varieties and hybrids with and without Bt were evaluated under HDPS for their compactness and amenability to mechanical picking with and without the plant growth regulator (MepiquatChrolide) at Nagpur, Sirsa and Coimbatore regional stations of ICAR-CICR. Promising ICAR-CICR defoliants were used and compared with commercial salt for leaf defoliation prior to mechanical harvesting. Most of the genotypes tested were found compact (height around 100 cm and width 50cm) and amenable to mechanical picking, in all three zones. All the hybrids and varieties evaluated responded well to application of mepiquat chloride sprayed at the rate of 25g ai/ha, twice at 45 and 65 days after sowing. ICAR-CICR variety Suraksha performed very well when machine picked with a spindle type picker
- Al-based smart Pheromone trap has been developed at ICAR-CICR for automated real-time monitoring of pink bollworm (PBW) in cotton. YOLO-based Machine learning algorithm (a real-time object detection system) was developed to detect and count the number of adult moths of pink bollworms. Higher detection and classification accuracy with the convolution neural network (CNN) could be used to detect accurate cotton boll rot diseases and classification. Based on the Nitrogen Adequacy Index, an algorithm was developed to assess the plant's nitrogen status through multispectral imaging. The algorithm gives an indication of the near real-time N status of the crop from which the spatial crop requirement can be worked out.
- Among the cotton varieties tested, desi cotton exhibited the highest yield under HDPS. Soil nutrient levels and plant nutrient concentration emphasized that mid-season nutrient management is essential for higher yields and sustainability.
- Biochar based composite fertilizers enhanced seed cotton yield by 34 to 48% compared to recommended dose of fertilizers in soils rich in calcium carbonate (>20%). It also increased nutrient availability by reducing the losses and nutrients fixation.
- The foliar spray of Potassium Salt of Active Phosphorus (PSAP) along with 100% recommended dose of fertilizers (RDF) enhanced the cotton P and K concentration compared to others.
- Based on the pot and field study, neither seed treatment (ST) nor foliar spray (FS) of zinc sources affected the Bt-cotton.
   However, in field conditions NanoZnO combined application (seed treatment and foliar spray) in calcareous soils recorded numerically higher SCY. In contrast, ST of Nano

- Zinc Oxide recorded higher SCY than others in black cotton soil.
- The calcium carbonate solubilizing bacterial (CSB) consortia inoculation as seed treatment and soil application significantly enhanced cotton growth along with solubilisation of macro and micronutrients in calcareous soil. The CSB formulation is eco-friendly, cost-effective, does not cause any harmful effects on cotton plants, soil biology, and can reduce chemicals usage for land reclamation, thus has a wider commercial application prospects in agriculture.
- The microbial-based volatile attractant formulation is a non-chemical approach for management of sucking pests in cotton. The attractant is eco-friendly and cost-effective, does not cause any harmful effects on cotton plants, soil nutrient status, soil biology, and can reduce chemical usage and pest resurgence in cotton, thus has wider commercial application prospects in agriculture.
- Compared to defoliant treated cotton leaves, control leaves were found green even after 10 days, whereas more than 85% green leaves dropped after 7 days of application of defoliant. The defoliation rates showed highly significant differences between control and treatment after 7 days of spray.

### Crop Protection Division

- PBW Management Strategies were successfully implemented in 41 districts of 11 states, encompassing 141 villages and covering an expansive 1550 acres during the 2022-23 season. Overall, 35.88% reduction in pink bollworm infestation was observed in IRM fields compared to non-IRM fields during the 2022-23 season.
- Potential loss in yield due to PBW infestation was estimated at 17.4% in Bt and 39.5% in Non-Bt cotton cultivars. Yield loss due to BR was estimated at 15.7% in Bt and 13.6% in Non-Bt cultivars. Proposed method is reliable and robust, useful for quick yield loss assessment in the event of "pest/ disease epidemic". A new dimension of linking PBW phenology model with pest damage and yield loss has been added for better focus of management strategies.
- Field populations of Helicoverpa armigera, are significantly more susceptible to emamectin benzoate when compared to more recent insecticides, and to profenophos when it comes to conventional insecticides that are being tested.
- Thrips species composition was determined, revealing the presence of Thrips tabaci, Thrips palmi, Scirtothrips dorsalis, Asprothrips bimaculatus and Thrips hawaiiensis in the cotton ecosystem.
- The plant volatile profiles of compounds detected from G. hirsutum, G. raimondii, and G. indicum were compared across species, considering all parts at specific times. The specific parts within each Gossypium spp. were also examined.
- Over the three years, about 16,000 green cotton bolls from diverse geographic locations were collected. These bolls were dissected to identify deceased pink bollworm larvae, resulting in the recovery of 210 infected larvae. Five fungal isolates and 30 bacterial isolates of entomopathogens were isolated from infected larvae. During the investigation, no virus infection was observed among the infected larvae. Among three entomopathogenic fungi tested, B. bassiana





- caused significantly higher mortality of pink bollworm larvae than M. anisoplie, L. lecanii.
- Roving survey conducted to access the diversity and incidence of C. cassiicola resulted in collection of 48 isolates with most locations showing symptoms at grades 1 to 2 (2-15% incidence). The genetic similarity observed across a significant number of base pairs between the collected Corynespora cassiicola isolates and those infecting different hosts underscores the organism's genetic uniformity throughout the country.
- The prevalence of boll rot pathogens in boll rot disease complex were successfully studied and integrated management strategies for the disease have been devised.
- Forty different Bt hybrids were tested for grey mildew severity wherein severity was found low at 90 DAS but increased in almost all the hybrids at 120 DAS with a highest mean PDI of 68.0%. A field trial on the management of grey mildew disease involving RCH-530 hybrid revealed that foliar spray of Trichoderma harzianum-Trichocash @ 5gm/L at 90 DAS + Propineb @3ml/L at 110 DAS showed highest reduction in disease (34.02%) over control.
- Two native strains of entomopathogenic nematodes, Heterorhabditis indica (CICR-HI-CL and CICR-HI-MN) were successfully isolated and evaluated, CICR-HI-CL's demonstrated superior potency against PBW with lower LD50 values. The study also demonstrated the remarkable effectiveness of Metarhizium anisopliae TMBMA1, achieving mortality rates up to 100% in third instar PBW larvae, highlighting its potential as a potent bio-insecticide.
- Under the CROPSAP project, effective cotton pest management strategies using Information and Communication Technology (ICT) tools were successfully implemented, contributing as a key stakeholder in 2022-23 in Maharashtra. All the three bollworms and sucking pests were overall under control during 2022-23.

#### Regional Station - Coimbatore

- The compact ideotype long staple cotton variety CICR-H Cotton 54 (Nano) has been notified for both Central and South Zone. The genotype CCH 19-2 showed excellent fibre quality in Coordinated Variety Trial of South Zone in both irrigated and rainfed conditions and identification proposal has been submitted.
- Major weed of irrigated cotton, Trianthema portulacastrum intensity and competiveness decreased under elevated CO<sub>2</sub>. Some minor weeds like Digera arvensis enhanced its spread due to elevated CO2. Aphids and Spodoptera infestation were more due to elevated CO, while jassid infestation was less and other pests non significant under elevated CO2. Partial closure of stomata with reduction in transpiration rate and enhancement in phtosynthetic rate recorded due to elevated CO<sub>2</sub>. Enhanced photosynthetic rate due to elevated CO, resulted in 36 % enhanced seed cotton yield.
- ELS cotton (G. barbadense) genotypes were in AICRP trials during 2022-23: CCB6 and CCB 29 (CVT Br 14a); CCB22-1, and CCB22-2 (IET Br12a).
- Fast Neutron (FN) induced mutagenesis, In M3 Generation, percentage of germination was recorded as 67.8%, survival percentage was 49.6% and reduction in survival percentage over check (suvin) is 31.3%. Spectrum of mutant like . An artificial intelligence (AI) enabled pheromone trap is being

- Variegated, Chlorina, and Glandless were observed in M3.
- Around 6 H x B hybrids were showing better yield and fibre quality for two consecutive years. The hybrid MCUVT5xICB 284 was showing stable performance for both yield and staple length for two years
- In total, 2,347 proteins were obtained in resistant, hybrid, and susceptible genotypes and the complete dataset is accessible via ProteomeXchange Consortium via the PRIDE (PXD038644). A set of 331 Differentially Expressed Proteins (DEPs) were detected only in RP-LH vs. RP, of which only one (uncharacterized protein LOC107904777, A0A1U8J8U7) was significantly up-regulated (FC - 26.929) in RP upon LH infestation.
- Increased plant population (90 x 30cm; 37,037 plants/ ha) combined with drip fertigation and canopy management using mepiguat chloride, can enhance the productivity of ELS cotton without any deleterious effect on fibre quality and in turn has the potential to give rich dividends to ELS farmers.
- Unmanned Aerial Vehicle sprayer can be used for application plant growth regulating chemical like mepiguat chloride for canopy management in cotton under High Density Planting System.
- Sustainable yield index (SYI) values was higher in closed planting system of Bt cotton variety - maize cropping system (0.74) as compared to wider spacing system of cotton hybrid -fallow (0.62), cotton variety - maize (0.59) and cotton hybrid - maize (0.46). Among the cotton - wheat cropping system, the higher sustainable yield index (SYI) values was observed in Bt cotton hybrid - wheat (0.87) and Bt cotton hybrid fallow (0.87) cropping systems. Application of integrated sources of nutrients (NPK + Mg + Zn + B + FYM (10 t/ha) once in two years) not only increased the seed cotton yield but also improved the sustainable yield index of cotton under cotton - maize (0.66) and cotton - wheat (0.86) cropping systems.
- Balanced form of macro, secondary and micronutrients were packed in one single pellet to increase the fertilizer use efficiency and achieve the higher cotton productivity
- The best dosage and method of application were standardized for newly synthesized zinc oxide nanoparticles or nano suspension (ICAR - CIRCOT) in order to increase the cotton productivity under alkaline soil condition. Application of zinc oxide nanoparticles through seed treatment @20 ppm along with foliar application @ 200 ppm at two critical stages like square formation and flowering stages of cotton significantly increased the seed cotton yield (21.3 g/ha) than control (14.4 q/ha).
- Foliar formulation of 19:19:19 (1%)+Mg SO4 (0.5 % )+ Ferrous Sulphate (0.25 %) + Zinc Sulphate (0.25 %) + Boric Acid (0.1 %) + CuSO4 (0.05 %) + Sodium molybdate (0.01%) + Na- EDTA 0.02 mM + NAA (20 ppm) + Salicylic Acid (50 ppm) + Ascorbic Acid (100 ppm) + Kinetin (20 ppm) + APSA 80 recorded higher yield of 2450 kg/ha in cotton Variety Suraj.
- Information on cotton improvement / production / protection technologies were disseminated using digital tools viz., Voice SMS, Mobile App and Web based weekly advisories.
- Thirty one datasets and appropriate database and retrieval system developed.



- pheromone trap. The Al trap is configured to transmit the count of insect trap catches directly to the user with additional information like trap location and weather data.
- A multi coloured glue-fin trap is developed and tested in field for the monitoring and management of jassids, thrips, whitefly, aphids and pink bollworm moths in cotton using a single trap system.
- Thiamethoxam 12.60% + Lambda-cyhalothrin 9.50% ZC and Dinotefuran 20 SG were found to be highly effective against H. theivora. A single H. theivora can cause an avoidable yield loss in cotton up to 13.36%.
- The stem weevil incidence was ranged from 8-86 per cent damage and number of galls was ranged from 1-7 galls per plant in 27 villages surveyed among seven districts. Madurai and Thoothukudi districts recorded higher incidence (>70%) of cotton stem weevil. Based on external morphology and genitalial characters, Pempherulus affinis was found to be the major species. Four promising volatile compounds were tested under field conditions. Under field condition volatiles failed to attract the stem weevil. Out of three Bt isolates (Bt 41, 62 and 721), Bt 41 and Bt 721 found effective against cotton stem weevil
- The PDI of Cercospora isolates collected from South Zone varied from 11.00 to 34.0 and isolates from Karnataka found to be more virulent compared to Telangana, Andhra Pradesh and Tamil Nadu.
- The fungicide combination, Azoxystrobin 18.2% + Difenoconazole 11.4% w/w SC, was found effective against uredospores under in vitro conditions. Viability of uredospores decreased over time under all storage conditions. Under room conditions, viability persisted for up to 40 days, with the lowest observed percentage of viability in the refrigerator-stored condition for up to 35 days.
- Spraying of liquid formulation of biopesticide consortia with Lecanicillium lecanii and Acinetobacter Iwoffii was effective against sucking pests and safer to natural enemies (Coccinellids) under field condition.
- Soil application of vermicompost enriched with talc based formulation of P. chlamydosporia @ 1Kg/ac or Soil drenching of liquid formulation of P. chlamydosporia @ 2.50 I/ac is recommended for the eco-friendly management of reniform nematode in Cotton.

## Regional Station - Sirsa

- In station trials for CLCuD resistance breeding, 19 resistant and 7 moderately resistant genotypes were identified. For seed cotton yield (Kg/ha), cultures i.e. CSH NB 4, CSH NB 11, CSH NB 19, CSH NB 31 and CSH NB 32 were found to be significantly better than Non Bt check CSH 3129 and selections were made among progenies developed from crosses involving GVS 8 and GVS 9.
- During evaluation of GEAC approved hybrids, out of 84 entries, 18 entries showed resistant (R) reactions against CLCuD with PDI range 19.21% - 77.25% in Trial I, while out of 16 entries, 03 showed moderately resistant (MR) reactions against CLCuD with PDI range 20.88% - 64.32%) in the Trial II.
- The non-Bt plants ranged between 0.86 to 10.83 percent among the twenty hybrids evaluated in the year 2022-23 under Haryana state sponsored trial.

- developed to circumvent the limitations of conventional . The seeds harvested at (140-150 DAS) & from middle stratum of the plants showed higher seed quality parameters and 72 hours of accelerated ageing at 450C and 90 (%) RH for G. hirsutum genotypes may be used as quick seed vigour
  - Research on "conservation agriculture practices for cottonwheat system" has been initiated with fixed laid out plan. During the first year of experimentation/ establishment year, effects were non -significant as no tillage and crop residue management could be applied to the cotton crop however these treatments had executed during the sowing of wheat crop in Rabi season.
  - During study on "management options for poor root development", highest values of root parameters and seed cotton yield of hybrid Bt cotton was obtained under MB plough > Sub soiling > Normal ploughing > Compact soil. Dry weight of roots, lateral root length and tap root length was significantly higher with Mepiguat chloride (S+F) @ 100 ppm; Mepiquat chloride (S) @ 100 ppm & Salicylic acid (S+F) @ 200 ppm over control under Normal ploughing & Compact soil conditions.
  - Whitefly biology affected when reared on CLCuD infected plants in comparison to healthy plants. Based on settling and ovipositional preference studies 8 genotypes perform better over designated resistant check. Afidopyropen followed by Pyriproxyfen, Buprofezin, Spiromesifen, Ethion showed effective mortality against whitefly nymphs.
  - The low and high temperature affects the survival of whitefly where influence of presence and absence of host was also recorded on survival percentage. The biology of whitefly affected after short exposure of low and high temperature exposure.
  - Seven selected cotton rhizospheric fungi (RFs) showed the highest seed germination and root rot reduction over control with the seed treatment of Rf-B/Th-11 (Trichoderma asperellum) followed by Rf-63-1 (Actinomortierella wolfi) and Rf-16-3-(T. virens) at 90 days after sowing (DAS) under pot experiment. The lowest area under the disease progress curve (AUDPC) at 150 days after sowing under sick field conditions was recorded with seed (@5g/kg seed) plus soil treatment (1kg/acre) of Rf-B/Th-11 followed by Rf-60-1, Rf-63-1 and Rf-16-3 in comparison to untreated control.

#### General

- During the period, a total of 58 research papers of which 50 research papers with >5 NAAS Score and 8 research papers with <5 NAAS Score as well as 25 popular articles were published.
- 63training programmes including virtual training programmes were organized where a total of about 6121 beneficiaries including farmers, students, field trainees, state government officials and extension functionaries participated.
- Linkages were fostered with sister ICAR Institutes, SAUs, other public sector Institutes, private companies, NGOs and farmer producer groups to commercialize and upscale varieties and technologies developed. Four MoUs were inked during January to December 2023.



# 02 | INTRODUCTION

#### 1.1: Brief History

The ICAR-Central Institute for Cotton Research (CICR) was established at Nagpur, in 1976. The two regional stations of IARI located at Sirsa (Haryana) and Coimbatore (Tamil Nadu) were transferred to ICAR-CICR to cater needs of north and south . Coordination and monitoring of applied research on national India, respectively.

#### 1.2: Mandate

Basic, strategic and adaptive research on production,
 Dissemination of technologies and capacity building.

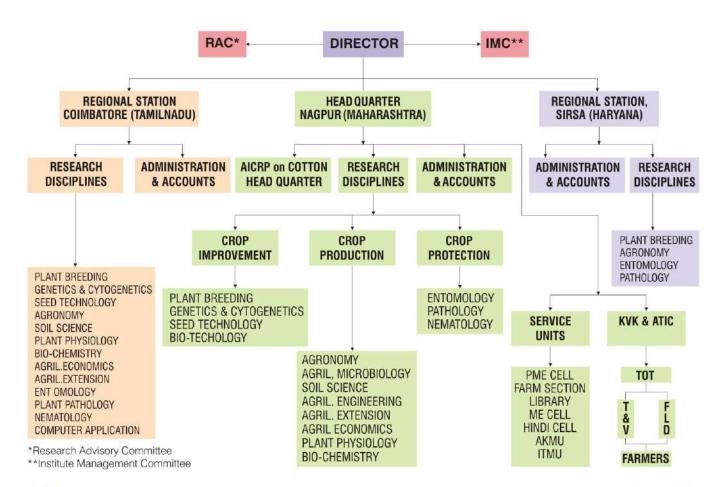
protection, fibre quality and by-products of cotton.

- Creation of new genetic variability for location-specific adoption in cotton-based cropping systems.
- and regional issues to develop improved varieties and technologies.

#### Location of the of ICAR-CICR Institute

Center	Latitude (°N)	Longitude (°E)
ICAR-CICR, Head Quarters, Nagpur, Maharashtra	21.037	79.056
ICAR-CICR, Regional Station, Coimbatore, Tamil Nadu	11.014	76.929
ICAR-CICR, Regional Station, Sirsa, Haryana	29.543	75.038

# ORGANOGRAM OF CICR







# 1.3 : Staff Position (as on 31st December, 2023)

Category	Sar	Sanctioned Cadre Strength				Post Filled Up			
	NGP	CBE	Sirsa	Total	NGP	CBE	Sirsa	Total	
Director (RMP)	1	7		1	1			1	
Scientific	48+6**	14	9	77	33	19	06	58	
Technical				72	38	10	06	54	
Administrative		-		46	16	03	03	22	
Skilled Support Staff		-		44+31*	28	03	13	44	
Krishi Vigyan Kendra									
Training Organizer	1	( <u></u> )		01	01			01	
Technical	11	-		11	10			10	
Administrative	02			02				122	
Skilled Support Staff	02	-		02	01			01	

NGP - Nagpur; CBE - Coimbatore

#### 1.4 : Financial Statement

The budget grant and actual expenditure for the year 2023 are furnished below:

(Rs. in Lakhs)

Name of Scheme	20	22-23	2023 (Jan-Dec 2023)	
	Sanction	Expenditure	Sanction	Expenditure
Plan Scheme	1833.75	1812.85	1585.01	1523.23
Deposit Scheme	2046.29	1152.02	3336.42	2400.14
Revolving Fund	23.55	4.87	19.60	19.43
Govt. Grants	4881.48	4880.96	4973.00	3637.21
Total (in lakhs)	8785.07	7850.70	9914.03	7580.01
Revenue Generation (Revenue Receipts)	3	8.29	1	9.13







 $<sup>^*</sup>$  Original sanction 44+31\* additional sanction which will abolished as and when vacated.  $^*$  \*06 Sanction for Junagarh, Gujarat



# RESEARCH ACHIEVEMENTS | 03

#### **CROP IMPROVEMENT DIVISION**

2.1 Project Name: Development of elite Bt cotton varieties /hybrids using deregulated transgenic events

SumanBala Singh (2018-march 2022), H.B. Santosh (March 2022 to June 2022), Rahul M. Phuke (July 2022-March 2023) (PIs), CO-PIs: V.N. Waghmare, D.V. Patil, V. Santhy, Raghavendra KP, Rakesh Kumar, MV Venugopalan, Ramkrushna Gl, Shah Vivek, Neelakanth S. Hiremani, S. Manickam, K. Baghyalakshmi, A. Sampathkumar, S.K. Verma, Rishi Kumar, S.K. Sain

Importance of the study: This project aims to enhance cotton productivity in India's rainfed areas by introducing early maturing, compact Bt cotton varieties. These varieties offer several benefits, including increased yields, reduced resource requirements, and enhanced protection against bollworms due to their early maturity. The strategy involves utilizing varieties, which will enable farmers to achieve higher yields and as mentioned in table 2.1.1

greater resilience in challenging rainfed environments. Additionally, the project explores the potential of high-density planting techniques to further optimize productivity and resource utilization in cotton cultivation.

#### Salient findings

Identification of Bt varieties for Release by varietal identification committee: Two Bt cotton varieties CICR Bt 20-31 & CICR 18 Bt were identified for release by Varietal Identification Committee of Cotton during Annual Group Meeting held on 06th-07th April, 2023 at Punjab Agricultural University, Ludhiana. Further these will be send for notification.

Nucleus seed production of Bt varieties: Nucleus seed of Bt varieties, namely CICR-Yugank Bt (48 Kg), CICR-Tejas Bt (28 Kg), CICR-Namami Bt (33 Kg), CICR-Samrat Bt (28 Kg), CICR 21 Bt (39 Kg), and CICR 25 Bt (17 Kg) was produced.

Evaluation of promising cultures in AICRP: Total of 14 entries deregulated transgenic events to develop these improved Bt sponsored by ICAR-CICR were tested in different AICRP trials

Table: 2.1.1 List of Bt cotton genotypes sponsored in different AICRP trial during 2022-23

Zone	Growing Condition	Initial Evaluation Trial (09)	Advanced Evaluation Trial I (3)	Advanced Evaluation Trial II (2)
North Zone (NZ)	Irrigated	CICR Bt-26, CICR Bt-30	Nil	Nil
Central zone (CZ)	Rainfed	CICR Bt 2, CICR Bt 4, CICR Bt 12, CICR 22-31, CICR 22-32, CICR 22-33	CICR Bt 21-32, CICR Bt 21-31	CICR 18 Bt, CICR 20-31 Bt
	Irrigated	CICR Bt 2, CICR Bt 4, CICR Bt 12	Nil	CICR 18 Bt, CICR 20-31 Bt
South Zone (SZ)	Rainfed	Nil	CICR 20-31 Bt	Nil
	Irrigated	Nil	Nil	Nil



Evaluation of Bt genotypes in Station Trial at Nagpur: A common station trial of 22 Bt entries along with four checks (Ajeet 155 BG II, RCH 608 BG II, PKV 081 Bt, and Suraj Bt) was conducted in RBD having two replications in 90 x 30 cm spacing of 4 rows. The Phenotyping for yield related and fibre quality traits were carried out along with protein expression for Cry I Ac, pest infestation, and disease incidence. Trial was severely affected by the continuous rains in July 2022. Population of Jassid, aphids and thrips was below ETL at 60 DAS and 90 DAS. Jassid population with grade II damage in many entries were recorded at 90 DAS. All entries reported more than 90% mortality for *Helicoverpa armigera* in leaf & square bioassay and

100% mortality in boll bioassay, protein expression ranged from 3.58 to 5.9 ppm at 60 DAS and 1.63 to 3.08 ppm at 90DAS. bacterial blight and grey mildew were the major diseases during the season. The max PDI of bacterial blight was seen in CICR 20 Bt (14.2%), grey mildew PDI ranged from 6-32%. The highest yields was recorded by Ajeet 155 (17.7 q/ha) followed by 211-234 (16.6 q/ha), 211-246 (16.9 q/ha) & 211-225 (16.20 q/ha) (table 2.1.2). Based on yield, resistance to pest & diseases and fibre quality two test entries viz., CICR 211-246 & CICR-211-225 (figure 2.1.1) were sponsored to compact AICRP trial for central zone in irrigated condition.

Table 2.1.2. Seed cotton yield and other data of Station trial entries

Genotype	DTF	PH (cm)	Boll wt (gm)	Lint Index	Seed Index	GOT	SCY (Kg/ha)	Cry Protein exp 60 DAS
Ajeet 155	73	90.1	3.4	5.35	9.4	36.0	1771.2	3.6
211-234	77	71.5	3.2	4.8	8.0	37.8	1662.7	5.9
211-246	77	105.3	2.8	4.4	6.2	40.2	1657.5	3.9
211-225	73	71.8	3.7	4.5	7.8	37.2	1620.2	4.8
RCH 608	74	67.8	4.7	4.7	9.5	33.3	1190.6	4.5
Suraj (Bt)	78	76.6	2.45	3.9	6.8	36.6	1240.2	3.9





Figure 2.1.1: Plant type of Bt cultures CICR 211-234 and CICR 211-225

Germplasm trial for early maturity and high GOT: The included. Spacing between plots is maintained at 90 x 30 cm, experiment comprises a total of 29 genotypes along with 5 checks, designed under a randomized block design (RBD) with two replications. Early maturity checks include C0 17 and Anjali, while the GOT check is CNH 204710 and the BG II hybrid check is Ankur 3028 BG II. Additionally, a local check, PKV 081, is

Visit of Institute germplasm identification committee to germplasm trial site for evaluation

with each plot occupying an area of 16.2 square meters. Most of the entries are observed as early maturing compared to early maturing checks. Four genotypes viz., CICR 211-275, CICR 211-404, CICR 211-369 and CICR 211- 217 were observed as most early maturing, which is also supported by last two years data i.e. 2020-21 & 2021-22.

Stability analysis Trial: The experiment encompasses a total of 22 entries involving 20 release varieties of CICR, divided into Bt and non-Bt categories, with two designated checks: Ajeet 155 BGII and Ankur 3028 BG II among them. Employing a randomized block design (RBD) with two replications. Each plot is spaced at 90×30cm, with three rows demarcated for the study. Sowing conditions are diversified into two categories: timely sowing on 2nd July 2022 and late sowing on 5th August 2022, offering a comprehensive assessment of growth dynamics under different temporal conditions for studying stability of release varieties of ICAR-CICR. The majority of



genotypes exhibited a decline in yield with delayed sowing, dates, thus recognized as the most stable genotype. To validate contrasting with the genotype PKV-081 (figure 2.1.2), which these findings, the trial will be repeated in the cropping season displayed the least deviation in yield across different sowing of 2023-24 to confirm the results.

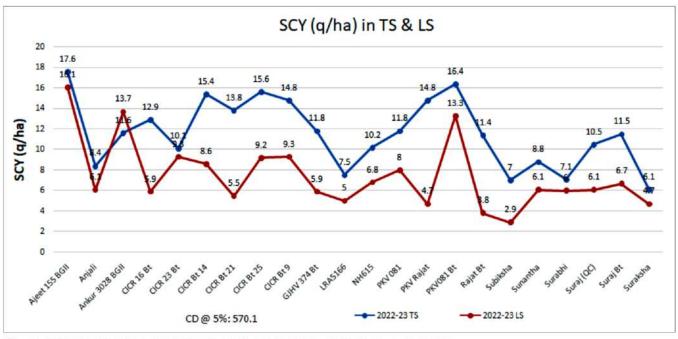


Figure: 2.1.2: Seed cotton yield of test genotypes in timely and late sown condition

Bt breeding material (BG I & BG II) from F<sub>s</sub> to F<sub>s</sub> generation comprising of total 64 families was advanced through pedigree method. Among the F<sub>6</sub> selected bulk the four families recoded seed cotton yield more than 20q/ha and the boll weight was in the range of 3.2 to 5.2 gm. The high yielding bulk with better fibre quality was advanced to station trial.

Field expression of Bulk and single plant selection from Bt breeding material

Bt conversion program at ICAR-CICR-Coimbatore: BC,F, population was raised involving recurrent parent's viz., Suraj, Surabhi, Supriya, Anjali, Sumangala, CCH 2623, Subiksha, Sunantha, Suraksha and Nano and selfing of background selected Cry1Ac positive plants was undertaken to produce BC<sub>4</sub>F<sub>5</sub> plants. About 250 F<sub>5</sub> population was raised involving female parents viz., Suraj, Surabhi, Supriya, Anjali, Sumangala,

Advancement and Evaluation of Bt Breeding material: The CCH 2623, Subiksha, Sunantha, Suraksha and Nano and donor parents viz., F 1861 Bt, PAU Bt1 (Mon 531); 7693 (Mon 15958). Selfing of Cry1Ac positive plants was undertaken to produce F<sub>s</sub> plants. Bioassay of 12 homozygous Cry1Ac positive plants were undertaken in leaf, boll and square and results indicated 100 % mortality in most cases (Table 2.1.3).

Table 2.1.3. Bioassay of Homozygous Cry1Ac positive plants (12) against Helicoverpa armigera

Genotype	No. of neonates	% M	ortality	
111 572	released	Leaf	Boll	
HO-1	10	100.0	100.0	
HO-3	10	100.0	100.0	
HO-7	10	100.0	100.0	
HO-17/1	10	100.0	100.0	
HO -18	10	100.0	100.0	
HO-19	10	96.7	100.0	
HO-23	10	100.0	100.0	
HO-28	10	96.7	100.0	
HO-29	10	100.0	100.0	
BB6/5	10	96.7	100.0	
BB6/6	10	90.0	100.0	
BB6/7	10	86.7	100.0	
Control	10	13.3	36.7	

Evaluation of interspecific (H x B) Bt hybrids at ICAR-CICR Coimbatore: 56 hybrids were tested for two years for yield and quality traits. The crosses combinations, PKV 081 Bt x ICB 258 (4853.9 kg/ha), GJHV 374 Bt x ICB 99 (4074.0 kg/ha), PKV 018 Bt x ICB 28 (4074.0 kg/ha), PKV 081 Bt x ICB 39 (3627.8 kg/ha), Rajat Bt x ICB 99 (3569.6 kg/ha), Rajat Bt x ICB 34 (3375.6 kg/ha), performed higher and significant mean value than



Rajat Bt x SUVIN (36.6mm), GJHV 374 Bt x ICB 176 (36.2mm), Rajat Bt x CCB 141 (35.7 mm), showed higher and significant 2.1.3). Four genotypes i.e. CICRS Bt 33, CICRS Bt 85, CICRS Bt fibre length. The hybrids PKV 081 Bt x ICB 258, Rajat Bt x ICB 258, and GJHV 374 Bt x CCB 141 showed stable performance for both yield and staple length for two years.

#### Bt breeding program at ICAR-CICR-Sirsa

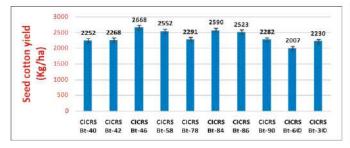
Identification of promising Bt cultures: 42 Bt varietal cultures were evaluated in two station trials (Table 2.1.4) including two checks CICR Bt 6 and PAU Bt 3 under RBD for CLCuD resistance, yield attributes and fibre quality traits during 2022-23 at CICR, RS, Sirsa. Out of 42 cultures, 3 Bt lines (CICRS Bt 33, CICRS Bt 46, CICRS Bt 70) were highly HR (Highly resistant) and 6, 15, 14, 4 Bt lines showed R (Resistant), MR (Moderately Resistant), MS (Moderately Susceptible), S (Susceptible) reactions respectively against CLCuD, while CICR Bt 6 showed MR & PAU Bt 3 showed S reactions in same environment. In these trials, 8 Bt cultures had recorded significantly better seed cotton yield than CICR Bt 6 while three entries i.e. CICRS Bt 46,

grand mean. The crosses GJHV 374 Bt x CCB 143 B (36.8mm), CICRS Bt 58 and CICRS Bt 84 were found to be significantly better than Best Bt check PAU Bt 3 for seed cotton yield (Fig 86 and CICRS Bt 99 found to have long (> 27.5 mm) fibre in this experiment.

> Identification of promising BG II cultures: 32 BG II varietal cultures were evaluated in two station trials (Table 2.1.4) along with checks CICR Bt 6, PAU Bt 3, RASI 773 (BG II hybrid) under RBD for CLCuD resistance, yield attributes and fibre quality traits during 2022-23 at CICR, RS, Sirsa. Out of 32 cultures, 19 BG II lines, 10 BG II and 3 BG II lines showed Highly Resistant, Resistant and Moderately Resistant reactions respectively against CLCuD, while CICR Bt 6 showed MR & PAU Bt 3 showed S reactions in same environment. In these trials, 7 BG II cultures found to have significantly better seed cotton yield than CICR Bt 6 while three entries i.e. CICRS Bt 36, CICRS Bt 88 and CICRS Bt 92 could record significantly higher seed cotton yield than best Bt variety check PAU Bt 3(Fig 2.1.4). Five genotypes i.e. CICRS Bt 36, CICRS Bt 38, CICRS Bt 50, CICRS Bt 59 and CICRS Bt 92 found to have long fibre (> 27.5 mm) in this experiment.

Table 2.1.4: Bt Cultures evaluation under station trials

Trial Details	Promising entries
Station Trial I and Station Trial II Entries: 19 Bt cultures + 2 Checks: CICR Bt 6 and PAU Bt 3 (each trial)	Highly Resistant entries: CICRS Bt 33, CICRS Bt 46, CICRS Bt 70 Prominent high yielding entries: CICRS Bt 40, CICRS Bt 42, CICRS Bt 46, CICRS Bt 58, CICRS Bt 78, CICRS Bt 84, CICRS Bt 86 and CICRS Bt 90 Prominent entries having good fibre quality: CICRS Bt 33, CICRS Bt 85, CICRS Bt 86 and CICRS Bt 99
Station Trial III and Station Trial IV Entries: 16 BG II cultures + 3 Checks: CICR Bt 6, PAU Bt 3 and RASI 773(each trial)	Highly Resistant entries : CICRS Bt 36, CICRS Bt 48, CICRS Bt 50, CICRS Bt 54, CICRS Bt 81, CICRS Bt 88, CICRS Bt 92  Prominent high yielding entries : CICRS Bt 36, CICRS Bt 48, CICRS Bt 50, CICRS Bt 54, CICRS Bt 81, CICRS Bt 88 and CICRS Bt 92  Prominent entries having good fibre quality : CICRS Bt 36, CICRS Bt 38, CICRS Bt 50, CICRS Bt 59 and CICRS Bt 92



3000 2654 2463 2501 Seed cotton yield 2393 2324 2251 2268 2500 2242 2049 2000 (Kg/ha) 1500 1000 0 CICRS CICRS CICRS CICRS CICRS CICRS CICRS CICRS RASI Bt-48 Bt-50 Bt-54 Bt-81 Bt-88 Bt-92 Bt-6© Bt-3© 773 ©

Fig 2.1.3: Promising high yielding Bt cultures

Fig 2.1.4: Promising high yielding BG II cultures

### Agronomic evaluation of released Bt cotton varieties

Canopy management for productivity enhancement 2022-23: A field experiment was repeated one more year to standardize canopy management techniques for inducting compactness, earliness, and synchronous maturity in Bt varieties/hybrids to facilitate mechanical harvesting and double cropping. One Bt variety CICR 191-165 Bt and three Bt (BG II) hybrids viz. H8 BGII, RCH 608 and Ajeet 155 were evaluated under 5 canopy management regimes- M1: HDPS (90 x 15 cm), M2: HDPS + CICR Canopy management, M3: HDPS + Rasi canopy management, M4: HDPS + Mechanical canopy management (Jalna), M5: normal spacing (90 x 45 cm).

On both calcareous and deep black soils. Under HDPS the 3 canopy managements tested gave statistically similar yield and these yields were significantly superior to wide spacing 90 X 45 cm and HDPS (90x15 cm) without canopy management .Mean yield over canopy management was in the order 191 -165 (1953 kg/ha) > and NCS 2778 (1831 kg/ha) > RCH 608 (1679 kg/ha) > H8 (1657 kg/ha) in calcareous soils and 191-165 (2731 kg/ha) > NCS 2778 (2686 kg/ha)>H8 (2486 kg/ha) > RCH 608 (2133 kg/ha) in deep black soil. The response of 191-165 to canopy management was not significant on both the soils. The highest yield gain due to closer spacing (2827 kg/ha in 90 X 15 cm Vs 2266 kg/ha in 90 X 45 cm on deep black soil and 2110 kg/ha in 90 X 15 cm Vs 1558 kg/ha in 90 X 45 cm) was introgression of the event in elite backgrounds, thus further observed in the genotypes 191 -165.

#### Identification of Bt varieties suitable for HDPS

The HDPS experimental was repeated for confirmation of results from 2021 experiment, design adopts a Factorial Randomized Block Design (RBD) with three replications. Plots were arranged with two different spacings: 90x30 cm and 90x15 cm. The study encompasses 10 Bt varieties: GJHV 374 Bt, Rajat Bt, CICR Bt 21, Suraj Bt, CICR Bt 25, PKV 081 Bt, CICR Bt 9, CICR 16 Bt, CICR Bt 14, and CICR 23 Bt. In addition to the specified Bt varieties, the experiment also incorporates two BGII hybrid checks: RCH 608 BGII and Ajeet 155 BGII. From the observation recoded over two year it is observed that two varieties i.e. CICR-PKV 081 Bt and CICR Bt 14 should be recommended for cultivation in HDPS condition for rainfed ecosystem.

#### 2.2 Project Name: Development of elite Bt cotton varieties using potential non-deregulated transgenic events

V.N. Waghmare (PI); Co-PI's: G Balasubramani, Vinita Gotmare, J Amudha, KP Raghavendra, M Saravanan, HB Santosh, Vivek Shah, Rakesh Kumar, Rishi Kumar, VS Nagrare

Importance of the study: Development of transgenic cotton varieties for sustainable bollworm management using available deregulated and indigenous new events available in ICAR-CICR and from Indian Research Institutions.

#### Salient findings

Introgression of Tg2E13 event: In the comparative evaluation of plants carrying events Tg2E13 and Mon531, alone and in combination in the contained facility showed that across all backgrounds, plants carrying Tg2E13 event had late progression from flower to boll opening, took more days for flower initiation and had lesser boll bursting at 145 DAS. In general, plants carrying Tg2E13 event were late in flowering with prolonged boll maturation period that goes beyond 180 days, which is not preferred in the wake of resistance developed against Bt by Pink Bollworm. After the deliberations with the developer and subsequent approval from the Council, further evaluation and introgression of Tg2E13 event was discontinued.

Introgression of CH12 event (cry2Ax1): The homozygous BC<sub>4</sub>F<sub>2</sub> plants carrying Cry2Ax1 &cry1Ac genes subjected to bioassay against H. armigera and Pink Bollworm indicated 20-100% mortality of the H. armigera larvae while for pink bollworm at 100 DAS showed 100% damage. Since event CH12/Cry2Ax1 gene did not show much promise against H. armigera and PBW, it was decided to discontinue the use of CH 12 event.

Evaluation of UASD 78 event (cry1Ac): The event was sourced from UAS, Dharwad. On intervention by DDG (CS), whole genome sequence data of the recurrent parent provided by the developer was jointly analyzed by ICAR-NIPB and ICAR-CICR. Since authenticity and uniqueness of the event could not be established, ICAR-CICR stopped introgression of the event pending validation for uniqueness of the event.

Evaluation of Tma12 Events: Four different Tma-12 events along with resistant and susceptible checks were evaluated for control of whitefly. The average population reduction of adults under open choice condition ranged between 8.26 to 14.45% in different events while under No-choice condition it ranged between 11.18 to 20.0% in comparison to N-Event (Coker 312).

evaluation of the events has been discontinued.

# 2.3 Project Name: Development of Bt hybrids in tetraploid cotton with high yield, superior fibre quality and tolerance to

Saravanan, M (PI), Co-PIs - Rahul M.Phuke, N Chandrashekar, Prabhulinga T

Importance of the study: The project envisaged to develop Bt hybrids with high yield, superior fibre quality and tolerance to Jassid using big boll germplasm accessions, ICAR-CICR released Bt varieties and jassid tolerant accessions.

Salient findings: ICAR-CICR released Bt varieties such as Suraj Bt, PKV081 Bt, GJHV374 Bt, Rajat Bt, CICR21 Bt, Jassid tolerant lines, Suraksha, Suchitra, High GOT genetic stock CNH204710 and big boll cultures were utilized in the line x Tester mating design. Jassid screening was carried out at 45, 60 and 90 days after sowing. Seven GMS lines were utilized for Bt conversion in the breeding programme. A total of 98 F1 hybrid combinations were developed for estimation of heterosis and combining ability.

#### 2.4 Project Name: Development of Asiatic cotton (G. arboreum) genotypes with high yield and improved fibre quality traits

Saravanan, M (PI), Co-PIs - Dr. V. N. Waghmare

Importance of the study: Desi cotton (G. arboreum) is inherently tolerant to both abiotic and biotic stresses particularly drought, salinity, leaf hoppers, rust, fungi and viral diseases. They are highly suitable for organic cotton cultivation. The project aims to breed high yielding and superior fibre quality desi cotton under changing climatic conditions.

Salient findings: Based on yield and fibre quality traits, 69 promising advanced progenies were selected from crosses between Phule Dhanwantari with PA255, PA812, PA740, PA785 and KWAN3. Out of 69, three entries CNA 21-31 (1000 kg/ha), CNA 21-78 (930.6 kg/ha) and CNA 21-92(916.7) performed better than zonal check AKA 7 (780.1 kg/ha). The best performing three entries were submitted to institute common trial for further evaluation.

#### 2.5 Project Name: Harnessing the potential of wild and unadapted germplasm for cotton improvement

Vinita Gotmare(PI) Co-PIs - Dr Santosh HB (Transferred to CRIDA, June 2022), Dr Rachna Pande, Dr Neelkanth Hiremani, Dr S.K. Verma (Sirsa), Dr Baghyalaxmi (Coimbatore)

#### Importance of the study:

Wild species are the reservoir of many useful genes governing different economic traits including lint yield, fibre quality and resistance to biotic and abiotic stress tolerance. In view of narrow genetic base of cultivated cotton, the available wild species, races of cultivated species, synthetic polyploids of Gossypium are conserved and utilized in introgression breeding to broaden the genetic base and also to create newer genetic diversity for various traits in turn for their utilization in the improvement of cultivated species.

#### Salient findings:

#### **Enrichment & Conservation:**

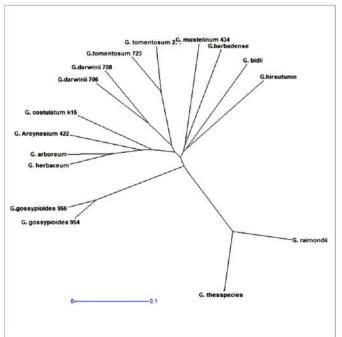
Total 23 accessions of 11 species were added to the existing collection of 24 wild species. Screening and evaluation report of the newly introduced specie was submitted to ICAR-NBPGR, New Delhi as per the mandate. 15 races of cultivated species The Tma 12 events did not exhibit much promise for and more than 45 synthetic polyploids are also conserved in the





Genetic diversity analysis was done for the 20 different

accessions of wild species accessions obtained from USDA using 40 SSR polymorphic markers (Figure 2.5.1)



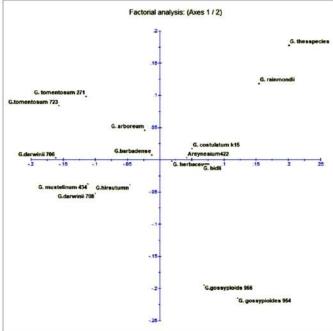


Figure 2.5.1. Genetic diversity analysis of in-vitro established wild species received from USDA using SSR polymorphic markers

Single plant selections (F, generation) from interspecific New wild species: G. sturtianum, G. gossypioides & G. crosses:

S.No.	Derivative	No. of Single Plant Selections
а	G. arboreumx G. longicalyx	32
b	G. arboreum x G. thurberi	43
С	G. arboreum race indicum x G. davidsonii	25
d	AK 8401 x G. davidsonii	28

Ten plants to row progenies of G. arboreum x G. longicalyx cross shared with the centres of AICRP- Pre-breeding trial with Fibre Length 22.4 - 26.6 mm and Fibre strength 24.9 - 28.8 g/tex were evaluated for second consecutive year. Five stable lines of each of G. arboreum race indicum x G. davidsonii (tolerant to sucking pests, salinity & Bacterial blight) and G. arboreum x G. longicalyx (Fibre fineness) were selected.

A total of 7344 new crosses were attempted between cultivars and wild species (wild species crosses, 1565) with 7.41% success and colour cotton backcrosses (4220) with 23.48% success.

Cultivars & Races: LRA5166, LRK 516, MCU5, MCU5VT, Arogya, Suvin, KH3, Moco, Suraj, MCU10, Africanum, G. arboreum cv Jawahar Tapti, AKA5, AKA7, PA255, PA402, CNA1003, Digvijay, AKA8401, G.cot. 23, DLSA17, G. hirsutum races : Latifolium, Palmeri, Richmondii; G. arboreum races Sinense, Indicum, Burmanicum, Bengalense, Cernuum & Soudanense.

#### Wild Species:

Old wild species: G. raimondii, G. stocksii, G. capitis viridis, G. anomolum, G. barbosanum, G. somalense, G. davidsonii & Thespesia lampas.

mustelinum.

#### Introgression Breeding:

Developed & evaluated more than 450 intorgressed lines for yield, fibre traits and biotic and abiotic stress tolerance while six introgresed derivatives were sponsored for various AICRP trials for evaluation as mentioned in the table below:

Trial	Name of genotypes
Br 22 (a/b) IET of G. arboreum Central Zone (CZ)	CNA 20178
Br 02 (a/b) IET of G. hirsutum Central Zone (CZ)	CNH 20449, CNH 20452, CNH 17395, CNH 19325, CNH 19480
Br 24 (b) CC CVT G. arboreumcolour cotton – Central Zone	CNA19475
Agronomy trial (Central Zone – Rainfed) Junagadh & Nanded	CNH18529

#### Release & Notification of Naturally Colour Cotton Varieties:

CICR-A Cotton 59 (CNA17522) is a G. arboreum based derivative of Wild species of Gossypium i.e. Gossypium arboreum race Burmanicum and G. raimondii & was released & notified for commercial cultivation possessing light brown colour lint, UHML 23.3 mm, micronaire of 5.3 µg/in, bundle strength of 23.1 g/tex and spinnable upto 20s counts. It is moderately tolerant to sucking pests and bollworms, resistant to Alternaria Leaf Spot, Grey Mildew & Bacterial Blight while it was moderately Resistant to Corynespora Leaf Spot & Rust. CICR-A Cotton 59 state of Gujarat, Madhya Pradesh and Maharashtra.





CICR-H Cotton 58 (CNH17395) is a G. hirsutum based derivative of Wild species of Gossypium. Parentage: G. hirsutum, G. raimondii, G. barbadense & G. thurberi. Average seed cotton yield of 2001 kg/ha, lint characteristics colour - dark brown, UHML-23.7 mm, fibre strength-24.4 and micronaire - 4.7. It is moderately tolerant to sucking pests, bollworms and resistant to Alternaria leaf spot, Grey mildew & Bacterial Blight while it was moderately resistant to Corynespora leaf spot & rust. It is tolerant to abiotic stresses. This variety is recommended for both Rainfed & irrigated regions of South Zone states of Telangana, Andhra Pradesh, Tamil Nadu and Karnataka.







c. Vaidehi-1 (16301DB)/ CICR-H Cotton 53 released and notified in 2021 was extended for commercial cultivation for the irrigated conditions of South Zone. Vaidehi-1 (ICAR-CICR 16301 DB or CICR- H NC Cotton 53) is a naturally colour cotton variety derived from wild species of Gossypium, G. hirsutum, G. raimondii, G. barbadense & G. thurberi. Average seed cotton yield of this variety is 1495 mm, fibre strength of 23.6, Micronaire of 4.1, moderately tolerant to sucking pests & bollworms, resistant to Alternaria leaf spot, Grey mildew and Bacterial Blight & GMS were deposited in MTS at the institute. moderately tolerant to Corynospora leaf spot & Rust.

Karnataka.

(CNA17522) is also tolerant to Abiotic stresses. This variety 2.6 Project Name: Collection, conservation, evaluation, is recommended for rainfed conditions in Central Zone documentation and maintenance of germplasm of cultivated species of Gossypium

> Vinita Gotmare (PI); Co-PI (s) - Sunil S. Mahajan, M. Saravanan, Neelakanth S. Hiremani, Manickam, A.H.Prakash, A. Manivannan, Debashis Paul, Anjali Kak

#### Importance of the study:

The ICAR-CICR has the responsibility to plan, promote and coordinate the collection, conservation, characterisation, evaluation, exchange, documentation and sustainable management of diverse germplasm of cotton and its storage (in-situ: wild species & ex-situ: cultivated germplasm under Medium Term Storage (MTS) with a view to ensure their availability for their utilization to breeders and other researchers.

#### Salient findings -

Conservation: Cotton Genetic Resources (12336) were conserved during 2022-23 at ICAR-CICR (Nagpur & Regional station, Coimbatore) in MTS & in-situ.

Name of Species	Total Numbers
G. hirsutum	8851
G. barbadense	536
G. arboreum	2053
G. herbaceum	565
WILD SPECIES	25
Races of Cultivated species an	d Derivatives
G. hirsutum	4
G. barbadense	1
G. arboretum	6
G. herbaceum	1
Synthetic Polyploids	40
Perenials& Other Races	254
TOTAL	12336

Two thousand one hundred and fifty-three (2153) accessions kg/ha with Dark Brown lint colour, Mean fibre length of 23.5 were shared with Breeders of the Institute & SAU's for their utilisation in breeding programs. Two hundred and forty-seven (247) breeding lines & germplasm accessions while 327 CMS &

Characterization and evaluation of germplasm: Recommended Area: Irrigated regions of South Zone Characterization, evaluation and multiplication of collected states of Telangana, Andhra Pradesh, Tamil Nadu & germplasm accessions were carried out in augmented design with checks (Table 2.6.1).

Table 2.6.1 Details of germplasm used for characterization, evaluation and multiplication

S. No	Name of the species	Numbers	Region of collection	Check Varieties
1.	Gossypium arboreum	57	Arunachal Pradesh, Assam, Nagaland, Tripura & Mizoram	PA402, Roja, AKA 8401 & AKA 07
2.	G. herbaceum	16	Gujarat & Tamil Nadu	Jayadhar, G. cot, DDHC-11
3.	G. hirsutum	32	Sundarban region of West Bengal	Suraj, Surabhi & Sunantha

DNA fingerprinting, genetic diversity analysis and factorial analysis of 30 germplasm accessions indented by a multinational company was also done. All the 30 accessions fall in 6 clusters as depicted in the dendrogram (Figure 2.6.1) and results are also indicated in the Factorial Analysis as well as dissimilarity graph.

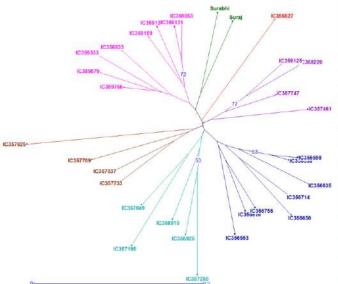


Figure 2.6.1 UPGMA based dendrogram for 30 accessions studied for genetic diversity

Back crossing to develop BC<sub>3</sub>-F<sub>1</sub> population for introgression of CLCuV: CICuV resistance material using donor lines namely GVS8 & GVS9 were developed at Nagpur for their screening at the hot-spot Sirsa. The average boll setting percentage was 21.35% in single crosses and 50.03% in reciprocal crosses. The details of crosses is mentioned in Table 2.6.2 Average Boll Setting Percentage: (-Single crosses: 21.35% & Reciprocal Crosses: 50.03%)}

Table 2.6.2 Details of single and reciprocal crosses generated using GVS 8 & GVS 9

Single crosses		Reciprocal Crosses		
Sr. No	Cross	Sr. No	Cross	
1	CSH 3075 × GVS - 8	1	GVS-8 x CSH-3075	
2	CSH 3129 × GVS – 8	2	GVS-8 x CSH-3129	
3	HS 6 × GVS – 8	3	GVS-8 x HS-6	
4	CSH 3075 × GVS - 9	4	GVS-9 x CSH-3075	
5	CSH 3129 × GSV - 9		<del>0</del>	
6	HS 6 × GVS - 9			

CMS Conversion Program on three identified Sterile Lines: Back crossing program for CMS conversion to develop 12 BC $_{\rm s}$ -  $F_{\rm 1}$  (Table 2.6.3) where an average boll setting was 85.85%.

Table 2.6.3. Details of 12 crosses for CMS conversion

Sr. No	Cross		
1	PF 10165 × IC 357694		
2	PF 10165 × IC 358002		
3	PF 10165 × IC 358277		
4	PF 10165 × AKH 9916		

Sr. No	Cross	
5	PF 10166 × IC 357694	
6	PF 10166 × IC 358002	
7	PF 10166 × IC 358277	
8	PF 10166 × AKH 9916	
9	HA 10167 × IC 357694	
10	HA 10167 × IC 358002	
11	HA 10167 × IC 358277	
12	HA 10167 × AKH 9916	

Characterization and multiplication of core collection and registered genetic stocks lines: The core collections and registered genetic stocks were characterized for different traits as mentioned in Table 2.6.4

Table 2.6.4 Classification of core germplasm and registered genetic stocks based on morphological traits

Name of Important Traits	No. of Accessions
Okra Leaf Shape	45
Dense Hairy Leaf	15
Zero Monopodial	11
Brown Lint Colour	25
Green Lint Colour	02
Big Boll	16
Fiber Length & Strength	19
Early Maturity	09
Jassids Tolerant	21
Marker Character	15

**Waterlogging tolerance:** Total number of 1559 crosses were attempted between tolerant and susceptible accessions to develop Backcross BC<sub>3</sub>F<sub>1</sub> generation. The percentage of successful crosses harvested was 18.92%.

Screening of germplasm for major pests and diseases: Core collection, genetic stocks and other accessions in breeding trials of GMS/ CMS conversion as well as CLCuD introgression were screened for major pests (jassids & Helicoverpa armigera) and diseases (Bacterial Blight & Grey mildew).

Screening for photosynthetically effective germplasm lines: Subtending leaves of 43 Gossypium hirsutum lines were tagged in both upper and lower canopy, photosynthetic parameters were assessed and the corresponding bolls were weighed after harvest. In few germplasm lines, the SPAD values of subtending leaves were correlated with boll weight. Subtending leaves of IC356595, IC358092 IC357354, N87, IC356665, IC.6-4-TL-63-1-70, EC745197 and IC692129 with SPAD values above 40.0 yielded bolls weighing over 5.3 to 6.5 g. Other parameters like canopy temperature in tagged subtending leaves and quantum sensor readings were taken in all the 43 germplasm lines.

Regional Station, Coimbatore: 327 Gossypium barbadense germplasm accessions were characterized, conserved and maintained at CICR, RS, and Coimbatore. Also, a set of 211 exotic accessions (EA) were evaluated in pot culture for characterization in CICR, RS, Coimbatore during 2022-23. Among them, 74 accessions were not at all flowered and remained vegetative. One accession (EC 959177) was a zero-



branching plant type (no monopodia). One accession was Table 2.6.5a Variation of cotton accessions for yield showing super okra leaf type (EC 959177). In flower, there were attributing parameters at CICR Sirsa no petal spot found in 15 accessions, seven accessions petal color was creamy yellow (EC 959017, EC 959064, EC 959071, EC 959087, EC 959088, EC 959092, and EC 959189) and two accessions were having deep yellow petal (EC 959150 and EC 959198). Accession EC 959156 borne round boll and others were elliptical. Seven accessions (EC 959189, EC 959078, EC 959191, EC 959192, EC 959199, EC 959214 and EC 959222) showed cluster boll bearing.

Regional Station, Sirsa: Core collection of 780 G. hirsutum germplasm lines were evaluated at Regional Station, Sirsa. Variation for yield attributing parameters were noted and promising accessions were selected for important economic traits (Table 2.6.5a 2.6.5b).

Trait	Range	Mean	SD
Plant Height (cm)	20-103	58	14.01
Monopod	0-7	1	1.32
Sympods	0-9	4.3	1.91
No. of bolls	0-18	5.81	3.64
Days to flowering (DAS)	53-123	87	18.91
GOT (%)	31.0-40.3	31.97	3.16
Boll weight (g)	1.9-3.6	1.8	0.36

Table 2.6.5b. Accessions selected for various traits of interest during study at CICR-Sirsa:

Trait	Selected accessions
No. of bolls [≥14)	CNH-123-8 (18), H-235 (15), IC-359881 (15), IC-366587 (15), N-6 (15), EC692147 (14), EC-745200 (14), IC-359820 (14), IC-359826 (14), IC-3560017 (14), Tashkent Khakhi (14)
GOT (%) [≥37]	EC-700007 (40.74), EC -745224 (40.67), IC -3577776 (40.00), IC -359123 (40.00), EC657104 (38.00), IC356626 (38.00), DCI-265 (37.56)
Boll weight (g) [≥2.8]	IC-356810 (3.6), IC -356696 (3.3), IC -357752 (3.3), IC -356924 (2.8), IC -356651 (2.8), CNH -123-7 (2.8)
No. of Sympods [≥8]	EC-559024 (9), EC -745200 (9), IC -359881 (9), Tashkent Khakhi (9), EC -700046 (8), EC -358148 (8), EC-359448 (8), IC-359762 (8), IC-359781 (8), IC-359904 (8)

#### 2.7 Project Name: Development of broad-based high plant progenies, 62 plant progenies of G. arboreum were yielding varieties of diploid and tetrapioid cotton through recurrent selection.

V.N. Waghmare (PI), Co-PI: S.K. Verma

Importance of the study: The project involving several parental lines aimed at development of broad-based G. arboreum and G. hirsutum varieties with improved fibre traits and high seed cotton yield through repeated cycles of selection and intercrossing. It also envisages development of high yielding spinnable as well coarse type G. arboreum varieties and GMS based hybrids for North Zone.

Evaluation of advance cultures: During 2022-23, 190 stable advance selections of G. arboreum and 60 of G. hirsutum were evaluated in 10 replicated trials (4 rows plots in 2 replications). About 109 advanced generation selections of G. arboreum were retained for further evaluation in replicated trial during 2023-24. The G. hirsutum trials were extensively damaged due to domestic pigs, hence, performance could not be assessed and all 60 selections had to be reevaluated during 2023-24. The range for seed cotton yield among the G. arboreum selections ranged from 540.3 to 2702 kg/ha, boll weight: 2.2-3.3, GOT: 27.7-42.9%, fibre length: 20.16-29.09 mm, micronaire: 4.16-6.85, UI: 78.42-81.73, fibre strength: 28.0-31.54 g/tex and fibre elongation: 4.52-13.05%. The fibre quality trait values among the upland cotton selections ranged 24.33-28.74mm for fibre length, 2.79-5.05 micronaire, 78.67-81.52% UI, 25.4-35.27 fibre strength and 5.47-6.25% fibre elongation.

Evaluation of single plant selection: Evaluated 1347 fertile single plants selections (1069 of G. arboreum and 278 of G. hirsutum) as plant to row progenies. Superior single plants 376 Nos. from the segregating progenies (233 of G. arboreum and Maintenance and multiplication of varieties: CNA1028, 143 of G. hirsutum) were identified and harvested separately for CNA1032. CNA1031, CNA1054, CNA1003, CNA1091, further evaluation. Based on the performance and uniformity of CNH1111 and CNH 1128.

identified for evaluation in replicated trial during 2023-24.

Evaluation of sterile plants: Based on evaluation of 1038 sterile single plant progenies of G. hirsutum, about 10% progenies superior for yield traits namely boll weight, GOT, seed cotton yield and fibre traits were identified. The remaining seeds of the identified progenies from the previous year in equal quantity bulked together to raise traits specific population. About 519 single sterile plants of G. arboreum were planted as plant to row progenies. The trait specific populations and sterile plant progenies were monitored for sterile and fertile plants at flowering and tagged. In composite populations, individual sterile plants were harvested separately. In sterile plant progenies, observations for economic traits were recorded on 3 fertile random plants of each progeny. Based on superiority for specific traits namely boll weight, GOT, seed cotton yield and fibre traits, about 10-15% superior progenies were identified to constitute trait specific population and further advance the recurrent selection cycle.

Recurrent population: Composite populations constituted for boll wt., GOT and SCY and fibre quality traits were constituted in G. arboreum and grown on large plots. Thus, two cycles of recurrent selection will be completed during 2023-24.

Entries promoted under AICRP trials: G. arboreum entry CNA 1085 promoted to AVT in Central Zone and three entries CNA 1084, CNA 1085 and CNA 1086 were promoted to Br. 24(a/b) AVT in South Zone.

Agronomy Trial: CNA 2034 and CNA 1092 a coloured cotton G. arboreum genotype were promoted to agronomy trial in Central and South Zone under rainfed conditions.





#### Sirsa

- Evaluation of GMS based G. arboreum Hybrids: Five GMS based hybrids were evaluated for seed cotton yield with check CICR 2. Two GMS based hybrids i.e. CISAA 22-3 and CISAA 22-1 recorded significantly higher seed cotton yield than hybrid CICR 2. Other two hybrids, CISAA 22-4 and CISAA 22-5 were numerially better than CICR 2 (Table 2.7.1)
- Evaluation of High Yielding G. arboreum genotypes: Sixteen varietal cultures were evaluated in RBD design including two check varieties CICR 1(CISA 310) and CICR 3(CISA 614). Three elite lines i.e. CISA 405-2 (2714 kg/ha), CISA 6-214-1 (2659 kg/ha) and CISA 33-7 (2583 kg/ha) recorded significantly higher seed cotton yield than high yielding best check CICR 3 (2209 kg/ha) (Fig 2.7.1).
- Table 2.7.1: Performance of Intra-arboreum hybrids

- Maintenance, Advancement and Selections: Four GMS lines DS 5, CISA 2, GAK 413A, CISG-20 and 03 newly identified GMS lines, CISG-10, CISG-13, CISG-14, were maintained through sibmating. Nine good combiner *G. arboreum* lines were also maintained. 14 *G.* arboreum selections with better spinnability (23-26 mm fibre length) were advanced. 19 *G. arboreum* selections with boll weight ranged 2.3 -2.8 g and other improved yield attributes were advanced.
- Entries under AICRP (North Zone): Two GMS based *G. arboreum* intra-arboreum hybrids i.e. CISAA 19-4 & CISAA 20-1 were promoted under Coordinated trial Br 25a. Two *G. arboreum* varieties i.e. CISA 405-2 and CISA 6-214-1 were sponsored in Br 22a/b National trial. Two intra-arboreum hybrids i.e. CISAA 22-3 & CISAA 22-1 were sponsored in Br 25a/b (National trial).

Entry Name	SCY Boll wt(g)		Bolls/		Fibre Traits			
	(kg/ha)		plant	GOT(%)	UHML (mm)	UI	Strength (g/tex)	Mic.
CISAA-22-1	2902	2.50	44.04	40.4	19.6	78.0	19.7	6.3
CISAA-22-2	2131	2.35	44.11	36.3	23.1	79.0	22.4	5.8
CISAA-22-3	3275	2.30	46.61	40.3	23.3	79.0	22.4	6.3
CISAA-22-4	2866	2.50	42.79	35.6	21.2	78.0	20.6	6.2
CISAA-22-5	2594	2.40	43.28	39.0	20.8	78.0	21.1	6.1
CICR-2	2547	2.40	42.12	37.0	19.7	78.0	19.9	6.2
CD	292.3							
CV (%)	5.83							

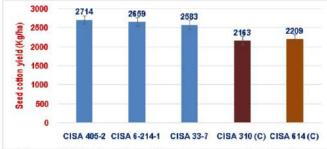


Figure 2.7.1: Prominent G. arboreum varietal culture

# 2.8 Project Name : Development of heterotic pools in G. hirsutum cotton

PI: D.V. Patil (PI)

**Importance of the study:** The project implemented to test the concept of heterotic pools among the hirsutum parents and achieve the genetic gain by improving the recombinational variability.

#### Salient findings

A first hand report on the standardization of methodology and mating designs used for the development of heterotic pools in *Gossypium hirsutum* cotton was established. Two major heterotic groups ('A' & 'B') were developed based on positive and negative specific combining ability effects. Recombinational combining ability used and improved the genetic gain resulted four sub groups AA1, AA2, BB1 and BB2. Sigma square value is one of the genetic component helping for the development of heterotic pools as sigma square values of crosses was much higher than that of sigma square value of parents.

# 2.9 Project Name: Advancement of MAGIC population to develop core set for genetic mapping and identification of potential inbred lines

Rahul M. Phuke (PI), Co-PI: Dr. Y. G. Prasad

Importance of the study: A multi-parent advanced generation inter-cross (MAGIC) population has been anticipated to have higher genetic diversity, smaller haplotype blocks, higher recombination, and better mapping resolution. MAGIC populations due to their complex pedigree structure offer great potential for improving the breeding population and providing better chance to break the negative linkage between yield and fibre quality. MAGIC population has richer diversity and recombination rate without population structure which, enable genetic dissection of complex traits to support modern plant breeding programs.

#### Salient findings

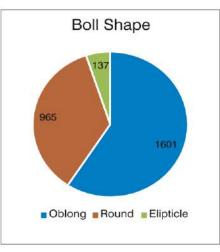
The 2731 MAGIC RILs were advanced through selfing from  $F_{\epsilon}$  to  $F_{\epsilon}$  generation. Each line was sown in single row of 5 dibbles each and data was recorded for plant phenology traits. The observed traits variation is as mentioned in table (2.9.1)

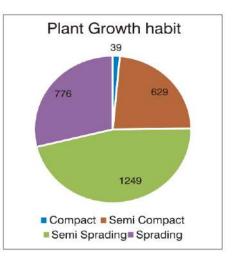
Table 2.9.1. Observed variation (Range) for studied traits in 2731 MAGIC RILs

S. No.	Characteristics	Minimum	Maximum
1	Nos. of monopodia	0.00	6.0
2	Nos. of sympodia	08	25
3	Nos. of bolls/plant	9.50	37.56
4	Plant height (cm)	52	146
5	Plant width (cm)	24.70	63.35









Variation for Morphological Traits

#### Jassid Resistant Trial:

Ten genotypes were evaluated evaluated for Jassid resistance involving three checks namely LRA 5166 (susceptible to Jassid), NH 615 (resistant to Jassid), and Suraj (noted for quality and yield). Each genotype was planted in four rows with a spacing of 60 cm x 45 cm, accommodating 48 plants per plot. A border row of the susceptible check LRA 5166 was also maintained to ensure a consistent population of insects/pests. Among the seven test genotypes (CICR JS-101 to CICR JS-107), two genotypes namely CICR JS-103 and CICR JS-104 were identified as resistant to Jassid, consistent with data from the past two years. The GGE biplots (figure 2.9.1) based on three years data for Jassid grade indicates stable resistance of CICR JS-103 and CICR JS -104 for Jassid. Additionally, these two genotypes exhibit high yield and improved fiber quality compared to the Suraj check variety.

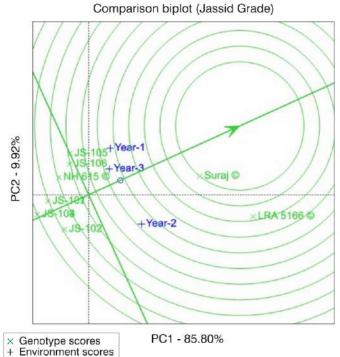


Figure 2.9.1. GGE bplot analysis for jassid grade for studies genotypes over three years data



Field experssion of CICR JS-103, showing resistance to lassid

2.10 Project Name: Seed priming through Nano particles to induce early seed germination and enhanced seedling vigor in cotton.

V. Santhy (PI) ,Co-Pls: K. Rathinavel

Importance of the study: Seed germination and vigor are important traits for a successful field stand which can be achieved to a large extent by suitable seed priming. Seed priming agent in nano formulations are considered promising due to their smaller size and enhanced efficacy. The translocation of the nanoparticles depends on their concentration, duration of treatment etc. which needs to be standardized for a specific crop seed for its utilization in an effective manner. Nano particles of iron, silver, zinc copper has been reported to be effective seed priming agents. Synthesis of these from naturally available sources can pave way for its use in organic and sustainable farming conditions too.

#### Salient findings:

Metal oxide nano-particles of three useful elements viz. Iron, Zinc and Silver were synthesized from botanical agents. Green tea extract was used for iron oxide NPs synthesis, aloe vera extract for Zinc oxide NP synthesis and neem leaf extract for silver NP synthesis. The characterization of synthesized nanoparticles were done by U/V spectroscopy, Zeta Potential, XRD, FTIR and TEM analysis.All the three synthesized nanoparticles showed values in the required range to be





categorized under nanoparticle. The germination test conducted on fresh acid delinted seeds showed above 80% in all the nano primed seeds compared to control which showed only 75%. There was significant increase in root length of seedlings in seeds nano-primed with iron np and silver np compared to untreated control. The shoot and root lengths of zinc oxide and copper oxide nano-particle primed seeds were at par with control.

x 30 cm and 120 x 30 cm, spacing) Figure 2.11.2 was used for the experiment. All the recommended package of practices (RPP) for seed cotton yield was followed and treated as control (T1). The other five additional interventions to enhance the quality seed production in cotton employed were RPP+ Additional KNO<sub>3</sub> @2% at 80-85 days (T2), RPP + Detopping at 80-85 days (T3), RPP + Micronutrients available in the market (@60, 80 and 100 days (T4), RPP + T2 + T4 (T5) and RPP+T2





Control

Iron Oxide Nanoparticles Treated Seeds

# 2.11 Project Name: Development of Quality Seed Production Protocol in Cotton

Sunil S. Mahajan (PI), Co-Pls: V. Santhy

Importance of the study: Package of practices developed for crop production are available but proper protocols for cotton seed production are meagre. Individual packages like, nutrients management, foliar application, micronutrients or growth hormones were studied by many researchers instead of whole package of practices for good quality seed production in cotton. Present work is therefore initiated to explore different available treatments with interventions under the resource-constrained conditions with aim to find out the answers regarding appropriate seed production methods to enhance quality seed recovery per unit area.

#### Salient findings -

The experiment was conducted in the existing seed production plots in three replications (RBD). One Bt variety, PKV 081 (90 x 30 cm, spacing) Figure 2.11.1 and one non Bt variety, Suraj (90

the experiment. All the recommended package of practices (RPP) for seed cotton yield was followed and treated as control (T1). The other five additional interventions to enhance the quality seed production in cotton employed were RPP+ Additional KNO<sub>3</sub> @2% at 80-85 days (T2), RPP + Detopping at 80-85 days (T3), RPP + Micronutrients available in the market @60, 80 and 100 days (T4), RPP + T2 + T4 (T5) and RPP+T2 +T3 +T4 (T6). The results indicated that the mean boll numbers per plant was highest in PKV 081 (37.1) as compared to Suraj (Mean 27.7). The effect of different treatments on boll number per plant was non-significant. The highest mean boll weight was recorded in Suraj (4.56 gm) as compared to PKV 081 (3.82 gm). The maximum mean boll weight was observed in T5 and T6 (4.42 gm each) followed by T2 (4.39 gm) and T4 (4.31 gm). The mean Seed cotton yields (SCY) were found significantly differed with respect to the variety and treatments. The highest mean SCY was 22.92 q/ha in PKV 081 as compared to 22.21 q/ha in Suraj. The highest mean SCY was recorded by T2 (23.56 q/ha) followed by T4 and T5 (23.05 q/ha each). The mean fuzzy seed was highest in PKV 081 (15.11 q/ha) as compared to 14.25 g/ha in Suraj. The mean fuzzy seed yields were 15.24 q/ha in T2 followed by 14.87 q/ha each in T4 and T5. After acid delinting, the sinkers seed were recovered in both the varieties. The final mean sinkers were 10.17 q/ha in PKV 081 as compared to 8.05 q/ha in Suraj. Similarly, the final mean seed recovery was 66.52% in PKV 081 as compared to 54.53% in Suraj. Among the treatments, the significantly highest sinkers were recorded in T2 (9.15 q/ha) followed by T5 (9.14 q/ha). However, the significantly highest seed recovery was recorded in T5 (60.74%) followed by T6 (60.20%). The mean GOT was highest in Suraj (35.75%) as compared to PKV 081 (34.27%). The effect of different treatments on GOT was non-significant. The mean 100 seed weight was highest in Suraj (9.64 gm) as compared to PKV 081 (8.38 gm). Among the treatments, T6 recorded highest 100 seed weight of 9.36 gm followed by 9.33 gm and 9.21 gm in T3 and T5, respectively. Seed germination was highest in Suraj (93.72%) as compared to 90.70% in PKV 081. The effect of treatment on seed germination was non-significant but vigour index was significantly highest in T6 (3168) followed by 3106 and 3066 in T4 and T5, respectively.



Figure 2.11.1: Seed Production Plot of PKV 081 Bt







Figure 2.11.2: Seed Production Plot of Suraj

#### 2.12: Project Name: AICRP on Seed (Crops)

V. Santhy (PI), Co-PIs K. Rathinavel, Sunil Mahajan, Debashish

Importance of the study: Seed is the basic medium of technology spread and supply of quality seeds is essential to get the developed cotton varieties popularize. The project thus aims to produce sufficient quantity of quality seed in the form of breeder seed and truthfully labelled seeds of released and notified crop varieties of cotton developed at CICR. These include Bt as well as non Bt cotton varieties thus catering to the needs of all types of cotton farmers, FPOs and various schemes including FLDs, NFSM, organic cotton manufacturers and researchers. In order to utilize the unutilized land as well as to improve the soil properties of these lands, seeds of other crop varieties such as red-gram, chickpea and linseed are also taken up in kharif and rabi season.

#### Salient findings -

varieties that are suitable for each zone was taken up as per cotton varieties (Table 2.12.1).

DAC indent as well as direct indents received, at Nagpur, Sirsa and Coimbatore during 2022-23. Nucleus seed of 15 Bt varieties (ICAR-CICR Bt 6, ICAR-CICR SurajBt, ICAR-CICR RajatBt, ICAR-CICR PKV-081 Bt, ICAR-CICR GJHV Bt, ICAR-CICR 9 Bt, ICAR-CICR 14 Bt, ICAR-CICR 21 Bt, ICAR-CICR 25 Bt, ICAR-CICR YugankBt, ICAR-CICR NamamiBt, ICAR-CICR TejasBt and ICAR-CICR SamratBt; 3 colour cotton varieties (Vaidehi-1, CNH-17695 and CNA-17522); 7 non Bt varieties (Suraksha, Suraj, Sunatha, Subiksha and Surabhi, CSH-3075 and CSH-3129), 6 desi cotton varieties (CNA-1003, CNA 1028, CNA-1032, CNA-1054, CICR-1 and CICR-3) and parents of hybrids viz. CICR-2, CSH-198, CSH-243, CSH-198) were produced at Nagpur as well as regional stations at Coimbatore and Sirsa as part of variety/parents of hybrids maintenance programme.

A total of 65.25 q breeder seed was produced for 20 released and notified cotton varieties at all three locations. This includes 12.75 q seed of Bt varieties, 39.38 q seed of 6 non Bt hirsutum Quality seed production of CICR released and notified cotton varieties, 3.3 q seed of 2 ELS cotton varieties and 9.8 q of desi

Table: 2.12.1 Breeder seed production (2022-23) of CICR varieties

S.No.	Genotype	Quantity produced (q)
1	ICAR-CICR-SurajBt	2.15
2	ICAR-CICR-RajatBt	2.60
3	ICAR-CICR-PKV081Bt	6.41
4	ICAR-CICR 23 Bt	0.75
5	ICAR-CICR Bt 6	0.85
6	Suraksha	14.00
7	Suraj	15.51
8	CICR H Cotton 58 (Nano)	2.76
9	Surabhi	2.67
10	LRK-516	1.12
11	LRA-5166	0.77

A CONTRACTOR OF THE PARTY OF TH	The state of the s
In addition, as part of wast	e land utilization as well as soil fertility
improvement, a total of 3:	2.0 q certified seeds was produced in

S.No.	Genotype	Quantity produced (q)
12	CSH 3129	2.00
13	CSH 3075	0.55
14	Suvin	2.15
15	B.Cotton 45	1.17
16	CNA1028	1.90
17	CNA1032	2.78
18	CNA1054	1.25
19	CNA1003	0.53
20	CICR-1	0.73
21	CICR-3	2.60

red gram, chickpea and linseed and supplied to Mahabeej.





#### 2.13 Project Name: An efficient regeneration system for Whereas, even more than 180 seeds testing might also lead to transformation studies with CICRcry2Ab1Ac gene in Cotton the rejection of a seed lot if improper mixing such as less than (G. hirsutum)

G. Balasubramani (PI); Co-PIs- J. Amudha, K. P. Raghavendra, N. Chandrashekar, . Joy Das and Dr. Rakesh Kumar

Importance of the study: The project aims to develop an efficient regeneration system and development of transgenic cotton using indigenously made gene construct CICRcry2Ab1Ac: chitinase.

#### Salient findings

The transformed plant cannot be truly transgenic unless a single cell is transformed and regenerates into a whole plant. Coker lines especially Coker 312 is amenable for somatic embryos formation and regeneration. As a result, efforts have been made to establish a methodology for rapid regeneration using the genotype Coker 312. Protocol for induction of somatic embryos and regeneration were standardized. The time loss to induce somatic embryos and fast regenerating plants from the somatic embryos were achieved by two methods viz., (A) incubating in Pre Induction Medium(PIM) for 30 minutes with A. tumefaciens suspension containing gene cassettes CICRcry2Ab1Ac::chitinase (OD600 0.3-1.0) and (B) applied with preinduced Agrobacterium suspension (OD600 0.3-1.0) of 5 & 10  $\mu$ I to the cut side of the cotyledonary and hypocotyl explants followed by co-cultivation and subculture in to MS medium supplemented with 2,4-D (0.1mg/l) and kinetin (0.5mg/l) and selection on kanamycin 25mg/L. Total 41 putative transformants comprising 21 and 20 from method A and B respectively, were regenerated through somatic embryogenesis. Twelve out of the 21 putative transformants regenerated from method A produced good rooting but five out of 20 are showing proper rooting in matured embryos regenerated from method B. Total 17 putative transgenic plants suppose to carry CICRcry2Ab1Ac::chitinase genes were established in the Polyhouse. These plants were subjected to molecular characterization. For rapid screening all the putative plants were tested with cry1Ac & cry2Ab ELISA plates; however the protein expression was found nil in all the plants. PCR was performed with gene specific primers, out of 17-plants 4-plants were showed positive with npt-II and chitinase genes specific primers. But none of the plants showed economical important transgene (cry1Ac & cry2Ab) integration. Thus, the work was concluded to reorient the gene construct by cloning cry1Ac & cry2Ab or any other gene at 5'-end of right border, so that the integration of transgene would be appropriate. The project was concluded.

#### 2.14 Project Name (ad-hoc): Blindfold testing of RIB practice in Bt cotton

#### G. Balasubramani (PI)

Importance of the study: The aim of the study was to establish the appropriate sampling size for tracking RIB compliance of non-Bt cotton seeds mixed in the commercial packet of Bt cotton seeds.

#### Salient findings

An ad-hoc project was taken to determine the lowest and efficient sampling size for gauging RIB compliance. The study was carried out consistently over three seasons (2020–2023) by gathering commercially available seed packets from the open market and developed a protocol and suggestions for RIB compliance. Present study revealed that two ELISA plate with the packet is mixed properly with 5% to 10% Non-Bt seeds. vacuum infiltration and transformation and regeneration events

5% or more than 10% non-Bt seeds. Further, since we randomly choose the seeds for the ELISA test, there is a chance for human error or that we might choose only Bt seeds or vice versa. Accordingly, we conclude that 180 seeds be tested for a trait using two ELISA plates based on three years' worth of data and statistical comparisons of different sample sizes.

#### 2.15 Project Name: Validation of molecular markers and genes linked to drought tolerance in cotton

J.Amudha (PI); Co-PI (s) - M.Saravanan, Jayant Meshram

Importance of the study: Abiotic stresses like drought are major limiting factors that influence plant growth and cotton crop production. Drought stress due to water deficit reduces the cotton lint production. Developing climate resilient cotton varieties is more important for increasing the production.

#### Salient findings

G. hirsutum X G. barbadense(28 I X Suvin) interspecific cross derived RIL population (129 lines) was sown in the field and Genomic DNA was isolated. QTLs/ markers mapped for osmotic potential(OP), carbon isotope ratio, chlorophyll a, b, RWC, canopy temperature(CT), root length, total dry matter, seed cotton yield, harvest index, boll weight, boll number and economically important traits linked with drought tolerance were selected for validation. RIL lines were also genotyped using 6 SSR molecular markers linked to root weight, 5 SSR markers linked to root length, 2 SSR markers linked to root tip, 5 SSR markers linked to root surface area, 10 SSR markers linked to root volume mapped on different chromosomes in the cotton genome for root traits.

#### 2.16 Project Title: Exploration of genomic resources for identification of candidate genes and promoters for cotton improvement

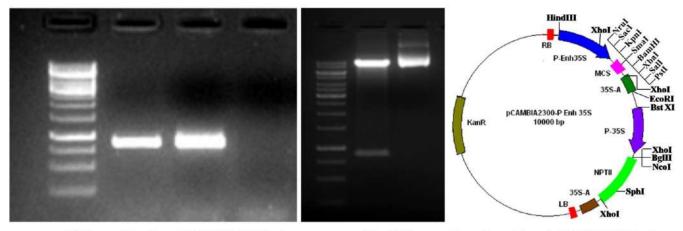
K P Raghavendra (PI); Co-PIs: Joy Das, Pooja Verma; Rakesh Kumar, Chandrashekar

Importance of the study: Biotechnological advances such as genome sequencing, functional genomics, RNA interference, genome editing, new molecular markers for economically important traits has resulted in sea of changes in cotton improvement. The deployment of biotechnology tools for cotton crop improvement demands discovery of novel genes associated with economical important traits and to unveil the possible role of engineered Cry toxin for enhanced toxicity against cotton bollworms.

#### Salient findings

Validation of cry1D gene for pink bollworm management and development of GhNAC9 gene construct : Diet incorporation bioassays were conducted against pink bollworm (F4) using Cry 1D, Cry 1Ac, and Cry 2Ab toxins along with buffer and water control. Freshly hatched larvae were subjected to Cry toxin concentration of 2.0 ppm with two diet change at 7th and 14th day after release, bio-efficacy of the Cry1D protein against field resistant pink bollworm populations was confirmed and developed cry1D gene constructs using custom synthesized codon optimized cry1D gene. Cry1D transgenic tobacco transformation resulted in identification of cry1D positive plants (T0) which was advanced top obtain T1 generation. Conditions for Sonication and vacuum infiltration aided agrobacterium mediated transformation using GUS gene construct was standardized. Transformation of cry1D gene 180 seeds would be appropriate to suggest as a sampling size if constructs in to cotton genotype through sonication and

using through somatic embryogenesis (Coker312) is in GhNAC9 transgenic events in tobacco for its further functional progress. Developed GhNAC9 gene constructs and generated validation against drought stress.



PCR amplification of GhNAC9 (890bp)

Restriction confirmation of insert GhNAC9 (890bp) in vector pCAMBIA2300 (10kb

GhNAC9 gene cassette in plant expression vector pCAMBIA2300 in XL-1 blue and Atumefaciens EHA105.

validation of genes/enzymes involved in chitin biosynthesis pathway of cotton pink bollworm (Pectinophora gossypiella)

Joy Das (PI), Co PIs: Dr. K. P. Raghavendra (Co-PI); Dr. Rakesh Kumar (Co-PI)

Importance of the study: Chitin, a crucial aminopolysaccharide, serves as a structural element in extracellular matrices in insects. As plants and vertebrates, including humans, do not synthesize chitin, its biosynthetic pathway becomes an attractive target for insecticide development. Current insecticides predominantly focus on isoforms of chitin synthase enzymes or function as postcatalytic chitin synthesis inhibitors, potentially leading to resistance development due to limited target options. This study aims to study the two potential target genes, UDP-Nacetyl glucosamine pyrophosphorylase (PgUAP) and phospho-N-acetyl glucosamine mutase (PgAGM), involved in chitin biosynthesis of Pink Bollworm (PBW), an important cotton pest. These enzymes play roles not only in chitin biosynthesis but also in other critical developmental and functional processes, such as GPI anchors on proteins and Nglycosylation. The investigation focuses on characterizing two genes, PgPGM and PgUAP, to assess their potential as targets for inhibiting chitin biosynthesis in PBW. The anticipated outcomes aim to enable precise chitin biosynthesis inhibition and provide insights into impeding additional metabolic activities orchestrated by these target genes in PBW.

#### Salient findings:

Raw transcriptome data representing fourth instar larva (whole larval body) of cotton pink bollworm (PBW) has been submitted to NCBI database (Accession No. PJRNA924511).Identified nine house-keeping genes from PBW, essential for carrying out gene expression studies. Out the nine house-keeping genes, the expression profile of the actin gene (actin5c1) has been investigated across all development stages and five major tissues of PBW, and found suitable as a candidate gene for normalization during gene expression studies. Expression profiles of chitin biosynthesis genes PgAGM and PgUAP documented across all the developmental stages and five major

2.17 Project Name: Identification, cloning and functional tissues of PBW. An in-house low-cost protocol for synthesizing in vitro dsRNA with high yield and quality has been optimised. The chitin synthesis gene (PgUAP) was targeted by RNAi in PBW, leading to detrimental effects on insect growth and development, thereby functionally validating the role of PgUAP

> Submission of PBW transcriptome data to NCBI database: Raw transcriptome data representing fourth instar larva (whole larval body) of cotton pink bollworm (PBW) has been submitted to NCBI database (Fig. 2.17.1).



Figure 2.17.1: Submission of PBW transcriptome data to NCBI database

Identification of candidate house-keeping genes from PBW: Identified nine house-keeping genes from PBW, essential for carrying out gene expression studies (Table 2.17.1).





Table 2.17.1: Candidate house-keeping genes from PBW

SI. No.	Genes	Transcriptome sequence ID	Size (Bp)
1	actin5C1 (act5c1)	TRINITY_DN723_c0_g1_i1	1106
2	actin5C2 (act5c2)	TRINITY_DN723_c0_g1_i12	1131
3	ribosomal protein L3 (rpl3)	TRINITY_DN12594_c0_g1_i3	1372
4	ribosomal protein L3 (rpl13)	TRINITY_DN4102_c0_g1_i2	659
5	alpha tubulin (αtub)	TRINITY_DN183_c0_g1_i4	1353
6	beta tubulin (βtub)	TRINITY_DN1015_c0_g3_i1	1344
7	elongation factor 1 (ef1)	TRINITY_DN3108_c0_g1_i1	1392
8	elongation factor 2 (ef2)	TRINITY_DN2034_c0_g1_i1	2535
9	glyceraldehyde-3-phosphate dehydrogenase (gadh)	TRINITY_DN3887_c0_g2_i1	999

# gene:

Out the nine house-keeping genes, the expression profile of the actin gene (actin5c1) has been investigated across all development stages and five major tissues of PBW, and found suitable as a candidate gene for normalization during gene expression studies (Fig. 2.17.2).



Fig 2.17.2: Expression profile of actin5c1 gene recorded across developmental stages and major tissues of PBW

#### Gene expression profiles of PgAGM and PgUAP genes :

Expression profiles of chitin biosynthesis genes PgAGM and PgUAP documented across all the developmental stages and five major tissues of PBW. The results exhibited ubiquitous expressions of both the genes, with varying degrees of transcript abundances in the examined samples representing the developmental stages and tissues of PBW (Fig. 2.17.3).

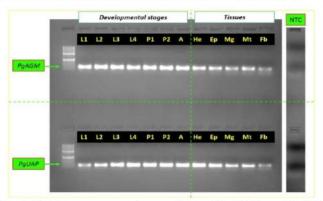


Fig. 2.17.3:Gene expression profiles of PgAGM and PgUAP genes recorded across developmental stages and major tissues of PBW.

Low-cost and high yielding dsRNA synthesis for RNA interference studies: An in-house low-cost protocol for synthesizing in vitro dsRNA with high yield and quality has been optimised (Table. 2.17.2; Fig. 2.17.4).

Identification of actin as one of the suitable normalising Table 2.17.2: Average yield of dsRNAsynthesised using the in-house optimised protocol

Reactions	dsRNA yield (μg/μL)	dsRNA yield (μg/20μL)	dsRNA quality (λ <sub>260/280</sub> )
1	5.53	110.6	2.197
2	5.41	108.2	2.191
3	5.20	104	2.18
4	4.97	99.4	2.23
5	4.80	96	2.183
6	4.17	83.4	2.17
Average	5.01	100.27	2.19

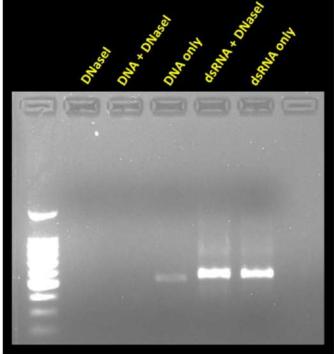


Fig. 2.17.4: The synthesized dsRNA is quality checked using DNAsel digestion. The DNAsel digestion profile in this gel picture confirms the synthesis of dsRNA from cDNA.

RNAi for knockdown of target gene (PgUAP) in PBW:The chitin synthesis gene (PgUAP) was targeted by RNAi in PBW, leading to detrimental effects on insect growth and



development, thereby functionally validating the role of PgUAP in PBW. Phenotypes included mortality of 24% (with Abbott's formula) along with severe aberrations in moulting and substantial weight loss in the RNAi treated insects.

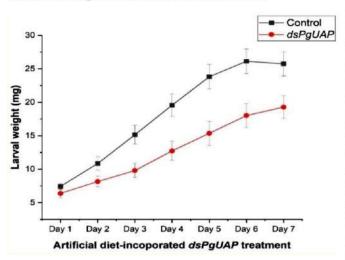


Fig. 2.17.5: Effect of RNAi with dsRNA targeting PgUAP(dsPgUAP) treatment (administered through artificial diet) on PBW.



Fig. 2.17.6: Larval deformities following RNAi of PgUAP

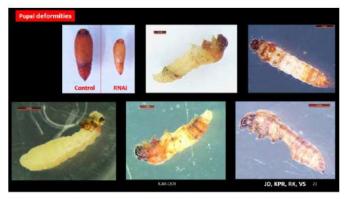


Fig. 2.17.7: Pupal deformities following RNAi of PgUAP

#### 2.18 Project Name: Precise base editing in Acetolactate synthase gene (ALS gene) for herbicide tolerance in Cotton

Rakesh Kumar (PI), Co-PIs:. Joy das, KA Molla

Importance of the study: Development of efficient CRISPR/Cas9 - mediated targeted mutagenesis system for Acetolactate synthase (ALS) inhibiting herbicide tolerance in Fig 2.18.3. CRISPR/Cas9 vector with U6-29 upland cotton (G. hirsutum)

#### Salient findings:

Following the available information on GhALS gene sequence and their copy numbers at NCBI nucleotide database, genespecific primers were designed for the full-length open reading frame of the wild isoform type of GhALS. The CDS sequence was then amplified from G hirsutum cv Suraj leaf cDNA preparations using a high-fidelity Taq polymerase PCR reaction. The amplified PCR fragment of putative GhALS was cloned and sequence confirmed through Sanger dideoxy sequencing method and subsequently cloned into proteinexpressing pET28c vector for recombinant protein expression (Fig.2.18.1). In addition, for high guide RNA expression in CRISPR/Cas-cassettes, cotton specific U6-small RNA promoter sequences ~1 kb upstream of their predicted transcription initiation sites were identified based on their homology with Arabidopsis thaliana U6-promoter sequences. Two U6 promoter sequences U6-26 (Gh6.7) and U6-29 (Gh6.3) were PCR amplified from G. hirsutum genome, cloned and sequenced (Fig.2.18.2). Furthermore, a 300-bp fragment of Gh6.3 promoter is cloned into a CRISPR/Cas9 vector (pK-Cotton-1) for its subsequent functional characterization in cotton (Fig.2.18.3).

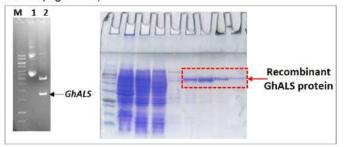


Fig. 2.18.1 Cloning and recombinant expression of GhALS protein

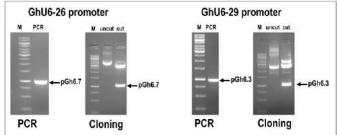
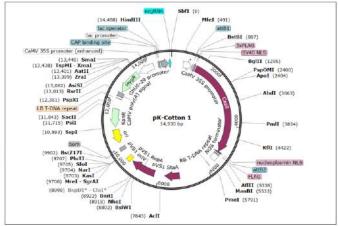


Fig. 2.18.2 PCR amplification and cloning of cotton-specific gRNA expressing promoter sequences



promoter for sgRNA expression





# gene in cotton germplasm for the development of herbicide resistant cotton through CRISPR/Cas9

Chandrashekar N (PI) Co-PIs - Saravanan, M

Importance of the study: Exploration and identification of diverse cotton genotypes with herbicide tolerance/resistance trait would contribute to development of non-transgenic glyphosate tolerant cotton.

Salient findings: Screening of 918 G. hirsutum germplasm lines for glyphosate resistance/tolerance was carried out under field conditions during Kharif 2022-2023. Glyphosate @100ml/15 litre water was sprayed at 45 DAS (Days after

2.19 Project Name: Molecular Characterization of EPSPS sowing) and the data was recorded until 14 days after glyphosate spray in terms of chlorosis, wilting, growth response, stunting etc. Based on these observations 10 most tolerant (No-3561, 3749, 3913, 4000, 4039, 4073, 4080, 4086, 4110 and 4199 and 10 most susceptible (No-3507, 3527, 3537, 3578, 3693, 4176, 4296, 4326, 4403 and 4419) lines were identified for further research activities.

> Around one kg of Suraj Non-Bt cotton seeds were irradiated from Gamma Irradiation facility at Professor Jayashankar Telangana, Agricultural University (PJTSAU) Hyderabad. The irradiated seeds were sown and cotton harvested at ICAR-CICR, Nagpur. The next generation plants (M2) will be screened against glyphosate during 2023-24.

#### CROP PRODUCTION DIVISION

#### 3.1 Long-term impacts of sub-soiling and cover crop rotation on soil properties and N requirement of cotton

D. Blaise (PI); Co-PI's: G. Majumdar and J. Somasundaram

Importance of the study: Farmers commonly report that the crop root growth is restricted to the top with an L-or S- shaped tap root. Hard pan developed by traffic or natural causes is a probable reason for poor root growth. Thus, it was conceived that alleviating soil compaction either by mechanical or biological means could improve crop growth and yields.

#### Salient findings:

Field experiments were conducted with the two treatments having mechanical options of sub-soiling; (i) deep sub-soiling and (ii) shallow sub-soiling compared with the (iii) no sub soiling treatment. Biological hardpan breakers included as separate

treatments were (i) pigeonpea, (ii) radish, (iii) sunnhemp, and (iv) sesbania to evaluate their effect on cotton crop growth and yield. The main-plot treatments were further sub-divided into three sub-plots, namely 75, 100 and 125% recommended dose of nitrogen with the objective of determining the fertilizer-N requirements and the use efficiency under sub-soiling and crop rotation. During the crop season, penetration resistance was recorded up to a soil depth of 37.5 cm. The penetration resistance values were lower in the deep sub-soiled and the rotation treatments as compared to the non sub-soiled treatments (Fig. 3.1.1). In an earlier study, it was observed that the root growth was adversely affected in the control treatment because it had greater bulk density and higher penetration resistance. Results of 2023-24 also indicated that the legume crops grown as rotation crops had higher yield than the recommended dose of nitrogen with no sub-soiling.

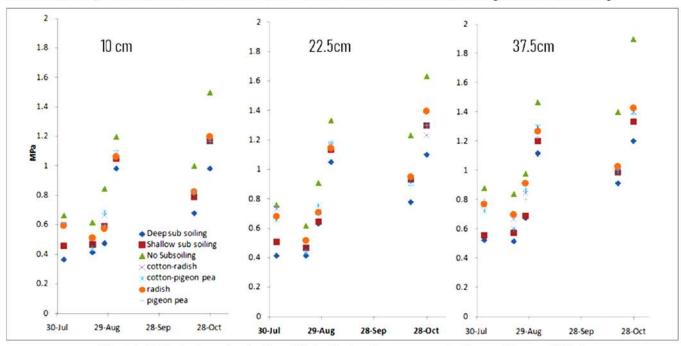


Fig 3.1.1 Effect of mechanical and biological options on penetration resistance (MPa)

#### 3.2 Validation and refinement of organic cotton production in non-organic farming can damage ecosystems, poison technology

Ramkrushna G.I. (PI); Co-PI's: Rachna Pande, Neelakanth S.

waterways and endanger workers who cannot always afford safety equipment needed to protect them. Organic cotton is a great eco-friendly fabric, grown without any use of pesticides, Importance of the study: Hazardous synthetic pesticides used herbicides or other chemical fertilizers, and is simply better for



human health and the environment. By encouraging biological diversity, farmers create conditions which reduce the likelihood of any insect, bird or mammal doing any major damage to their crop. Keeping this in view, a project is planned to validate and refine available organic cotton production practices.

# Salient findings:

# Evaluation of cotton cultivars under organic cultivation

Evaluation of non-GM straight varieties of cotton was undertaken during the *kharif* season of 2022. *Four G. arboreum* (cotton) varieties CNA-1032, CNA-1054, PA-810, PA-812 and nine *G. hirsutum* varieties *viz.*, BB 7, Suraj, Suraksha, Surabhi, Anjali (LRK 516), NH 615, ADB 39, NDLH 1938 and a HxH hybrid Partech-30 were evaluated under organic conditions. *Desi* cotton varieties produced on par seed cotton yield (13.80 to 15.25 q/ha) with Partech-30 (15.91 q/ha) and superior over *G. hirsutum* varieties. *Corynespora* leaf spot (CLS) recorded highest PDI in BB-7 (31.4%), whereas all the *desi* cultivars and Partech-30 were free from BLB and *Corynespora* leaf spot. Lowest PDI of Grey mildew was seen in Surabhi followed by NH-615 and highest was observed in Partech-30 (Fig 3.2.1).

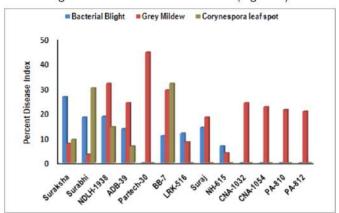
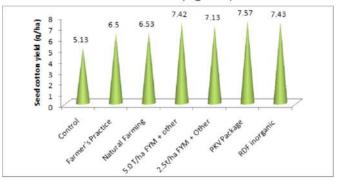


Fig. 3.2.1 Percent Disease Index (PDI) of major diseases in different cotton cultivars.

# Identifying optimum nutrient supply combination to organic cotton

An experiment was conducted to identify a substitute for FYM to reduce the cost of cultivation and reliance on FYM. Five t/ha FYM with other sources of nutrients (300 kg/ha vermicompost, 200 kg/ha neem cake, two sprays of vermi wash, two sprays of Panchgavya + Biomulching of sunnhemp + biofilm) produced (7.42 q/ha) similar seed cotton yield (CD at p = 0.05: 1.43) as that of PKV package of practice (10 t/ha FYM + Biofertilizer + Intercrop with Mung + Biomulching). Significant difference was observed in soil biological activity among the organic treatments over control and fallow (Fig 3.2.2).



# Fig 3.2.2 Effect of nutrient management on seed cotton yield Comparative study of botanicals in organic cotton

The different plant extracts were evaluated under field condition against the insect pests of cotton. Against the sucking pests, NSKE 5%, Dashparni10% and Pongamia5%, were found effective and were on par with Neem oil 0.5% and recomended insecticides. The prevalence of the boll rot was also less in all the treatments in comparison to the control. Bacterial blight disease severity (PDI) ranged from 18.4 % to 44.0% and the severity of disease was the highest in control, whereas reduction in disease severity over control was maximum in Calotropis 5% treated plants.

# Laboratory bioassay of botanicals and microbials against American bollworm and pink bollworm.

Evaluation of organic products (conc. 0.5%, 1%. 2%, 3%) by using leaf bioassay for *H. armigera* was conducted under laboratory conditions. Neem leaves, pongamia, *Annona*, NSKE and dashparni caused upto 83% mortality. An on-plant bioassay was conducted against pink bollworms where NSKE 5% and Dashparni 10% caused 63% mortality. Diet bioassay of cultural filtrate and different concentrations of microbes were conducted under laboratory conditions. Maximum larval mortality of 55% *H. armigera* and 91% pink bollworm was recorded by the cultural filtrate of *Trichoderma harzianum* and *B. tequilensis*, *Trichoderma longibrachiatum* respectively. Seventy five per cent mortality of *H. armigera* and 93% mortality of Pink bollworm was recorded by *Diaporthe* sp. (CFL 34)10<sup>5</sup> and *Daldinia eschscholtzii* (M1-4)10<sup>4</sup>, *Diaporthe* sp. (CFL 34)10<sup>5</sup>, respectively on the basis of concentration.

# 3.3 Evaluation of genotypes, defoliants and growth regulators for different hybrids/varieties under HDPS for machine picking of cotton

**Gautam Majumdar (PI);** Co-PI's: Ramkrushna G.I., Jayant Meshram, Blaise Desouza, A. Raja, Amarpreet Singh

Importance of the study: Seed to seed mechanization in cotton cultivation is the need of the hour for reducing cost of cultivation, for achieving timely sowing, intercultural and plant protection operations and harvesting. Though mechanization in sowing, spraying and intercultural operations are happening in the recent past, harvesting of cotton using Mechanical Cotton Harvester was the missing link in complete mechanization. In order to facilitate complete mechanization of cotton cultivation practices, ICAR-Central Institute for Cotton Research has developed, standardized, demonstrated and popularized 'High Density Planting Systems' (HDPS) technology package amenable for machine picking. As most of the cotton cultivars retain huge foliage biomass even at the time of crop maturity, it is imperative to defoliate the crop through application of harvest aid chemicals / defoliants which further facilitate synchronized boll opening to assure a single machine picking operation.

### Salient findings:

## Evaluation of Genotypes under HDPS for compactness

Central Zone, Nagpur Centre: The promising compact hybrids identified for deep soils in central zone were RCH608, SP7149, Ajeet 5 and varieties namely, ADB39, CO17, which had plant height around 100 cm and width 50 cm. All the hybrids and varieties evaluated were found to be compact after the application of mepiquat chloride (25 g a.i./ha) sprayed twice at 45 and 65 days.



North zone, Sirsa Centre: Thirteen cotton genotypes were tested under HDPS (spacing 90 x 15 cm). Highest seed cotton yield (2,100.9 kg/ha) was obtained by RCH-926 BG-II hybrid and PAU Bt-3 (1,485.6 kg/ha) among the genotypes tested. PAU Bt-3 and CSH-3075 among varieties and RCH-773 and RCH-926 among hybrids were found promising in terms of compactness and higher yields.

South zone, Coimbatore Centre: Five non-Bt varieties (Suraksha, Subhiksha, Suraj, Nano, Co-17) and three BG II hybrids (RCH 608, NCS 2778 and RCH 578) were evaluated for compactness. The varieties were planted at 90 x 10cm spacing and hybrids were planted at 90 x 15 cm spacing. Among varieties, Nano produced highest seed cotton yield of 1972 kg/ha with mepiquat chloride application and the height of lowermost boll was 18 cm from ground surface. Among hybrids, RCH 608 BG II recorded highest seed cotton yield of 2375 kg/ha. However, RCH 578 BG II recorded better ground clearance for machine picking as the height of lower most bolls was 23cm.

# Evaluation of defoliants and growth regulators

Subiksha and Suraksha among varieties and CH 578 BGII among hybrids outperformed the rest in terms of compactness and height of lowermost boll, with the application of mepiquat chloride in the south zone. Among the defoliants tested in north zone, applications of ICAR-CICR defoliant at 7 days interval resulted in highest number of fully opened bolls per plant (28.0),



boll opening percentage (97.3 %) and defoliation percentage (92.6%) (Fig 3.3.1). For machine harvesting at Coimbatore, ICAR-CICR defoliant sprayed @ 140 days after sowing and desired level of boll opening and defoliation outperformed the commercially available salts.

# Performance of spindle type picker in cotton variety Suraksha

At Coimbatore, 150 day old cotton variety Suraksha under HDPS system (90 x 10 cm spacing) in one-hectare was harvested using Shaktiman Cotton Master 1437 spindle type two row picker. Theefficiency of the picker was one acre per hour. The total trash content in the harvested kapas ranged from 8.9 -12.4 % on seed cotton basis. On seed cotton basis, dried/green leaves, bracts/burrs and sticks contributed 5%, 2.9% and 0.6% of mean trash content, respectively.





Fig 3.3.1 Evaluation of Defoliants a: Control (Water spray); b: DNF-2 spray; c: Dried leaves on the stem with Paraquat @ 2.5 lt/ha at ICAR-CICR, Regional Station, Sirsa, Haryana 125 055



Mechanical cotton picker in action

# 3.4 Network Program on Precision Agriculture (NePPA): Cotton

Y.G. Prasad (PI); Co-Pls: Blaise Desouza, Gautam Majumdar, R. Raja, Amarpreet Singh, K. Rameash, Prabhulinga T, Shailesh Gawande, Dipak Nagrale, N. Hiremani, P. Nalayini, A. Manikandan, D. Kanjana, J.H. Meshram, Pooja Verma

**Importance of the study:** Precision agriculture aims at location specific application of inputs with the right intensity and at the right time. Therefore, precision agriculture does not treat the entire farm/field as a homogenous unit; rather it divides the field/farm into zones so that variable rate inputs can be delivered as per the requirement of individual zones.

# Salient findings:

Remote sensing is a promising method of assessing in-season N status with the adoption of reliable low-cost unmanned aerial vehicles (UAV), high-resolution multi-spectral sensors and availability of advanced image processing software for



Rate Technology (VRT). Through multispectral imaging, an attempt was made to develop vegetation indices based algorithm and management zone maps (Fig. 3.4.1) for top dressing nitrogen at variable rates. Nitrogen Sufficiency Index based management zone map has been developed for variable rate application of nitrogenous fertilizers.

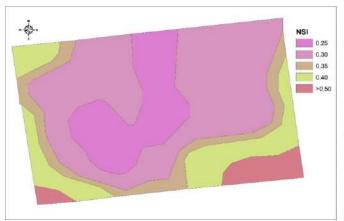


Fig. 3.4.1.Nitrogen Sufficiency Index based management zones -Variable Rate Technology for fertilizer-N

Al based smart Pheromone trap: A smart trap was developed at ICAR-CICR for automated real-time monitoring of pink bollworm (PBW) in cotton. The system consists of a single board computer; camera module; weather sensor and a Wi-Fi/ GSM transmitter. The standalone system is powered by a solar panel with a Li-ion rechargeable battery. The AI trap records insect catches as images; the inbuilt machine learning algorithm counts the number of insects trapped and transmits the data to a remote server at hourly intervals along with weather parameters (temperature, relative humidity, atmospheric pressure and altitude). YOLO-based Machine Learning algorithm detects the trapped adults of pink bollworm with 91.4% detection accuracy. An android app and a Windows application are developed to receive, store and retrieve the data (along with weather parameters) from the Al smart trap to a mobile device and a personal computer. By investigating the real-time trap catch with corresponding weather data, the pest dynamics over a wider area could be comprehended in a better way and subsequently it helps to establish a reliable pest forewarning system and better pest management practices in cotton.

An attempt was made to evaluate the spray distribution and bio efficacy of insecticide (Dinotefuran 20 SG @ 150 g/ha) applied through UAV against sucking pests on cotton during kharif 2022 at ICAR-CICR Regional Station, Coimbatore. The UAV flight altitude of 2 m and speed of 2.5 m/s were kept at constant rate, while the spray fluid volumes were applied @10 L /ac, 15 L/ac, 20 L/ac and 25 L/ac. The results indicated that spray volume of 20 L/ac and 25 L/ac recorded significantly uniform spray distribution in the top, middle and bottom canopy of cotton plant with superior bio-efficacy against the sucking pests.

Sensor-based precision irrigation: Sensor-based drip irrigation besides saving of irrigation water. Water requirement sustainability.

precision application of fertilizer-N in cotton based on Variable of ICAR-CICR-23 Bt was 78.3 ha-cm under conventional method while it was 51 ha-cm with drip (1.0 ET) and 45.3 ha-cm under sensor-based drip irrigation. Thus water saving due to sensor-based drip irrigation was 5.7 lakh litres over ET-based irrigation.

# 3.5 Nutrient Profile based fertilizer management in cotton

A. Manikandan (PI); Co-PI: K. Sankaranarayanan

Importance of the study: Soil test-based fertilizer recommendations yield favourable outcomes, yet it is essential to correlate the mid-season cotton nutrient uptake pattern with boll initiation, development, and soil nutrient status. Previously, fertilizer prescription equations relied on the whole plant nutrient concentration. However, it is crucial to acknowledge that the rate of photosynthesis and nutrient concentrations vary within different parts of the plant and their positions, ranging from upper to lower branches. This variation may result in poor boll setting percentage, days required for boll development, and fiber quality. Therefore, in order to understand the midseason nutrient uptake of the index leaf, it is imperative to generate a fundamental dataset for cotton.

#### Salient findings

Pre-plant nutrient testing (PPNT) indicated low levels of nitrogen (N), phosphorus (P), and micronutrients, excluding potassium (K). Pre-side-dress nutrient testing (PSNT) and Preflowering nutrient testing (PFNT) showed medium levels of phosphorus (P) and high levels of potassium (K). Pre-harvest nutrient testing (PHNT) status revealed low levels of nitrogen (N) and phosphorus (P) in cotton-growing soils from on-farm and on-station experiments. Based on the nutrient index value (NIV), 98% of soils exhibited low organic carbon (OC), 82% were low in available phosphorus (P) and 50 % soils were low in mineralizable nitrogen (N). All soils were rich in exchangeable potassium (K). DTPA-extractable micronutrients exhibited varied soil status (Figure 3.5.1). Rapid plant tissue testing at 18-32 days after sowing, fourth-node leaf nutrient analysis at 50% flowering, and RGB image analysis of soil and cotton leaves highlighted the varied soil nutrient status and cotton nutrient concentration in different cotton-growing soils.

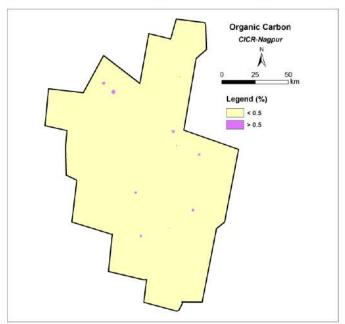
Nutrient analysis of boll subtending leaves (60, 90, 120, 150 & 180 DAS) and post-harvest nutrient analysis (210 DAS) of boll subtending leaves showed an increase in nutrients up to 120 DAS followed by a decrease from 150 DAS afterwards. Post harvest nutrient analysis showed lesser values. Suraksha under organic cotton cultivation yielded 49 kg/ha higher than conventional nutrient management with spacing of 90 x 30 cm. However, conventional nutrient management of NH 615 production yielded maximum seed cotton yield (SCY), 352 kg/ha higher than others (non-Bt cotton), under HDPS (90 x 10 cm). Similarly, among the Bt-varieties, PKV 081-BGI exhibited the maximum SCY tested under HDPS (90 x 15 cm). Among desi cotton varieties, PA 740 yielded maximum around 3925 kg had under HDPS (90 x 10 cm). Bt-Cotton hybrids recorded SCY of 1824-2413 kg ha<sup>-1</sup> in 90 x 60 cm spacing with varying levels of calcium carbonate (Table 3.5.1). Among the cotton genotypes tested, desi cotton demonstrated the highest yield under irrigation resulted in water saving and yield enhancement HDPS. Bt-varieties under HDPS, particularly in calcareous and compared to the ET-based drip irrigation. The yield shallow soils and Non-Bt varieties under organic conditions enhancement with sensor based irrigation was to the tune of 6 showed promising results. These findings suggest that midg/ha over conventional irrigation and 4 g/ha over ET-based season nutrient management is essential for higher yields and

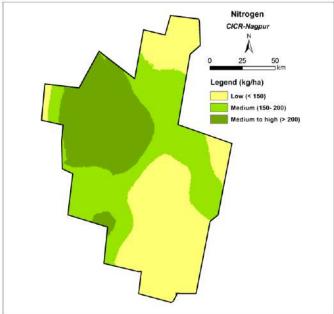


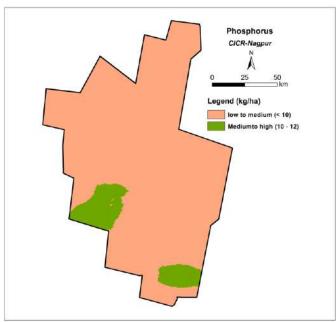


Table 3.5.1. Seed cotton yield (kg ha<sup>-1</sup>) in on-station experiments (2022-2023)

Cotton	Spacing (cm)	SCY (kg/ha)	Cotton	Spacing (cm)	SCY (kg/ha)	
А	merican cotton	<del></del>	Bt-Hybrid (<10% CaCO₃)			
NH615	90 x 10	1367	Ajeet-155	6	2253	
Suraksha - Inorganic	90 x 30	1015	Ankur-3028		2182	
Suraksha - Organic		1064	Dhandev +	90 x60	2413	
	Bt- variety	:	RCH 779		2092	
PKV-081 Bt	90 x15	2502	Bt-Hybrid (>20% CaCO <sub>3</sub> )			
Rajat Bt		2178	Ankur Kirti	90 x60	2518	
Suraj Bt		1611	Dhandev +		1824	
	Desi cotton	i de la companya de l				
CNA1028	90 x10	3253				
PA-740		3925				
Phule Dhanwantary		3573				







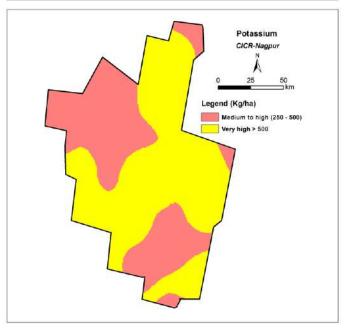


Fig 3.5.1 Soil fertility map- Panjari farm

# 3.6 Evaluation of biochar nutrient composites to improve Salient findings: NUE for cotton grown in calcareous soils (Adhoc trial)

# A. Manikandan (PI); Co-PI:D. Blaise

# Importance of the study

In Maharashtra, over 35% of rainfed cotton-growing soils are shallow and characterized by high content of calcium carbonate. These calcareous soils typically exhibit surface soil with elevated levels of calcium carbonate ranging from 5 to 30%, coupled with low organic matter content ranging from 0.1 to 0.3%. This composition adversely affects soil characteristics such as water holding capacity and availability of nutrients. Additionally, the presence of free calcium carbonate and bicarbonate toxicity exacerbates multiple nutrient deficiencies during critical stages of growth, leading to poor cotton yields. However, biochar-based nutrient-enriched composites offer a novel solution in the form of organo-mineral complexes designed for remediating pollutants, providing slow-release fertilizer, and promoting agricultural sustainability.

### Salient findings:

Biochar nutrient composite(BNC) -processed with 16% N, 8% P<sub>2</sub>O<sub>5</sub>, and 8% K<sub>2</sub>O, and Composite-Unprocessed (BBNC) with 12% N, 8% P<sub>2</sub>O<sub>5</sub>, and 8% K<sub>2</sub>O were made using conventional fertilizers. The results indicated that cotton morphology, yield (Figure 3.6.1), and nutrient concentrations consistently exhibited higher levels with composites compared to conventional fertilizer management in rainfed calcareous soil. However, no significant differences were observed in fiber quality.

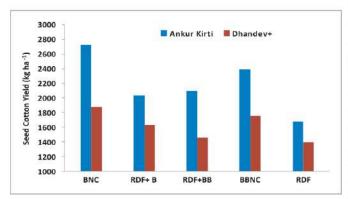


Figure 3.6.1. Effect of biochar based nutrient composite on cotton yield of rainfed calcareous soil

# 3.7 Response of Potassium Salt of Active Phosphorus to Cotton

# A. Manikandan (PI); Co-PI:D. Blaise

Importance of the study: For newly developed Bt-cotton hybrids, the intensity of nutrient requirements and plant protection measures are higher. Further, the existing conditions like soil alkalinity and limited moisture reduce the availability of P and K at critical stages of cotton, especially at boll initiation and development stages. Concomitant plant protection measures for pests and diseases also ensure the potential yield of Bt-hybrids. Therefore, this study is aimed to investigate the effects of foliar spray of novel potassium active salt of phosphorus (PSAP) i.e., 00-40-40 on cotton yield and plant protection through balanced nutrition. The effects of the combination with or without nutrients (0, 50 and 100%) and plant protection measures (0, 50 and 100%) were also examined under rainfed conditions.

Significant differences were observed on morphology and yield over the conventional recommended package of practices (Table 3.7.1). Similarly, both soil and cotton nutrient analysis revealed that the foliar spray of PSAP assisted for balanced nutrition than control. Infestation of sucking pests and bollworm complex was below the ETL with no incidence of diseases (leaf spot, leaf blight and boll rot) during the testing period (2022-2023). Use of potassium salt also increased the net profit of Rs.10, 740/- per ha than recommended package of practice.

Table 3.7.1. Effect of PSAP on rainfed cotton yield attributes (RCH-779 BGII)

Treatment	Seed Cotton(g) /plant	SCY (kg/ha)
T <sub>1</sub> -NPK100%+ Plant protection (100%)	130ª	2816ª
T <sub>2</sub> : T <sub>1</sub> +PSAP <sup>+</sup>	135ª	3019 <sup>a</sup>
T <sub>3</sub> : N100%, P50%, K 50%+ Plant Protection (50%)	120ª	2564 <sup>ab</sup>
T <sub>4</sub> : T <sub>3</sub> + PSAP <sup>+</sup>	124 <sup>a</sup>	2704 <sup>a</sup>
T <sub>5</sub> : Absolute Control + Plant Protection (Nil)-Water spray only	88 <sup>b</sup>	1982 <sup>b</sup>
T <sub>6</sub> : T <sub>5</sub> +PSAP <sup>+</sup>	117ª	2010 <sup>b</sup>
SEd	8.73	295.49
CD(0.05)	19.45**	658.40*
CV(%)	8.99	14.38

# 3.8 Efficacy evaluation of ICAR-CIRCOT nano-ZnO as nanofertilizer in field crops

N. Vigneshwaran, ICAR-CIRCOT, Mumbai (PI) and Manikandan (CC-PI)

Importance of the study: The present study aimed to assess the impact of nano zinc oxide (nZnO) as a micronutrient zinc source on rainfed cotton cultivation in alkaline black calcareous soils. The experiment encompassed seed treatment (ST), soil application (SA), and foliar spray (FS) techniques at various growth stages, compared with conventional zinc oxide (ZnO) and zinc sulphate (ZnSO<sub>4</sub>) treatments.

# Salient findings:

The results indicated that seed treatment with different zinc sources exerted negligible influence on the germination, shoot, and root length of Bt-cotton. However, the secondary lateral root length was notably greater in nZnO-treated plants. Although, no significant differences were observed in cotton morphology particularly, ST with ZnO resulted in the most significant enhancement in boll weight compared to the control. Despite nZnO having a slightly lower mean Zn content when employed as seed treatment (50 mg kg<sup>-1</sup>), its availability was maximized during boll initiation (84 and 121%) and boll development (44 and 61%) in comparison to ZnSO4 and ZnO respectively within the soil. Soil Zn levels were greater in pots supplied with ZnO. Among various plant parts, Zn levels followed the order of cotton root  $(125 \mu g g^{-1}) > leaf (108 \mu g g^{-1}) >$ stalk (100 µg g<sup>-1</sup>). Among the fibre quality parameters evaluated, nZnO treatment improved the upper half mean length by6.6-7.4% compared to other sources. Pot studies demonstrated that nano zinc oxide (nZnO) had positive response in terms of



fiber length and zinc levels in both the soil and plant system. differences were observed on growth (plant height, improving cotton cultivation. In field trials, no significant Zinc oxide under different soils.

Thus seed treatment with nZnO is as effective as the monopodia, sympodia and leaf area), yield and fibre quality conventional zinc sources, making it a promising option for parameters. However, higher values were recorded with nano

Table 3.8.1. Effect of Nano Zinc formulations on seed cotton yield (kg ha')

Treatments	Calcareous soil	Black soil
T1-Control (RDF+12.5 kg of ZnSO <sub>4</sub> )	1545	2499
T2-ST-ZnO NP's @ 20 mg kg <sup>-1</sup>	1289	2460
T3-ST-ZnO NP's @ 50 mg kg <sup>-1</sup>	1299	2648
T4-FS -ZnO NP's @ 200 mg kg-1 (45,60 DAS)	1512	2558
T5-ST-ZnO NP's @ 20 mg kg <sup>-1</sup> + FS ZnO NP's @ 200 mg kg <sup>-1</sup> (45,60 DAS)	1504	2253
T6-ST -ZnO NP's @ 50 mg kg <sup>-1</sup> + FS ZnO NP's @ 200 mg kg <sup>-1</sup> (45,60 DAS)	1745	2376
T7-ST-Nano Zn Suspension(NZnS)@ 50 mg kg <sup>-1</sup>	1511	2635
T8-FS-Nano Zn Suspension@ 200 mg kg <sup>-1</sup> (45 DAS)	1391	2129
T9-ST-Nano Zn Suspension@ 50 mg kg <sup>-1</sup> + FS-NZnS @ 200 mg kg <sup>-1</sup>	1677	2311
T10-FS-Nano Zn Suspension@ 200 mg kg-1 (45,60 DAS)	1738	2340
C.D.(0.05)	NS	NS
SE(m)	134	195
SE(d)	189	276
C.V. (%)	15	14

# Maharashtra

PI: K. Velmourougane, Co-PI's: A. Manikandan, D. Vasu (NBSS & LUP, Nagpur)

Importance of the study: Pedogenic formation of CaCO. induces soil sodicity, which affects soil properties including drainage, infiltration rate, nutrient availability, soil health and crop productivity. The present study is aimed to isolate calcium carbonate solubilizing bacteria, and develop consortia of calcium carbonate dissolving bacteria for dissolution of pedogenic CaCO<sub>3</sub> in soils to improve soil properties enhancing soil and plant productivity.

# Salient findings:

A consortium of calcium carbonate solubilizing bacteria (CSB-Lysinibacillus fusiformis) was developed which possesses plant

3.9 Project name: Microbial dissolution of carbonate to growth promoting attributes along with solubilising potential of ameliorate soil sodicity in Black Soil Regions of other soil macro and micronutrients. Based on the field evaluation in 13 farmers field of Purna river valley, Amravati and Akola districts, Maharashtra, the CSB inoculation as seed treatment (5g kg1 seed) and soil application (5kg ha1) was found to be effective in solubilisation of CaCO<sub>3</sub> fractions (70% increase in water soluble calcium,12% increase in exchangeable calcium, and 12% increase in carbonate bound calcium) along with significant enhancements in seed cotton yield (17% increase), soil nutrient availability (32% OC, 20% N, 98% P, 17% K, 36% S, 62% Zn, 25% B, 24% Cu, 23% Fe, and 31% Mn) and soil biology (Table 3.9.1). The CSB formulation is ecofriendly, cost-effective and does not cause any harmful effects on cotton plants and soil biology. It can reduce chemicals usage for land reclamation, thus has a wider commercial application prospects in agriculture.

Table 3.9.1. CSB formulation inoculation on soil properties in 13 farmers' field in Purna valley (All the values are average of 3 three replications)

Attributes	Farmer Practice	Farmer Practice + CSB	% increase	p (0.05)
Seed cotton yield (q/ha)	19.92	23.23	16.6	Sig.
Ginning out turn	37.96	38.24	0.72	NS
Lint index	5.65	5.93	4.89	Sig.
Seed index	8.46	8.96	5.9	NS
Fibre length (mm)	26.65	26.91	0.98	NS
Uniformity ratio (%)	83.07	83.23	0.18	NS
Micronaire (µg/inch)	4.16	3.97	-4.6	NS
Bundle strength (g/tex)	26.71	26.73	0.08	NS
Soil chemical attributes				
pH	7.37	7.20	-2.30	Sig.
Organic carbon (%)	0.259	0.341	31.8	Sig.
Nitrogen (kg/ha)	86.1	103.4	20.1	Sig.



Attributes	Farmer Practice	Farmer Practice + CSB	% increase	p (0.05)
Phosphorus (kg/ha)	2.78	5.5	97.8	Sig.
Potassium (kg/ha)	667.7	783.5	17.3	Sig.
Sulphur (mg/kg)	0.268	0.365	36.4	Sig.
CaCO3 (%)	8.18	5.32	-34.9	Sig.
Calcium (mg/kg)	2140.8	2412.8	12.7	Sig.
Zinc (mg/kg)	0.22	0.357	62.5	Sig.
Boron (mg/kg)	0.537	0.672	25.1	Sig.
Copper (mg/kg)	0.704	0.871	23.7	Sig.
Iron (mg/kg)	3.23	3.98	23.1	Sig.
Manganese (mg/kg)	8.46	11.05	30.6	Sig.
Water soluble calcium (mg/kg)	2.89	4.93	70.4	Sig.
Exchangeable calcium (mg/kg)	161.4	180.8	12	Sig.
Carbonate bound calcium (mg/kg)	446.2	391.5	-12.2	Sig.
Soil biological attributes				
MBC (mg/kg)	812.6	847.5	4.3	Sig.
Glomalin (mg/g)	0.451	0.696	54.2	Sig.
Dehyrogenase (µg/g)	6.33	7.05	11.2	Sig.
Alkaline phosphatase (µg/g)	307.3	388.5	26.4	Sig.
Acid phosphatase (μg/g)	190.7	241	26.3	Sig.

Calcium Carbonate Solubilizing bacteria (CSB) inoculation as seed treatment and soil application (during Squaring, flowering and boll formation stages)

# 3.10 Bioprospecting microbial volatiles for plant growth plant growth promotion and management of sucking pests in promotion and sucking pest (Whitefly and Jassids) management in Bt cotton (DST-SERB Project)

# K. Velmourougane (PI)

Importance of the study: Sucking pests (SP) cause significant yield and quality loss in cotton. Farmers largely depend on conventional groups of insecticides to manage SP, which upon continuous use resulted in pest resistance to insecticides, resurgence of minor pests, decline of natural enemies and environmental pollution. Although yellow sticky traps (YST) were popularly used as mechanical control options for sucking pest management, further enhancement in the attraction of sucking pests to YSTs will be useful. Microbial volatile organic compounds (mVOCs) represent a new frontier in bioprospecting where they produce complex volatile compounds having multifunctional roles in agriculture. The aim of this project was to develop ecofriendly and cost-effective microbial volatile formulation for field application to enhance

### Salient findings:

ICAR-CICR has developed bacterial-based microbial volatile (mVOC) formulations, which on three-year large-scale field studies and multi-location evaluation in 15 AICRP (Cotton) centres, proved to manage SP of cotton through their attraction toward YST. The mVOC formulations designated as CICR-BVW, CICR-BVJ, CICR-BVA and CICR-BVT recorded attraction efficiencies of 168%, 197%, 189%, and 175% over control (only YST) for whiteflies, jassids, aphids and thrips, respectively. The attractant is eco-friendly and cost-effective, does not cause any harmful effects on cotton plants, soil nutrient status, soil biology, and can reduce chemical usage and pest resurgence in cotton, thus has wider commercial application prospects in agriculture. Based on the results, following five patents were filed in September 2023 (Table 3.10.1).

Table 3.10.1 List of patents filed under the microbial volatiles project

	Title	Inventors	Application Number
1	Bacterial-based volatiles composition as aphid attractant	K. Velmourougane	202321058816
2	Bacterial-based volatiles composition as jassid attractant	K. Velmourougane (Lead), Pooja Verma, A. Manikandan, Y.G. Prasad	202321058813
3	Bacterial-based volatiles composition as thrip attractant	K. Velmourougane	202321058814
4	Bacterial-based volatiles composition as whitefly attractant	K. Velmourougane (Lead), Pooja Verma, A. Manikandan, Y.G. Prasad, Rishikumar, D. Blaise	202321058818
5	Bacterial-based volatiles composition as beneficial insects attractant	K. Velmourougane (Lead), Y.G. Prasad	202321058817

Table 3.10.2. Microbial resource conservation

No.	Bacterial Strains & their attributes	Accession number	Depositor(s)
1	Achromobacter insuavis- biofilm forming PGPR	NAIMCC- B-03429	K. Velmourougane, Raghavendra KP
2	Alcaligenes faecalis - biofilm forming PGPR	NAIMCC- B-03430	K. Velmourougane, Raghavendra KP
3	Bacillus haynesii- abiotic stress alleviator PGPR	NAIMCC- B-03431	K. Velmourougane, Raghavendra KP
4	Bacillus paramycoides – abiotic stress alleviator PGPR	NAIMCC- B-03432	K. Velmourougane, Raghavendra KP
5	Enterobacter mori - biofilm forming PGPR	NAIMCC- B-03433	K. Velmourougane, Raghavendra KP
6	Enterobacter gallinarum- biofilm forming PGPR	NAIMCC- B-03434	K. Velmourougane, Raghavendra KP
7	Enterobacter gallinarum- biofilm forming PGPR	NAIMCC- B-03435	K. Velmourougane, Raghavendra KP
8	Kosakonia sacchari – abiotic stress alleviator PGPR	NAIMCC- B-03436	K. Velmourougane, Raghavendra KP
9	Lysinibacillus fusiformis- abiotic stress alleviator PGPR	NAIMCC- B-03437	K. Velmourougane, Raghavendra KP
10	Pantoea dispersa -biofilm forming PGPR	NAIMCC- B-03438	K. Velmourougane, Raghavendra KP
11	Lysinibacillus fusiformis -CaCO <sub>3</sub> solubilizing PGPR	NAIMCC- B-03439	K. Velmourougane, A. Manikandan, Raghavendra KP
12	Lysinibacillus fusiformis-CaCO <sub>3</sub> solubilizing PGPR	NAIMCC- B-03440	K. Velmourougane, A. Manikandan, Raghavendra KP

# 3.11 Project Name: Evaluation of chemical defoliants Salient findings: augmenting leaf senescence for mechanical picking in Bt Cotton (DST-SERB Project)

# J.H.Meshram (PI)

Importance of the study: Defoliation is pre-conditioning the plants to prepare cotton for harvest and reduce trash content in harvested cotton fibre. This action cuts the time, the crop is left standing in the field prior to harvest, thereby reducing the risk of exposure to bad weather, pests or diseases. Abscission is a process that allows plants to shed tissues or organs via cell separation. Removal of leaves through the use of chemical defoliants is very important for mechanical harvesting of cotton. However, our knowledge about the molecular and biochemical mechanisms of the defoliation response involved is limited. The possible crosstalk between growth hormone such as cytokinin and ethylene regulates cotton defoliation, and may provide new insights into the molecular mechanisms underlying the mode of action of defoliants in cotton.

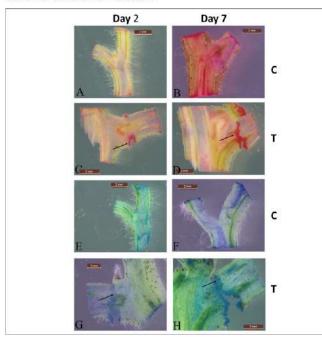
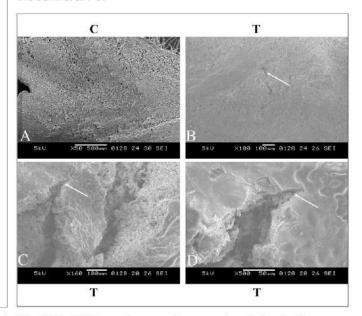


Fig. 3.11.1. Histochemical analysis of chemical defoliant Fig. 3.11.2. Ultra microscopic analysis of abscission zone induced abscission zone formation at adjunction of leaf and formation using scanning electron microscopy (SEM) of stem of cotton plants. (A, B, C, D- Congo red. E, F, G, H- transverse section and surface of leaf petiole (A, B- T.S of Evan's blue. C-Control, T-Treatment)

The effect of chemical defoliant on cellular degradation in abscission zone is shown by staining with congo red and evans blue dye (Fig. 3.11.1 & 3.11.2). Although, the biochemical mechanism which drives the abscission zone formation is mostly related to enhanced senescence induced cell wall degradation and oxidative burst, involvement of oxidative stress senescence was proven by elevated peroxidase enzyme activity from 1 to 7 days after defoliant application with increase in leaf defoliation.

Dynamics of leaf abscission in response to defoliants and changes in leaf morphology and histology were determined at the boll-opening stage both in the field and in greenhouse conditions and compared with control (water spray). Control leaves were green even after 10 d, whereas some green leaves were dropped at 7 d post treatment, with a defoliation rate of more than 85%. The defoliation rates of the control and treatments showed highly significant differences compared to the control at 7 d.



leaf petiole. C-Control T-Defoliant treated).



# CROP PROTECTION DIVISION

# 4.1 Project Title: Monitoring insecticide resistance in 4.2 Project Title: Revisiting the ETLs and yield loss American bollworm, Helicoverpa armigera (Hubner) populations from cotton growing regions of Maharashtra and Gujarat (2021-26)

Vivek Shah (PI); Co-PI: Rachna Pande

### Importance of the study:

Insecticide applications under field conditions are affected by various environmental factors that lead to exposure of insects to sub-lethal dose. Continuous use of recommended insecticides under field conditions over a period of time has led to development of resistance in the target insect. Hence, field efficacy of these insecticides should be continuously monitored. In this context, present study was formulated to understand the status of development of resistance in populations of American bollworm (Helicoverpa armigera) to the recommended newer and selected conventional \* insecticides under laboratory conditions.

# Salient findings

- The screening of *H. armigera* populations from 11 districts in Maharashtra and 8 districts in Gujarat involved the assessment of their susceptibility towards five newer insecticides (Chlorantraniliprole, Flubendiamide, Indoxacarb, Spinosad, Emamectin benzoate) and three conventional insecticides (Cypermethrin, Novaluron, Profenophos).
- Emamectin benzoate exhibited the highest efficacy against H. armigera among the newer insecticides, while indoxacarb demonstrated the least effectiveness (Fig 4.1.1). Overall newer molecules demonstrated significantly higher efficacy compared to conventional insecticides.
- Among different conventional insecticides, profenophos emerged as the most effective insecticide, followed by novaluron and cypermethrin (Fig 4.1.2).

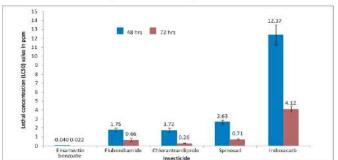
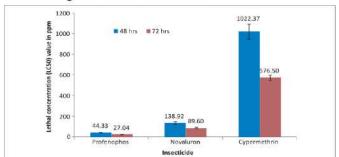


Fig 4.1.1 Mean lethal concentration of populations screened against newer insecticides



screened against conventional insecticides

# assessment for pink bollworm and boll rot in cotton

B. B. Fand (PI) Co-Pls: Vivek Shah, D. T Nagrale

### Importance of the study:

Pink bollworm (PBW) and boll rot (BR) cause significant yield loss to cotton due to deterioration of lint quality and seed damage. Present research was prompted by paucity of precise methods for yield loss assessment due to damage by these two biotic factors.

# Salient findings

- The yield loss calculated using graded degrees of PBW and BR incidence based on proportions of damaged loculi in randomly drawn samples of seed cotton from open bolls in fields (Fig 4.2.1).
- Reduction in oil contents of seeds damaged by PBW and BR estimated.
- Risk of PBW infestation in Indian cotton-growing areas mapped by coupling phenology model with a geographic information system.
- Future invasiveness of PBW studied by simulating phenology model under different climate change scenarios (representing 0.5 to 2.5 °C rise in temperature) across ten locations in North, Central, and South cotton growing zones of India.
- PBW damage potential linked to loculi damage data (%) on Bt cotton from 2015 to 2022 at various locations.
- Current and future trends in losses due to PBW estimated quantitatively and monetarily (Table 4.2.1 and 4.2.2).
- Potential loss in yield due to PBW infestation estimated at 17.4% and 39.5% in Bt and Non-Bt cotton cultivars, respectively.
- Yield loss due to BR estimated at 15.7% and 13.6% in Bt and Non-Bt cultivars, respectively.
- PBW and BR damage reduced cotton seed oil content by 63.70% and 65.76%, respectively.
- Currently, ~60% of cotton areas in India can experience the development of 8.0 PBW generations in a year, causing economic losses, with a potential increase to ≥ 80% by 2050.
- Coupling PBW damage with phenology revealed annual losses in seed cotton of 13.35 lakh bales, accounting for monetary losses of 12,996 million Indian rupees (Table 4.2.2).

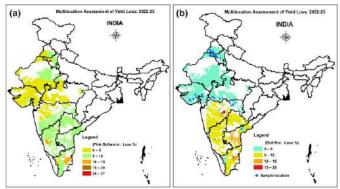


Fig 4.1.2 Mean lethal concentration of populations Fig 4.2.1. Multilocation assessment of yield losses due to pink bollworm (a), and boll rot (b) in India.

(%) sso current trend of pink cotton yield -0.82-0.65 -0.41 0.16 -0.26 0.10 -1.29 -1.00 -0.80 Future change over -0.31 0.43 111 1.37 2.43 0.54 bollworm activity\* damage Mean 10.43 -3.56 -1.36 -2.83 -1.17 -4.38 -1.80 -4.82 -5.60 1.80 0.63 0.39 5.85 -3.51 2.24 (%) predicted Future 0.44 0.74 0.18 6.39 4.08 4.65 7.35 0.17 4.40 4.58 4.55 6.52 5.68 7.92 3.91 Seed cotton yield loss (%) Predicted 5.15 1.26 1.05 0.59 5.96 4.43 4.17 3.98 5.55 6.48 7.38 0.82 5.94 4.92 5.51 Current Observed 1.56 11 4.98 3.66 5.06 3.00 5.69 9.08 5.09 3.87 7.83 5.23 1.21 0.61 5.21 predicted Future 24.18 19.45 16.53 17.26 19.74 27.78 31.39 33.82 27.25 18.67 0.45 19.31 1.57 2.89 0.40 Mean loculi damage ± SE (%) Predicted 25.44 23.50 17.70 25.35 23.69 21.94 27.68 20.96 31.58 18.82 16.87 5.13 4.25 3.23 2.25 Current  $22.53 \pm 3.83$ 20.75±0.70  $15.91 \pm 0.32$ 21.71 ± 4.66  $12.75 \pm 3.86$ 22.33 ± 5.24 24.28 ± 5.64 33.69±1.20 38.65±0.90 16.13±2.01  $6.77 \pm 3.12$ 4.28±1.06 4.66±1.46 21.60±4.91  $2.35 \pm 0.94$ Observed Future climate (2050)2.74 2.75 6.49 6.05 8.36 2.98 3.25 8.25 6.65 6.62 7.62 6.2 6.71 9.1 9.6 Activity index (AI) **Current climate** (1951-2000)7.16 3.53 3.32 3.12 7.88 7.48 6.29 6.12 7.86 96.9 6.52 7.52 8.34 3.71 Longitude 74.95 70.46 80.43 78.48 75.04 73.88 72.83 74.65 77.04 77.33 77.36 76.94 75.01 76.94 75.71 (E) Latitude 29.15 29.54 21.52 21.17 19.39 19.15 15.48 15.46 11.93 30.21 29.91 16.37 16.22 11.01 20.7 2 Sriganganagar Chamrajnagar Location Lam Guntur Coimbatore Junagadh Bhatinda Dharwad Nandyal Nanded Raichur Rahuri Akola Surat Hisar Sirsa growing Cotton Central South North

\*The negative and positive values indicate decrease and increase respectively, of pink bollworm activity.



Table 4.2.2. Forecasted losses in Indian cotton production due to pink bollworm based on model predictions

40

Cotton growing State	Average production of seed cotton	State wise yield loss (9	State wise estimates of seed cotton yield loss (%) based on loculi damage	seed cotton oculi damage	Losses	Losses in cotton production (Lakh bales)	oduction )	Monet	Monetary losses in cotton production (Million INR) <sup>§</sup>	cotton INR) <sup>s</sup>	Future trend in losses over current losses
	(Lakh bales)*	Cur	Current	Future	uno	Current	Future	Current	rent	Future	(Million INR)
		Observed	Predicted	naiomaid	Observed	Predicted	pancinald	Observed	Predicted	naioinaid	
Punjab	7.08 ± 1.67	1.56	1.26	0.44	0.11	0.09	0.03	107.21	86.60	30.13	-56.47
Haryana	16.20 ± 1.55	0.86	0.94	0.45	0.14	0.15	0.07	135.89	147.52	71.63	-75.89
Rajasthan	27.46 ± 2.31	1.21	0.59	0.18	0.33	0.16	0.05	323.90	158.18	47.45	-110.73
Gujarat	87.95 ± 8.87	4.32	5.73	5.40	3.80	5.04	4.75	3698.05	4909.43	4,621.31	-288.12
Maharashtra	78.86 ± 5.05	4.38	4.19	4.19	3.45	3.30	3.30	3362.93	3215.93	3,215.54	-0.39
Andhra Pradesh	19.54 ± 1.83	4.10	5.75	4.60	0.80	1.12	06:0	780.50	1092.91	875.22	-217.69
Karnataka	17.38 ± 1.18	5.64	5.52	6.52	0.98	96.0	1.13	954.21	933.03	1,102.20	169.17
Tamil Nadu	$4.82 \pm 0.74$	9.08	7.38	7.92	0.44	98.0	0.38	426.37	346.50	371.70	25.19
Others#	75.75 ± 5.09	4.71	5.15	5.10	3.57	3.90	3.86	3471.96	3797.81	3,762.22	-35.59
All India	335.03 ± 11.08	3.99	4.06	3.87	13.35	13.59	12.95	12,996.77	13,227.20	12,608.23	-618.97



<sup>\*</sup>Average production of seed cotton during the pink bollworm outbreak period (2015-2023) was considered for estimating the losses.

<sup>\*</sup>Minimum support price for cotton @ Rs 9734/ bale of 170 (Rs 5726/ quintal) is considered (Source: Commission for Agricultural Costs and Prices, Ministry of Agriculture, Government of India https://cacp.dacnet.nic.in/ViewContents.aspx?Input=1&PageId=36&KeyId=0, Accessed on 05/07/2023)

<sup>\*</sup>Telangana, Madhya Pradesh, Odisha and other states for which data on loculi damage was missing were clubbed together and the average of loculi damage from central and south zone locations was used in yield loss estimation

# 4.3 Project Title: Identification of Host Cues from Cotton Salient findings (Gossypium hirsutum) to elicit behaviour of female pink bollworm (Pectinophora gossypiella)

RachnaPande (PI); Co-PI's: Prabhulinga T., Pooja Verma

Importance of the study: The advent of Bt-cotton, • encompassing Bollgard I (2002) and Bollgard II (2006), marked a significant milestone in cotton pest management, conferring resistance against bollworms till 2010. However, the emergence • of resistance in the pink bollworm (P. gossypiella) to both Cry1Ac and Cry2Ab poses a formidable challenge. The concealed feeding habits of pink bollworm (PBW) larvae provide them with effective protection against conventional insecticides applied to the crop. In this evolving landscape of pest resistance, understanding the intricacies of host-seeking behaviour becomes paramount. The PBW's rapid development of resistance underscores the urgency to explore alternative strategies for effective pest management. Host cues, signaling • the presence of the preferred host, play a pivotal role in shaping insect behavior, particularly during crucial phases such as oviposition.

- Volatile profile analysis of G. hirsutum, G. raimondi, and G. indicum between 45-135 days after sowing was carried out utilizing GCMS
- GCMS protocol, incorporating time and solvent ratio, for compound identification using the NIST library was standardized.
- Compound compositions among species, within species across different plant parts, and over the study duration varied for the same plant part (Table 4.3.1).
- A total of 22 common compounds among G. hirsutum, G. raimondi, and G. indicum, were identified after 75 days of growth period.
- Bioactive roles of identified compounds, revealing insectspecific effects studied.
- Parallel experiment showed the same number of males can mate with nearly double the number of females, suggesting implications for population dynamics and reproductive strategies.

Table 4.3.1 Comparison of bioactive compounds within the species (G. hirsutum)

		Plant Parts		
Tender leaf	Matured leaf	Square	Flower bud	Flower
.alfaCopaene	.alfaCopaene	.alfaCopaene	.alfaCopaene	
Naphthalene- hexahydro-dimethyl	Naphthalene- hexahydro-dimethyl	Naphthalene- hexahydro-dimethyl		
.betaMyrcene	.betaMyrcene	.betaMyrcene		
trans-Geranylgeraniol		trans-Geranylgeraniol	trans-Geranylgeraniol	
Azelaic acid	Azelaic acid			
Octatriene-dimethyl	Octatriene-dimethyl			
Octylcyclopropene or derivatives		Octylcyclopropene or derivatives		
4H-Pyran-4-one, dihydro-dihydroxy-6- methyl				4H-Pyran-4-one, dihydro-dihydroxy-6- methyl
	Neophytadiene	Neophytadiene	Neophytadiene	
	Cycloundecatriene- tetramethyl	Cycloundecatriene- tetramethyl	Cycloundecatriene- tetramethyl	Cycloundecatriene- tetramethyl
Dodecatrien or derivatives	Benzenemethanol, 2- (2-aminopropoxy)-3- methyl-		3-Carene	(Trimethyl-(prop-1-en- 2-yl) cyclotetradeca- triene
Isobutyramide, N-hexyl	.alphaGuaiene			Cyclopentanedione
Benzofuran, -dihydro				Dotriacontane
Cyclohexane-ethenyl- methyl-bis (methylethenyl)				

# 4.4 Project Title: Development of EPF (Beauveria bassiana and Metarhizium anisopliae) & EPN based bio-formulation for sustainable management of pink bollworm and sucking pest complex in cotton

Shivaji Thube (PI); Co-Pl's: Prabhulinga T., Nandini Gokte-Narkhedkar

Importance of the study: Cotton (Gossypium spp.) is a major cash crop globally and plays a vital role in the textile industry. However, the cultivation of cotton is often plagued by various pests, with the pink bollworm (Pectinophora gossypiella) and a range of sucking pests being particularly notorious. These pests inflict severe damage to cotton crops, leading to significant yield losses and economic setbacks for farmers. In

addition, the extensive use of chemical pesticides to control these pests has raised concerns about environmental pollution, human health hazards, and the development of pesticideresistant pest populations.

Given the urgency to find sustainable and eco-friendly alternatives to chemical pesticides, this project aims to address these important issues.

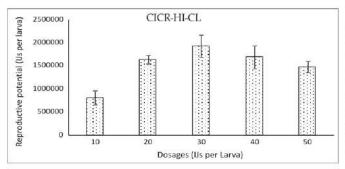
# Salient findings

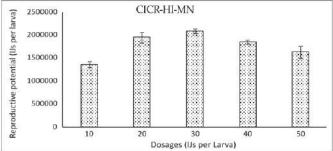
Two native strains of entomopathogenic nematodes (EPN), Heterorhabditis indica, denoted as CICR-HI-CL and CICR-HI-MN, were isolated and evaluated for their effectiveness against the pink bollworm (PBW).





- The larval bioassay showed that EPN strain CICR-HI-CL exhibited superior potency when compared to CICR-HI-MN against various PBW larval instars. Specifically, it had lower LD<sub>50</sub> values, indicating higher efficacy, with LD<sub>50</sub> values of 5.45, 4.45, and 4.60 infective juveniles (IJs) per larva for 2<sup>nd</sup>, 3<sup>rd</sup>, and 4<sup>th</sup> instar PBW larvae, respectively.
- In the pupal bioassay, both EPN strains were more effective when directly applied to PBW pupae as opposed to soil application. Strain CICR-HI-CL had an LD<sub>50</sub> value of 29.65 IJs per pupa, while CICR-HI-MN had an LD<sub>50</sub> value of 73.88 IJs per pupa when directly applied. In contrast, the LD50 values increased to 147.84 and 272.38 IJs per pupa for CICR-HI-CL and CICR-HI-MN, respectively, when applied to the soil.
- Both EPN strains demonstrated their ability to penetrate and reproduce within 4th instar PBW larvae. When inoculated with 30 IJs per larva, they produced a maximum of 19.28 and 20.85 lakh IJs per larva in the subsequent generation, indicating their capacity for population growth and persistence within the PBW larvae (Fig. 4.4.1).
- In the separate experiment involving Metarhizium anisopliaeTMBMA1, the study evaluated the efficacy of this fungal bio-insecticide against second instar PBW larvae. Larvae were exposed to varying concentrations of the fungus, resulting in mortality rates that ranged from 46.6% to 100%.
- The highest mortality rate (100%) was observed at the highest fungal concentrations, specifically at concentrations of 1×10<sup>9</sup> and 1×10<sup>10</sup> spores/ml.
   Conversely, the lowest mortality rate (46.6%) was noted at the lowest concentration of 1×10<sup>3</sup> spores/ml.
- Microscopic examination confirmed the external and internal infection PBW larvae with M. anisopliae.





**Figure 4.4.1.** Reproductive potential of *H. indica* strains (CICR-HI-CL and CICR-HI-MN) on  $4^{th}$  instar larvae of *P. gossypiella*. Errors bars indicate standard error of mean (SEM). Different letters on the bars indicate statistically significance difference across dosages within the *H.indica* strain using WASP software in completely randomized design at  $P \le 0.05$  level of significance.

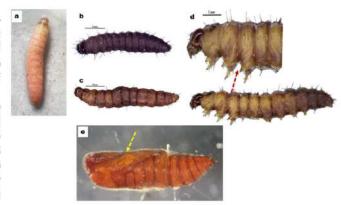


Fig 4.4.2. Infection of *H. indica* to *P. gossypiella* (a) Freshly inoculated larvae; (b) Brick red cadaver after 48 h of inoculation; (c) Yellowish brown larval cadaver after 72 h of inoculation; (d) Translucent larval cadaver with visible mass of EPN in larval haemocoel; (e) Translucent pupal cadaver harbouring *H. indica* within body

# 4.5 Project Title: Insecticide Resistance Management: Dissemination of Pink Bollworm Management Strategies

V.S. Nagrare (PI); Co-Pl's: V. Chinna Babu Naik, S.P. Gawande, B.B. Fand, D.T. Nagrale, S.S. Patil, K. Rameash, Rishi Kumar, Rachna Pande, Neelakanth Hiremani, S.K. Sain, J.H. Meshram, K. Shankarganesh, Prabhulinga T., Shivaji Thube

### Importance of the study:

The introduction of Bt cotton in India effectively managed infestations by major bollworms at initial period. However, the unexpected survival of PBW in 2008 in Gujarat indicated resistance to Cry1Ac, leading to escalated occurrences from 2014. In North India, PBW infestation was first observed in 2017-18, causing substantial damage and posing a threat to cotton production, impacting farmers and the economy. Over the last 7-8 years, the pest has become a severe menace, prompting the need for effective management strategies to ensure the long-term sustainability of cotton farming and protect the Indian economy. Hence, the project was formulated to disseminate effective PBW management strategies. This initiative becomes crucial to not only curb the immediate threat to cotton crops but also to safeguard the long-term sustainability of cotton farming, ensuring the well-being of cotton farmers and the resilience of the Indian economy.

ICAR-CICR led the project as the Nodal Institute, collaborating with 10 State Agricultural Universities and 6 ATARIs and involving 20 KVKs.

# Salient findings

- The project was implemented in 41 districts across 11 states covering 141 villages and 1550 acres in the 2022-23 season
- Comprehensive strategies included cultural practices, biological controls, and judicious pesticide use was recommended to the beneficiary farmers.
- IRM fields received an average of 5.12 sprays, significantly lower than 7.91 in non-IRM fields.
- IRM fields showed a notable 18.14% advantage with an average seed cotton yield of 1908 kg/ha compared to 1615 kg/ha in non-IRM fields.
- The accrued Benefit: Cost ratio stood at an impressive 2.33:1.





- Furthermore, the project showcased a reduction in pesticide usage in IRM fields, both in terms of cost (34.63%) and volume (38.13%) compared to non-IRM .
- Demonstrations on the use of Gossyplure 4% (RTU) against PBW were conducted on 500 acres across 20 districts in 9 cotton-growing states, benefitting from a collaborative PPP mode involving ICAR-CICR, ATARI, SAU-KVK, and ATGC Biotech, Hyderabad.
- Rigorous outreach programs were conducted with extensive efforts in IRM villages, including 1075 field visits, 43 farmer trainings, 32 sensitization workshops, 582 mobile messages, 27 exhibitions, 93 training workshops, 29 TV programs, 43 radio talks, and addressing 6924 farmer queries.
- In this project, five farmers' fairs were organized, 667 lectures were delivered, and there were 7723 farmer interactions.
- In North India, IRM fields experienced 8.83% infestation, compared to 14.33% in non-IRM fields.
- A reduction in PBW infestation was recorded from 9.35% to 5.73% in Central India.
- IRM fields in South India recorded a 7.51% PBW infestation compared to 10.74% in non-IRM fields.
- Overall, a 35.88% reduction in pink bollworm infestation was observed in IRM fields compared to non-IRM fields during the 2022-23 season.

# 4.6 Project Title: Crop pest surveillance and advisory project (CROPSAP) in Maharashtra.

V. S. Nagrare (PI), Co-PI: B.B. Fand

# Importance of the study:

The state of Maharashtra, covering about one-third of India's total cotton cultivation, is crucial for cotton production, often intercropped with soybean and pigeon pea. However, biotic stresses like pests and diseases pose threats to yields. To address this, the Agriculture Department initiated the e-Crop pest surveillance and advisory project (CROPSAP) in 2009-10, employing Information and Communication Technology (ICT). In collaboration with ICAR Institutes, State Agriculture Universities, and government agencies, including NIPHM and MAIDC, the project focuses on major crops like cotton, soybean, rice, pigeon pea, sugarcane, and chickpea. CROPSAP utilizes real-time monitoring and timely advisories, especially when pest populations exceed economic threshold levels (ETL). ICAR-CICR plays a pivotal role, formulating Integrated Pest Management (IPM) strategies tailored for cotton and providing pest-specific advisory capsules. The project establishes a model for sustainable and technology-driven agricultural practices in Maharashtra, safeguarding crops and fostering collaboration among various stakeholders.

# Salient findings

- A total of 40 growth stage-wise advisories for pest and disease management were issued.
- Four comprehensive training sessions and lectures to enhance farmer awareness were conducted.
- Field visits in eight districts, analyzing pest infestation scenarios were executed.
- PBW infestation started escalating from the 30<sup>th</sup> SW in three villages, achieved peak in the 35<sup>th</sup> and 38<sup>th</sup> SW, then diminishing occured (Fig. 4.6.1).

- Pink bollworm infestation in 2022-23 was significantly lower than the previous years (2020, 2021) (Fig. 4.6.2).
- Jassid population crossed ETL in 12 villages from the 30<sup>th</sup> SW and persisted throughout the season. Peak jassid incidence was recorded during the 35<sup>th</sup> SW, 38<sup>th</sup> SW, and 39<sup>th</sup> SW (Fig. 4.6.3).
- Boll rot disease remained minimal, affecting a maximum of six villages during the 41<sup>st</sup> and 42<sup>nd</sup> SW (Fig. 4.6.4).
- Compared to the previous season (2021-22), boll rot incidence was significantly lower in 2022-23.
- Whitefly, thrips, and other bollworms (Helicoverpa armigera & Eariasvittela) showed negligible infestation in observed districts.

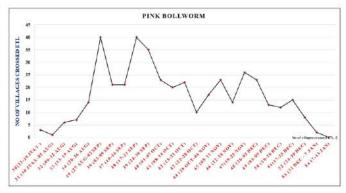


Fig 4.6.1 Pink bollworm infestation crossed ETL in a number of villages over the season 2022-23 in Maharashtra

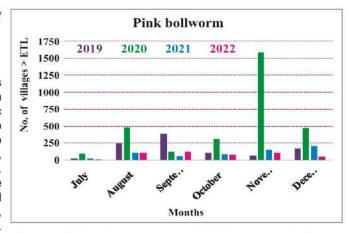


Fig 4.6.2 Pink bollworm crossed ETL in number of villages over the years (2019-22)

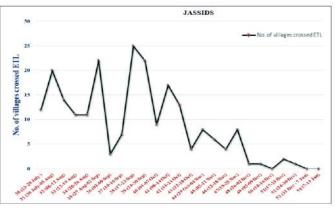


Fig 4.6.3Jassid infestation crossed ETL in number of villages over the season 2022-23 in Maharashtra





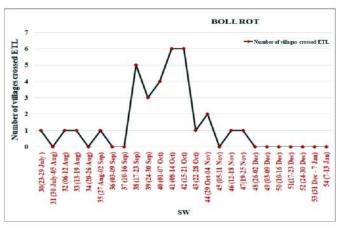


Fig 4.6.4 Boll rot incidence in number of villages over the season 2022-23 in Maharashtra

# Population dynamics of sucking pests at ICAR-CICR experimental farm

- The experimental field study on population dynamics reveals that, until the first week of October, the numbers of cotton jassids, whitefly, and thrips were slightly elevated but started decreasing as the season progressed, falling below the Economic Threshold Level (ETL).
- Notably, the jassid population never exceeded the ETL, while whitefly reached a peak of 16.24 whitefly/3 leaves by the 46th week, still below the ETL, mirroring the trends observed for thrips and aphids (Fig 4.6.5).

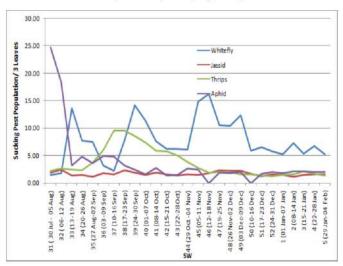


Fig 4.6.5 Population dynamics of sucking pests over the season in RCH 2 during 2023-24

# Pink bollworm infestation in non-Bt and Bt cotton

- In non-Bt cotton (Suraj), pink bollworm infestation crossed the Economic Threshold Level (ETL) (>10% green boll infestation) from 41 SW (8-14 Oct), reaching its peak at the end of the cropping season.
- In RCH 2 BGII, pink bollworm infestation exceeded the ETL three weeks later, during 44 SW (29 Oct - 04 Nov), intensifying throughout the season. Although, both Bt and non-Bt cotton experienced a steady increase in infestation, non-Bt cotton exhibited a 43% higher pink bollworm Fig 4.6.8 Sticky trap catches of Jassid and whitefly during infestation compared to Bt cotton (Fig 4.6.6).

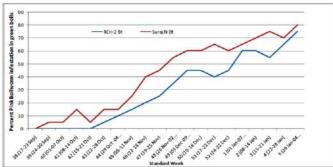


Fig 4.6.6 Pink bollworm infestation in Bt and non-Bt cotton during 2023-24

# Pheromone trap catches at ICAR-CICR experimental farm

- In 2023, PBW moth catches were minimal from 33 SW to 43 SW, but a sudden increase occurred from 43 SW onwards, peaking in the first week of December and the fourth week of January.
- Negligible catches of cotton bollworm and spotted bollworm were noted throughout the season, while tobacco caterpillar moth catches fluctuated, with over 10 catches in September to October, yet without evident infestation on cotton (Fig 4.6.7).

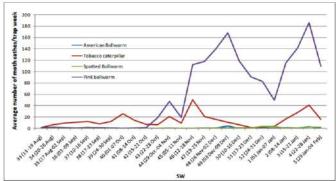
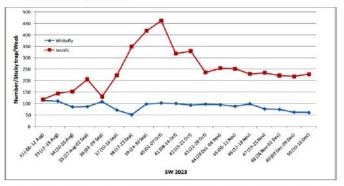


Fig 4.6.7. Pheromone trap catches during 2023 (Nagpur)

# Yellow sticky trap catches of cotton jassid and whitefly

- Yellow sticky traps captured the cotton jassids starting from the second week of August, with catches increasing until reaching a peak at 40SW (01-07 Oct), after which they gradually declined.
- Whitefly trap catches ranged from 52 to 115 whiteflies per trap, and no significant peak was observed throughout the season (Fig 4.6.8).



2023-24



# 4.7 Project Title: Investigations on bio-efficacy of Importance of the study: entomopathogens against cotton pinkbollworm, Pectinophoragossypiella Saunders

V.S. Nagrare (PI); Co-PI's: V. Chinna Babu Naik, S.P. Gawande, D.T. Nagrale, J. Gulzar Banu

# Importance of the study:

The resurgence of pink bollworm in all three cotton-growing regions of India posed a significant threat to both cotton cultivation and the nation's economy. The larvae of the pink bollworm are internal feeders, residing within the green bolls and consuming developing seeds, rendering conventional chemical control methods less effective against them. To address this challenge, a range of pest management strategies is being explored, with particular attention to the potential of entomopathogens as biological control agents. These include bacteria, fungi, viruses, and entomopathogenic nematodes (EPNs). This project focuses on the comprehensive characterization of entomopathogens associated with pink bollworm larval infections across diverse geographic locations. Furthermore, it investigates the bio-efficacy of these entomopathogens against pink bollworm populations under both laboratory and field conditions. By elucidating the traits and effectiveness of these natural control agents, this research aims to contribute to the development of sustainable and environmentally friendly approaches for managing pink bollworm infestations in cotton fields.

# Salient findings

- A comprehensive sampling effort spanning three years . involved the collection of around 16,000 green cotton bolls from diverse geographic locations.
- Dissection of these bolls led to the identification of 210 deceased pink bollworm larvae, from which 5 fungal isolates and 30 bacterial isolates were obtained as entomopathogens.
- No virus infection was observed in the investigated infected larvae.
- Larval assay and ovicidal effects of entomopathogenic nematodes (EPN) were conducted.
- The efficacy of entomopathogens including B. bassiana, M. anisoplie, L. lecanii, EPN, and HaNPV against pink bollworm was evaluated under both laboratory and field conditions.
- Soil baiting with pink bollworm larvae resulted in the discovery of a native isolate of entomopathogenic nematode, Steinernema siamkayai.
- S. siamkayai demonstrated significantly higher mortality of pink bollworm larvae and pupae compared to Heterorhabditis indica and S. glaseri under in vitro conditions.
- The study revealed that nematode multiplication in larvae and pupae increased with the rise in nematode concentration up to 50 infective juveniles (IJ), after which the multiplication rate showed a declining trend.
- Among the three entomopathogenic fungi tested, B. bassiana caused significantly higher mortality of pink bollworm larvae than M. anisoplie and L. lecanii.

# 4.8 Project Title: Investigations on host plant resistance mechanisms in cotton genotypes against thrips

T. Prabhulinga (PI); Co-Pl's: ShivajiThube, PoojaVerma

Cotton, a crucial fibre crop globally, is extensively cultivated for its fibres, vital to the textile industry. Despite its significance, cotton cultivation faces severe challenges from various pests and diseases, resulting in significant yield losses. Thrips, belonging to the order Thysanoptera, pose a major threat by causing substantial damage to cotton plants through feeding on young leaves and buds. While traditional chemical pest control methods are commonly used, they are costly, environmentally harmful, and contribute to thrips resistance development. Therefore, there is a pressing need for alternative, sustainable approaches to thrips management to ensure the long-term sustainability of cotton production. Resistance breeding emerges as a viable and sustainable strategy, and the exploration of traits from wild relatives/genotypes for resistance breeding is crucial. Consequently, a project has been formulated to investigate host plant resistance mechanisms in various cotton genotypes.

### Salient findings

- Field and glasshouse screening of 93 cotton genotypes, including indigenous and exotic varieties, was conducted against thrips, with 82 being G. hirsutum, nine G. arboreum, one G. herbaceum, and one G. barbadense.
- Thrips damage assessments were recorded for all genotypes at four intervals, along with observations on plant height, leaf area, gossypol gland density, trichome hair density, and chlorophyll content.
- Based on the assessment of thrips damage grades, identified specific genotypes for subsequent screening in the upcoming season. These selected genotypes include G. hirsutum varieties (GISV-267, NH615, AG-8, SMP-1855, 183059-4, SMP-1833, MCV-5VT, NH-545), commercial hybrids of G. hirsutum (Kaveri seeds-KCK-14K59, Agriseeds-SWCH-4753, Veda seeds-KSCH-212, Nuziveedu-NSC-929, Aditya-KCH-15K39, Bioseeds-GHH-029, and Srikar-605566), G. arboreum selections (Phule Dhanwantary, AKA-8, AKA-7, CNA-1003, CNA-1032), and a G. herbaceum genotype (Jayadhar).
- Thrips species composition was determined, including Thrips tabaci, Thrips palmi, Scirtothrips dorsalis, Asprothrips bimaculatus, and Thrips hawaiiensis.

# 4.9 Project Title: Rasi Seeds: Evaluation of nectarilessRasi cotton hybrids against bollworms

# V. Chinna Babu Naik (PI)

# Importance of the study:

The recent Pink Bollworm (PBW) outbreak in Bt cotton has resulted in significant damage, rendering existing management strategies ineffective in reducing pest incidence and crop yield losses. Urgent attention is required to develop environmentally friendly and sustainable management strategies against bollworms. Given the development of resistance to pesticides in bollworms, current investigations focus on utilizing host plant resistance traits, such as nectariless cotton genotypes, to suppress the bollworm complex at the field level.

# Salient findings

Field evaluation of different nectariless Rasi cotton hybrids against Pectinophora gossypiella and Helicoverpa armigera infestation at various stages indicate that, treatments T4: THCT-20-7850, T5: THCT-20-7852, and T6: THCT-21-8773 exhibited significantly lower infestation level compared to other



treatments. This suggests potential resistance or deterrent effects of these hybrids against the *Pectinophora gossypiella* and *Helicoverpa armigera*, highlighting their importance in pest management strategies for cotton production.

The laboratory evaluation of hybrids shows that T6: THCT-21-8773 consistently exhibited the lowest populations of *Pectinophora gossypiella* and *Helicoverpa armigera* eggs, suggesting a potential resistance or deterrent effect against both pests. This performance was statistically comparable to that of T5: THCT-20-7852 and T4: THCT-20-7850, indicating the effectiveness of these hybrids in controlling bollworm infestations under controlled conditions.

# 4.10 Project Title: Multi-pronged and Bio-rational management of pink bollworm, *Pectinophora gossypiella* (Saunders) on cotton in India

V. Chinna Babu Naik(PI); Co-PI (s) - YG, Prasad, BB Fand, Rishi Kumar and K Rameash

#### Importance of the study:

Bollworms are the major menace in cotton cultivation causing significant yield loss for more than three decades. The study's importance lies in addressing the longstanding challenge of bollworms in cotton cultivation, particularly the economically damaging PBW. This pest's impact on cotton, especially during mid to late crop stages through internal feeding behavior, results in significant yield reduction and quality deterioration. The introduction of Bt cotton initially provided effective control over bollworm complexes but subsequent resistance development, notably by Pink Bollworm, has necessitated a shift towards alternative eco-friendly measures due to increased pesticide use and insect resistance issues. Therefore, this project aims to investigate the efficacy of mass trapping of PBW males and the impact of the egg parasitoid *Trichogramma bactrae* for managing PBW infestations.

# Salient findings

- The trials conducted across different locations in Nagpur, Chandrapur, and Amravati in farmers' fields assessed the impact of mass trapping of PBW using varying trap densities.
- The results showed a clear correlation between trap numbers and moth catches, with T7 (40 traps/acre) recording the highest moth numbers and T2 (8 traps/acre) the lowest. Higher trap densities led to reduced boll infestation percentages, with T1 (control) and T2 (8 traps/acre) exhibiting the highest infestation and T7 (40 traps/acre) the lowest. This decrease in infestation by up to 20% compared to the control demonstrates the effectiveness of mass trapping in reducing PBW infestations and increasing yield potential by 1-2 quintals per acre. Overall, mass trapping using pheromone traps has proven to be a significant and effective method for controlling pink bollworm infestations in cotton fields, leading to improved yields. A field trial was conducted at ICAR-CICR, Nagpur to assess the efficacy of the egg parasitoid T. bactrae in managing PBW infestation in cotton. The trial included eight treatments with varying release schedules of T. bactrae and a control treatment . using chemical spray. Observations were made on rosette infestation and green boll infestation at regular intervals. Results showed that rosette infestation was lowest with five and six releases of T. bactrae, comparable to chemical control, while green boll infestation was also reduced with ...

these releases. Notably, the five and six releases of *Trichogramma* resulted in the lowest pink bollworm infestation compared to other treatments.

4.11 Project Title: Evaluation of mating disruption technology of wax based Gossyplure 4 % (RTU) formulations against pink bollworm on cotton in PPP mode (ICAR-CICR, ATARI, SAU-KVK & ATGC Biotech, and Hyderabad) (2023)

# V. Chinna Babu Naik (PI)

# Importance of the study:

Mating disruption technology (MDT) is a wax-based formulation having sustained-release pheromone leads to the mating disruption and prevents insect pests from reproducing. Simulation of emitting the natural pheromone of female insects that causes males to become confused and incapable of locating a female to mate with. This results into collapse of insect pest population due to reduced mating rates. Hence, its evaluation under real field condition is very important for its inclusion in the pest agent strategies designed for the management pink bollworm.

# Salient findings

The "Evaluation of mating disruption technology of wax based *Gossyplure 4% (RTU)* formulations against pink bollworm on cotton in PPP mode" was conducted across the different cotton growing zones in India in 20 KVKS covering area of 500 acres across the India. The results found that the difference in rosette flower (%), green boll damage (%), locule damage (%) and moth catches of pink bollworm in *Gossyplure* treated and untreated plots across the Northern, Central and Southern cotton growing zones of India. The average green boll damage of treated and untreated cotton plots of Northern (5.67 and 8.53%), Central (2.89 and 6.14%) and Southern (5.98 and 10.08%) were recorded. Southern zone exhibited the highest infestation of pink bollworm, with comparatively higher infestation in untreated plots across the three zones.

# 4.12 Project Title: Studies on target leaf spot of cotton caused by Corynespora cassiicola

S. P. Gawande (PI); Co-PI's: S. K. Sain, Chandrashekar N.

# Importance of the study:

Present investigation was proposed to gather the information on the target leaf spot of cotton; an emerging disease, for location specific management, which is presently lacking. More data on distribution across Indian cotton acreage disease onset and diversity are needed to understand disease development and potential impact on cotton yield.

#### Salient findings

- Roving surveys were conducted across 48 locations in 22 cotton-growing districts in India.
- Incidence of C. cassiicola in cotton assessed using a 0 to 4 scale, with most locations showing symptoms at grades 1 to 2 (2-15% incidence).
- Higher incidence (exceeding 40%) observed in some locations in Maharashtra.
- Onset of target spot symptoms observed as early as the last week of August (60-70 days after sowing).
- Initial symptoms appeared as irregular, circular, brick-red





- spots with dark borders and tan to light brown centres on the lower plant canopy. Gradually infected leaves displayed small circular to irregular dark red spots (2 mm to 10 mm) with necrotic lesions, characteristic of "target spot" symptoms (Fig. 4.12.1).
- Nine fungal isolates were sent to NAIMCC, NBAIM, Mau, for deposition, and obtained accession numbers (Table. 4.12.1).
- · Radial phylogenetic analysis revealed a close association
- between published isolates and those collected across India (Fig. 4.12.2).
- ISSR analysis categorized isolates into three distinct clusters based on dendrogram generated through UPGMA analysis. Cluster 1 comprised 27 isolates from Maharashtra, Andhra Pradesh, and North India, further subdivided into two sub-clusters (1A, 1B). Clusters 2 and 3 consisted of 21 isolates from Central India and North India, respectively (Fig. 4.12.3).

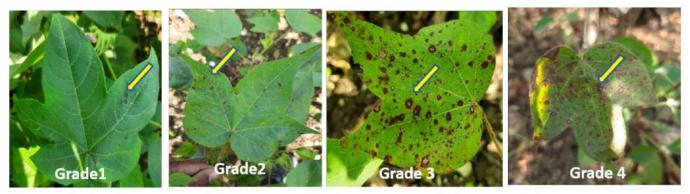
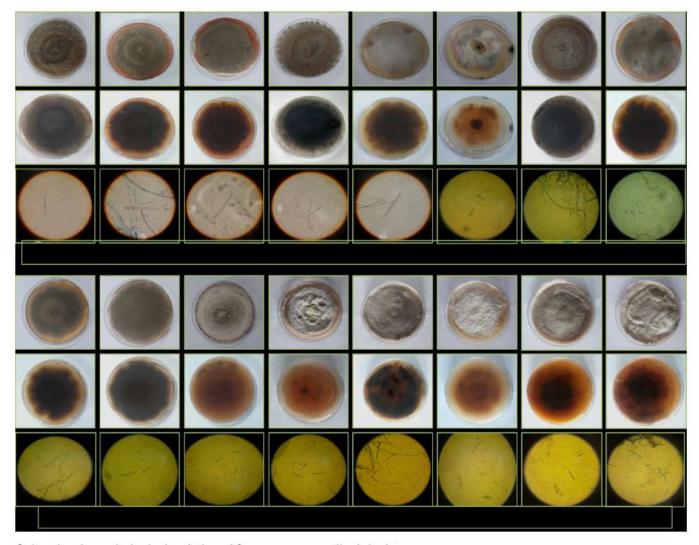


Fig. 4.12.1 Grade-wise symptoms of Target spot caused by Corynespora cassiicola on cotton leaf



Cultural and morphological variation of Corynespora cassiicola isolates





Table 4.12.1. Fungal cultures submitted to NAIMCC-NBAIM, Mau

Code	GPS Location	Location	NAIMCC-Acc No.
CS01	29.546096N, 75.037421E	Sirsa, Haryana	NAIMCC-F-04403
CS02	29.545564N, 75.035017E	Sirsa, Haryana	NAIMCC-F-04404
CS04	29.542820N, 75.037324E	Sirsa, Haryana	NAIMCC-F-04405
CS06	29.933646N, 73.896577E	Sriganganagar, Rajasthan	NAIMCC-F-04406
CS07	30.673546N, 74.744642E	Faridkot, Punjab	NAIMCC-F-04407
CS09	29.363724N, 75.231026E	Fatehabad, Haryana	NAIMCC-F-04408
CS10	29.855954N, 75.414584E	Hisar, Haryana	NAIMCC-F-04409
CS11	29.196487N, 75.677929E	Hisar, Haryana	NAIMCC-F-04410
CS13	21.169642N, 72.797612E	Surat, Gujarat	NAIMCC-F-04411

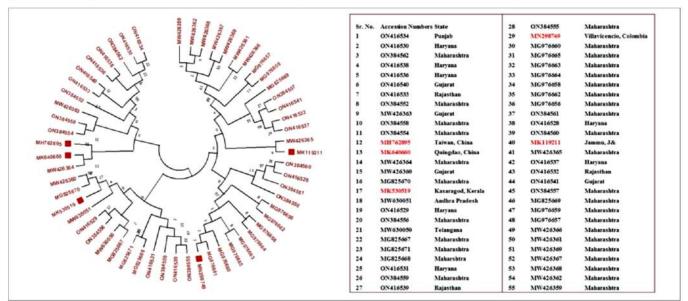


Fig .4.12.2 Radial Phylogeny based on ITS sequences C.cassiicola isolates

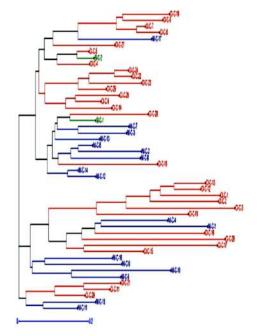


Fig.4.12.3 Dendrogram of Corynespora cassiicola isolated from major cotton growing regions of India using ISSR

(Where NI-C1-C17= Isolates from North India, CI-C1-C29= Isolates from Central India, SI-C1, C2= Isolates from South India)

# 4.13. Project Title: Studies on boll rot in cotton-Etiology and Management

D. T. Nagrale (PI); Co-PI: B. B. Fand

# Importance of the study:

Boll rot disease complex in cotton is an emerging problem in major cotton growing zones of the country since it not only affects the fibre and seed quality but also reduce the total seed cotton yield. Diverse group of the pathogens are involved in boll rot disease which are observed in different agroclimatic zones and cultivation practices. In the climate change scenario, boll rot problem has also posed great challenges to cotton production and therefore it is important to understand the etiological factors, insect-pathogen relationship and to devise the suitable management practices for the disease complex.

# Salient findings:

 Comprehensive survey and sampling of boll rot disease complex across Maharashtra, Telangana, and Madhya Pradesh were conducted.





- Bacterial and fungal pathogens associated with boll rot were characterized and subsequently symptomatology and pathogenicity were studied and their impact on both Bt cotton hybrid (BG-II) and non-Bt variety (cv. Suraj) were demonstrated.
- Determined Thiram 37.5%+Carboxin 37.5% WS@ 0.35% as the optimal seed treatment fungicide and identified Carbendazim 50 WP@0.04%, Propiconazole 25 EC@
- 0.1%, Propineb 70% WP @0.25% and Captan 70% + Hexaconazole 5% WP @ 0.15% as effective fungicides against prevalent fungal boll rot pathogens under in *vitro* and in vivo conditions (Table 4.13.1).
- Favourable conditions for reduced boll rot severity in BG-II
  hybrids were identified and Thrips sp. vectoring *Pantoea*spp., intensifying internal boll rot were studied. (Table
  4.13.2).

### Bacterial boll rot











Fungal boll rot











Symptomatology caused by bacterial and fungal pathogens on upland cotton

Table 4.13.1 Field assessment of boll rot disease complex during 2022-23

Sr.	Treatment		Disease :	severity	(%) PDI*(	0-4 scale)		Mean
No.			C	bservati	ion at day	'S		
		75	90	105	120	135	150	
٦.	Copper oxychloride 50% WP (0.25%)	6.7	11.7	16.7	6.7	8.33	8.33	9.74
2.	Kasugamycin 5%+ Copper oxychloride 45 WP (0.06%)	11.67	8.3	6.7	8.3	11.67	13.33	10.00
3.	Copper sulphate 47.15%+Mancozeb 30% WDG (0.5%)	6.7	8.33	8.3	6.7	11.7	8.33	8.34
4.	Captan 70%+Hexaconazole 5% WP (0.15%)	5	11.67	6.7	8.3	8.33	6.7	7.78
5.	Propineb 70% WP (0.25%)	6.7	8.3	8.3	6.7	8.3	11.67	8.33
6.	Carbendazim 50 WP (0.04%)	0	0	6.7	11.67	8.3	8.3	5.83
7.	Propiconazole 25% EC (0.1%)	3.3	0	6.7	8.33	6.7	8.3	5.56
8.	Copper oxychloride 50% WG (0.3%)	0	16.67	3.3	13.3	11.67	8.33	8.88
9.	Bronopol (0.2%)	11.7	8.33	8.33	10	11.67	8.33	9.73
10.	Thiram 37.5%+carboxin 37.5% DS (0.035%) Seed treatment only	0	16.7	13.3	15	8.33	11.7	10.84
11.	Control	11.67	26.7	26.7	15	20	26.7	21.13

Table 4.13.2 Transmission of boll rot disease by thrips in cotton during crop growing seasons 2022-23

Treatment details	Incidence of	boll rot (%)
	2022-23	Mean
Bolls developed from the flowers of cotton plants on which thrips culture was maintained	14.67±4.18 (20.26±5.700	11.00±3.67 (15.20±5.07)
Bolls developed from the flowers of cotton plants on which culture of <i>Pantoeadispersa</i> was inoculated and after one week of inoculation, thrips were allowed to feed for 72 h	65.95±4.79 (54.43±2.860	60.12±5.83 (50.95±3.48)





Treatment details	Incidence of	boll rot (%)
	2022-23	Mean
Bolls developed from the flowers of cotton plants on which thrips were transferred from <i>Pantoeasp</i> . inoculated flowers	68.33±1.86 (55.79±1.180	69.17±0.83 (59.39±3.61)
Bolls developed from the flowers of cotton plants which were maintained completely free from thrips (control)	10.71±3.03 (17.16±4.81)	8.45±2.16 (13.21±3.95)
F-test	48.16	191
SE(m)±	1.36	S#7
CD	4.18	(#0):
CV (%)	0.92	-

# 4.14. Project Title: Studies on grey mildew disease of cotton caused by Ramularia areola

# Neelakanth Hiremani (PI); Co-PI: P. Valarmathi Importance of the study

Grey mildew disease was first reported on upland cotton, then it spread to all the cultivated cotton species. The constant shift in this disease over the years may be due to the variability existing among the pathogen. There is very limited information is available regarding the pathogenic and genetic variability of *R. areola* making it difficult to manage either through resistant cultivars or through fungicides.

### Salient findings

- The isolation of grey mildew pathogen Ramularia areola was re-attempted on different media by employing standard methodologies. None of the media or method helped to isolate the exact pathogen as morphological characters and ITS sequence analysis revealed growth of other fungi like Fusarium, Colletotrichum, Alternaria, Corynespora, Nigrospora etc.
- A field trial was taken with 40 popular Bt hybrids to assess

- the severity of grey mildew disease at 90 and 120 DAS (Fig. 4.14.1). The severity of grey mildew disease was low at 90 DAS wherein highest mean PDI recorded was 17.78%. However, the severity of the disease increased at 120 DAS in almost all the hybrids and reached a highest mean PDI of 68.0%.
- A field trial with eight treatments was taken to identify the best management approach against the disease. Bt hybrid RCH-530 was sown along with two infector rows of PA-740 and PA-810. Spraying of the respective bioagent/ chemical was taken at two different intervals e.g at 90 DAS and 110 DAS. The results revealed that (Fig. 4.14.2), T6 (foliar spray of Trichoderma harzianum-Trichocash @ 5gm/Lat 90 DAS + propineb @3ml/L at 110 DAS showed highest reduction in disease (34.02%) over control followed by T1 (foliar spray of T. harzianum-Trichocash @ 5gm/ L at 90 and 110 DAS). Whereas, in case of T5 (Foliar spray of combi product Azoxystrobin 18.2% + Difenoconazole 11.4% @ 90 and 110 DAS) though the reduction in disease was comparatively less (15.8%), it may be inferred that the spraying of the said chemical at 90 DAS resulted in low disease severity.

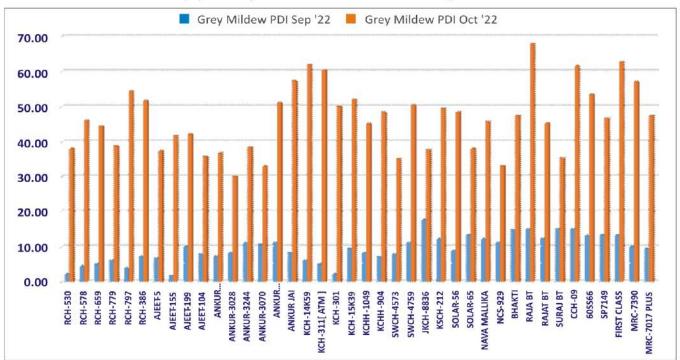


Fig 4.14.1 Mean percent disease index (PDI) of grey mildew disease in 40 different popular Bt hybrids of cotton at 90 and 120 DAS.





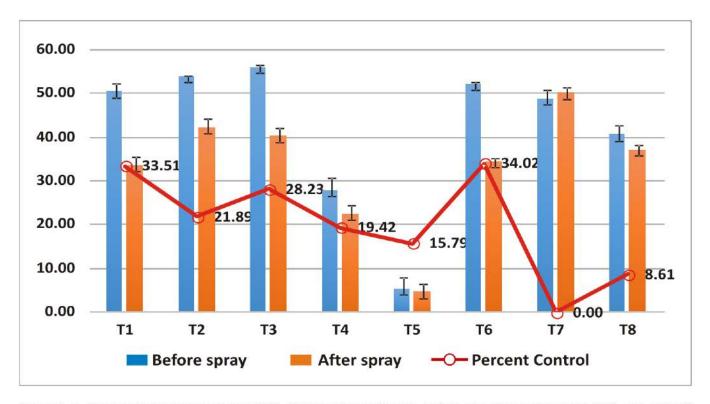


Fig 4.14. 2. Mean percent disease index (PDI) of grey mildew disease before and after spray at 110 DAS and percent reduction in disease over control. Where, T1 (Foliar spray of T. harzianum @ 90 and 110 DAS), T2 (Foliar spray of Pseudomonas fluorescens@ 90 and 110 DAS), T3 (T1 + T2), T4 (Foliar spray of Kresoxim methyl @ 90 and 110 DAS), T5 (Foliar spray of combi product Azoxystrobin 18.2% + Difenoconazole 11.4% @ 90 and 110 DAS), T6 (Foliar spray of T. harzianum@ 90 DAS + Propineb @110 DAS), T7 (untreated control) and T8 (Foliar spray of Kresoxim methyl @110 DAS) are different treatments.

# **REGIONAL STATION - COIMBATORE**

# 5.1. Development of high strength cotton genotypes by under both irrigated and rainfed conditions and identification reducing the short fibre content

# S. Manickam (PI), Co-PIs: A.H. Prakash and J. Gulsar Banu Importance of the study:

Fibre quality, especially fibre length, tenacity and micronaire assumes significance for determining the usefulness of the fibre for spinning into yarn. Ideal combination of these characters for a given length is still more important. The development of high strength cultures of long staple category will be useful for spinning good quality yarn of higher counts.

### Salient Findings

The compact ideotype long staple cotton variety CICR-H Cotton 54 (Nano) has been notified for both Central and South Zone. The mean and potential yields as well as fibre quality parameters of the variety are furnished in Table 5.1.1. The variety has a yield potential of 2859 kg/ha under irrigated conditions of South Zone, 2963 kg/ha in irrigated conditions of Central Zone and 2381 kg/ha in rain fed situations of South Zone with good combination of fibre quality attributes.

One hundred and twenty-five progeny bulks of long staple cultures were seed multiplied for further evaluation and utilization. CCH 19-2 progenies were multiplied which is in advanced stage of multi-location evaluation in ICAR-AICRP on Cotton trial. The genotype CCH 19-2 (Fig.5.1.1) showed excellent fibre quality in Coordinated Variety Trial of South Zone

proposal has been submitted (Table 5.1.2).

Fig 5.1.1. (a) Plant of CCH 19.2, (b) Flower of CCH 19.2, (c) Green boll of CCH 19.2, (d) Burst boll of CCH 19.2





Table 5. 1. 1. Performance of CICR-H Cotton 54 (Nano) in ICAR-AICRP Trials over the years

Character	South Zo	one (Irrigated)	Central Zo	ne (Irrigated)	South Zone (Rainfed)		
	Mean	Potential	Mean	Potential	Mean	Potential	
Yield (kg/ha)	2123	2859	1815	2963	1469	2381	
UHML (mm)	30.8	33.7	30.1	33.6	29.4	32.1	
Micronaire (µg/inch)	4.1	4.9	3.7	4.3	3.9	4.8	
Tenacity (g/tex)	30.8	33.2	30.2	35.5	30.4	32.3	

Table 5.1.2. Performance of CCH 19-2 in ICAR-AICRP South Zone Trials over the years

Character	Irrig	ated	Rainfed		
	Mean	Potential	Mean	Potential	
Yield (kg/ha)	2035	2929	1377	2503	
UHML (mm)	31.7	34.0	31.2	33.6	
Micronaire (µg/inch)	3.9	4.4	4.0	5.4	
Tenacity (g/tex)	30.9	34.9	30.7	33.6	

# 5.2. Breeding for high yielding, early maturing sucking pest Salient Findings tolerant extra-long staple G. barbadense genotypes with Fibre profiling of ELS cotton (G. barbadense) released improved fibre properties

### PI: A. Manivannan Co-PI: K. Rameash

Importance of the study: In order to cater the need of Extra Long Staple (ELS) cotton demand of the country, the project envisaged to develop high yielding with superior fibre quality G. barbadense premium varieties.

# varieties

Fibre profiling of CICR B Cotton 37 and CICR B Cotton 45 variety was done from CIRCOT, Mumbai and SITRA, Coimbatore independently. The average of both results showed the following attributes of CICR B cotton 37 with a length of 35.8 mm, strength of 38.45 and micronaire of 3.65; CICR B cotton 45 with a length of 35.65 mm, strength of 36.75 and micronaire of 3.3 (Table 5.2.1).

Table 5.2.1. Fibre properties of ELS cotton (G. barbadense) released varieties

Varieties	Fibre traits	CIRCOT	SITRA	Mean
CICR B Cotton 37	UHML (mm)	35	36.6	35.80
	Strength (g/tex)	39	37.9	38.45
	Micronaire (mic)	3.7	3.6	3.65
CICR B Cotton 45	UHML (mm)	33.8	37.5	35.65
	Strength (g/tex)	37.4	36.1	36.75
	Micronaire (mic)	3.3	3.3	3.30

Promising ELS genotypes in AICRP trials during 2022-23: Seed multiplication: Mass multiplication of seeds of released CCB6 and CCB 29 (CVT Br 14a); CCB22-1, and CCB22-2 (IET Br12a)

Insect resistant lines: CCB-25 and CCB-28 for Aphids; CCB-28 for both Aphid and Jassid tolerant were identified for sucking pest tolerance.

Evaluation of Advanced Progenies for sucking pest tolerance: BC<sub>2</sub>F<sub>10</sub> generation of high yielding and sucking pest tolerance were evaluated namely H, - Suvin x (ICB-241 x CCB-29), H<sub>2</sub>- Suvin x (EC-18 x CCB-3), H<sub>3</sub>. Suvin x (ICB85 x CCB-29), H<sub>5</sub> - Suvin x(ICB126 x CCB-29), H<sub>6</sub> - Suvin x(ICB124 x CCB-29), H<sub>7</sub>-Suvin x(ICB124 x CCB-6), H<sub>8</sub>-Suvin x (ICB-124 x CCB-5), H<sub>9</sub> - Suvin x (ICB-27 xCCB-12), H10 -Suvin x (ICB-214 xCCB-6), H<sub>11</sub>- Suvin x (EC18 xCCB-29).

Germplasm: A set of 327 G. barbadense germplasm lines is being maintained at CICR, Regional Station, Coimbatore. Around 210 Exotic Accessions (EA) were evaluated for their establishment in pot culture.

Spontaneous mutants: Brown linted fibres identified from the EA 203, Big boll from EA159 were send for multi-location testing for registration as new genetic stock (Fig 5.2.1)

varieties CICR B Cotton 37, CICR B Cotton 45, and CICR B Cotton 55; AICRP trials cultures (CCB 22-1, CCB 22-2) and advance cultures (CCB 3, CCB 4, CCB 5, CCB 7, CCB 8, CCB 12, CCB 13, CCB 28, CCB 64, CCB 64B, CCB 129, CCB 141, CCB 142).





Fig. 5.2.1. Mutants derived from advanced cultures of G.barbadense; a) brown (EA 203) and b) Big boll (EA159)





# 5.3 Induced mutagenesis for improvement of ELS cotton Fast Neutron (FN) was used as a source of inducing mutation in (G.barbadense)

PI: A. Manivannan; Co-PIs: K. Rathinavel, K. Shankarganesh, A. Sampathkumar

Importance of the study: Ginning out Turn (GoT) is an important trait to increase the fiber yield to improve the cotton production. Fast Neutron (FN) is an advanced mutagenic agent which is employed in the traditional variety of G. barbadense, Suvin for increasing its GoT.

#### Salient Findings

A Sum of 125 plants from M<sub>s</sub> population that showed higher GoT and yield traits were selected and advanced to Ma generation.

the popular variety suvin in order to increase the Ginning out turn (GOT) percentage. In M2, progeny, the highest heritability was observed for the traits, days to maturity, number of monopodia and number of sympodia. Moderate heritability was observed for days to flowering, boll weight and number of bolls. However low heritability was found for the trait GOT. It was observed in the range of 27.1 to 39%. Spectrum of mutant like Variegated, Chlorina, and Glandless were observed in M<sub>3</sub> (Fig 5.3.1 a, b, c). In M<sub>3</sub> Generation, percentage of germination was recorded as 67.8%, survival percentage was 49.6% and reduction in survival percentage over check (suvin) is 31.3% (Table 5.3.1).







a) Variegated

b) Chlorina

c) Glandless

Fig. 5.3 1. a, b, c. Spectrum of mutants observed in M, generations

Table 5.3.1. Effect of Fast Neutron on germination and survival in M, generation

	Total rows plante d (TR)	Total rows germinate d (RG)	Total seeds sown	Plant stand in M <sub>3</sub>	PI. Stand at maturity (pm)	Germination% (G %)	Survival% (S %)	Reduction in survival percentage over check
FN 30 Gy treated	625	610	6250	4241	3104	67.8	49.6	31.3
Control (Suvin )	50	50	500	424	405	84.8	81.0	

Expressed Proteins (DEP) in cotton genotypes with contrasting resistance to leafhopper and development of the protein biomarkers/functional markers for leafhopper resistance

PI: A. Manivannan; Co-PI: K. Shankarganesh

Importance of the study: Discerning the Differential Expressed Proteins (DEP) towards leafhopper resistance aid in identifying the key peptides involved in resistance. Unravelled peptides sequence information would help in development of functional markers for marker-assisted selection towards leafhopper resistance in cotton.

#### Salient Findings

# Differentially Expressed Proteins (DEPs) for leafhopper resistance registered in PRIDE data bank

In total, 2,347 proteins were obtained in resistant, hybrid, and susceptible genotypes and the complete dataset is accessible via Proteome Xchange Consortium via the PRIDE (PXD038644).

# DEPs for leafhopper resistance

A total of 2,022 DEPs were identified in response to LH A0A1U8J8U7) was significantly up-regulated (FC - 26.929) in infestation. The resistant genotype showed a greater number of RP upon LH infestation. Similarly, expansin, calciumup regulated proteins (399) than down regulated proteins (344). transporting ATPase 1, histone H2A, UDP- glucuronate

5.4. DST CRG Project: Unraveling the Differential The susceptible genotype showed a total of 659 DEPs were identified, with 346 up-regulated and 313 down-regulated after leaf hopper infestation. In addition, 620 DEPs were identified in hybrid, of which 329 showed up-regulated expression and 291 were down-regulated.

# Gene Ontology GO: Biological process involved in leafhopper resistance

The DEPs identified in resistant genotype were mainly enriched in the following GO terms: macromolecule metabolic process. amide biosynthetic process, gene expression, and translation in the Biological Process.

# KEGG Pathway: Pathways involved in leafhopper resistance

KEGG pathway analysis showed that the DEPs were enriched in glyoxylate and dicarboxylate metabolism, ribosome, photosynthesis and nitrogen metabolism.

# Differentially Expressed Proteins (DEPs) indentified for leafhopper resistance

A total of 331 DEPs were detected only in RP-LH vs. RP, of which only one (uncharacterized protein LOC107904777,



decarboxylase, oxysterol-binding protein, and 60S ribosomal protein L8-3 were also found up-regulated. The most common MF categories were associated with nucleic acid binding, organic cyclic compound binding, structural molecule activity, RNA binding, and calcium ion binding. KEGG pathway analysis showed that Glyoxylate and dicarboxylate metabolism, Carbon fixation in photosynthetic organisms, Photosynthesis, Ribosome, and Pentose phosphate pathway.

# 5.5. Development and evaluation of ELS interspecific hybrids with better yield and fibre quality

PI: K. Baghyalakshmi, Co-PI (s): M. Amutha, A. Sampath Kumar

# Importance of the study:

Indian cottons have very wide range of quality; many common types and hybrids don't have the perfect balance of micronaire (4-4.5), fiber strength (25 to 37 g per tex), and fiber length (33–37 mm). There is an urgent need to promote these cottons, whose quality might be closer to what modern textile mills demand and HxB fills that need.

### Salient findings

Two sets of HxB hybrids were evaluated for two years (2021-2023) for yield and fibre traits. In set I, Suraj x ICB 99 (4106.4 Kg/ha), CCH15-1 x ICB 99 (3472.6 Kg/ha), Surabhi x ICB 46 (3142.8 Kg/ha) and in set II MCUVT5 x ICB 284 (6277.1 Kg/ha) and MCUVT5 x CCB 143 B (3505.7 Kg/ha) were identified as better hybrids for seed cotton yield. For fibre length, CCH15-1 x CCB 11 A (40.2 mm), Surabhi x CCB 11 A (38.7), MCUVT5xICB 46 (38.5 mm) and MCUVT5 x CCB 25 (38.0mm) in set I and MCUVT5 x SUVIN (38.1mm), CCH15-1xCCB 143 B (38.0 mm), MCUVT5 x ICB 258 (37.8 mm), MCUVT5 x ICB 284 (37.7 mm) in set II were identified as better hybrids for fibre length. The high yielding genotypes among both the sets are listed in Table 5.5.1. Suraj x ICB29, Suraj x ICB284, Suraj x ICB176 and MCU5VT x ICB258 was found to be free from all diseases and most of the hybrids were showing R reaction to sucking pests and pink boll worm. 18 F3 families and 35 F4 families were raised and were evaluated for various traits. Most of the entries were found to show moderate resistance to high resistance reaction to the insect pests. The hybrids Suraj x ICB 99, MCUVT5xICB 284, CCH15-1 x ICB 161, Surabhi x ICB 46, and CCH15-1x ICB 284 were found to show yield stability for two years (2021-22, 2022-23). Among the tested 56 hybrids, the genotypes namely CCH15-1 x CCB 11 A, Surabhi x CCB 11 A, MCUVT5 x ICB 46, MCUVT5 x CCB 25, MCUVT5 x SUVIN, MCUVT5xICB 176, MCUVT5 x ICB 284, MCUVT5 x ICB 258, CCH15-1 x CCB 143 B were showing stable performance for fibre length for two years. The hybrid MCUVT5 x ICB 284 was showing stable performance for both yield and staple length for two years (Fig 5.5.1).

Table 5.5.1. Top performing genotypes based on yield with quality parameters from both the sets

S.No	Genotypes	SCY (kg/ha)	UHML(mm)		
1	MCUVT5xICB 284	6277.1	37.7		
2	SurajxICB 99	4160.4	37.0		
3	MCUVT5xCCB 143 B	3505.7	36.5		
4	SurajxICB 176	3484.3	36.6		
5	CCH15-1xICB 99	3472.6	35.7		
6	SurajxSUVIN	3332.0	36.6		



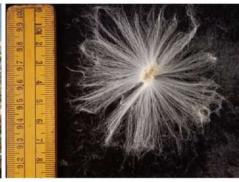


Fig 5.5.1. a.H x B hybrid MCUVT5 x ICB 284 single plant; b. fibre with a length of 37.7mm

# 5.6. Implementation of PVP legislation 2001 and DUS testing of cotton under ICAR-SAU system

# PI- K. Rathinavel, Associate: V. Santhy, A. Manivannan Importance of the study

The project aimed for the establishment and maintenance of database on extant cotton varieties, conduct of DUS test of New, VCK and Farmers varieties, and maintenance breeding of reference cotton varieties, morphological characterization of cotton varieties and registration of extant cotton varieties.

# Salient findings

ICAR-Central Institute for Cotton Research, Regional Station, Coimbatore is the nodal centre for the conduct of Distinctiveness Uniformity and Stability testing of cotton varieties (centrally sponsored and funded by PPV &FRA). With the active participation of co-nodal centres such as ICAR-Central Institute for Cotton Research, Nagpur, National Seeds project Unit, UAS, Dharwad; Department of Cotton CCSHAU, Hisar; Regional Research Station Bathinda, PAU and the Department of Cotton, MPKV, Rahuri field trials were conducted for characterization of candidate cotton varieties in line with reference varieties. The data on DUS traits received from co-nodal centres were verified and compiled at ICAR-CICR, Regional Station, Coimbatore and provided to PPV&FRA for the issuance of plant variety protection certificate.

At ICAR-CICR, Regional Station, Coimbatore during the year 2022, the cotton varieties notified through CVRC were included in the data base on extant cotton varieties. The field trial on DUS test of candidate varieties include new and VCK category and they are 2223 SZ1, 2223 SZ2, 2223 SZ3, 2223 SZ4, 2223 SZ5, 2223 SZ6, 2223 SZ7, 2223 SZ8, 2223 SZ9, 2876/2758 Along with 25 candidate hybrids, the hybrids produced from Shimoga center are compared and characterised. Another 12candidate hybrid and 3 typical varieties were characterised. Reference varieties such as Puli BGII (6188-2BGII), Yuva BGII (7215-2), Bindass BGII (7213-2), Junglee (MRC7017 BGII, Dhandev+ (MRC7373 BGII), Dhandev+ (MRC7373 BGII), MRC7351 BGII, Bahubali (MRC 7918 BG II), RCH 386 BGII, RASI MAGNA BGII, RASI NEO BGII, RCH 659BGII, SURPASS First Class (SP 7149, Surpass Minerva (SP911 BGII), Surpass Superb (SP 7517 BGII), Malini NCS 9015 BG II were also grown for the establishment of Distinctiveness. Sowing was taken up in replicates and morphological characters such as Hypocotyl: Pigmentation, Leaf: Colour, Leaf: Hairiness, Leaf: Appearance, Leaf: Gossypol glands, Leaf: Nectaries, Leaf: Petiole pigmentation, Leaf: Shape, Plant: Stem hairiness, Plant: Stem pigmentation, Bract: Type, Flower: Time of flowering, Flower: Petal colour, Flower: Petal spot, Flower: Stigma, Flower: Anther



Sterility, Boll: Bearing habit, Boll: Colour, Boll: Shape, Boll: treatments Surface, Boll: Prominence of tip were tested for all the entries. The data once received from participating centers will be submitted to PPV&FRA for issue of registration certificate. Monitoring of DUS trials at the participating centres have also been done through online meetings on 9.10.2020 at RRS Bathinda, 4.12.2020 at ICAR-CICR, Nagpur and MPKV Rahuri, on 31.12.2020 at UAS Dharwad and on 27.1.2021 at ICAR-CICR, Coimbatore.At ICAR-CICR, Nagpur centre, MPKV Rahuri new hybrids were grown in the first-year trial and they were evaluated for DUS traits.

# 5.7. Crop-weed interactions under ambient and elevated CO,

# PI: P. Nalayini, Co-PI: A.H. Prakash and M. Amutha Importance of the Study

The current atmospheric burden of carbon dioxide is unprecedented and will impact on crops and weeds which will alter the dominance weed species and crop weed interaction and hence it is essential to study its impact to design sustainable weed management for changing climate scenario.

# Salient Findings

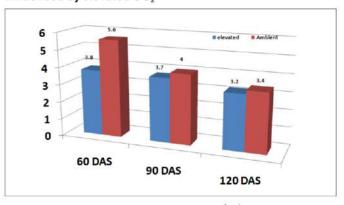
Open top chamber experiment was conducted at ICAR- CICR Regional Station, Coimbatore with five treatments viz., IWM and unweeded check under ambient and elevated CO<sub>3</sub> (e. CO<sub>3</sub>) with weed free open field for comparison using suraj Bt as test cultivar in randomized block design with four replications. This study interestingly brought out visible changes in relative density of weeds, dry matter accumulation, nutrient uptake, physiological changes and pests' incidence due to e.CO2. The notable reduction in Relative Density (RD) of major broadleaved weed, Trianthema portulacastrum from 51.2 % under ambient to 39.2 % with e.CO, the RD of grassy weed, Brachiaria ramosa reduced from 18.5 % to 4.39 % and the lone sedge weed, Cyperus rotundus, from 15.3 % to 5.06 %. On the other hand, the RD of Digeraarvensis enhanced from 8.3 to 42.2 % and Dactyloctenium aegyptium from 2.67 to 4.32 % due to e.CO2. The total weed count on 45 DAS revealed no significant difference for the efficacy of pre-emergence weedicide while the weed count on 75 DAS has shown better weed control due to post emergence weedicide under e.CO, (Table 5.7.1). The SEM image of cotton has shown partial closure of stomata with e.CO, which might have resulted in reduction in transpiration rate (Fig. 5.7.1) and enhancement in photosynthetic rate (Fig. 5.7.2.) with e.CO2. The growth and development of cotton crop was influenced positively due to e.CO, as evidenced from taller plants (92.9 cm), more (72) number of leaves, longer root length (33.1 cm) on 90 DAS as compared to shorter (81.6 cm) plants, lesser (51) number of leaves and shorter (23.5 cm) root length recorded with ambient grown cotton. The root cation exchange capacity was 25.1 m eq./100 g roots as against 24.5 with ambient cotton. The overall crop growth rate recorded during 60 -90 DAS was 8.15 gm<sup>-2</sup> per day as against 4.56 under ambient cotton. The enhancement in nutrient uptake ranged from 1.05 to 2.09 fold due to e.CO, and thus the enhancement in growth and development of cotton with e.CO, resulted in 36 per cent yield enhancement with integrated weed management over its ambient grown cotton (Fig 5.7.3.) Among pests, Aphids and Spodoptera were significantly more with lesser Jassids and no effect on whitefly and Thrips due to e.CO, (Table 5.7.2).

Filament colouration, Flower: Pollen colour, Flower: Male Table 5.7.1. Total weeds/m<sup>-2</sup> as influenced by weed control

Treatments	Total weeds/m <sup>-2</sup>				
	45 DAS	75 DAS			
Elevated CO <sub>2</sub> (IWM) OTC	63.5 (7.7)	0 (1.0)			
Elevated CO <sub>2</sub> (UWC) OTC	534 (23.2)	197 (14.0)			
Ambient (IWM) OTC	184.5 (13.4)	52 (7.2)			
Ambient (UWC) OTC	532(23.1)	223 (14.9)			
SEd	2.49	0.57			
CD (p=0.05)	5.42	1.24			

Figures in parenthesis are square root transformed values for statistical analysis.

Fig 5.7. 1. Transpiration rate (µ molm<sup>2</sup>S<sup>-1</sup>) in cotton as influenced by elevated CO.



5.7.2. Phtosynthetic rate (µ molm<sup>2</sup>S<sup>-1</sup>) in cotton as influenced by elevated CO,

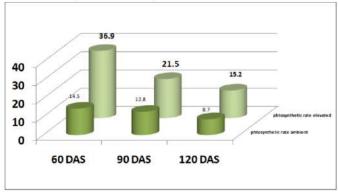


Fig 5.7. 3. Seed Cotton yield (kg/ha) as influenced by elevated CO2 and weed control treatments

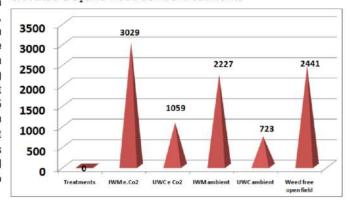




Table 5.7.2. Impact of elevated CO2 and weed control treatments on cotton insect pests

Treatments		Spodoptera				
	Aphids	Mealybug	Jassids	Thrips	Whitefly	larvae/plant
Elevated CO <sub>2</sub> (IWM) OTC	77.9	0.10	0.10	1.50	0.83	1.38
Elevated CO <sub>2</sub> (UWC) OTC	11.7	0.52	0.12	0.70	1.39	0.52
Ambient (IWM) OTC	30.0	0.67	0.12	2.84	1.52	0.10
Ambient (UWC) OTC	16.1	0.32	0.42	3.33	0.64	0.00
Weed Free open field	6.37	0.64	0.52	1.55	0.56	0.00
SEd	0.75	0.099	0.05	0.46	0.14	0.06
CD (p=0.05)	1.67	NS	0.11	NS	NS	0.145

# aberration of drought and water logging in cotton

PI: K. Sankaranarayanan, Co PIs: J. Annie Sheeba, M Amutha, P. Valarmathi, J.H. Meshram

# Importance of the study

Cotton is an annual crop and is susceptible to climate change. The expected erratic distribution of rainfall leads to frequent wet and dry spells. Continuous dry/wet or both spells during critical crop growth periods of squaring, flowering, and boll development may affect the yield of the crop. Water logging coupled with drought leads to poor performance of crops. The contingent measures come out from this project could be useful for managing low and excess moisture stress.

# Salient Findings

Significantly 35.2 per cent higher seed cotton yield was harvested with drainage by ridges and furrows followed by foliar application of melatonin@ 100µM single spray (1695 kg/ha) as compared to control (water logging) (1254 kg/ha) which was on par with ridges and furrow followed by foliar application of Salicylic acid @0.5mM single spray (1641 kg/ha). Reduction of Seed cotton yield of 60.8, 79.2 and 84.9 percent respectively was observed due to water logging at 10-20 days of plant growth of cotton species G. hirsutum (Suraksha), G. barbadense (Suvin) and G. arboretum (PA 810). The maximum yield reduction was recorded in G. arboreum followed by G. barbadense and G. hirsutum. Significantly 24.4 per cent higher yield was registered with by land shaping of ridges and furrows followed by foliar application of glycine betaine 100ppm single spray (1733kg/ha) as compared to rainfed control (1391 kg/ha)



Fig. 5.8.1. Field View of Water logging Stress

5.8 Evaluating agro techniques for overcoming weather which was on par with ridges and furrow followed by PPFM @ 1% of three sprays at weekly intervals (1729 kg/ha) and Salicylic acid 100ppm single spray (1721 kg/ha).

# 5.9. Sustainable Intensification of Extra Long Staple Cotton **Production in South Zone**

PI: R. Raja Co PIs: J. Annie Sheeba and K. Rathinavel

# Importance of the study

After the introduction of Bt hybrids for commercial cultivation in India during the year 2002-03, the composition of cultivation of cotton species drastically changed. Presently, most of the cotton area is under G. hirsutum (>95%, 2012) and marginalized the cultivation of other species of cotton including the extra-long staple (ELS) cotton. The domestic ELS cotton production hovers around five lakh bales only and our textile industry imports around 21 lakh bales (2021-22). Hence, there is a felt need to increase the production and productivity of domestic ELS cotton in a sustainable manner in order to make it remunerative to ELS farmers as well as to increase the availability of ELS cotton fibre to the domestic textile industry while maintaining the cotton species diversity. Adoption of higher plant density with appropriate canopy management and drip fertigation makes it possible to produce increased number of bolls per unit area and higher seed cotton yield. Field experiments are being conducted at ICAR-CICR Regional Station, Coimbatore to study the effect of increased plant density and use of growth regulators on the ELS cotton productivity and fibre quality under drip fertigation system.

### Salient Findings

Increased plant density (90 x 30 cm; 37,037 plants/ ha) combined with drip fertigation and canopy management (Mepiquat Chloride application @ 60 ppm when height to node ratio (HNR) reached 1.5 followed by 30 ppm twice at 15 days interval after first spray) significantly enhanced the seed cotton yield of MRC 7918 (2638 kg/ha) vis-a-vis farmers' practice (90 x 60 cm; 18,518 plants/ha; 1721 kg/ha). Similarly, in case of Suvin, increased plant density (90 x 30cm; 37,037 plants/ ha) combined with drip fertigation and canopy management has produced higher seed cotton yield (1389 kg/ha) compared to farmers' practice (90 x 60 cm; 18,518 plants/ha; 841 kg/ha). In both the genotypes, the yield increases in closer spacing (90 x 30cm) was attributed to significantly higher number of bolls per unit area vis-à-vis farmers practice. Mepiquat chloride application for canopy management has not affected the fibre quality parameters in Suvin as well as MRC7918 BG II (Table 5.9.1).



Table 5.9.1: Effect of increased plant density and use of Mepiquat Chloride for canopy management on the ELS cotton fibre quality

Treatments		Suvir	1	MRC 7918 BG II				
	UHML (mm)	Mic	Tenacity (g/tex)	UHML (mm)	Mic	Tenacity (g/tex)		
T <sub>1</sub> : 90 x 60 cm spacing	40.03	3.57	39.90	36.90	3.10	35.80		
T <sub>2</sub> : 90 x 45 cm spacing	39.10	3.73	38.60	36.30	3.03	34.63		
T <sub>3</sub> : 90 x 30 cm spacing	38.30	3.77	38.77	36.60	3.00	35.60		
T <sub>4</sub> : 120 x 45 cm spacing	39.63	3.80	40.17	35.93	3.03	35.17		
T <sub>5</sub> : 120 x 30 cm spacing	38.40	3.83	38.80	35.93	3.07	34.37		
T <sub>6</sub> : 120 x 25 cm spacing	39.27	3.73	39.40	36.47	3.07	35.67		
T <sub>7</sub> : Farmers practice (90 x 60 cm)	38.53	3.60	38.03	34.27	3.20	32.60		
SEd	0.882	0.146	1.126	0.640	0.080	0.758		
CD (P=0.05)	NS	NS	NS	NS	NS	NS		

# cotton and crop canopy management using unmanned aerial system

PI: R. Raja (PI); Co-PIs: D Kanjana and T. Arumuganathan, PS (FMP), ICAR-SBI, Coimbatore

# Importance of the study

Canopy management is a technique practiced in cotton, either manually or chemically, to control excessive vegetative growth, prevent lodging and improve yield. Application of chemical topping agent i.e., plant growth regulating (PGR) chemical like mepiquat chloride (MC) is a prerequisite for obtaining optimal plant canopy architecture in high density planting system (HDPS), which is suitable for mechanization of cotton cultivation in India. Spraying of agro-chemicals using Unmanned Aerial Vehicle (UAV) system offers an efficient, quick and economical spraying option vis-à-vis conventional spraying methods. An attempt was made to evaluate the usefulness of chemical spraying UAV for application of MC for canopy management in cotton under HDPS.

# Salient Findings

Effectiveness of MC application through UAV sprayer was evaluated in a field experiment at ICAR-CICR Regional Station, Coimbatore during kharif 2022. For this, cotton cv. Suraksha was raised under HDPS system (90 x 10cm spacing, 1,11,111 plants ha1). The treatments involved were application of management.

5.10. Active Optical Sensors based yield prediction in recommended dose of MC on a.i. basis using Knapsack sprayer (T1) and Boom sprayer (T2), respectively, application of recommended dose of MC on a.i. basis mixed in 20 and 30 litre spray fluid (water)/ acre, respectively using chemical spraying UAV (T3 & T4), and no MC spray (Control - T5) (Fig.5.10.1). The recommended dose of MC is application of 60 ppm when height to node ratio reached 1.5 followed by 30 ppm twice at 15 days interval after first spray. The results indicated that application of recommended dose of MC mixed in 20 litre spray fluid/acre using chemical spraying UAV produced optimal plant architecture with 100.6cm plant height, 15.83 sympodial branches, 120.8 bolls m-2, 4.1g boll weight at harvest (Table 5.10.1). The seed cotton yield produced under T3 (2428 kg ha1) was on par with that of T1 (2112 kg ha<sup>-1</sup>). The spray droplet size distribution in different strata of cotton crop canopy under T3 revealed that the leaves in upper plant canopy received an average of 28.3 droplets cm2 with volume mean diameter (VMD5) of 390µm on the upper (adaxial) leaf surface while the lower (abaxial) leaf surface received an average of 14.6 droplets cm-2 with VMD5 of 384µm. The middle plant canopy received comparatively lesser droplet deposition (14.8 droplets cm<sup>2</sup> on the adaxial and 5.8 droplets cm<sup>-2</sup> on the abaxial surface) while the lower canopy received the least number of droplets. The results indicated that UAV system can be used in cotton for application chemical topping agent under HDPS for canopy

Table 5.10.1. Effect of Application of Mepiquat Chloride using Knapsack/ Boom/ Drone Sprayer on Plant Growth and Yield **Parameters** 

Treatment	Plant Height (cm) at 120 DAS	Nodes	No. of sympodia	DMP (kg ha <sup>-1</sup> )	No. of bolls per m <sup>2</sup>	Boll weight (g)	Seed Cotton Yield (kg ha <sup>-1</sup> )
T <sub>1</sub> : Knapsack sprayer	89.7	20.73	15.10	9590	110.2	4.0	2112
T <sub>2</sub> : Boom sprayer	105.0	22.13	17.10	7735	109.7	4.0	2056
T <sub>3</sub> : Drone @ 20 liters spray fluid/ acre	100.6	20.93	15.83	8519	120.8	4.1	2428
T <sub>4</sub> : Drone @ 30 liters spray fluid/ acre	95.6	20.67	15.40	9136	114.4	4.2	2595
T <sub>5</sub> : Control (No mepiquat chloride application)	119.8	21.50	16.97	9897	115.7	4.0	2079
S Ed	2.68	0.54	0.44	670.2	8.31	0.30	211.4
CD (P=0.05)	5.59	1.14	0.95	NS	NS	NS	NS







Fig. 5.10.1: Spray application of Mepiquat Chloride using (a) UAV Sprayer, (b) Boom Sprayer and (c) Knapsack sprayer

5.11. Effect of long-term application of organic and inorganic sources of nutrients on continuous cultivation of Bt and non Bt cotton cropping system under irrigated conditions system of conditions system of conditions system of conditions system, sustainable yield index (SYI) values were higher in closed planting system of Bt cotton variety – maize cropping system (0.74) as compared to wider spacing system of cotton hybrid – fallow (0.62), cotton variety – maize (0.59) and cotton

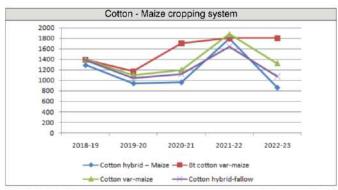
# PI: D. Kanjana, Co PI: K. Sankaranarayanan, Amarpreet Singh Importance of the study

Long term fertilizer experiment was conducted in the permanent field of CICR, Regional station, Coimbatore (cotton – maize cropping system) and Sirsa (cotton - wheat cropping system) under irrigated conditions not only to measure the yield sustainability of irrigated cotton under different cotton cropping systems and different nutrient management practices by assessing yield trends but also to monitor the changes in soil quality under continuous cotton – maize / wheat cropping systems.

### Salient Findings

After five years continuous adoption of cotton – maize and cotton – wheat cropping systems under irrigated conditions, yield sustainability and yield trends of cotton were calculated (Fig 5.11.1 and Fig 5.11.2). Among the cotton – maize cropping

closed planting system of Bt cotton variety - maize cropping system (0.74) as compared to wider spacing system of cotton hybrid - fallow (0.62), cotton variety - maize (0.59) and cotton hybrid - maize (0.46). Among the cotton - wheat cropping system, the higher sustainable yield index (SYI) values were observed in Bt cotton hybrid - wheat (0.87) and Bt cotton hybrid - fallow (0.87) cropping systems than non Bt cotton hybrid wheat (0.85) Bt cotton variety - wheat (0.84) non Bt cotton variety - wheat (0.81). Application of integrated sources of nutrients (NPK + Mg + Zn + B + FYM (10 t/ha) once in two years) not only increased the seed cotton yield but also improved the sustainable yield index of cotton under cotton maize (0.66) and cotton - wheat (0.86) cropping systems. Regarding the changes of soil quality under continuous cotton-maize cropping system, Bt cotton variety -maize and Bt cotton hybrid-maize showed the increased trend of soil organic carbon (SOC) after 2nd year cotton - maize cropping system in both surface as well as sub surface soil. Similarly, among the different sources of nutrients, increased trend of SOC was noticed in INM treatment in surface soil and decreased trend was noticed in control.



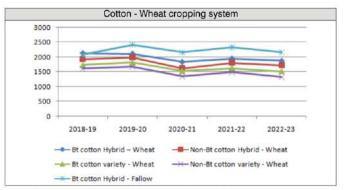
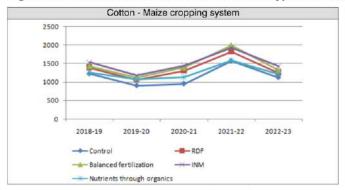


Fig 5.11.1. Yield trends of cotton under different types of cotton-maize and cotton-wheat cropping system



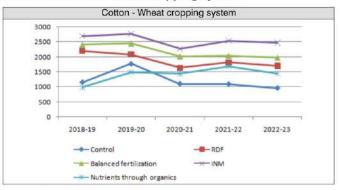


Fig 5.11.2. Yield trends of cotton in different fertilization treatments of cotton-maize and cotton-wheat cropping system



### 5.12. Formulation of customized fertilizers for cotton

# PI: D. Kanjana, Co-PI: R. Raja and S Usha Rani

### Importance of the study

To achieve the balanced nutrition, enhance the fertilizer use efficiency, realize the full yield potential in crops and sustain the farm profitability under different soil conditions, custom made fertilizers *i.e.*, customized fertilizers / multi nutrient carriers are needed by cotton growers.

### Salient Findings

Pelletization process was standardized to develop the customized fertilizer by calculating the nutrient requirements based on STCR equations and RDF. Different types of pellets based on STCR and RDF were developed by using different types of binding materials and in different ratios. Customized fertilizer pellet form was characterized in terms of diameter, thickness, average weight of pellet, no. of pellets produced per hectare, pH, EC and solubility rate.

# 5.13. Efficacy evaluation of nano-ZnO as nanofertilizer in cotton (ICAR – CIRCOT Project)

PI: N. Vigneshwaran, (ICAR-CIRCOT, Mumbai) Co PI: D. Kanjana

### Importance of the study

Zinc is one of the most important micronutrients for better growth and development of cotton. By using the advanced technologies like nanotechnology, the insoluble zinc oxide with higher nutrient content (80 % Zn) can be modified into soluble zinc oxide nanoparticles. The minimum dosage of zinc oxide nanoparticle can be utilized for increasing the zinc use efficiency and sustaining the cotton productivity. ICAR-CIRCOT synthesized ZnO NPs and nano zinc suspensions will be evaluated on cotton under field experiment for standardizing their dosage and efficacy in different mode of applications such as seed treatment and foliar spray.

# Salient Findings

The highest seed cotton yield (21.3 g/ha) was obtained in application of zinc oxide nanoparticles through seed treatment @ 20 ppm along with foliar application @ 200 ppm at two critical stages like square formation and flowering stages of cotton. Similarly, seed treatment of ZnO nanoparticles @ 50 ppm showed the incremental effect on plant height, leaf area index, dry biomass accumulation, number of opened bolls, boll weight and seed cotton yield of cotton (20.8 q/ha). Foliar application of Nano Zn Suspension @ 200 ppm at one stage (19.3 q/ha) was on par with foliar application of ZnO nanoparticle @ 500 ppm at two stages (20.5 q/ha), foliar application of Nano Zn Suspension @ 200 ppm at two stages (19.5 q/ha) and ZnO nanoparticles @ 200 ppm at two stages (18.7 q/ha) (Fig 5.13.1). The detrimental effect on growth, physiological and yield parameters of cotton was noticed due to the highest dosage of 500 ppm of ZnO nanoparticles through foliar spray at three times and treatment combinations of 50 ppm of ZnO nanoparticles or nanosuspension through seed treatment along with foliar application of 200 or 500 ppm of ZnO NP's or nano suspension. No significant difference was found on fibre quality parameters viz., upper half mean length, uniformity index, micronaire, fibre strength and fibre elongation of cotton due to nano zinc applications (ZnO nanoparticles and nano zinc suspensions) through seed treatments as well as foliar spray.

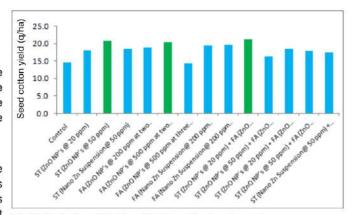


Fig 5.13.1: Seed Cotton Yield under treatments

## 5.14. Development of a nutrient and plant hormoneenriched foliar formulation for cotton

PI: J. Annie Sheeba Co-PI: D. Kanjana

### Importance of the study:

A large percentage (66 to 75 %) of the yield is produced on first-position fruiting sites. Hence retention and maturation of these bolls is critical. Use of PGRs may increase boll retention at the first fruiting sites, enhance and accelerate crop maturity, promote an earlier harvest, and improve lint quality, and potentially alter membrane properties associated with enhanced tolerance to deviation in temperature. With this background this project is formulated to develop a foliar formulation of nutrients and hormones combining the nutrients and plant hormones.

### Salient findings:

Fifteen treatment combinations were tried in cotton variety to test the effective combination of hormones and nutrients to improve the productivity in cotton variety Suraj under field conditions. Among the treatment's combinations, T, (Urea (1 %) + MAP (0.5 %) + KCl (0.5%) + Mg SO<sub>4</sub> (0.5 %) + Ferrous Sulphate (0.25 %) + Zinc Sulphate (0.25 %) + Boric Acid (0.1 %) + NAA (20 ppm) + CuSO<sub>4</sub> (0.05 %) + Sodium molybdate (0.01%) + Na- EDTA 0.02 mM + Salicylic acid (50 ppm) + Ascorbic acid (100 ppm) + Kinetin (20 ppm) + APSA 80) increased the total chlorophyll (5.1 mg/g) content. Higher NR activity of 113 µg NO<sub>2</sub>/g/hr was recorded by T10: KNO<sub>3</sub> (2 %) + MAP (0.5 %) + Mg SO<sub>4</sub> (0.5 %) + Ferrous Sulphate (0.25%) + Zinc Sulphate (0.25 %) + Boric Acid (0.1%) + NAA (20 ppm) + Na- EDTA 0.02 mM + CuSO<sub>4</sub> (0.05 %) + Sodium molybdate (0.01%) + Salicylic acid (50 ppm) + Ascorbic acid (100 ppm) + Kinetin (20 ppm) + APSA 80. Among the different treatments, higher N content was recorded by T<sub>4</sub>: KNO<sub>3</sub> (2 %) + MAP (0.5 %) + Mg SO<sub>4</sub> (0.5 %) + Ferrous Sulphate (0.25%) + Zinc Sulphate (0.25 %) + Boric Acid (0.1 %) + NAA (20 ppm) + Na- EDTA 0.02 mM + Cu SO<sub>4</sub> (0.05 %) + Sodium molybdate (0.01 %) + Salicylic acid (50 ppm) + Ascorbic acid (100 ppm) + Kinetin (20 ppm) + Triton X 100. Plants which received treatment of T<sub>o</sub>: DAP (1%) + Potassium Chloride (0.5 %) + Magnesium Sulphate (0.5%) + Ferrous Sulphate (0.25%) + Zinc Sulphate (0.25%) + NAA (20 ppm) + Boric Acid (0.1 %) + CuSO<sub>4</sub> (0.05 %) + Sodium molybdate (0.01%) + Na-EDTA (0.02 mM + Salicylic acid (50 ppm) + Ascorbic acid (100 ppm) + Kinetin (20 ppm) + Triton X 100 recorded higher K content. Higher yield of 2540 Kg/ha was recorded by T<sub>12</sub>: 19:19:19 (1 %) + Mg SO<sub>4</sub> (0.5 %) + Ferrous Sulphate (0.25 %) + Zinc Sulphate (0.25 %) + Boric Acid (0.1 %) + CuSO<sub>4</sub> (0.05 %) + Sodium molybdate (0.01%) + Na- EDTA



0.02 mM + NAA (20 ppm) + Salicylic Acid (50 ppm) + Ascorbic same through functional and financial analysis. Acid (100 ppm) + Kinetin (20 ppm) + APSA 80.

# 5.15. Economic Analysis of Value Chain of Cotton Market in Tamil Nadu

# PI: Isabella Agarwal Importance of the Study

The lack of an efficient feedback system at all levels of the cotton chain hinders information flow and scope for change in practices needed to improve the quality of cotton. Knowing the commercial importance of cotton at the country and State levels, it is felt that there is need to map the cotton chain (consisting of producer and various processors) and study the

# Salient Findings

Farmers, ginners and spinners are the agents involved in the cotton chain. Of all the sample members in the chain, spinners possessed benefit-cost ratio of 1.52 with first profitability rank followed by weavers 1.44, ginners 1.38 and farmer with 1.08, respectively. It could be inferred from Table 5.15.1 that marketing channel I namely Farmer - Commission agent -Ginner - Spinner was the efficient marketing channel as it had highest farmer's share of 66.50 per cent and lower price spread of 33.50 per cent when compared to Channel II viz., Farmer -Village traders - Ginners - Spinners with 63.24 percentage of farmers' share and higher price spread of 36.43 per cent, respectively from the sample stakeholders.

Table 5.15.1. Price Spread and Returns of Cotton for sample Marketing Channels (Rs. /qtl.)

S.No.	Particulars	Channel I	Channel II
1	Net price realized by producer	6486.44	6064.84
2	Village trader net margin		1046.29
3	Commission agent net margin	747.54	
4	Cost of marketing	1297.91	1251.12
5	Consumer price	9754.27	9754.27
6	Price spread	3267.83	3526.01
	*	(33.50)	(36.43)
	Farmers share in consumer rupee (%)	66.50	63.24

Fig. in parenthesis indicate percentage to total

In the proposed value chain model (Table 5.15.2), inclusion of varieties/ hybrids. Some zoning system along with supply of quality inputs and technology information are felt to be important factors to aid in increased yield. In addition, the postharvest practices and storage go downs would increase the quality of the produce and fetch higher price for the produce. Sales through Co-operatives, regulated markets and FPOs might be beneficial for few farmers wherein storage go downs might not be possible but still can fetch higher price. In any condition, sale of the produce directly to ginneries fetch higher returns to the producer resulting in total value addition of Rs.17,805/qtl of the produce against the existing model which is around Rs. 14,500/qtl. Input supply to the farmers should be

good quality seeds and other inputs may have to be considered. No segment in the cotton value chain can function in isolation. Cotton yield in India has to increase 40%. At least 20% can be achieved in a year just by weeding out spurious seeds. The cotton cultivation in most of the sample districts of Tamil Nadu showed increasing returns to scale. So, it is possible to improve the technology of cotton production and by judicious use of inputs, in order to achieve higher output levels. As cotton is an internationally demand driven crop, it can be grown in a rationalized manner by identifying the viable zones exclusively intended for export purpose as well as domestic regularized especially notified popular and recommended seed mills requirement - Top-down approach (vertical integration).

Table 5.15.2 Proposed value chain model of cotton in Tamil Nadu (Rs. /qtl)

Value chain	Farmers	VT	WS	CA	Со-ор	RM	FPOs	Ginner	Spinner		
Participants											
Value addition practices	Quality inputs, tech information, Post-Harvest practices	Nil	Nil	Nil	Nil	Nil	Nil	Processing	Processing		
Produce	Kapas	Nil	Nil	Nil	kapas	kapas	kapas	Lint, seed	Yarn		
Gross Return	9285	Nil	Nil	Nil	6725	6714	6550	26533	59917		
Total Cost	5990							24030	37910		
Value addition	3295							2503	12007		
				1.5	IV.	Total val	ue additio	on (Rs. /qtl.)	17805		

VT Village trader; WS Wholesaler; CA Commission Agent RM Regulated Market





# **5.16.** Efficient Resource Allocation Patterns for Cotton 30, 28, 12, 7, per cent respectively. The probability of shift in Farms in Tamil Nadu – Fuzzy Goal Programming Approach area from Coconut to cholam was only 2.2 per cent and to

# PI : Isabella Agarwal

# Importance of the Study:

The cropping pattern followed by the farmers of the region has been evolved through experience gained and inherited through generations. A critical examination from a scientific point of view is necessary to evolve optimal agricultural production patterns. Resource allocation is one of the major elements in reorganizing cropping systems. Certainly, there is need to change the crop cafeteria to suit the ecology and the consumers' preference, hence ensuring that value is captured across all areas of concern before initiating a shift in the crop. An effort is made in this study to suggest optimum cropping plans with minimum cost for the Cotton based cropping systems of Tamil Nadu, where cotton is the main crop along with other subsidiary crops. The plans are developed for average small, medium and large farms, with the objective of minimization of the cost of cultivation from the available resources of Land, Labour (male, female, bullock pair), Irrigation and Capital. The study is based on farmers' data on cost of cultivation of prevalent crops in the region. Input-output coefficients will be worked out for all enterprises for the small and medium average farm situations. It would be worthwhile to evaluate the relationship between acreage and value and use this to plan future actions, to make the most of agricultural assets, outputs and markets.

### Salient Findings:

Primary data analysis showed that the major crops grown in five blocks of Coimbatore district are cholam, coconut, cotton, cumbu, green gram, groundnut, maize, gingelly, sugarcane, red gram, cow pea and horse gram based on the data collected from district statistical office. Markov chain analysis was done to know the shift in cropping pattern at the major block level. The major crops grown in five blocks of Coimbatore district are cholam, coconut, cotton, cumbu, green gram, groundnut, maize, gingelly, sugarcane, red gram, cow pea and horse gram. At Annur block, the probability of retention of existing area under Sugarcane was estimated at 72 per cent. Similarly, for Coconut 52 per cent, Cholam, Red gram and Maize were 20, 5 and 1 per cent respectively. The analysis also reveals that the probability of shift in area from Sugarcane to other crops was 18 per cent, to red gram 7.6 per cent and to cotton 1.4 per cent. At Karamadai block, the probability of retention of existing area under maize was estimated at 49 per cent with coconut 43 per cent, groundnut, sugarcane, red gram, cholam and green gram, it was 36, 8, 16, 9, 5 per cent, respectively. The probability of shift in area from maize to coconut was 27 per cent and cholam 23 per cent. At Kinnathukadavu, groundnut was stable crop as the probability of retention of existing area was estimated as 100 per cent and for coconut 37 per cent. The probability of shift in area from coconut to other crops including fruits and vegetables, condiments and spices etc., at 32 per cent and cholam 30 per cent. At Madukkarai, the probability of retention of existing area under Coconut was estimated at 89 per cent. Similarly, for Sugarcane the probability of retention was 56 per cent and Cholam 38 per cent. Moreover, the probability of shift in area from coconut to other crops was 4.6 per cent, groundnut 4.0 per cent, cotton 0.33 per cent, maize 0.9 per cent, gingelly 0.03 per cent, and red gram 0.1 per cent. At Pollachi (N), coconut occupied stable area with probability of retention to the tune of 96 per cent. Similarly, for Cholam it was 33 per cent, cotton, other crops, groundnut and cumbu, it was

30, 28, 12, 7, per cent respectively. The probability of shift in area from Coconut to cholam was only 2.2 per cent and to cotton was 0.02 per cent. At S SKulam, the probability of retention of existing area under Sugarcane was estimated at 72 per cent. Similarly, for coconut the probability of retention was 52 per cent, cholam and red gram 20 and 5 per cent respectively. The probability of shift in area from sugarcane to other crops was 18 per cent, to red gram 7.6 per cent and to Cotton was 1.4 per cent. In total, three blocks and nine villages with 120 sample farmers from Coimbatore district have been selected based on the secondary data collected from G return register, District Statistical office.

# 5.17. ICT Dissemination of Cotton Technologies for Production Augmentation and Knowledge Empowerment

PI: S. Usha Rani Co PIs: M. Sabesh, Jayant Meshram, S.K. Sain

Importance of the study: In the midst of plenty of laurels to applaud, Indian cotton sector has always been besieged by its low average productivity at world level. Presence of technologies, welfare schemes, technology diffusion mechanisms and policies guarantee the possibilities of increasing the productivity but reach of these good tidings to the end users has always been an unattained task. Cotton extension services practiced earlier and even now could not fully satisfy the felt need of end users which is timely availability of information on technology, monsoon behaviour, price, welfare schemes and policies. Modern Information and Communication Technology (ICT) allows new possibilities to overcome this information gap from which cotton growers suffer. Harnessing the astonished growth and development in ICT as a new dawn in the knowledge transformation of cotton growers and stakeholders, ICAR-CICR had already developed few extension innovations like e-Kapas, CICR Cotton Web Portal, Web based Weekly advisory services, CICR Cotton Mobile App and disseminated cotton technologies using these tools, which, made a great impact in the country's major cotton growing areas during the endemic situations of whiteflies and pink boll worms attack. Up scaling these CICR-ICT tools PAN INDIA is the need of the hour for swiftly disseminating all yield enhancing technologies, weather and market information, and eco-friendly technologies to increase the nation's cotton productivity and foster the production of sustainable cotton. At the same time developing new tools by taking the benefits of advancements in ICT to disseminate yield enhancing and sustainable cotton production and protection technologies to all sections of cotton growers in the country is thus a prerequisite for promoting a new paradigm in Indian cotton sector. This calls for development of an effective cotton information system with already developed and with more number of novel advanced ICT tools for knowledge and skill dissemination in cotton which could promote yield and sustain the environment. Documenting the impact created by these types of modern extension innovations in terms of knowledge level, adoption behaviour, productivity and income is the supplementary significant task to be done at this hour. Hence, a project entitled "ICT Dissemination of Cotton Technologies for Production Augmentation and Knowledge Empowerment" is proposed.

# Salient Findings

Frequently Asked Questions in cotton were collected and keeping them as basis voice SMS about cotton improvement / production / protection technologies with 30 seconds duration were developed and sent to the registered beneficiaries during





the entire crop season including weather and market and initiated to develop retrieval module with appropriate information in vernacular languages. A total of 9911229 voice software tools. advisories sent on cotton production technologies out of which 4096058 (41.33%) were successful. Content was collected and validated for updating of the ICAR-CICR cotton Mobile App on topics viz., About CICR, Varieties and Hybrids of ICAR-CICR, Cultivars of SAU, Production Technology, Insect Pest Management, Disease Management, Farmers outreach Programs. Weekly advisories (21) were uploaded in the ICAR-CICR website in nine different languages. On farm demonstrations were conducted in the ICAR-CICR, Regional Station on cotton variety BB7 in Normal, Poly Mulching and HDPS conditions, Subhiksha in Normal and Poly Mulching, Sunantha in Normal and Poly Mulching and Suraksha in Normal and Poly Mulching. Proposed for external funding as pilot project with a title "Awareness and Extension Services on Best Farm Practices for Cotton Farmers to Improve Quality, Yield and Sustainability" and got sanctioned for Rs.2.53 crore from Cotton Corporation of India to execute through 20 participating centers.

# 5.18. Development of Web-based Cotton Data Query System

PI: M. Sabesh, Co PI: Isabella Agarwal, Sunil Mahjan Importance of the study:

Cotton is the leading commercial crop in India and the crop has diversified stakeholders. With the changing economic and environmental situations, locally and globally, the policy and decision makers have to take the decision from the past experience and happenings. The past experience may be documented in quantitative or qualitative form but should be readily available and also easily accessible to the users stationed anywhere in the globe.

Data, information, and knowledge are the pivotal elements in decision and policy making. Many of the datasets are in printed copies which have be digitized for keeping it in safer mode as well as to make it available to the stakeholders in easily accessible mode. There is no centralized data collation and diffusion system for cotton as a commodity. Plenty of datasets on cotton have been generated within the institute level and also by many agencies. With the emerging information and communication technology, development of web enabled data query system could be the better option for the user to access the data from across the globe.

# Salient findings

Datasets collected - 1) District wise Cotton Area, production and productivity data from 1996 to 2022; 2) Minimum Support price for cotton from 2003-04 to 2022-23; 3) World Extra Long Staple Cotton Output from 1999 to 2020; 4) State wise employment in power loom sector from 1980 to 2014; 5) Count wise production of Cotton yarn from 1992 to 2014; 6) Count wise production of non-Cotton yarn from 1992 to 2014; 7) Count wise production of blend yarn from 1992 to 2014; 8) State wise production of cotton yarn by textile mills from 1995 to 2011; 9) State wise production of blend yarn by textile mills from 1995 to 2011; 10) State wise production of non-cotton yarn by textile mills from 1995 to 2011.

All these datasets were checked for consistencies and have been digitized. Databases were also created and developed prototype information retrieval system with sample datasets. Different data retrieval modules were tried and finalized the



5.19. Development of Al enabled pheromone trap for lepidopteran pests and multi-fin glue trap for sucking pests on cotton.

PI: K. Rameash; Co-PI: M. Sabesh

### Importance of the study:

To circumvent the limitations of conventional pheromone trap, research is undertaken to develop an artificial intelligence (AI) enabled pheromone trap to transmit the count of insect catches directly to the user with additional information like location of the trap and weather data. Conventional pheromone trap technologies have inherent limitations viz., the process of data collection is laborious, time consuming and prone to human error. The manual data from pheromone trap are usually taken at weekly intervals. With poor temporal resolution count, the dynamics of pest population in the field cannot be accurately monitored. Multi location trap data cannot be synchronized to monitor the target pest population over a wider area. The Al enabled pheromone trap addresses all these issues in the cotton pest monitoring. Sticky traps based on the response of insects to colour have been widely used for pest monitoring and management in cotton. Yellow stick trap is being used for monitoring sucking pests like jassids, aphids and whiteflies pests and blue sticky traps were found to be preferred for monitoring thrips and resulted good control in cotton. The research work is proposed to develop a multi coloured glue-fin trap for the monitoring and management of jassids, thrips, whitefly, aphids and pink bollworm on cotton using a single trap system.

## Salient findings

To train the machine learning model and for the development of image processing algorithms in detecting the cotton pests, over 2000 images of adult moths of Spodoptera litura and Helicoverpa armigera under different views viz., dorsal, ventral and lateral; using different imaging devices viz., digital SLR camera, Raspberry PI camera and mobile camera; under various illuminated conditions viz., natural light, LED flash light were recorded. Fabrication of AI trap using Raspberry Pi 4 Model B Single board computer; 160 FoV Fish eye camera; Wifi/Bluetooth module GSM module (4G); PCB Control Board; 12 v Li-ion Battery; 20w solar panel was undertaken (Fig 5.19.1, 5.19.2 & 5.19.3). During the season 2022-2023, field efficacy of multicolour glue-fin traps was tested in a supervised field experiment with nine treatments (T1. yellow + blue + white + gossyplure; T2. yellow + blue + green + gossyplure; T3. yellow module which is more user - friendly after series of refinement + blue + red+ gossyplure; T4. florescent yellow + fl. green +





+ gossyplure; T<sub>s</sub>. florescent yellow + fl. blue + fl. red + gossyplure; T<sub>7</sub>. yellow + yellow + yellow + gossyplure; T<sub>8</sub>. yellow cylinder trap; T<sub>s</sub>. standard funnel trap with gossyplure) in RBD replicated three times. A pre-season trial was conducted for identifying optimum glue for trapping all the sucking pests and pink boll worm moths simultaneously in a single trap. Among the sticky materials tested viz., vaseline petroleum jelly; white lithium grease; industrial castor oil; commercial insect gum; high viscous hydraulic oil and removable sticky film, the

Fl. white + gossyplure; T<sub>s</sub>, florescent yellow + fl. blue + fl. green high viscous hydraulic oil was found superior in trapping the test insects. The mean trap catch data from the second field experiment showed that the yellow + blue + white + gossyplure combination recorded the maximum trap catch of the sucking pests viz., jassids, aphids and thrips. The occurrence of whiteflies was low throughout the season. There is no difference among the colour traps in attracting the pink bollworm adults. However, the sticky trap catches were significantly low (2.9-14.6/week) when compared to the catches in the standard funnel trap (27.3/week).

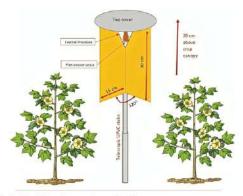


Fig.5.19.1: Multicolour glue-fin trap

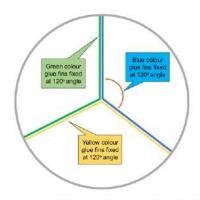


Fig. 5.19.2: Top view of the multicolour glue-fin trap

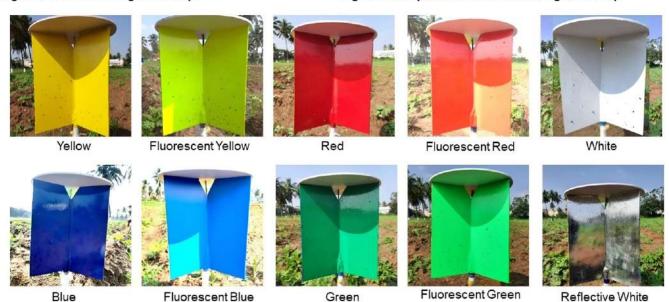


Fig. 5.19.3: Different colours tested in the multicolour glue-fin trap

# 5.20. Biology and holistic management strategies for emerging pest tea mosquito bug (Helopeltis sp.) in cotton

# PI: M. Amutha

### Importance of the study:

Tea mosquito bug (TMB) Helopeltis sp. is the emerging pests on cotton and causes seviour damage in cotton. Estimation of yield loss caused by Helopeltis theivorain cotton is essential to determine the ETL for this pest. Information on efficacy and level of resistance of different group of insecticides against H. theivora in cotton ecosystem is essential to recommend the effective insecticides. These data will help to formulate effective and sustainable IPM strategies for H. theivora.

# Salient findings

Nine insecticides were evaluated for LC 50 and LC 90 against were recorded for tea mosquito bug.

tea mosquito bug at laboratory condition. Thiamethoxam 12.60% + Lambda-cyhalothrin 9.50% ZC was recorded with lowest LC50 and LC 90 of 0.052 and 1.807 respectively. Next to this, Dinotefuran 20 SG was recorded with LC50 and LC 90 of 0.181 and 1.339 respectively (Table 5.20.1). Eleven pesticides were tested in the field for their efficacy against the tea mosquito bug. Thiamethoxam 12.60% + Lambda-cyhalothrin 9.50% ZC and Dinotefuran 20 SG were shown to be highly effective, resulting in a 92% and 88% corrected percent reduction in the number of insects/plant respectively, followed by Bifenthrin 8% SC and Fipronil 5 SC (Table 5.20.2). The highest and lowest avoidable yield loss of 52.54 and 13.36% was recorded in treatments with five and one tea mosquito bug per plant (Table 5.20.3). Totally nineteen alternate hosts from different families



Table 5.20.1. Efficacy of different insecticides against H. theivora

S.No	Insecticides	LC50 (ppm)	Fiducial limit (95%)		LC90 (ppm)	Fiducial limit (95%)		Slope
		Control of State	Min	Max		Min	Max	
1.	Bifenthrin 8%SC	0.626	0.450	0.850	4.276	2.782	8.038	1.536±0.185
2.	Cypermethrin	6.047	4.206	8.502	52.532	29.011	159.833	1.365±0.232
3.	Dinotefuron	0.181	0.076	0.307	1.339	0.792	3.110	1.473±0.225
4.	Fipronil	0.494	0.351	0.670	3.322	2.220	5.912	1.549±0.181
5.	Flonicamid	11.283	8.783	13.818	34.417	26.794	50.123	2.646±0.363
6.	Imidacloprid	4.679	1.816	8.194	16.808	9.299	125.335	2.308±0.294
7.	Thiacloprid21.70 % SC	2.212	1.610	2.963	12.635	8.324	24.092	1.694±0.225
8.	Thiamethoxam25 % WG	4.758	4.149	5.440	9.287	7.820	11.889	4.412±0.528
9.	Thiamethoxam 12.6% + Lambda cyhalothrin 9.5%ZC	0.052	0.001	0.199	1.807	0.439	210.190	0.831±0.129

Table 5.20.2. Evaluation of efficacy of different insecticides against *H. theivora* under field condition

, v							
S.No	Insecticide Name			insects/plant (7 DAT)	Boll damage %		
		Pre	Post	% Reduction over control	Pre	Post	% Reduction over control
1.	Bifenthrin 10 %SC	6.20	0.50	84.33	63.58	36.04	31.52
2.	Thiamethoxam 12.6% + Lambda cyhalothrin 9.5%ZC;	5.10	0.20	91.67	64.97	26.91	48.44
3.	Thiacloprid 21.70 % SC	5.30	0.90	77.00	60.76	36.25	31.51
4.	Thiamethoxam 25 % WG	4.70	0.80	81.50	50.44	38.86	25.25
5.	Azadirachtin 0.03 (300 PPM)	5.80	1.10	69.33	56.02	41.25	21.25
6.	Cypermethrin 25 EC	5.40	0.80	79.83	65.14	31.10	40.66
7.	Dinotefuran 20 SG	6.50	0.30	88.33	61.04	32.88	37.34
8.	Fipronil 5 SC	4.90	0.50	85.17	57.60	35.65	32.44
9.	Flonicamid 50 WG	3.80	0.80	76.00	58.33	38.85	25.71
10.	Imidacloprid 17.8 SL	4.50	1.20	67.00	61.23	35.99	31.79
11.	Lambda-Cyhalothrin 5 EC	5.30	0.70	79.33	63.82	53.03	0.00
12.	Control	5.90	3.90	0.00	63.58	36.04	31.52
	S. Ed		0.074	4.202		1.378	2.878
	CD		0.166	9.359		3.069	6.410

Table 5.20.3. Estimation of avoidable yield loss due to H. theivora on cotton by artificial infestation\*

Treatments	Yield	d of single plant	(g)	Avoidable yield loss (%)			
	2021-22	2022-23	Pooled	2021-22	2022-23	Pooled	
T1 (1 insect/plant)	35.99	32.95	34.47	9.57	17.14	13.36	
T2 (2 insect/plant)	33.67	30.80	32.23	15.41	22.55	18.98	
T3 (3 insect/plant)	31.63	26.82	29.23	20.52	32.55	26.53	
T4 (4 insect/plant)	22.05	23.89	22.97	44.61	39.92	42.26	
T5 (5 insect/plant)	18.95	18.81	18.88	52.38	52.71	52.54	
T6 (Control)	39.80	39.77	39.78				
S.Ed	0.108	0.159	0.122				
CD	0.243	0.360	0.275				

<sup>\*-</sup> Mean of two years pooled data





# 5.21. Development of Semiochemical based attractants for Screening of cotton varieties and hybrids against cotton sustainable management of cotton stem weevil Pempherulus affinis (Faust) Curculionidae: Coleoptera)

# PI: K. Shankarganesh

# Importance of the study:

Cotton, stem weevil is one of the key insect pests in south India especially in Tamil Nadu. If infestation occurs in 12 to 15 days old seedlings, it can cause the mortality up to 90%. Control with insecticides targeted at adult stage is becoming increasingly difficult as the more effective insecticides were banned and non-availability or limited availability new chemistry insecticides. Framers were struggling to control this pest because of the invisibility of the life stages of this pest. The susceptibility most promising Bt and non Bt varieties to stem weevils were unknown. Further, existing management strategies were ineffective in managing this pest. Studies on influence of plant derived volatiles on behaviour of stem weevil in cotton were less studied. As the initial phase of stem weevil infestation is associated with the volatiles emanating from the cotton seedlings attract this pest. In susceptible varieties, it leads to death of the young seedlings. Hence an understanding on the host plant interactions mediated by semiochemicals would offer clue for deciphering the weak links in the biology of the stem weevil. Hence it is imperative to study the chemo profiling of resistant and susceptible genotypes/ varieties/ hybrids (Bt and Non Bt) against stem weevil. Hence characterization of semiochemicals would help to identify the attractants or repellents for stem weevil infestation. Based on the differential profile of semiochemicals, promising compounds can be synthesized and validated for their efficacy on behaviour of stem weevils. The outcome of this study would lead to developing chemo lures for management of stem weevils.

# Salient findings

# Survey and sampling of cotton stem weevil infested districts of Tamil Nadu

Survey was undertaken in major cotton growing districts of Tamil Nadu such as Coimbatore, Madurai, Dindigul, Virudhunagar, Thoothukudi, Tirunelveli, Tenkasi, Trichy and Perambalur during the year June 2022 to assess the damage potential of stem weevil in 27 locations. The villages for sampling of cotton stem weevil incidence were selected based on the acreage of cotton cultivation. The percent incidence was calculated through destructive sampling method. From the survey, it was observed that the BG II was predominantly cultivated in all the districts. Incidence of stem weevil was ranged from 8-86 per cent damage. Madurai, Thoothukudi and Trichy districts recorded higher incidence (>70%) of cotton the weevils was identified. stem weevil. Number of galls per plant was ranged from 1-7 galls per plant. The survey indicated that factors such as ratooning of kharif sown cotton, leaving the cotton stubbles without uprooting, uprooted stubbles kept in fields and cattle grazing were conducive for the incidence.

# Morphological diversity of stem weevil

Cotton stem weevil adults collected from 27 locations were sent to ICAR-NBAIR Bengaluru for species confirmation based of morphological characters. The morphological and identification of cotton stem weevil collected from Tamil Nadu were confirmed as Pempherulus affinis based on their external morphology and genitalial characters.

# stem weevil by no choice method

A total of 15 cotton varieties and five wild types were subjected to no choice ovipositional preference assay. Cotton varieties were subjected to an ovipositional preference study. The results revealed that, under confined conditions adult stem weevil failed to lay eggs on the caged seedlings whereas the same varieties showed cotton stem weevil damage under field conditions.

Table 5.21.1. List of cotton varieties /hybrids used for varietal preference of cotton stem weevil

S. No.	Cotton cultivars	S. No.	Cotton cultivars
1	G. raimondii	11	Sunandha
2	G. stocksii	12	Bhahubali
3	G. capitisvirides	13	RasiBumbac BG II
4	G. anomalum	14	BB 7
5	G. aridum	15	LRA 5166
6	Suraj	16	Mallika
7	Suvin	17	MCU 3
8	Suraksha	18	MCU 5 VT
9	Surabhi	19	SVPR 4
10	Sumangala	20	SVPR 6

# Olfactory response of cotton stem weevil adult to synthetic volatiles from pure compounds

Based on the previous findings, the stem weevil attracting volatiles were short listed and ten different pure compounds were procured from SIGMA Aldrich USA. Under laboratory condition Y tube orientation study was carried out. Out of ten volatiles, the compounds, viz., A, B, C, E and I showed positive responses from adult stem weevil at 1000 ppm. The best performing volatiles were selected for testing the attractancy under field condition. A modified pitfall trap was designed to accommodate the rubber septa loaded with volatiles and they were kept under field condition. The volatiles compound A attracted predatory earwig. Earwig specimens were sent to UAHS, Shimoga, Karnataka for identification and it was identified as Labidura riparia an important predator of Lepidopteran eggs and other insects (Fig 5.21.1). The orientation behaviour of stem weevil towards potential behavior modifying compounds was studied by using Y tube and multi

arm olfactometer. The optimum dose of each compound which could elicit the response from

# Efficacy of cry Bt 41, Bt 62 and Bt 721 obtained from ICAR -Sugarcane Breeding Institute

Three Bt isolates (Bt 41, 62 and 721) were tested against larvae of cotton stem weevil. The mortality percentages were 80, 75 and 55 per cent for Bt 41, Bt 721 and Bt 62 respectively. Bt 41 and Bt 721 found to be more toxic to the larvae of stem weevil.



Fig.5.21.1. Labidura riparia





#### 5.22. Identification and genetic variability of Alternaria and base. Conidia measured 35-95 x 3 - 5 μm size with 5 - 17 septa Cercospora isolates of cotton using molecular markers

#### PI: A. Sampathkumar

#### Importance of the study

Alternaria leaf spot disease, caused by Alternaria macrospora and A. alternata is the major leaf spot disease which occur entire cotton growing zones of India. A. macrospora is the major pathogen which attacks the cotton. The average PDI of leaf, twig and boll infections of Alternaria blight were 21.76 in protected and 50.52 per cent in unprotected treatments. The Alternaria blight disease incidence was recorded as 30.03% in the cotton growing districts of Nanded, Parbhani, Beed and Osmanabad of Marathwada region of Maharashtra. The A. macrospora was the pathogen responsible for the disease. Alternaria blight was the major disease observed in farmer fields of central zone and the disease intensity ranged between 2.16 to 24.12 per cent irrespective of variety/hybrids and locations. Housekeeping gene primers are widely used to identify the Alternaria pathogen as well as species differentiation. Cercospora leaf spot symptoms appear in late season of the crop. Matured leaves are susceptible to the disease. Reddish lesions will appear on these leaves during the early stages. In advanced stages, the lesions enlarge and turn white to light brown or grey in the centre with a purple, dark brown or blackish margin. The lesions are circular or irregular in shape and vary in size depending on the time of infection. Abiotic stress, especially nutrient and moisture stress induces the plants towards susceptibility to Cercospora leaf spot. Cultural and morphological characterization of the pathogen is necessary for precise identification and evolution in the pathogen morphological characters. Pathogen variability on its virulence is a basic requirement to know the pathogen population structure and formulation of effective management strategies.

#### Salient findings

#### Isolation of Cercospora from leaf spot samples of South Zone

Out of fifty-five Cercospora leaf spot samples collected from nine major cotton growing districts of Karnataka namely Dharwad, Haveri, Gadag, Belagavi, Raichur, Vijayapura, Yadagiri, Kalaburagi and Ballari, 29 Cercospora isolates were isolated on PDA. Seven Cercospora isolates were isolated from fifteen samples collected from Ranga Reddy, Warangal, Nirmal and Adilabad districts of Telangana. Six isolates were isolated from ten leaf spot samples collected from Kurnool district of Andhra Pradesh. Among twenty leaf spot samples collected from Coimbatore, Annur and Kinathukadavu blocks of Coimbatore, 9 Cercospora isolates were isolated.

#### Cultural and morphological characterization of Cercospora isolates

Cultural characters of Cercospora gossypina isolates were studied on PDA. Colony colour varied from dull to dark grey, ashy or greyish black with irregular or smooth colony margin. Mycelial characters recorded as flat to medium raised with velvety to smooth texture. Conidia and Conidiophore characters of Cercospora gossypina isolates were studied using compound microscope. Conidiophores were short unbranched, tufted olivaceous pale brown and septate. They were fasciculate and pale towards apex. They were straight or slightly curved. Conidia were thin-walled hyaline and multiseptate. They were needle-shaped, slender and slightly curved. They appeared as cylindric, truncate to subtruncate at the base. Tips of the conidia were straight or variously curved. They were Fig 5.22.3 Spray inoculation of pathogen on LRA5166 Acicular with acute base with thickened and darkened hila at the seelings after pin pricking

(Fig. 5.22.1 and 5.22.2).

#### Pathogenicity and virulence characterization of Cercospora isolates

Pathogenicity and virulence classification of Cercospora gossypina isolates were carried out on 30 days old susceptible genotype LRA 5166 under glass house conditions (Fig. 5.22.3 and 5.22.4). PDI ranged from 11.0 to 34.0 for 29 Karnataka isolates. Among them, 3 isolates recorded as highly virulent, 13 as moderately virulent and 13 as less virulent. PDI of 7 Telangana isolates varied from 14.0 to 23.5 with 3 isolates recorded as moderately virulent and 4 as less virulent. PDI ranged from 12.0 to 21.5 for 6 Andhra Pradesh isolates. Among them 2 isolates recorded as moderately virulent and 4 as less virulent. Tamil Nadu isolates recorded PDI from 15.0 to 26.0 for 9 isolates. Five isolates found to be moderately virulent and 4 as less virulent.

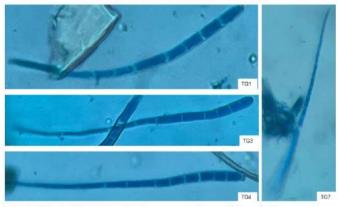


Fig 5.22.1 Microscopic images of conidia of Cercospora isolates from Telangana

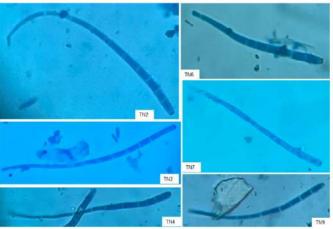


Fig 5.22.2 Microscopic images of conidia of Cercospora isolates from Tamil Nadu













Fig 5.22.4 Poly bag covering after spray inoculation of pathogen (LRA5166 seedlings)

5.23. Studies on rust disease of cotton caused by Phakopsora gossypii and cotton necrosis disease caused by TSV and its management

#### PI: P. Valarmathi

Importance of the study: *Phakopsora gossypii*, an emerging cotton disease, has led to substantial yield losses. The current study aims to examine rust uredospores viability and survival in diverse storage conditions. Spore germination is influenced by maximum TSV incidence of 9.4% (disease grade 1).

temperature and incubation duration. Additionally, *in vitro* assessment of systemic fungicides at varying concentrations on the percent inhibition of uredospore germination was studied.

Salient findings: Among the systemic and combination fungicides evaluated, the maximum % inhibition of uredospore germination (90.1%) was observed by Azoxystrobin 18.2% + Difenoconazole 11.4% w/w SC followed by Carbendazim 12%+ Mancozeb 63% WP (88.2%); least inhibition was noticed with non-systemic fungicide Copper oxychloride (81.98%) (Table 5.23.1). Uredospore germination commenced early (25.30% at 4 h) and progressively increased, reaching 69.40% after 8 h of incubation (Fig. 5.23.1). The highest germination (96.40%) occurred after 24 h at 25°C, with lower rates at 30°C (36.12%), 35°C (13.54%), and 40°C (2.15%). Temperature beyond 25°C were unfavourable for uredospore germination. Across storage conditions, % viability of uredospores decreased over time. Under room conditions, viability was maintained for 40 days, decreasing from 85.20 to 4.80%. (Fig.5.23. 2). Following this, under-tree-shade conditions sustained uredospore viability for up to 35 days of storage (80.25 to 6.2%). No uredospore germination occurred after 45 days across all storage conditions. The lowest percent viability of uredospores (3.2%) was observed in refrigerator storage for 35 days. Among the Bt hybrids, RCH 659BG II observed maximum TSV incidence of 14.5 % (disease grade 3) and in varieties Surabhi observed

Table 5.23.1. In vitro evaluation of systemic fungicides at different concentrations on % inhibition of uredospore germination of *Phakopsora gossypii* 

S. No	Treatments	% Inhibition concentrations					
		0.025 %	0.05%	0.075 %	0.1 %	Mean	
1.	T1- Kresoxim-methyl 44.3% SC	75.4* (60.2) **	81.2 (64.3)	84.5 (66.8)	89.3 (70.9)	82.6 (65.3)	
2.	T2- Propiconazole 25% EC	78.2 (62.2)	83.4 (65.9)	88.0 (69.7)	91.2 (72.7)	85.2 (67.4)	
3.	T3- Propineb70%WP	80.1 (63.5)	83.3 (65.8)	85.3 (67.5)	88.5 (70.2)	84.3 (66.6)	
4.	T4-Fluxapyroxad 167 g/l + Pyraclostrobin 333g/l SC	75.2 (60.1)	80.2 (63.5)	83.1 (65.7)	90.3 (71.8)	82.2 (65.1)	
5.	T5-Azoxystrobin 18.2% + Difenoconazole 11.4% w/w SC	86.2 (60.8)	87.4 (69.2)	92.3 (73.8)	94.6 (76.5)	90.1 (71.6)	
6.	T6-Metiram 55% + Pyraclostrobin 5% WG	76.3 (68.2)	81.2 (64.3)	84.3 (66.6)	89.7 (71.2)	82.8 (65.5)	
7.	T7- Copper oxychloride	76.4 (60.9)	81.0 (64.2)	84.2 (66.5)	86.3 (68.2)	81.9 (64.8)	
8.	T8- Carbendazim12%+ Mancozeb 63% WP	80.1 (63.5)	88.2 (69.9)	91.4 (72.9)	93.2 (74.8)	88.2 (69.9)	
9.	T9- Mancozeb	77.2 (61.5)	82.3 (65.2)	86.5 (68.4)	89.6 (71.2)	83.9 (66.3)	

<sup>\*</sup> Figures indicate original values; \*\* Figures in parenthesis indicate arc-sine transformed values.





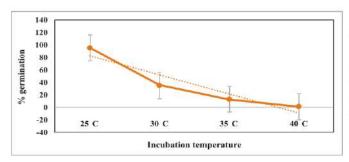


Fig.5.23. 1. Percentage germination of *P. Gossypii* uredospores at different incubation temperature

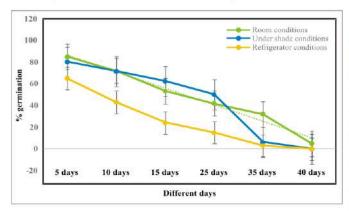


Fig. 5.23.2. Viability and survival of *P. Gossypii* uredospores under different storage conditions

#### 5.24. Studies on plant parasitic nematodes of cotton

PI: J. Gulsar Banu; Co-PI: Nandini Gokte-Narkhedkar

**Importance of the study:** This study aimed to standardize protocol for spore yield maximization in *Pochonia chlamydosporia* and to develop eco-friendly nematode management using formulations of *Pochonia chlamydosporia* and novel chemistries.

#### Salient findings

Standardisation of substrate and duration for increased spore yield in *Pochonia chlamydosporia*.

Maximum chlamydospore yield of *P. chlamydosporia* was recorded in maize grains at 33 DAI (Days After Inoculation) which was followed by Pearl millet. Apart from being egg parasite of nematodes, *P. chlamydosporia* secretes nematicidal toxins and also have plant growth promoting activity.

#### Integrated nematode management in Cotton

The following methods are recommended for the management of nematodes in Cotton.

- Soil application of vermicompost enriched with talc based formulation of *P.chlamydosporia* @ 1Kg/ac. Vermicompost supported survival of *P. chlamydosporia* and longer persistence of spores under field condition.
- Soil drenching of liquid formulation of P. chlamydosporia@
   2.50 l/ac.

Identification of novel chemistries for management of nematodes

Four metabolites viz., Nonanol, Triamcelone, Glafenine

hydrochloride and Nicotinamide mononucleotide were tested against reniform nematode eggs and juveniles under *in vitro* condition. Two modes of action were recorded. Quick knock down effect and kills within 6-12 hours at higher concentration whereas under slow killing action, vacuole formation and merging of vacuole which was followed by rupturing of the cuticle was noticed. All the four metabolites are having nematicidal activity and hatching inhibition at different concentration tried. Due to the presence of extra cuticle, entomopathogenic nematodes are not affected by these molecules even at higher concentrations at 24 Hours after inocultion.

# 5.25. Development of biocontrol consortia with multifaceted fungi for the management of important pests and nematodes of cotton

PI: J. Gulsar Banu; Co-PIs: M. Amutha and Shivaji Thube

Importance of the study: Sucking pests and nematodes are important biotic factors which affects cotton production in India. Plant parasitic nematodes interact with fungus and causes nematode fungal disease complex where the yield reduction is several folds increased. They are managed by using chemical pesticides. Indiscriminate use of these chemicals resulted in environmental pollution, ground water contamination, development of resistance in target pests, adverse effect on natural enemies and also harmful to human beings. Several microorganisms with different mode of action are being used to manage them. Biocontrol consortia with different mode of action will be helpful to increase the efficacy of these biocontrol agents. This study aims to identify eepiphytic and endophytic fungus with different mode of action and development formulations for the ecofriendly management of these pests in Cotton.

#### Salient findings

Out of 644 endophytic fungal isolates collected, forty promising isolates were identified based on nematode mortality and hatching inhibition study. Out of which EF 11, EF-41 and EF 42 significantly reduced the root penetration and multiplication of reniform nematode in Cotton.

Bio efficacy studies with Lecanicillium lecanii and Beauveria bassiana alone and consortia was effective against sucking pests and Helicoverpa armigera. When formulation was developed the consortia was more effective against H. armigera and colonization by B. bassiana was noticed within 48 Hours after inoculation in H. armigera. Therefore, biocontrol consortia with L. lecanii and Acinetobacter woffii was developed and tested against sucking pests under in vitro and pot culture condition. Biopesticide Consortia recorded significantly quick mortality and colonization than the single microbe tested. This formulation was found to be safer to Coccinellid grubs and beetles under field condition. Akanthomyces lecanii isolate L.I-CICR isolated from mealybug was submitted to gene bank (OP925904). Soil application of Biocontrol consortia with Pseudomonas flourescens and Pochonia chlamydosporia could significantly reduce the reniform nematode infestation in cotton.



#### 6.1 Project Name: Development of varieties of upland cotton having better fiber traits and tolerance to CLCuD

PI: S.K. Verma/Subhash Chandra; Co-PI: V.N. Waghmare Importance of the study: This study aims to the development of G. hirsutum genotypes having better fiber traits and tolerance to CLCuD.

#### Salient findings

- Under two station trials conducted with 16 entries each during 2022-23, out of 32 advanced cultures (derived from different 14 crosses), 19 were resistant, 7 were moderately resistant and 6 were moderately susceptible for CLCuD at CICR, RS, Sirsa, while Non Bt check CSH 3129 and Bt check PAU Bt 3 showed moderately susceptible reactions under same environment. For seed cotton yield (Kg/ha), cultures i.e. CSH NB 4, CSH NB 11, CSH NB 19, CSH NB 31 and CSH NB 32 were found to be significantly better than Non Bt check CSH 3129, While CSH NB 31 and CSH NB 32 were significantly better than PAU Bt 3 (Figure 6.1.1). Genotypes i.e. CSH NB 4, CSH NB 5, CSH NB 9, CSH NB 16, CSH NB 21, CSH NB 25 and CSH NB 32 exhibited better fibre length (UHML >27.00 mm) than best yield check PAU Bt 3 (UHML 25.50 mm).
- A total of 12 Crosses (6 fresh bi-parental crosses and 6 back crosses) were attempted for pyramiding CLCuD resistance, high yielding traits and better fiber quality traits Fig. 6.1.1: Promising cultures for seed cotton yield

- (Table 6.1.1).
- Seven Single plant selections (F<sub>5</sub>) i.e. SPS 11, 22, 23, 28, 29, 30 and 31 performed better than best check CSH 3129 among the 40 Single plant Selections (SPS) during evaluation.
- CLCuD resistant genotypes i.e. GVS 8 & GVS 9 and highly susceptible genotype for CLCuD i.e. HS 6 were being maintained as ratoons in CLCuD screening nursery. For genetic studies, F1 (GVS 9 X HS 6), F2 (GVS 9 X HS 6), BC 1{(GVS 9 X HS 6) X GVS 9}and BC 2 {(GVS 9 X HS 6) X GVS 9} were being maintained. Observations for CLCuD were recorded in parents/ populations and resistant progenies were identified for further advancement.

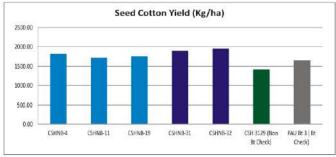


Table 6.1.1: Details of crosses attempted during 2022

S. No.	Details of Back crosses	S. No.	Details of New Crosses
1.	(GVS 9 x F2228) × F2228	7.	GVS 9 × CSH 3129
2.	(GVS 9 x CSH 3129) × CSH 3129	8.	GVS 9 × CSH 3075
3.	(GVS 9 x HS 6) × HS 6	9.	GVS 9 × CICR Bt 6
4.	(GVS 9 x HS 6) × GVS 9	10.	GVS 8 × CSH 3129
5.	(GVS 8 x CSH 3075) × CSH 3075	11.	GVS 8 × CSH 3075
6.	(F2228 x GVS 9) × F2228	12.	GVS 8 × CICR Bt 6

#### 6.2 Project Name: Common research trials on evaluation of GEAC approved Bt cotton hybrids in North Zone

S.K. Verma (Trial In-charge and Trial Coordinator), Rishi Kumar, . S.K. Sain, Amarpreet Singh, Subhash Chandra and D. Paul

Importance of the study: This study aims to evaluate GEAC approved Bt cotton hybrids for yield attributes, fibre quality traits, Insect-pest reactions and CLCuD reactions for combined recommendations for north zone and respective state (Haryana).

#### Salient findings

- Under this project, 84 entries were evaluated in Experiment ... I (Common Research trial for North zone) and 16 entries were evaluated in Experiment II (Research trial for Haryana State) for yield attributes, fibre quality traits, insect-pest reactions and CLCuD reactions. Entries depicted huge variation for the traits (Table 6.2.1).
- Entries i.e. 501, 502, 521, 528, 542, 544, 549, 554, 557, 574 were better yielders (seed cotton yield >30.00 g/ha) in Exp I while, Entries i.e. 706, 710, 712 and 716 were better yielders (seed cotton yield >30.00 q/ha) in Exp II.
- Out of 84 entries, 18 entries showed resistant (R) reaction in

Exp. I while out of 16 entries in the Exp. II, 03 showed moderately resistant (MR) reactions against CLCuD.

- Among all hybrids (84 entries), whitefly population ranged from 45.39 to 67.44 /3 leaves, the lowest in entry no. 505. Jassid ranged from 0.94 and 2.89 /3 leaves, with entry 544 having the minimum. Thrips ranged from 6.50 to 14.28/3 leaves. Entry 508 showed the lowest green ball damage (5.00%), entry 535 had the least open boll damage (10.73%), and entry 544 recorded the lowest locule damage (5.10%).
- In another set for Haryana state hybrids trial (16 entries), whitefly populations ranged between 53.89-63.67/3 leaves, with the lowest in entry 704. Jassid populations varied from 3.48-4.89/3 leaves, with entry 713 having the lowest, and thrips populations ranged between 7.85-10.11/3 leaves, with the minimum in entry 702.
- To study the off season carryover, during 2021, incidence of pink bollworm from the bolls collected from cotton stalks at different farmers field locations ranged between 0.00 to 8.20 % and during 2022, ranged between 0.66 to 14.01 % at different locations.

Table 6.2.1: Variations for yield attributes, fibre quality traits, insect-pest reactions and CLCuD reactions in GEAC approved hybrids at ICAR-CICR, RS, Sirsa during 2022

Item/trait	Range in Experiment I (84 entries)	Range in Experiment II (16 entries)
Yield (Kg/ha)	967 - 3851	1975 - 3683
Boll Numbers	24.4 - 55.35	37.20 - 52.40
Boll Weight(g)	1.38 - 3.81	2.90 - 4.58
GOT(%)	23.8 - 37.0	32.7 - 36.0
Fibre length (mm)	24.2 - 29.7	24.2 - 27.0
Micronaire value	3.5 - 4.9	3.90 - 4.40
CLCuD (PDI %)	19.21 - 77.25	20.88 - 64.32
Whitefly/3 leaves	45.39 - 67.44	53.89 - 63.67
Jassid/3 leaves	0.94 - 2.89	3.48 - 4.89
Thrips/3 leaves	6.50 - 14.28	7.85 -10.11
Green boll damage (%) due PBW	5.00 - 30.00	10.00 - 25.00
Open boll damage(%) due PBW	10.73 - 22.67	13.24 - 19.40

#### 6.3 Project Name: Physiochemical traits determining genotypic response towards Accelerated Ageing process in Cotton

PI: Debashis Paul; Co-PIs: V. Santhy, Sunil Mahajan Importance of the study:

This study aims to access optimum picking time and boll . position having better seed quality as well as the influence of maturity durations and boll positions influencing Accelerated Ageing Process

#### Salient findings

The seeds harvested at (140-150 DAS) and from middle

stratum of the plants showed higher seed quality parameters. The Seed vigour indices (SV-I & SV-II) were significantly higher for seeds harvested during 140 DAS (2027.77 & 1435.44) to 150 DAS (2158.11 & 1254.21) compared to seeds from later harvests.

- 72 hours of accelerated ageing at 45°C and 90 (%) RH for G. hirsutum genotypes may be used as quick seed vigour test (Table 6.3.1).
- The seeds harvested at (140 DAS) and from middle stratum of the plants showed least response to accelerated ageing test.

Table 6.3.1: Two years mean genotypic response for Germination (%) with respect to Accelerated Ageing at 45°C & 90 (%) Humidity

Genotype	Initial/Control (0hour)	48 hour	72 hour	96 hour
Rajat Bt	76.30	71.60	63.50	54.0
CNA-1028	78.67	67.60	55.0	33.25
PKV-081	94.30	86.0	76.0	67.25
CICR 16 Bt	78.30	67.0	60.25	58.75
CICR 23 Bt	82.30	76.40	63.0	51.75
Suraksha	64.30	59.20	51.50	43.50
Suraj	74.60	65.40	57.50	49.0
Supriya	68.60	67.20	58.75	49.75
Surbhi	66.30	61.80	55.50	50.30
Sumangala	70.30	65.40	56.50	53.0

#### 6.4 Project Name: Evaluation of commercially available Bt Salient findings cotton hybrids for the state of Haryana

Debashis Paul (Trial In-charge), S.K. Verma (Trial Coordinator) and Rishi Kumar

#### Importance of the study:

This study aims to evaluative the commercially available BG-II hybrids with respect to proportion of non Bt seeds mixed as 'refugia' in seed packets

- The non-Bt plants ranged between 0.86 to 10.83 percent among the twenty hybrids evaluated in the year 2022-23(Figure 6.4.1).
- Among the hybrids evaluated 25 % hybrids were within the recommended limit of 'refugia' (5-10%), 70% hybrids were below the recommended limit of 'refugia' (<5%) and 5% hybrids were above the recommended limit (>10%).







Figure 6.4.1: State trial at ICAR-CICR Sirsa (a) Field view of experiment (b) Qualitative ELISA Plate during non-Bt plants identification

### 6.5 Project Name: Conservation agriculture practices for cotton-wheat system

PI: Amarpreet Singh; Co-PIs: G. Majumdar

#### Importance of the study:

The study aimed to understand the effects of conservation agriculture practices under cotton-wheat cropping system with components like residue retention / incorporation and removal; zero / minimum and strip tillage and conventional tillage practices etc. under north-western Indian conditions.

#### Salient findings

 An experiment on Conservation Agriculture practices for cotton-wheat system was initiated with fixed laid out plan.
 Sowing of Bt cotton hybrid (RCH 926 BG II) was been done as per the approved lay out plan for the 2022-23 cropping year. No tillage and crop residue management treatments could be applied to the cotton crop as it was the first crop of the cropping cycle and the field was mould board ploughed and laser levelled before start of the experiment.

- A non significant effect among all the treatments was obtained w.r.t. yield attributes, seed cotton yield, insect pests and diseases of cotton during the first year of experimentation as it was an establishment year for the experiment and no tillage and crop residue management treatments could be applied to the cotton crop.
- Tillage and crop residue management treatments have been executed during the sowing of wheat crop in *Rabi* season of the 2022-23 cropping year as depicted in Figure 6.5.1.



Figure 6.5.1: (a) Mulching of cotton stalks with tractor operated Mulcher Machine before wheat sowing; (b): Cotton stalk shredding with tractor operated Cotton Stalk Shredder Machine before wheat sowing; (c) Wheat sowing with Happy Seeder Machine in standing cotton stalks; (d) Wheat sowing with Supper Seeder Machine in standing cotton stalks; (e) Happy seeder sown wheat in standing cotton stalks (after operating mulcher); (f) Happy seeder sown wheat in standing cotton stalks (incorporation of cotton stalks) at ICAR-CICR, Regional Station, Sirsa, Haryana

### **6.6 Project Name: Management options for poor root** growth is often hindered in the Indo-Gangetic plain soils due to **development in Hybrid Bt cotton** the presence of soil compaction. This study aims to understand

PI: Amarpreet Singh

Importance of the study: Cotton (Gossypium hirsutum) root options on cotton root systems.

growth is often hindered in the Indo-Gangetic plain soils due to the presence of soil compaction. This study aims to understand the impact of different soil conditions, chemical and biological options on cotton root systems.





#### Salient findings

- Under this project field experiments were conducted under four conditions i.e., (i) Normal Ploughing (ii) Sub Soiling (iii) MB Plough and (iv) Compact Soil (Figure 6.6.1). Ten various chemical and biological options including untreated control were tested for their efficacy in root development / root growth enhancement as seed dressing /seed treatment as well as seed dressing /seed treatment + foliar application under all the soil conditions.
- Highest values of root parameters and seed cotton yield of hybrid Bt cotton was obtained under MB plough > Sub soiling > Normal ploughing > Compact soil.
- Dry weight of roots and tap root length was significantly

- higher with Mepiquat chloride (S+F) @ 100 ppm; Mepiquat chloride (S) @ 100 ppm &Salicylic acid (S+F) @ 200 ppm over control under Normal ploughing & Compact soil but all treatments were at par with each other under MB plough & Sub soiling.
- Lateral root length was significantly higher under Mepiquat chloride (S+F) @ 100 ppm; Mepiquat chloride (S) @ 100 ppm &Salicylic acid (S+F) @ 200 ppm over control under all the soil tillage conditions.
- Significantly higher values of seed cotton yield were obtained under Mepiquat chloride (S+F) @ 100 ppm > Mepiquat chloride (S) @ 100 ppm > control and all other treatments under all the soil tillage conditions.



Figure 6.6.1: (a) Normal Ploughing with tillers and planking; (b) Sub Soiling; (c) MB Plough; (d) Soil compaction with tractor at ICAR-CICR, Regional Station, Sirsa, Haryana

### 6.7 Project Name: Whitefly: Studies on Ecology and Host Plant Resistance

PI: Rishi Kumar; Co-PIs: S.K. Sain, T. Parbhulinga

#### Importance of the study:

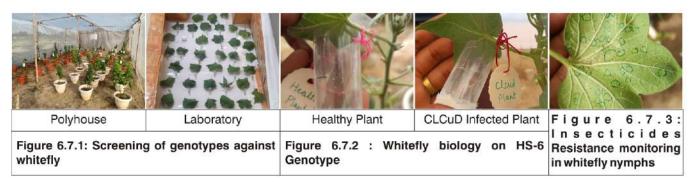
This project aims to study the population Ecology, life Table analysis of Whitefly in cotton, behaviour of whitefly on different genotypes choice or no-choice conditions in field as well as polyhouse conditions and resistance monitoring pattern in whitefly against label claimed & commonly used insecticides.

#### Salient findings

• Rearing of whitefly Bemisia tabaci on CLCuD infected plant affected the biology. The total nymphal duration(days) was comparatively less when whitefly reared on CLCuD infected plants (14.2±1.30& 15.6±1.50) in comparison to healthy plants (18.2±1.30 & 20.8±2.49) during 2020 & 2021, respectively. Similarly, total life cycle duration (days) of females was longer (32±1.87 & 34.2±2.39) in case of whitefly reared on healthy plants in comparison to infected (24.2±3.27 & 26.6±1.36) during 2020 & 2021, respectively. Fecundity was more on healthy (32.8±5.17 & 36.8±3.96)

and less on infected plants ( $22.6\pm2.70~\&~24.2\pm2.23$ ), during 2020 & 2021, respectively (Figure 6.7.2).

- In polyhouse and field screening of 112 genotypes over 3 years (Figure 6.7.1), settling (%) and ovipositional preference (based on Nymphal counts) for whitefly adults recorded, 8 entries NGP- 102, NGP-117, NGP-127, EC-344385, EC-700108, EC-700140, BGDS- 1063, and SCS-1001 superior over resistant check (LPS141)
- Based on insecticide resistance monitoring bioassays conducted against label claimed insecticides maximum mortality at recommended dosage was in Afidopyropen (64%) followed by Pyriproxyfen, Buprofezin, Spiromesifen, Dinotefuran, Ethion, Diafenthiuron, Flonicamid and Azadirachtion 0.03 in whitefly red-eyed nymphs. The LC50 value (g or ml/litre water) based on the bioassay conducted on nymphs was 0.96 (0.40-1.57) & 1.64 (0.98-2.70) in Afidopyropen 50 DC during 2021-22 & 2022-23 followed by 1.35 (0.69-23.65) & 1.43 (0.97-2.15) in Flonicamid 50%WG, 0.50 (0.35-0.96) & 0.65 (0.42-1.10) in Dinotefuran 20 % SG and 3.20 (1.88-14.84) & 3.82 (2.23-6.84) in Ethion 50 % EC, respectively (Figure 6.7.3).







# 6.8 Project Name: Thermal stress induced effect on insecticide susceptibility and fitness traits in whitefly, Bamesia tabaci, a serious pest of worldwide concern

PI: Rishi Kumar; Co-Pls: Debashis Paul & B.B. Fand Importance of the study:

This study aims to investigate the effects of basal and induced thermal stress on fitness traits of whitefly. This research will also enumerate the stress induced effect on efficacy of insecticides upon fitness traits in whitefly as well as associated biochemical changes in host plants and insects with basal and induced thermal stress.

#### Salient findings

 The whiteflies were subjected to basal thermo-tolerance studies under two sets i) with host i.e. cotton leaves and another ii) without any host in a glass vial at predefined low (7-19°C) and high temperature (37-47°C). The mortality (%) at exposure in the presence of cotton host in case of cold hardiness ranged between 11.32-41.25 whereas when exposure was given without any host (directly in glass tube) mortality (%) was comparatively more and ranged between 31.25-58.05, maximum at 7°C and minimum at 17°C. In the case of heat hardiness, the mortality (%) in the presence of the host ranged between 18.07-81.82, maximum at 47°C and minimum at 37°C, while without a host it ranged between 30.70 -100 (%). The mortality (%) recorded at 26°C (normal) ranged between 15.07-16.47 (with host) and 30.02-37.68 (without host) (Figure 6.8.1).

Life cycle studies of surviving whitefly individuals after exposure at various temperatures along with conducted at normal temperature indicated an effect on fecundity and hatching of survivors from both low and high temp in comparison to the survivors of normal temperature revealing the basal thermal effect on the biology of the whitefly. When exposed at different temperature (19-35°C) at two different humidity regimes (65 & 71%), RH 71% was more suitable to whitefly in comparison to 65%, high humidity may have helped in cop-up with high temperature (Table 6.8.1)

Table 6.8.1: Effect of different temperature on survival of field collected Whitefly at RH 65% & 71%

Exposure Temp °C	Without host With ho		host	Exposure	Without host		With host		
	At 65 %	At 71 %	At 65 %	At71 %	Temp °C	At 65 %	At 71 %	At 65 %	At71 %
17	-	29.02	-	11.28	27	33.33	34.17	16.50	13.85
19	21.00	33.87	10.00	13.33	29	35.83	20.43	19.17	10.83
21	32.57	10.59	5.00	1.86	31	28.69	18.18	11.50	5.80
23	36.92	17.14	4.35	1.25	33	29.23	20.99	10.43	5.09
25	37.00	18.18	14.39	10.66	35	32.50	14	11.17	120



Rearing of whitefly at normal temperature in polyhouse.



Exposure of whitefly with and without host at different temperature.



Biology of whitefly at normal temperature.

Figure 6.8.1: Experimentation for thermal stress induced effect in Whitefly

# 6.9 Project Name: Collection, characterization and evaluation of beneficial fungal microorganisms from North, Central and South Cotton growing zones

PI: S.K. Sain; Co-Pls: S.P. Gawande, P. Valarmathi

#### Importance of the study:

This study aims to isolation, characterization, and screening of rhizosphere fungi from cultivated cotton for disease management, plant growth, and enhancing productivity in the integrated and organic farming system.

#### Salient findings

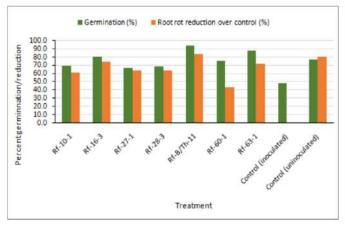
 Seven promising cotton rhizospheric fungi (RFs) were selected based on in vitrodual culture test (mycelial growth inhibition) against Rhizoctonia solani, Macrophomina phaseolina, Corynespora cassiicola and Alternaria alternata in the laboratory. These Rf isolates were evaluated against root rot pathogen under polyhouse conditions for two consecutive years 2021-22 and 2022-23 at ICAR-CICR RS Sirsa.

The pooled results (2021-22 & 2022-23) exhibited the highest seed germination and root rot reduction over control with the seed treatment of Rf-B/Th-11 (*Trichoderma asperellum*) followed by Rf-63-1 (*Actinomortierella wolfi*) and Rf-16-3-(*T. virens*) at 90 days after sowing (DAS) (Figure 6.9.1) under pot experiment. Similarly, in another cup experiment with pathogen-inoculated soil, the highest pooled vigor index (germination x root-shoot growth) at 30 DAS was recorded with the seed treatment(@ 10°c.f.u.) of



Rf-b/Th-11, Rf-63-1 and Rf-16-3 (Figure 6.9.2). These Rf isolates were evaluated under root rot sick field conditions at ICAR-CICR Regional Station, Sirsa. Among all treatments, the lowest area under the disease progress curve (AUDPC) at 150 days after sowing was recorded with seed (@5g/kg seed)plus soil treatment (1kg/acre)of Rf-B/Th-11 followed by Rf-60-1, Rf-63-1 and Rf-16-3 in comparison to untreated control having highest AUDPC (Fig 6.9.3).

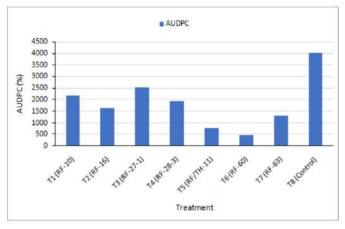
Ten best-selected Rf isolates were evaluated in vitro against soil-borne and foliar fungal pathogens for their antagonistic activity using the dual culture technique at ICAR-CICR-RS, Coimbatore. Maximum mycelial inhibition of Rhizoctonia solani pathogen was recorded with T. viride isolate TNAU Tv1 (52.7%) followed by T.viride CRSVPTv1 (51.1%), and Penicillium spp. CICR pc1 (50%). Similarly, Rf isolates TNAU Tv1 and CRSVPTv1 showed maximum inhibition of Macrophomina spp. 82.4% and 62.4%, respectively. However, the maximum inhibition of the foliar pathogen is the pathogen Alternaria sp. was recorded with Rf isolates CRSVPTv1 (72.8%) followed by TNAU Tv1 (63.6%) (Fig.6.9.4).

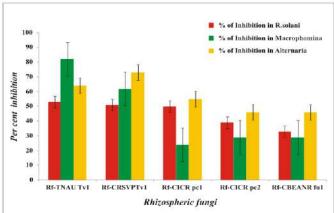


■ Vigour Index (%) 5000.0 4500.0 4000.0 (%) xapui 3500.0 3000.0 2500.0 2000.0 Vigour 1500.0 1000.0 500.0 RI.B/Th.11

on seed germination and root rot control at 90 on cotton plant vigour index at 30 DAS. Rhizospheric DAS:Rhizospheric fungi(Rf)-10-1-T. pleuroticola, Rf-16-3-T. fungi(Rf)-10-1-T. pleuroticola, Rf-16-3-T. virens, Rf-27-1-T. virens, Rf-27-1-T. asperellum, Rf-28-3-T. asperellum, Rf-B-Th-11- asperellum, Rf-28-3-T. asperellum, Rf-B-Th-11-T. asperellum, Rf-28-3-T. T. asperellum, Rf-60-1 Actinomortierella ambigua, Rf-63-1-A. 60-1 Actinomortierellaambigua, Rf-63-1-A. wolfii wolfii

Fig. 6.9.1: Effect of selected cotton rhizospheric fungi (RFs) Fig. 6.9.2: Effect of selected cotton rhizospheric fungi (RFs)





cotton rhizospheric fungi (RFs) on root rot management against soil-borne and foliar fungal pathogen of cotton under sick field conditions: Rhizospheric fungi(Rf)-10-1-T. pleuroticola, Rf-16-3-T. virens, Rf-27-1-T. asperellum, Rf-28-3-T. asperellum, Rf-B-Th-11-T. asperellum, Rf-60-1 Actinomortierella ambigua, Rf-63-1-A. wolfii

Fig. 6.9.3: Effect of seed and soil treatment of selected Fig. 6.9.4: Antagonistic activity of rhizospheric fungi (Rf) using dual culture technique: Rf-CICR isolates Tv-Trichodermaviride, pc-Penicillium sp, fu-Fusarium sp.

# 04 | TECHNOLOGIES DEVELOPED, | EVALUATED AND TRANSFERRED

Sr. No.	ICAR certified ICAR-CICR Technologies, Processes, etc
1	New Protocol for evaluation of transgenic cotton genotypes interogressed with protein against whitefly, Bemisiatabaci (Gennadius) in cotton
2	Technology for Management of Whitefly - Bemisiatabaci (Gennadius) and Cotton Leaf Curl Disease (CLCuD) in North Cotton Growing Zone of India
3	Product/Process- Oil-based entomopathogenic fungal bio-insecticide formulation ( <i>Metarhizium anisopliae</i> CICR-RS- Ma-1299 @1x108cfu/ml): CICR Green Guard-1 (NAIMCC-F-04455)
4	Product/Process- Oil-based entomopathogenic fungal bio-insecticide formulation ( <i>Cordyceps javanica</i> –CICR-RSS-Cj-0102 @10 <sup>8</sup> cfu/ml): CICR Cotpest Guard-1 (ITCC-10499.17)
5	Product/process: Oil-based entomopathogenic fungal bio-insecticide formulation ( <i>Beauveria bassiana</i> CICR RS-Bb-4511 @10 <sup>8</sup> cfu/ml): CICR Cotpest Guard-2 (NAIMCC-F-04402)
6	Development and validation of Degree day-based model for predicting pink bollworm phenology across geographical locations of subtropics and semi-arid tropics of India
7	Innovative on-plant bioassay method for selection of superior genotype/cultivar/event against pink bollworm, Pectinophoragossypiella (Saunders) in cotton under protected screen house condition
8	Wireless Smart Trap for Automated Pest Monitoring in Cotton
9	Development of loop mediated isothermal amplification (LAMP): A new tool for rapid diagnosis of cotton leaf curl viral disease







# 05 | EDUCATION, TRAINING AND CAPACITY BUILDING

#### 5.1: Training and Capacity Building

#### 5.1.1: Training Received

#### Scientist

#### International

Sr. No.	Name of Training Programme	Name	Place/ Organized	Training Start Date	Training End Date
1.	Environmental Risk Assessment (ERA) Workshop: Non Target Organism (NTO) testing	Dr Y G Prasad	Agriculture Food Systems Institute (AFSI), Ames, IOWA, Washington DC, USA	26.06.2023	30.06.2023

#### National

Sr. No.	Name of Training Programme	Name	Place/ Organized	Training Start Date	Training End Date
1.	Hands-on training on LaTex Software (Online)	Dr Joy Das, Dr Rakesh Kumar	SIAS, Calicut University, Kerala	21-02-2023	01-03-2023
2.	Application of Bioinformatics in Accelerating Agricultural Research	Dr J.Gulsar Banu	ICAR-NAARM, Hyderabad	13-02-2023	17-02-2023
3.	Modelling and Simulation using Discovery Studio software (In person)	Dr J.Gulsar Banu	TNAU, Coimbatore	29-05-2023	31-05-2023
4.	Analysis of experimental data using R	Dr K Bhagyalakshmi	ICAR-NAARM, Hyderabad	21-08-2023	25-08-2023
5.	DBT Funded training on Biosecurity and Biosafety: Policies, Diagnostics, Phytosanitary treatments and issues	Dr V Santhy	ICAR- NBPGR, New Delhi	04-09-2023	14-09-2023
6.	Orientation training programme for retiring government officials (OTP- RGO-14)	Dr. MVVenugopalan	ISTM, New Delhi	18-09-2023	19-09-2023
7.	Pedagogy Development Program for enhancing pedagogical competencies for Agriculture Education Conducted by NASS	Dr Saravanan Manimozhi, DrPrabhulinga T.	NAAS New Delhi	25-09-2023	30-09-2023
8.	Next Generation Sequencing (NGS) Data Analysis	Dr Valarmathi	ICAR-NAARM, Hyderabad	16-10-2023	20-10-2023
9.	Pedagogy Development Program for enhancing pedagogical competencies for Agriculture Education Conducted by NASS	Dr Dipak Nagrale, Dr R.Jaya Kumaravardan	NAAS, New Delhi	20-11-2023	24-11-2023
10.	Laboratory Management System as per ISO/IEC 17025:2017 & Internal Auditing	Dr Rakesh Kumar	ICAR-NINFET, Kolkata	04-10-2023	06-10-2023





#### **Technical Staff**

Sr. No.	Name of Training/ Programme	Participants	Place/ Organized	Training Start Date	Training End Date
1.	Training for Extension staff on Organic & Natural Farming	Mrs. Pooja Gonge, Mr. Homraj Mundafale, Mrs. Rachana Deshmukh, Mr. Mayur Meshram, Mr. Ajit Meshram	RCOF, Nagpur	27-07-23	28-07-23
2.	Post-Harvest and Value Addition Capacity Building of Agri. Extension Professional ATARI-VII	Mrs. Sunita Chauhan	ICAR-CIPHET, Ludhiana	07-08-23	11-08-23
3.	Recent Advances in Millets Crop Production, Processing, Value Addition and Marketing	Mrs. Sunita Chauhan	ICAR-IIMR, Hyderabad	16-08-23	25-08-23
4.	Application of Statistical Software for Analysis of Agricultural Survey Data	Mr. Bhumeshwar Fande	ICAR-IASRI, New Delhi	08-09-23	13-09-23
5.	Laboratory management system/ as per ISO/IEC 17025:2017 and Internal Auditing	Mrs. Mithila Meshram	NINFET, Kolkata	04-10-23	06-10-23
6.	CAFT training on : Concept of Agrometerology & Crop weather models	Dr Sachin Yadavrao Wankhede	Department of Agril. Meterology, College of Agriculture, Pune.	28-11-23	18-12-23

#### **Administrative Staff**

Sr. No.	Name of Training/ Programme	Name	Place/ Organized	Training Start Date	Training End Date
1.	Training on Technical service rules (in-person mode)	Mr. Mahesh Tiwari, Mrs. S.P. Kharche, Mr. Kapil Nandeshwar	ICAR-NAARM, Hyderabad	10-07-23	11-07-23
2.	Pre examination training for Limited Departmental Audit and Account Examination	Mr. N Rameash, Mr. Kamarajugadda Vedavyas, Ms. R.P. Mrs. Deepa, R Ramya	ICAR-National Institute at Abiotic Stress Management Malegaon, Baramati	26-07-23	06-10-23
3.	Training on Pension and Retirement Benefits of NPS	Mr. Shital Kumar Sharma, Mr. Saurabh Kishor Patil	ICAR-NBSS LUP, Nagpur	15-11-23	17-11-23

#### Student Internship

Name of Student	Name of Training Duration Coordinator		Title	
Ms. Sakshi Wankhede, Ms. Sakshi Khonge, Ms. Vishakha Cham	Dr KP Raghavendra	20-06-23	19-07-23	Agribacterium mediated <i>In planta</i> Transformation in cotton
Mr. Chaitanya A. Bobale	Dr KP Raghavendra	28-07-23	28-10-23	Agribacterium mediated <i>In planta</i> Transformation in cotton
Ms. Samruddhi S. Lakde	Dr KP Raghavendra	06-10-23	06-01-24	Agribacterium mediated <i>In planta</i> Transformation in cotton
Mr. Tushar H. Umathe	Dr Jayant Meshram	27-10-23	27-01-24	Efficacy of Bacillus spp. And Pseudomonas spp. on Growth, Yield and Leaf Senescence on Stevia rebaudiana





### 5.2: Trainings organized

Name of the Training	Place& Date	Participant Category	Scheme under which Training is held	Number of participant (Male)	Number of participant (Female)	Name of Training Coordinator
Farmers Field Training on Cotton Health Management Strategies	Kalathur Village, Coimbatore 19-25 January 2023	Farmers	IRM	29	21	Dr K Rameash
Integrated Crop Management in Cotton	ICAR-CICR, RS, Coimbatore 24-25 January 2023	Farmers	Institute	60	2	Dr A H Prakash, Dr S Usha Rani and Dr D Kanjana
ICM in cotton	ICAR CICR,RS, Coimbatore 30-31 January 2023	Farmers	Institute	40	0	Dr A H Prakash, Dr S Usha Rani and Dr J Annie Sheeba
ICM in cotton	ICAR CICR Regional Station Coimbatore 01-03 February 2023	Farmers	Institute	32	8	Dr A H Prakash, Dr S Usha Rani
Summer Training	ICAR-CICR Sirsa 20 February- 20March, 2023	M.Sc. students of Chaudhary Devi Lal University, Sirsa	Other	4	6	Dr Rishi Kumar & Dr Debashis Paul
Improving ELS Cotton production- Farmers Training cum Input Distribution	Thozhampalayam, Karamadai Block 21 February 2023	Farmers	DST SERB CRG Project under SSR activity	25	25	Dr A Manivannan
Cotton Farmers Training	ICAR- CICR, RS, Coimbatore 22-23 February 2023	Farmers	SSEPERS- ATMA scheme of Tamil Nadu	35	7	Dr A.H. Prakash
Field Exposure visit cum Training	ICAR-CICR Sirsa 01 March, 2023	Post Graduate Students of CMK College, Sirsa	Other	5	20	Dr Rishi Kumar & Dr Debashis Paul
Training program and distribution of vegetable kits to the SC farmers	Welsakhara, Godhani and Thombra 03 April 2023	Farmers	MGMG	75	45	Dr Sunil Mahajan
Training on GM cotton testing for officials from ADA (Seed testing), Department of Seed Certification, Organic Certification, Department of Agriculture, TN	Coimbatore 02-09 May 2023	ADA and AOs	Institute	0	4	Dr A Manivannan
Summer Training	ICAR-CICR Sirsa 08-16 May 2023	B.Sc. students of CMK College, Sirsa	Other	5	13	Dr Rishi Kumar & Dr Debashis Paul
Training program on Best Management Practices in cotton	Chadiwal, Khedi villages of Sirsa 11 May 2023	Farmers	MGMG	61	0	Dr Rishi Kumar, Dr S.K. Sain, Dr Amarpreet Singh & Dr Debashis Paul





Name of the Training	Place& Date	Participant Category	Scheme under which Training is held	Number of participant (Male)	Number of participant (Female)	Name of Training Coordinator
Technological interventions for climate smart cotton cultivation	ICAR-CICR Sirsa 26 May 2023	Farmers	Institute under campaign of LiFE	60	0	Dr Rishi Kumar and Dr Subhash Chandra
Training program on Integrated Pest Management in Cotton	Jind, Haryana 08 June, 2023	Agri-Officials	Other	35	0	Dr Rishi Kumar & Dr Debashis Paul
ELISA-based Testing of Cry Protein in Bt Cotton"	ICAR-CICR, Nagpur 22 June 2023	CICR Employees	Institute	16	5	Dr G. Balasubramani, Dr KP Raghavendra, Dr J. Amudha, Dr Rakesh Kumar and Dr Joy Das
Training Program on Cotton Production Technology and Integrated Pest Management	Padampur, Rajasthan 25June,2023	Agro-Input Dealers	Others	50	0	Dr Rishi Kumar
Training program on Best Farm Practices for Cotton Farmers to improve Yield	ICAR-CICR Sirsa 28 June,2023	Farmers	CCI-CICR pilot project	47	3	Dr Rishi Kumar, Dr S.K. Sain, Dr Amarpreet Singh & Dr Debashis Paul
Training Program on Cotton Technology	Kharian village of Sirsa30 June 2023	Farmers	Other	200	0	Dr Rishi Kumar
Training on Cotton Production and Protection Technologies	Agroha(Hisar) and Khariyan (Sirsa) 06 July, 2023	Farmers	Other	600	0	Dr Rishi Kumar
Training on Cotton Production and Protection Technologies	Satyam palace Sirsa 07 July, 2023	Farmers	Other	500	0	Dr Rishi Kumar & Dr Amarpreet Singh
Training on Integrated Pest Management in Cotton	Hanumangarh, Rajasthan 08 July, 2023	State Department officials, Agro input dealers and farmers	Other	200	0	Dr Rishi Kumar & Dr Amarpreet Singh
FFS & AESA for farmers	Village:- Kheri; District:-, Sirsa, Haryana 17 July 2023	Farmers	CCI - CICR Pilot Project	178	22	Dr Amarpreet Singh
Training on Field and Laboratory Techniques related to Cotton Crop	ICAR-CICR Sirsa 17July -04 August 2023	M. Sc students of CDLU University, Sirsa	Other	21	14	Dr Rishi Kumar & Dr Debashis Paul
Training programme on 'Cotton Technologies and the Package of Practices'	ICAR-CICR, RS, Sirsa 21July, 2023	Area/Territory Managers of Dhanuka Agritech. Ltd	Other	64	26	Dr Rishi Kumar, Dr Amarpreet Singh & Dr Debashis Paul
Farmers Training on hybrid seed production practices	Bhadra, Begu and Chadiwal villages Sirsa 23 July, 2023	Farmers	Other	30	0	Dr Debashis Paul & Dr Subhash Chandra



Name of the Training	Place& Date	Participant Category	Scheme under which Training is held	Number of participant (Male)	Number of participant (Female)	Name of Training Coordinator
Refresher Training Course on Latest Cotton Production and Protection Technologies	ICAR-CICR, RS, Sirsa 26-27 July 2023	Extension Functionaries	Ambuja Cement Foundation	103	63	Dr Amarpreet Singh
Agro Ecosystem Analysis (AESA) based Farmers Field School	Chadiwal, Sirsa 01 August, 2023	Farmers	CCI-CICR Pilot project	40	0	Dr Rishi Kumar, Dr S.K. Sain, & Dr Debashis Paul
Training on Latest Cotton Production and Protection Technologies	ICAR-CICR 11 August, 2023	Field Extension Persons Revive Green Revolution- TATA Trust	Other	62	13	Dr Rishi Kumar, Dr Amarpreet Singh & Dr Debashis Paul
Farmers' Field School and Training on Improved Cotton Production Technologies	ICAR-CICR, RS, Sirsa 18 August 2023	Farmers	CCI - CICR Pilot Project	51	14	Dr Amarpreet Singh
Farmers' Training on Seed Production Techniques in Cotton	ICAR-CICR Sirsa 18 August, 2023	Farmers	CCI-CICR pilot project	70	0	Dr Rishi Kumar, Dr S.K. Sain, Dr Debashis Paul & Dr Subhash Chandra
Farmer training on IPM and Organic Cotton Production Techniques	Jamal, Sirsa 30 August, 2023	Farmers	CCI-CICR pilot project	70	0	Dr S.K. Sain, Dr Subhash Chandra & Dr Amarpreet Singh
Farmers Interactive Meeting of NFSM – Special Project on Cotton funded by MoA & FW & CCI – CICR Extension Pilot Project	ICAR- CICR, RS, Coimbatore 31 August 2023	Farmers	NFSM special project on cotton	47	6	Dr K. Sankaranarayanan
Hands on practices for hybrid seed production with special emphasis on desi cotton	ICAR-CICR Sirsa 05September, 2023	Farmers	Other	50	0	Dr Debashis Paul & Dr Rishi Kumar
Training Programme on Best Farm Practices for Cotton	Gudia Kheda 22 September, 2023	Farmers	CCI-CICR pilot project	75	0	Dr Rishi Kumar, Dr S.K. Sain and Dr Amarpreet Singh
Best practices to enhance cotton productivity	Rajsamabd district, Bhilwara 03-06 November, 2023	Farmers	NFSM Special project on Cotton	105	0	Dr S.K. Sain
Training for Agro- Input Dealers	Sirsa , Haryana 04 November 2023	Agro-input Dealers	Other	80	0	Dr Rishi Kumar



#### **EDUCATION HUB**

### program: AnICAR Initiative under National Educational Policy 2020

As per the decision of Hon'ble Agriculture Ministerand President of ICAR, aninitiative has been taken by ICAR to convert the Indian Agricultural Research Institute (IARI) in to the Multidisciplinary Education and Research University (MERU) as per the National Educational Policy 2020. In this context, ICAR-IARI has been taken forward along with the ICAR regional institutes in first Phase in sun-planet-satellite mode, where in 16 regional hubs have been identified to enroll students in UG, PG, and PhD programs through Graduate school IARI. The guidelines of the Graduate School, IARI, was made applicable for academic functioning of regional hubs.

ICAR-CICR Nagpur has been recognized as Nodal Institute of IARI Nagpur Hub in the 418th Academic council meeting of IARI, held on 23rd February, 2023. ICAR-NBSS &LUP, ICAR-CCRI, ICAR-CIRCOT(GTC), Nagpur to act as Satellite institutes for IARI Nagpur Hub under ICAR- IARI-MERU. The first academic

IARI Nagpur Hub Academic Session 2023-24 for PG & PhD session of 2023-24 of IARI Nagpur Hub was started in December 2023 with the enrollment of 4 PhD students and 05 PG students in the disciplines of Entomology and Plant Pathology. During the process, the IARI academic council has recognized 48 and 31 scientists from the nodal and satellite institutes as PG faculty and research guides respectively. Dr. YG Prasad is the Hub Nodal Director of IARI Nagpur Hub. Director ICAR-CICR has nominated Dr KP Raghavendra as academic coordinator and Dr G.T.Behere as Programme Coordinator (PG)of IARI Nagpur

Institute	PG faculty	Research Guide
ICAR-CICR	30	18
ICAR-NBSS&LUP	07	03
ICAR-CCRI	09	09
ICAR-CIRCOT	02	01
Total	48	31











# 06 | AWARDS AND RECOGNITIONS

Name of the officer	Name of the Award/Recognition	Awarded by	Conferred on
Dr P Valarmathi	Academic Editor in Editorial Board for International Journal of Plant & Soil Science	BP international publishers- International journal of Plant & soil science	05-01-2023
Dr Subhash Chandra	Best Poster Award	International Conference on Vegetable Oils 2023 (ICVO 2023)	21-01-2023
Dr Satish Kumar Sain	Member, Poster Evaluation Committee in the IPS Platinum Jubilee Conference on "Plant and Soil Health Management: Issues and Innovations" at University of Mysore, Mysuru, Karnataka	Indian Phytopathological Society, New Delhi	04-02-2023
Dr Satish Kumar Sain	Fellow of Indian Phytopathology Society 2021	Indian Phytopathology Society, New Delhi	04-02-2023
Dr Debashis Paul	Best Oral Presentation Award	CCSHAU, Hisar	19-02-2023
Dr K Shankarganesh	Best oral presentation award 2nd ICFPLS- 2023 by Pragati International Scientific Research Foundation (PISRF), Meerut, India & Andaman Science Association (ASA), Port Blair, Andaman & Nicobar Islands, India	Pragati International Scientific Research Foundation (PISRF), Meerut, India	20-09-2023
Dr Rishi Kumar	First Prize in Photo Contest held on the ocassion of World Cotton Day	ICAR-Central Institute for Cotton Research	07-10-2023
Dr Satish Kumar Sain	Best Stall of the Krishi Kumbh Millets & Seed Processing Expo held at Karnal, Haryana (20- 23 Oct 2023)	Global Media Group supported by NFPC	23-10-2023
Dr Rishi Kumar and his team	Best Stall of the Expo (1st) in the Krishi Kumbh-Millets and Seed Processing Expo	Global Media group & Supported by NFPC Ltd.	23-10-2023
Dr. Amarpreet Singh	Best Oral Presentation	Soil Conservation Society of India, (SCSI), New Delhi, India.	10-11-2023
Dr. Rishi Kumar	Best Oral Presentation Award	International Conference on Plant Health Management (ICPHM-2023)	15-11-2023
Dr Babasaheb B	Best Oral Presentation Award	Plant Protection Association of	18-11-2023
Dr Satish Kumar Sain	Fellow of Plant Protection Association of India	Plant Protection Association of India, Hyderabad	18-11-2023
Dr J.GULSAR BANU BANU	Fellow, Plant Protection Association of India	Plant Protection Association of India	18-11-2023
Dr J.GULSAR BANU	Best Oral Presentation Award	Plant Protection Association of India	18-11-2023
Dr Babasaheb B Fand	Editorial Board member of Journal of Cotton Research	Chinese Academy of Agricultural Sciences	01-12-2023
Dr J.GULSAR BANU	Best Poster Presentation Award	Indian Society for Cotton Improvement, Mumbai	08-12-2023
Dr Rakesh Kumar	BEST POSTER AWARD	9th ASIAN COTTON RESEARCH & DEVELOPMENT NETWORK (ACRDN) MEETING & INTERNATIONAL CONFERENCE held at ICAR-CIRCOT Mumbai during 06-08th December, 2023	08-12-2023





# 07 | LINKAGES AND COLLABORATIONS

Areas of Linkages	Institution		
Refinement of spindle type header prototype for development of a cotton picker	CSIR-CMERI-CoEFM, Ludhiana		
Crop pest surveillance in Maharashtra.	CROPSAP, Maharashtra		
Insecticide Resistance Management (IRM): Dissemination of Pink bollworm Management Strategies.	DAC, Govt of India and SAUs (Dr PDKV Akola, VNMKV Parbhani, MPKV Rahuri, NAU Surat, JAU Junagarh, RVSKVV Gwalior, UAS Dharwad, UAS Raichur, PITSAU Hyderabad and ANGRAU Guntur)		
Genetic diversity pink bollworm in India	DST-SERB, Ministry of Science And Technology, Govt of India		
Implementation of PVP legislation 2001 and DUS testing of cotton.	Protection of Plant Varieties and Farmers' Rights Authority, Govt of India		
Evaluation of insecticide combinations against insect pest complex of cotton	M/s Gharda Chemicals Ltd, Thane Mumbai		
ICAR project on Seed Production in Agricultural Crops and Fisheries.	ICAR, New Delhi		
Quantitative estimation of carbon and moisture fluxes over the cotton based agro-ecosystem.	National Carbon Project, ISRO, Hyderabad		
Transgenic research on plant protection	CSIR and NBRI, Lucknow		
Pheromone technology	CSIR and IICT, Hyderabad		
Value addition Naturally colored cotton	Dr. PDKV, Akola and ICAR -CIRCOT, Mumbai		
Student collaboration for research	RTMNU, Nagpur		
Production and commercialization of Bt cotton varieties.	Maharashtra State Seeds Corporation Ltd. (Mahabeej), Akola		
HRD of implementation partners of BCI programme in India	Better Cotton Initiative, New Delhi		
Whitefly management	PAU, Ludhiana, HAU, Hisar RAU, Sriganganagar		
Dissemination of weekly advisories and BMPs for cotton	State Agricultural Departments of cotton growing states		
Strengthening Bt referral lab for BT/HT tests	DAC, Gol		
Digital landscape diagnostic survey in Maharashtra	Rajiv Gandhi Science and Technology Commission Mumbai		
Nectariless cotton genotypes evaluation for bollworm resistance	RASI Seeds		
Breeding for cotton leaf curl virus	ATGC, Hyderabad		
Evaluation of mating disruption technology for PBW	Rallis India (Pvt ltd), Bengaluru		
Bio-efficacy of new Bt cry proteins against PBW populations	Bayer Crop Sciences		
Variable Rate Technologies (VRTs) for site specific input (pesticide, water & Nitrogen) management	Network Program on Precision Agriculture (NePPA		
Promotion and commercialization of Bt cotton varieties	M/s Nairuthi Seeds Pvt Ltd., Hyderabad		
Implementation of the Project Bandhan	Agrovision Foundation, 402 Govind Apartment, W.H. C. road, Shankar nagar Nagpur		
Establishing sustainable organic cotton production ventures in selected farms located in Ghatanji of Yavatmal District, Kalmeshwar of Nagpur district and Dhamangaon of Amravati District	Cottonguru MahaFPC Limited, 210,211,227, Runwa Commercial Complex, LBS Marg, Mulund (W), Mumbai		
Popularization of Long linted Desi cotton varieties	Better Cotton Initiative, India and VNMKV Parbhani		
AND			

Areas of Linkages	Institution
To Evaluate Nectariless Rasi Cotton hybrids against pink bollworm and American Bollworm on Cotton	Rasi Seeds Pvt Ltd
To develop recommendations for cotton High Density Planting System (HDPS) pertaining to canopy and nutrient management through collaborative agronomy TRIALS/DEMOS	Rasi Seeds Pvt Ltd, Nuziveedu Seeds Ltd
Soil Testing Services related to Regenerative Agriculture	World Wide Fund For Nature-India (WWF India)
Evaluation of mating disruption technology	ATGC Biotech Pvt Ltd
Seed production and commercialization of Bt cotton varieties developed by ICAR-CICR, Nagpur (ICAR-CICR 16 Bt and ICAR-CICR 23 Bt, ICAR-CICR PKV081 Bt (Bt 12), ICAR-CICR RS 2013 Bt (Bt 6), ICAR-CICR GJHV374 Bt (Bt 3)	ALP GIRI SEED Sciences Pvt Ltd
The response of potassium salt of active phosphorous (PSAP) fertilizer grade by foliar spray in Bt hybrid cotton	M/s. Isha Agro Sciences Pvt. Ltd., Pune
Multiplication and commercialization of Bt Cotton Varieties- ICAR-CICR 16 Bt and ICAR-CICR 23 Bt	M/s. Pinnacle Agri Sciences Pvt Ltd. Kurnool
Multiplication and commercialization of ICAR-CICR 23 Bt Cotton Variety	M/s. Nirupama Seeds Pvt Ltd. Hyderabad
Multiplication and commercialization of Bt Cotton Varieties- ICAR-CICR 16 Bt and ICAR-CICR 23 Bt	M/s. Sahaja Crop Sciences Pvt Ltd. Kurnool
MoU with M/s ITC Limited	M/s ITC Limited, Guntur
Promotion and commercialization of Bt cotton varieties ICAR-CICR GJHV 374 Bt, ICAR-CICR PKV081 Bt and ICAR-CICR 23 Bt	M/s Dinkar Seeds Pvt Ltd. Himatnagar, Gujarat
Entomopathogenic fungi	ICAR- Central Plantation Crops Research Institute (ICAR-CPCRI), Kasargod, Kerala
Non-GM cotton varieties to organic cotton growers in Central Southern part of India	Welspun Foundation for Health and Knowledge (WFHK), Welspun, Kutch, Gujarat





# 08 | ICAR-AICRP ON COTTON

#### Salient Achievements 2023

#### List of non-Bt cotton varieties/ hybrid notified during 2023

S. No.	Name of the variety /hybrid	Species	Notification number	Date
1	Nandyal Cotton 25 (NDLH 2035-5)	G. hirsutum	S. O. 1056 (E)	06-03-2023
2	CICR-B Cotton 55 (CCB 51-2)	G.barbadense	S. O. 1056 (E)	06-03-2023
3	PhuleSatpuda (JLA 1207)	G. arboreum	S. O. 4222 (E)	25-09-2023
4	Gujarat Cotton-46 (G.Cot-46: SorathSwet Hem) (GJHV 522)	G. hirsutum	S. O. 4222 (E)	25-09-2023

#### List of non-Bt cotton varieties/ hybrids identified during VIC 2023

S. No.	Name of the variety/hybrid	Sponsored by	Zone / State	Situation	Remark
1.	PBD 88	PAU, Bathinda	North	Irrigated	Arboreum
2.	TVH 007	TNAU, Veppanthattai	Central	Rainfed	Hirsutum
3.	AKA 2013-8	PDKV, Akola	Central	Rainfed	Arboreum
4.	NDLA 3116-3	RARS, ANGRAU, Nandyal	Central	Rainfed	Arboreum
5.	DDCC 1901	UAS, Dharwad	Central	Rainfed	ColouredArboreum
6.	CPD 1902	UAS, Dharwad	South	Irrigated	Hirsutum
7.	CCH 19-2	ICAR-CICR, Coimbatore	South	Irrigated &Rainfed	Hirsutum
8.	DHCC 1901	UAS, Dharwad	South	Irrigated &Rainfed	ColouredHirsutum
9.	CCHC 19-1	ICAR-CICR, Coimbatore	South	Irrigated &Rainfed	ColouredHirsutum
10.	CCHC 19-2	ICAR-CICR, Coimbatore	South	Irrigated &Rainfed	ColouredHirsutum
11.	DB 1901	UAS, Dharwad	South	Irrigated	Barbadense
12.	NDLH 2056-4	RARS, ANGRAU, Nandyal	South	Rainfed	Hirsutum
13.	NDLA 3104-4	RARS, ANGRAU, Nandyal	South	Rainfed	Arboreum
14.	PA 883	VNMKV, Parbhani	South	Rainfed	Arboreum
15.	CNH 18529	ICAR-CICR, Nagpur	Central	Irrigated &Rainfed	ColouredHirsutum

#### List of Bt cotton varieties/ hybrids identified during VIC 2023

S. No.	Name of the variety/hybrid	Sponsored by	Zone / State	Situation	Remark
1.	ARCV 22 Bt	Ankur Seeds Pvt. Ltd	North	Irrigated	Hirsutum
2.	ACH 902-2 BGII	Ajeet Seeds Pvt. Ltd.,	North	Irrigated	нхн
3.	KCH 9344 BGII	Kaveri Seed Company Ltd.,	North	Irrigated	нхн
4.	KCH 9322 BGII	Kaveri Seed Company Ltd.,	North	Irrigated	нхн
5.	MC 5410 BGII	Rallis India Limited	North	Irrigated	нхн
6.	RCH 983 BGII	Rasi Seeds (P) Ltd	North	Irrigated	нхн
7.	C 9314 BGII	Mahyco (P) Ltd	North	Irrigated	нхн
8.	C 7938 BGII	Mahyco (P) Ltd	Central	Irrigated	HXB
9.	G Cot 10 Bt	NAU, Surat	Central	Irrigated	Hirsutum
10.	CICR 18 Bt	ICAR-CICR, Nagpur	Central	Rainfed	Hirsutum
11.	CICR 20-31 Bt	ICAR-CICR, Nagpur	Central	Rainfed	Hirsutum
12.	NH 1901 Bt	VNMKV, Nanded	Central	Rainfed	Hirsutum



S. No.	Name of the variety/hybrid	Sponsored by Zone / State		Situation	Remark
13.	NH 1902 Bt	VNMKV, Nanded	Central	Rainfed	Hirsutum
14.	NH 1904 Bt	VNMKV, Nanded	Central	Rainfed	Hirsutum
15.	ATCH 1365 BGII	AgriTop Seeds Pvt. Ltd	Central	Irrigated	нхн
16.	RCH 981 BGII	Rasi Seeds (P) Ltd	Central	Irrigated	нхн
17.	BIO 6101 BGII	Bioseed Research India	Central	Irrigated	нхн
18.	D 1199 BGII	Daftari Agro Pvt Ltd	Central	Irrigated	нхн
19.	D 1579 BGII	Daftari Agro Pvt Ltd	Central	Irrigated	нхн
20.	MC 5500 BGII	Rallis India Limited	South	Irrigated	нхв
21.	C 7938 BGII	Mahyco	South	Irrigated	нхв
22.	SS 246 BGII	Sumathi Seeds	South	Rainfed	нхн
23.	SP 7680 BGII	Crystal Crop Protection Pvt Ltd	South	Rainfed	нхн
24.	SP 7688 BGII	Crystal Crop Protection Pvt Ltd	South	Rainfed	нхн
25.	60SS66 BGII	Sri SathyaAgri Biotech Ltd.	South	Rainfed	нхн
26.	RCH 990 BGII	Rasi Seeds (P) Ltd	South	Rainfed	нхн
27.	MC 5444BGII	Rallis India Limited	South	Rainfed	нхн
28.	Daftari 2244 BGII	Daftari Agro Pvt Ltd	South	Rainfed	нхн
29.	Jai Ho BGII	Eldorado AgritechPvt. Ltd.	Central	Irrigated	нхн
30.	Rasi Max 006 BGII	Rasi Seeds (P) Ltd	Central	Irrigated	нхн
31.	Rasi Max 009 BGII	Rasi Seeds (P) Ltd	Central	Irrigated	нхн
32.	ACH 9-2 BGII	Ajeet Seeds Pvt. Ltd.,	Central	Irrigated	нхн
33.	ARCH 3028 BGII	Ankur Seeds Pvt. Ltd	Central	Irrigated	нхн
34.	Rasi Max 066 BGII	Rasi Seeds (P) Ltd	Central	Rainfed	нхн
35.	ACH 9-2 BGII	Ajeet Seeds Pvt. Ltd.,	South	Irrigated	нхн
36.	Rasi Max 009 BGII	Rasi Seeds (P) Ltd	South	Irrigated	нхн

#### List of Bt cotton varieties/ hybrid notified during 2023

S. No.	Name of Variety / hybrid	Species	Developed by	Notification Number	Date
1.	SP 7674 BG II	нхн	Bayer Bioscience Pvt Ltd	S. O. 1056 (E)	06-03-2023
2.	PBH Bt 21 (PAU Bt 5)	G. hirsutum	PAU, Bathinda	S. O. 1056 (E)	06-03-2023
3.	ARCH 3106 BG II	нхн	Ankur Seeds Pvt. Ltd.	S. O. 1056 (E)	06-03-2023
4.	Rocky (Hy. Cotton Daftari 3434 BG II)	нхн	Daftari Agro Pvt Ltd	S. O. 1056 (E)	06-03-2023
5.	Pushpa (Hy. Cotton Daftari 2244 BG II)	нхн	Daftari Agro Pvt Ltd	S. O. 1056 (E)	06-03-2023
6.	SP 7679 BG II	нхн	Crystal Crop Protection Pvt Ltd	S. O. 1056 (E)	06-03-2023
7.	GBCH 1801 BG II	нхн	Green Gold Seeds Pvt. Ltd	S. O. 1056 (E)	06-03-2023
8.	SP 7686 BGII	нхн	Crystal Crop Protection Pvt Ltd	S. O. 1056 (E)	06-03-2023
9.	CCH 03 BG II (CCH 333 BG II)	нхн	Crystal Crop Protection Pvt Ltd	S. O. 1056 (E)	06-03-2023

#### **Quality Research**

· Quality parameter data was generated on the cotton samples received from the cotton breeders pertaining to the ICAR-AICRP on Cotton Zonal Trials (North Zone, Central Zone and South Zone) and National Trials. The quality • The major observation from fibre analysis are

parameters of all cotton fiber samples were measured by using the High Volume Instrument operated in the HVI Mode. The data was analysed and reported. Totally 3246 samples have been tested.



- G. arboreum trial most of the entries have resulted higher micronaire which may be useful only for surgical cotton
- . G. herbaceum trial performed better than local and zonal Entomology checks
- Natural coloured cotton trial of both central and south zone have shown less tenacity and higher micronaire comparative to the minimum requirement
- In G. hirsutum trial most of the entries have resulted higher micronaire
- · Br14a CVT G.barbadense variety trail, quality testing of entries viz. CCM 26, CCB 22-2, CCB22-1 showed promising results in terms of better UHML and tenacity
- In full spinning, 75% of the cotton samples received from the breeders satisfied the count and CSP norms
- · Calibration cotton for testing ELS cotton has been developed. Participated in CSITC international round robin trials for quality analysis of cotton

#### **Crop Production**

- · Conservation agriculture trial results of North zone revealed that 100% wheat residue incorporation by rotavator followed by sowing of cotton in Kharif and 100% cotton residue incorporation after picking and sowing of the wheat crop through Super seeder in one go in rabi recorded 18.9 and 22.0 percent higher seed cotton yield at Faridkot (4364 kg/ha) and Bathinda (3099 kg/ha) and 22.6 and 13.5 percent higher wheat grain yield at Faridkot (6544 kg/ha) and Bathinda (5704 kg/ha) respectively in cotton - wheat rotation in North zone.
- Yield maximization techniques found that the package of closer planting, Detopping at 100 cm height, Pruning of monopodia at 45 DAS and two sprays of Mepiquat chloride @ 25 g a.i. at 45 and 60 DAS had yielded 64.0, 51.0, 35.7 and 40.7 percent higher seed cotton yield respectively at Akola (2690 kg/ha), Bhawanipatna (3558 kg/ha), Nanded (2223 kg/ha) and Chamrajnagar (2172 kg/ha) as compared to the conventional practice followed
- Drip fertigation, polymulch, closer planting, Detopping at 100 cm height, Pruning of monopodia at 45 DAS, and two sprays of Mepiguat chloride @ 25 g a.i. at 45 and 60 DAS, recorded 150.8 percent higher seed cotton yield at Rahuri (5103 kg/ha) as compared to control (2035 kg/ha)
- · Canopy management trial result found that application of mepiquat chloride @ 45ppm at square initiation followed by 15 days after first spray and subsequently 15 days after the second spray along with detopping increased seed cotton yield @ 45.3,31.2 and 39.5 percent and reduced the height node ratio @ 12.0, 18.7 and 13.2 percent in Bhawanipatna, . Junagadh and Chamrajnagar respectively
- Drought management strategy of Broad Bed Furrow with Glycine Betaine @100 ppm spray after depletion of 75 % soil moisture is promising at Nanded which arrived with a higher seed cotton yield of 42.7 percent as compared to control. Adoption of Broad Bed Furrow with Salicylic acid @100ppm spray found 71.5 percent higher seed cotton yield as compared to control at Akola
- · Land configuration of Ridges and Furrow followed by application of 20 kg/ha extra nitrogen and potassium after drainage of water logging field found 49.4, 126.9 and 39.6

percent higher seed cotton yield as compared to control respectively at Junagadh, Rahuri, and Raichur respectively

#### **Crop Protection**

- · Two promising hirsutum cotton entries identified tolerant to jassids (PBH-79 N-Bt& ACRV-44 Bt), 3 (F-2732, ACRV-44 Bt, HS-310) for Whitefly in North Zone. In Central Zone 2 entries (AKH-2013-3& GISV 323) for jassids, 2 (GJHV 522& RAH 1076) for Whitefly were recorded tolerant. Similarly in South Zone tolerant entries identified were 2 (RAH 1076 & RHC 1409) for jassids, 3 (RHC 1409, RAH-1076, AKH 2013-1) for Whitefly.
- Seasonal dynamics of key pests in relation to climatic conditions recorded Leafhopper peak activity between 28th -34" SMWat different locations in North Zone, 35" - 45" SMW in Central zone and 39th - 47th SMW in South Zone across N-Bt and Bt-genotypes selected for study. Similarly, thrips peak activity was between 28th -32nd SMW at different locations in North Zone, 34th - 39th SMW in Central Zone and 34th - 44th SMW in South Zone across N-Bt and Bt-genotypes .In case of whitefly peak activity was observed between 28th - 34th SMW at different locations in North Zone, 41st - 52nd SMW in Central Zone and 38th -51st SMW in South Zone, across N-Bt and Bt-genotypes selected for study. In aphid population, peak activity was observed between 35th-52nd SMW in Central and 34th - 48th SMW in South Zone, across N-Bt and Btgenotypes selected for study.
- Bollworm dynamics in N-Bt-Cotton in North zone: 0 to 5.33 larval population / 5 plants of Spotted Bollworm; 0.77 to 40.82% green boll damage. In Central zone: 0-2.0 larval population of each American Bollworm, Tobacco caterpillar and Spotted Bollworm /5 plants and green boll damage ranged between 0-90.0 percent. In South zone, 0.0-5.60 larval population of ABW /5 plants, 0.0-5.0 tobacco caterpillar, 0.0-2.4 spotted bollworm and green boll damage 0.0-81.25 percent.

#### Plant Pathology

- Confirmation of disease resistance trials under field and artificial screening for three consecutive years revealed that 19 entries were identified as resistant to cotton leaf curl disease (CLCuD): 3 entries (RS-2909, F-2687, RAH-1076), bacterial leaf blight (BLB): 2 entries (GSHH-15032, GSHH-15035), Corynesporacassiicola (CoLS): 2 entries (DHCC-1801. DHCC-1902), rust: 3 (RAH-1083, CNH-19480, Suraj), grey mildew (GM): 2 entries (SCS-1206, DB-14) and Alternaria leaf blight (ALB) - 2 entries (GJHV-584, CCB-29). Multiple disease-resistant entries recorded for BLB & ALB - 2 entries (GJHV 557, GISV-323), ALB& GM-2 entries (SVA-1118, DB-14), rust &CoLS-1 entry (CNH 20-31)
- Multilocation field trials for disease managementwere conducted and promising treatments were noted:
- Application of CICR Bacillus aryabhattai + Bacillus tequeilencis as seed treatment @10g/kg + soil application @ 2.5 kg/ha (30 & 60 DAS); and seed treatment Carboxin 37.5+Thiram 37.5%WS @ 0.2% and foliar application of Pyraclostrobin @ 0.1% recorded maximum reduction in ALB, BLB and GM at Akola
- Application of CICR Pf-CICR as seed treatment @10g/kg + soil application @ 2.5 kg/ha (30 & 60 DAS) with FYM/compost was superior over other treatments for managing ALB, BLB at Surat.





- Among the new IPM and new biomodules developed using the first 2 sprays of neem oil (300ppm), 1-2 sprays of insecticides and 1-2 sprays of CICR bioinsecticides (CICR Front Line Demonstrations in Cotton under NFSM-Bb4511-Beauveria bassiana, CICR Ma1299 - Metarhizium Commercial Crops anisopliae and CICR Cj-102- Cordyceps javanica), reduction . in whitefly nymphal, adult mortality and CLCuD was recorded over control. Mortality of nymphs and adults in new IPM modules ranged 34.9 to 47%, and 38.8 to 53.6% and in new Biomodules it was 34.3 to 41.3% and 39 to 45.5%.
- Among the 11 CIB & RC recommended chemicals evaluated for the management of foliar diseases and boll rot, the top . effective treatments (1-2 spray) over control are as follow
- Sooty mold (whitefly & aphid): 3 sprays of Propiconazole 25 and Flonicamid 50 WP @0.6g/L Faridkot, Hisar& Tamil Nadu.
- Fungal foliar spots- Kresoxim methyl @1 ml/L, Azoxystrobin + Difenoconazole @1 ml/L
- ALB &CoLS- Fluxapyroxad + Pyraclostrobin@0.8ml/L, Azoxystrobin + Difenoconazole@1 ml/L
- GM & Rust- Fluxapyroxad + Pyraclostrobin@0.8 ml/L, Metiram + Pyraclostrobin@.2g/L,

#### Annual Group Meeting - 2023

Annual Group Meeting of AICRP on Cotton: 2023 held in Panjab Agricultural University, Ludhiana between 6th and 7th April. The BLB &Boll rot-Fluxapyroxad + Pyraclostrobin@0.8 ml/L and Copper oxychloride, @2.5g/L

- Under FLDs on ICM on cotton, 538 demonstrations were conducted in 538 ha in 957 farmers' fields with a budget outlay of Rs.43.04 lakh
- Under FLDs Desi / ELS / Seed production in Cotton, 163 demonstrations were conducted in 163 ha in 472 farmers' fields for Rs. 14.67 lakh
- Under FLDs on intercropping in cotton, 165 demonstrations were conducted in 165 ha in 210 farmers' fields with a total budget of Rs.13.20 lakh
- EC @ 1 ml/L, copper oxychloride (COC) 50 WP @ 2.5 g/L, Altogether, 1639 farmers participated in demonstrations conducted in an area of 865 hectares. A total of 327 SC/ST farmers, 551 OBC farmers and 111 farm women were benefitted out of this program during the year 2022-23.
  - A total of 198 visits by the Scientists, 101 farmers' meetings, 46 field days and 39 awareness programs were conducted by the centers. In addition, some centers disseminated the cotton technological information through radio talks, TV talks, newspaper clippings and voice SMS.

meeting was jointly organized by ICAR-CICR (AICRP on Cotton), Indian Council of Agricultural Research, New Delhi & Punjab Agricultural University, Ludhiana









#### AICRP trails monitoring

Monitoring Team report of ICAT-Bt and ICAR-AICRP (cotton) trials of south zone conducted at Karnataka, Andhra Pradesh, Tamil Nadu were visited during the period of November 1 to 9, 2023 with Chairmanship Dr. K Sankaranarayanan, Principal Scientist (Agronomy), ICAR-CICR, RS, Coimbatore, along with

Members: Dr Vineet Kumar, Cotton Breeder, PAU, RRS, Bathinda, Dr Rupesh Kumar Arora, Plant Pathologist, PAU, RRS, Bathinda, Dr.R.D. Patel, Assistant Research Scientist, Entomologist, NAU, Surat, Dr.Manivannan, Senior Scientist, ICAR-CICR, RS, Coimbatore and Sh. Abhijit S Patil, M/S Mahalakshmi Seeds Pvt. Ltd



# 09 | KRISHI VIGYAN KENDRA

#### **Trainings**

#### On campus and Off campus training

Eighty six short duration (1 to 3 days) on-campus and off- functionaries. In all 4252 participants including 1149 SC/ST campus training courses were conducted in different participants benefited from the training programs. (Table 9.1).

disciplines for practicing farmers, rural youth and extension

Table 9.1: Details of training conducted

Clientele	No. of Courses	Male	Female	Total participants
Farmers & farm women	56	1818	818	2636
Rural youths	20	781	335	1116
Extension functionaries	5	103	37	140
Skill Training	5	266	94	360
Vocational Training	0	0	0	0
Total	86	2968	1284	4252

#### Cluster Front Line Demonstrations on Oilseed and Pulses

#### **Crop enterprises**

Two CFLDs on oilseeds (i.e. Soybean (Phule Sangam, & pulses (i.e. Pigeonpea (BDN-716)) were conducted in the adopted villages of Nagpur district viz. Chirvaha, Bendoli & Bothli.

Several extension activities like field day, field visits of farmers and extension functionaries, group discussion and scientist farmers meet etc. were conducted for effective implementation of technologies. These demonstrations were conducted on 100 farmers field covering 40 ha. area.

Table 9.2: Agronomy: Weed management for maximizing soybean yield

Crop	Thematic	No. of	Area	Yie	eld (kg,	/ha)	Check % Parameters of Demo Parameter of				ameter of Ch	eck		
	area	farmers	(ha)	High	Low	Avg. (	Yield (kg/ha)	increase	Yield q/ha	Cost of cultivation	B:C Ratio	Yield q/ha	Cost of cultivation	B:C Ratio
Soybean	Weed management	13	5.2	16.4	8.24	13.03	6.3	106.83	13.03	22480	2.66	6.30	25460	1.13

#### FLD on Livestock Production -

#### 1) Supplementation of mineral lick blocks to the cows

This demonstration is conducted on 30 cows of 15 farmers of Chirvha village of Mauda tahsil. In this



Mineral lick block

demonstration, hanging mineral lick blocks @ ad-libitum were provided to the dairy cows in addition to their daily diet. The average daily milk yield, milk fat content and BC ratio were 6.63 I/cow/day, 4.64% & 1.27 and 6.25 I/cow/day, 4.30% & 1.24 in demonstration and local check (LC), respectively. There was no significant effect on milk yield and milk fat content of milk, whereas, reproductive performances were improved remarkably in the demonstration group with 15 days earlier onset of oestrus after parturition, reduction of inter-calving period by 32 days than LC. 100% conception rate was observed in demo group.

#### Scientific feeding of concentrate ration to the crossbred cows for enhancing its production

In this demonstration, concentrate ration @ 2 kg/cow/day was added in the diet of crossbred cows, in which 30 cows of 15 farmers of Dhurkheda village of Umred tahsil were involved. The daily average milk production was increased by 15.29%, whereas, body weight of cows increased by 9.7% in demonstration group than local check. The BC ratio in demo and LC were 1.51 and 1.36, respectively.



#### FLD on Home-Science

#### Cultivation of Cole crops in Nutrition Garden with IPM component and Natural input

Name of Technology Demonstrated	Parameter	Demo	Check	% Change in parameter	Net Profit	B.C Ratio
Cultivation of Cole crops in Nutrition Garden with IPM	Quantity of vegetable produced (kg)	412	286	36	4203	1.3.77
component and Natural input	Cost of cultivation	1125	1517	26	7115	1.7.22

Cabbage and cauliflowers cultivated on 18 farm women Demonstration of Onion De-topper tool was conducted at Ghanjivamrutham, Jivamrutham, DGA (Milk Jaggary & Egg) completion of work in less time by 30%. reduces the cost of cultivation by 26% and receives 36% more production, excellent and qualitative curd formation. 90% excellent growth of curd without any infestation was observed due to alternate drenching and foliar application of DGA at the interval of 15 days for nutrient management and spraying of Azadarachtin & Dashparni during the growth period.

#### 2) Performance of onion De-topper for drudgery reduction of farm women

Name of Technology demonstrated	Parameter	Demo	Check	% Change in parameter
Performance of	Pain Observed(%)	45	60	25
onion De-topper	Time required hr/q	03	4.02	30
for drudgery reduction of farm women	Heart rate(bpm)	84	112	25

Nutrition Garden in 4000 sq. ft area. Under above Cole crops Shivapur, Bhivapur tahsil of Nagpur district on 18 farmer's field. demonstration using trap crop of marigold, Coriander, mustard It revealed that while using Onion De-topper reduction in Heart and Sorghum and naturally prepared input like, rate and drudgery is found 25% less. This was beneficial in



Traditional Method of Onion De-topping Improved Method of Onion De-topping

#### On Farm Trials (OFT)

#### Horticulture Discipline

OFT-1:- Assessment on Short duration early high yielding variety of marigold

Technology	No. of Farmers	Yield (t/ha)	Net Return (Rs.)	B:C Ratio
T1 - Farmers Practice (Suman)	13	5.1	280500	4.5:1
T2 -Pusa Basanti	13	8.9	439400	6.4:1
T3- Arka Banagara	13	7.6	452000	6.6:1

Result: Production of both variety are higher as compared to local marigold with high price.



Plant Protection



Marigold Variety- Pusa Basanti and Arka Banagara



OFT 1- Management of stem fly and girdle beetle in soybean

Treatment	% of Green Boll damage	% of Larval Boll damage	Average Yield (q/ha)	% increase yield
T1 - Farmers Practice 2 to 3 chemical pesticide sprays comprising of Profenophos 50 EC 20 ml, Emamectin benzoate 5 SG @ 5 g per 10 lit water	19.50	12.62	12.10	
<ol> <li>T2 - Technology Assessed</li> <li>Seed treatment with Thiamethoxam 30% FS @ 10 ml/kg of seed.</li> <li>Removal of infested leaves, dried branches in initial stages.</li> <li>5% NSKE spray in early stages before flowering.</li> <li>ETL based spraying of Thiamethoxam 12.6% + Lamdacyahalothrin 9.5% @ 2.5 ml per 10 litre water</li> </ol>	09.42	3.82	13.52	11.73
T3 - Technology Assessed Soil application of Phorate 10 G@ 4 kg/acre at the time of sowing followed by spray of Thiamethoxam 12.6% + Lamdacyahalothrin 9.5% @ 2.5 ml per 10 litre water	11.24	5.33	13.35	10.33

#### **Veterinary Science**

### OFT 1 Assessment of production performances of goats fed on cotton straw based pelleted complete feed

Major part of goat population is reared by landless labourer or small farmers who have small piece of land. Feeding of cotton straw based pelleted complete feed is low cost alternative for them. This pelleted feed contains 60% cotton straw, 20% maize,

18.5% GNC/CSC, 1% mineral mixture and 0.5% salt. This trial was conducted for one month on 39 goats of 13 farmers of Godhani village of Umred tahsil. The pelleted feed was fed to the goats @ 1kg/goat/day and compared with sem-intensive (Grazing + Green fodder @ 1 kg/day/goat + Concentrate feed @ 200 g/day/goat) and extensive (Grazing for 6 to 8 hours) methods of goat rearing. The details of assessment of parameters are as follows

Sr. No.	Parameters	Farmer's Practice (TO1)	Technology Option (TO2)	Technology Option (TO3)
1	Body weight gain (kg/month)	1.55	2.65	2.04
2	Feed consumption (Kg/month)	Ad-lib.	30	36.5
3	Feed conversion ratio	8	12.32	18.02
4	Gross cost of feeding (Rs/goat/month)	300	360	360
5	Gross return (Rs/goat)	562.65	961.95	740.52
6	Net Return (Rs/goat)	262.65	601.95	380.52
7	BC Ratio	1.87	2.67	2.06

**Major Observation** / **Feedback**: Highest body weight gain of 2.65 kg/month was observed in TO2 option followed by 2.04 kg/month in TO3 and 1.55 kg/month in TO1 (Farmer's practice).







# OFT2 Evaluation of fodder hybrid Napier varieties under scientific management in Nagpur district performance in terms of green fodder yield, number of tillers,

In order to ensure the supply of quality green fodder to the dairy cows throughout the year, a trial was conducted at Umred Tahsil on 'Evaluation of fodder hybrid Napier varieties under scientific cultivation' during. Two multi-cut perennial varieties of hybrid Napier i.e. Super Napier and BNH-10 were compared with local prevalent variety CO4 on 4.68 ha area on 13 farmer's field. Both

the varieties i.e. Super Napier and BNH-10 showed better performance in terms of green fodder yield, number of tillers, number of leaves and milk yield on feeding of greens than locally grown CO4 variety. As per the feedback of farmer green fodder intake was more in TO2, in which Super Napier was fed to the cows. That might be due to less serration, high succulence and good palatability of Super Napier. The details of the parameter of assessment were as follows -





S.No.	Parameters of Assessment	Farmer's practice (TO1): CO4	Technology option (TO2): Super Napier (Packchong-1)	Technology option (TO3): BNH-10
1	Plant Height (feet)	8.1	10.60	9.86
2	No. of tillers/clump	29	36	32
3	No. of leaves/tiller	6.03	6.67	6.34
4	Green fodder yield (in 1st cutting) (t/ha)	20.82	24.76	23.22
5	Net Return (Rs/acre)	42240	63570	56640
6	Average Milk yield of cows on feeding greens (I/day)	7.40	8.45	8.24

#### Home Science Discipline

#### OFT-1:- Assessment of different models of Nutrition Garden for small land holders for nutritional sustainability

Technology	Area of garden (meter)	Quantity of Vegetables produced in three months	Cost of cultivation (Rs)	Net Profit	B.C ratio
T1 – Farmers Practice Growing vegetable Tomato, Brinjal, Cow-pea, Bottle Guard	4 mtr	32	126	414	1.4.28
T2 – Nutrition Garden GLV: Spinach, Methi, Amaronthus, Coriander Other vegetables: Brinjal, Tomato, Cowpea, Okra, Cluster Beans (source: IIHR, Bangalore)	4mtr	76	119	709	1.6.95
T3 – Nutrition Garden Sat Din Sat Kyari GLV: Spinach, Methi, Amaronthus, Coriander Other vegetables: Brinjal, Tomato, Cowpea, Cluster Beans Cucurbitaceous: Bottle Guard, Spong Guard, (source: ICAR-IIVR, Varanasi and IIHR, Bangalore)	4mtr	96	104	924	1.9.89





Result: Area under production of vegetables in Nutrition vegetables & other vegetable produced through improved Quantity of Green leafy vegetables (GLV), cucurbitaceous Rs. 924 /family in three months.

Garden in all trials is 4 meter for four family members. Under practice in T3 is 96 kg in Rabi season which is higher and better Saat Din ki Saat kyari model of nutrition Garden (T3) practice, as compared to T1 (32 kg) & T2 (76 kg). This saves which saves

OFT-2:- Assessment on suitability of mittens in harvesting soybean crop (27)

Treatments of	Av. Mean	Av. Mean	ean HR beats <sup>1</sup>			Area	Av. Reduction	
mittens	Age	Weight	Before	After	% change	coveredm <sup>2</sup> /h	in drudgery	
T1	30	45	77.67	124	59.65	156.78	7.56	
T2- Parbhani	31.67	47.78	77.3	95	22.90	127.44	2.44	
T3 Dharwad	32.44	50	78.44	94.22	20.12	119.11	1.33	
Sem	1.16	1.7	.98	3.1		1.04	.32	
CD5%	NS	NS	NS	9.29		3.11	.95	
CV	11.1	10.74	3.77	8.91		2.32	23.15	

Result: Use of UAS Dharwad Mitten is significantly superior over VNMKV Parbhani mitten & local practice as it covers more area with less time with less drudgery.

#### Attracting and retaining rural youth in Agriculture (ARYA)

The Attracting and Retaining Rural Youths in Agriculture (ARYA) project was initiated in the year 2015-16. KVK-CICR, Nagpur is one of the centre operating two enterprises for lively-hood of rural youth. 1) Developments of disease free sampling Nagpur mandarin 2) Fruits and vegetable processing. Project ARYA (Attracting & Retaining Rural Youth in Agriculture) is focusing on creating awareness and capacity building training programmes for youths in rural areas to take up various agriculture, allied and service sector enterprises for sustainable income and gainful employment. During the year 2023, KVK trained 125 rural youths for production of disease free seedlings of Nagpur mandarin and 110 members of 11 self help groups for preparation of pickles, citrus juice, Potato chips ,preparation of Mixed Fruit Jam, Tomato Ketchup, solar drying of vegetables juicer, Potato chips machine, Gravy machines and Automatic acquiring training under ARYA.

Papad making machines are distributed to 11 Self help Groups as Critical Inputs for establishing Processing enterprises. Three units of processing of pickles and two units of sugarcane, one unit of custard apple pulper, One solar drying unit of chilli processing, Two potato chips unit, Two mix fruit jam units, one orange juice processing unit and one Vegetable momos unit are running successfully at Besa, Beltarodi, Chichbhuvan, Gondbori, Wakodi, Bhiwapur, Nagalwadi, Katol, Jamtha. Additionally, KVK provided technical training support to rural youth of Katol block for multiplication of disease free Nagpur mandarin seedlings. 13 rural youth beneficiaries developed their nursery on Nagpur mandarin and generating significant income. 13 Knapsack sprayers are distributed to Citrus Nursery Growers as critical inputs from Paradsinga, Kalmeshwar, and preparation of Millet Laddus. Vegetable chopper, Citrus Mohpa, Ladgoan, Kukadipanjara village of Tahsil Katol and





Distribution of Different processing machine viz. Vegetable chopper, Gravy machine, Potato slicer, Citrus Juicer at the hands of Shri. Sunil Kedar MLA and Dr. Y.G. Prasad, Director ICAR-CICR, Nagpur 2023





#### **KVK GKMS ACROSS**

#### Agromet Advisory Services Bulletins

During the period of January to December, 2023 a total of 1414 bi weekly agrometeorological advisory services bulletins were prepared and disseminated to the Nagpur district farmers through various modes under KVK Gramin Krishi Mausam Sewa scheme through the District Agromet Unit, Nagpur.

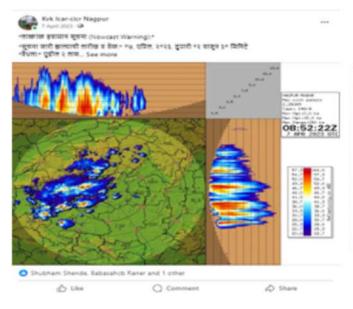
#### **Nowcast warning**

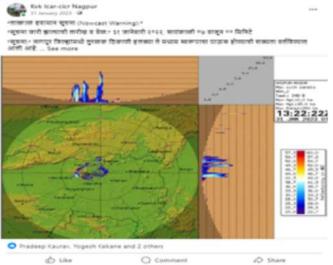
The nowcast warning and forecast are received from time to time by Regional Meteorological Centre, Nagpur is disseminated to the farmers on priority on their registered

#### Impact based forecast and advisory

The impact-based forecast and advisory were prepared and disseminated by DAMU to the District Collector Office, SAUs, District Disaster Management Authority, District Information Office, State Department of Agriculture, Nagpur, NGOs, FPOs, SHGs and farmers of the Nagpur district before and after occurrence of adverse weather event through different modes. A total of 11 IBF bulletins were prepared and disseminated during 2023.

mobile number through different social media platform. The nowcast warning includes warning on heavy rainfall, hail, thunderstorm, lightning as well as gusty winds valid for next 3 hours from the nowcast forecast issued.





#### Farmers Awareness Programme on agrometeorological Observation can significantly empower farmers by providing advisory services at Nagpur

A total of 17 farmers awareness programs were conducted in Nagpur to promote the use and application of agrometeorological advisory services. These programs, held at the KVK campus and various villages, play a crucial role in educating farmers about the benefits of utilizing such services for effective farm management, especially in mitigating the risks posed by adverse weather conditions. The use of mobile applications such as Meghdoot, Damini, Mausam, and Public

timely weather updates and forecasts. By leveraging these applications, farmers can make informed decisions regarding crop cultivation, irrigation scheduling, pest management, and other agricultural practices, thereby optimizing yields and minimizing losses.

Overall, initiatives like these contribute to enhancing the resilience and sustainability of agricultural systems, ultimately improving the livelihoods of farmers and strengthening food security in the region.



Exposure visits of State Agriculture Department staff to Agromet Exposure visits of State Agriculture Department staff to Agromet Observatory of ICAR- CICR, Nagpur on 01.02.2023



Observatory of ICAR-CICR, Nagpur on 01.02.2023







Awareness programme on Agromet Advisory Services at Awareness programme on Agromet Advisory Services at KVK RAMETI, Nagpur on 09.02.2023



to Chindhwara District on 17.02.203



FAP on the occasion of World Meteorological Day on FAP conducted on 30.08.2023 23.03.2023





FAP conducted at KVKs on 05.12.2023



FAP conducted at KVKs on 26.12.2023



FAP conducted at KVKs on 27.12.2023



**Students Awareness Programme** 

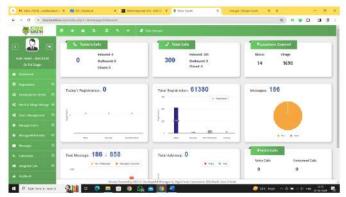




#### Dissemination of Agromet Advisory Services at Nagpur

Agromet Advisory Services bulletins are being disseminated effectively across various social media platforms, significantly benefiting farmers and stakeholders across the district. The distribution strategy encompasses diverse channels, ensuring widespread coverage and accessibility. WhatsApp emerges as a prominent medium, with 308 groups facilitating communication to 61,576 farmers, while an additional community group caters to 2,572 members. The mKisan portal, along with the Kisan Sarathi portal, extends outreach to 169,607 and 61,380 farmers respectively, fostering a substantial online presence. Telegram supplements these efforts, engaging 1,899 individuals, while Facebook connects with 4,978 farmers. Altogether, these platforms facilitate the dissemination of vital agricultural advisories, fostering informed decision-making and enhancing agricultural resilience. The concerted utilization of social media underscores a commitment to leveraging A total of 186 text messages sent to the 61380 farmers technology for the betterment of farming communities, thereby through Kisan Sarathi portal.

fostering sustainable agricultural practices and rural development.



The following social media platform were created and used for dissemination of Agromet Advisory service.

Sr. No.	Social media platform	No. of farmers
1.	Whats app (308 group)	61576
2.	Whats app community group (1)	2572
3.	mKisan portal (1)	169607
4.	Kisan Sarathi portal (1)	61380
5.	Telegram (3)	1899
6.	Facebook (1)	4978
Total		302012

#### International Year of millets (Shree Anna) 2023

Smt. Sunita Chauhan, SMS (Home Science), KVK, ICAR-CICR, Nagpur has nominated as Nodal officer of International Year of Millet (IYoM) 2023 for ICAR-CICR& its regional stations

Coimbatore & Sirsa &AICRP Cotton as per the directives of the ministry of Agriculture and farmers welfare weekly and monthly report regarding celebration of millet activities were furnished to ICAR. Following activities was conducted during 2023.

Sr. No.	Activities	Numbers
1	Millet crop cafeteriaKharif & Rabi 2023	02
2	Farmers field demonstrations (Hingna Tahsil)	30
3	Participation of staff in various National & International programmes of ministry/ Govt. of India	03
4	Training Programme conducted	09
5	Farmers Meet Organised	01
6	Wider publicity among the farmers & stake holders for awareness about millets	
a.	Programmes of AIR/Radio Talk delivered	03
b.	National & Global Conference attended	03
C.	Serving of Millet meals in meetings & canteen	Jan _Dec 2023
d.	Use of Face book & Twitter and other media tagging to Ministry of agriculture	01
e.	Nomination of Nodal office for Coordinating all activities & reporting to the council	Smt. Sunita Chauhan, SMS (Home science)

#### Farming System (IFS) for Doubling Farmer's Income

Krishi Vigyan Kendra, Nagpur has developed an Integrated Cotton based IFS module in 2021 covering one hectare area. This IFS is having three components viz., crop component (Cotton + Soybean), Horticulture component (vegetable & fruits) and animal components (Goat, cow, fish) and allied . enterprise (mushroom cultivation).

Responsibility of establishment, strengthening of Horticulture component was given to Sunita Chauhan, SMS (Home Science) bringing nutritional security and enhancing income of the family at large.

- In Horticulture Component all seasonal vegetables of Kharif and Rabi crop are grown organically.
- Organic waste is also converted into manure using Waste Decomposer.





- 179 Mango plants of Amrapali was planted in March 2021 in high density method and 64 Guava of L-49 variety are planted in June 2021 on mulch.
- Nearly 1350 Dignitaries, Tribal & Schedule Caste farmers, Farm Women, RAWE students, SHG were visited. Skill training on Nursery raising, Seedling transplanting on mulch, Operation of drudgery reduction tools were provided during reporting period for women empowerment.
- A model of Cole Crops with Bio Control was demonstrated. Excellent quality of Cabbage, Cauliflower, Broccoli, Red . cabbage were cultivated during Rabi Season. All produce

- was sold to the ICAR-CICR staff on first come first serve
- Onions, Green Leafy Vegetable were also cultivated during Rabi Season. Training on value addition turmeric, chili powder was given to Farm Women, SHGs for enhancing income of rural community.
- Demonstration and use Jivamrutham, Panchgavya, Dashparni, fermented fruit Juice to PFM, PFF, EFF.
- Introduction of cultivation of watermelon in Zaid season.
- Demonstration of Oyster Mushroom in Outdoor, Mobile Unit for additional income generation.





A low cost small model shade for a family of 2-4 person for care for training purpose and rearing. A Fish Pond having Rohu, and maintenance is also established Cotton, Soybean Katla, Mrigal were also put for rearing by Dr Nandankar and Dr. production in IFS as well as low cost poultry, duck rearing was U.V. Galkate. SMS, KVK, ICAR-CICR, Nagpur. started in IFS. Goat shade and Desi Cow are also established

#### NATURAL FARMING

Krishi Vigyan Kendra conducted workshop cum training on 28th Scientific Advisory Committee Meeting Natural farming under Home Science discipline for farmers, farm women, students and Farmers Producing Organization (FPO) on 17 August 2023. In the inaugural address Dr. S. N. Rokde, Principal Scientist & Head KVK, ICAR-CICR, Nagpur emphasized the need for popularization efforts for "Natural Farming" and stressed the role to be played by the farmers producing organization. In the technical session demonstration on preparation of Biological inputs viz. Jivamrutham, Panchagavya, Saptdhanankur and preparation of Biopesticides viz. Dashparni, LAMIT Ark and Botanicals for the use of Natural Farming by Smt. Sunita Chauhan, SMS, Home Science, KVK, ICAR-CICR, Nagpur. 163 farmers 215 students, FPO Nagpur, Saoner, Hingna were benefited during 2023.

#### Swachhta Pakhawada was observed from December 16 to December 31, 2023

Krishi Vigyan Kendra, ICAR-CICR, Nagpur Conducted Swachhata Pakhwada from 16/12/2023 to 31/12/2023. Under this program various activities related to cleanliness were carried out.

#### Meetings

#### Twenty-Eighth Scientific Advisory Committee Meeting of KVK, ICAR-CICR, Nagpur held on 09.06.2023

At the outset Dr. S.N. Rokde, Principal Scientist (LP&M) & Head KVK welcomed Director, ICAR-CICR, Nagpur and Chairman of SAC meeting, Director, ATARI, Pune, other chief guests, officials including the representatives of different line departments and progressive farmers who joined on-line SAC meeting.

Dr. Y.G. Prasad, Director, ICAR-CICR, Nagpur Chaired SAC meeting. In his address he explained the role of KVK for the benefit of farmers.

Then Dr. S.N. Rokde, Principal Scientist (LP&M) & Head KVK, ICAR-CICR, Nagpur presented the suggestions given by the honorable members of 27th SAC meeting held on 22.06.2022 and the action taken report thereof. Then he presented the work done by KVK, ICAR-CICR, Nagpur during the year 2022. Then he presented the Action Plan of proposed work to be done during 2023 by KVK, ICAR-CICR, Nagpur.





#### Meetings/ Workshop/Conference/Training attended

Name of the officials	Name of event	Location	Date
Smt. Sunita Chauhan	Workshop on Natural Farming & Millets	ATARI ,Pune	19/1/2023
Smt. Sunita Chauhan	On – line webinar on Making India A Global Hub for Shree Anna	ICAR-CICR, Nagpur	18.02.2023
Smt. Sunita Chauhan	On Line webinar of strategies & implementation of SAMARTH scientist & stakeholders on by Director ICAR-CICR, Nagpur	ICAR-CICR, Nagpur	18.02.2023
Smt. Sunita Chauhan	Global millet Conference	Subramaniyam Hall, New Delhi	18-19.03.2023
Dr. S. S. Patil	Action Plan Workshop of KVKs Maharashtra	ICAR-NRC Graps, Pune	22-24.02.2023
Dr. S. N. Rokde, Dr. S. S. Patil, Dr. U. V. Galkate, Smt. Sunita Chauhan, Dr. Mayur Meshram, Dr. P. B. Deulkar & Dr. Sachin Wankhede	Action Plan Workshop of KVKs of Vidarbha Region	Dr. PDKV, Akola	13-14.05.2023
Dr. S. S. Patil	Orientation meeting of Special Project on Cotton	ICAR-CICR, Nagpur	12.06.2023
Dr. S. N. Rokde	Annual Zonal Workshop of KVK	KVK, Aurangabad	28-30.07.2023
Smt. Sunita Chauhan	Post harvest & value addition, capacity building of agriculture Extension professionals ATARI	ICAR-CIPHET, Ludhiana	07-11.08.2023
Smt. Sunita Chauhan	Recent advances in millets crops production, processing, value addition and marketing	ICAR-IIMR, Hyderabad	16-25.08.2023
Dr. Deepa Lal	Asian Citrus Congress	At CCRI, Nagpur	28-29. 10.2023
Dr. Deepa Lal	Attended ARYA Annual Report meeting	Online	08.09.2023
Dr. Deepa Lal	International Conference of One Health One World	Online	29.12.2023
Dr. Deepa Lal	21 Days International Training on Agriculture in Future and Future in Agriculture	Online	20.11.2023 to 10.12.2023
Dr. M. R. Meshram	Online Training on Awareness about Use of Glyphosate for Pest Control Operators	NIPHM, Hyderabad	19.10.2023
Dr. M. R. Meshram	Workshop on Dr. Panjabrao Deshmukh Natural Farming Mission, Akola	VANAMATI, Nagpur	03.11.2023
Dr. M. R. Meshram	6 Day workshop on "Organic and Natural Farming" under Dr. PDNFM, Akola	Ghaziabad and Krukshetra	03-09.12. 2023

#### Publication / Research Paper

- Dr. Deepa Lal, Smt. Jayshree Khobragade and Amol Raghorte (2023) "Transforming Lives of Rural Youth of Nagpur through Citrus Nursery Venture: Success story of ARYA, Indian Citriculture Vol.1, Issue 2 (2023) Page No.121-126.
- Sunita Chauhan, (2023) "Natural farming\_Empowering farmers to drive economic growth Indian Research Extension Education; pp 230

#### Published popular articles

 Dr. Deepa Lal, Smt. Jayshree Khobragade and Amol Raghorte (2023) Sarveshwar Sugarcane is juicing more profits: Success story, Krishak Jagat on 4th October 2023.

#### **Guest Lectures:**

Delivered Guest lecture on "Production technology of

- cotton under Smart Cotton Project" by Dr. M. R. Meshram, I/c, SMS(Agronomy), KVK, ICAR-CICR, Nagpur on Dated 09.05.2023 organized by ATMA, Nagpur for farmers and extension functionaries of Kanholibara.
- Delivered Guest lecture on "Production technology of cotton under Smart Cotton Project" by Dr. M. R. Meshram, I/c, SMS (Agronomy), KVK, ICAR-CICR, Nagpur on Dated 09.05.2023 organized by ATMA, Nagpur for farmers and extension functionaries of Sawlibibi, Hingna.
- Delivered Guest lecture on "Nutrient Management in Cotton under Smart Cotton Project" by Dr. M. R. Meshram, I/c, SMS (Agronomy), KVK, ICAR-CICR, Nagpur on Dated 25.07.2023 organized by ATMA, Nagpur for farmers and extension functionaries of Kanholibara.
- Delivered Guest lecture on "Nutrient Management in Cotton under Smart Cotton Project" by Dr. M. R. Meshram, I/c, SMS (Agronomy), KVK, ICAR-CICR, Nagpur on Dated



- 25.07.2023 organized by ATMA, Nagpur for farmers and iii. extension functionaries of Sawlibibi, Hingna.
- Delivered Guest lecture on "Post harvest technology and value added products from Soybean" by Smt. Sunita Chauhan, SMS, KVK, ICAR-CICR, Nagpur on Dated 20.04.2023 organized by RAMETI, Nagpur for Agriculture Assistant and Supervisor of Vidharbha
- Delivered Guest lecture on "Processing of Pulses for income generation for SHG" by Smt. Sunita Chauhan, SMS, KVK, ICAR-CICR, Nagpur on Dated 31.05.2023 organized by RAMETI, Nagpur for Agriculture Assistant and Supervisor of Vidharbha
- Delivered Guest lecture on "Value addition of Soybean, ii. Linseed & Safflower" by Smt. Sunita Chauhan, SMS, KVK, ICAR-CICR, Nagpur on Dated 07.09.2023 organized by RAMETI, Nagpur for Agriculture Assistant and Supervisor of Vidharbha

#### Awards received

- Dr. Deepa Lal, SMS, Horticulture, KVK, ICAR-CICR, Nagpur has received Young Scientist Award-Horticulture at National Drone Conference 2023. Drone: A boom for Agriculture at CSJN University, Kanpur, U.P. on 29<sup>th</sup> January 2023 by Agri meet foundation (NITI Ayog).
- Smt. Sunita Chauhan, SMS (Home Science), KVK, ICAR-CICR, Nagpur has received certificate of appreciation for significant contribution in developing Integrated farming system Module at KVK, ICAR-CICR, Nagpur.

ii. Smt. Sunita Chauhan, SMS (Home Science), KVK, ICAR-CICR, Nagpur has received Best KVK Professional award in 1st International Extension education Congress conducted by Society of Extension Education on Dec 19, 2023 at Jaipur Rajasthan.

#### Radio Talks (AIR, Nagpur):

- Radio talk was delivered by Dr. M. R. Meshram, I/c SMS (Agronomy), KVK, ICAR-CICR, Nagpur on "Poushtik shridhanya utpadan ani tyanche mahatv – Bhashan" which was broadcasted in All India Radio on dated 01.05.2023.
- ii. Dr. P. B. Deulkar delivered Radio talk "Phone in programme for farmer community in Vidarbha region", Hello Annadata – farmers queries related to care and management of animals on dated 06.12.2023, broadcasted on 06.12.2023, 13.12.2023 and 20.12.2023.
- iii. Dr. S. S. Patil delivered Radio talk "Phone in programme for farmer community in Vidarbha region", Hello Annadata – farmers queries related Kharf crop on dated 08.09.2023, broadcasted on 10.09.2023.
- iv. Smt. Sunita Chauhan delivered Radio talk on "Benefits of Millets for good health" which was broadcasted in All India Radio on dated 23.03.2023
- v. Smt. Sunita Chauhan delivered Radio Talk on "Importance and health benefits of Finger Millets" which was broadcasted in All India Radio on dated on 18 July 2023.



Conference on making India a global hub for Shree Anna at ICAR-CICR, Nagpur





## GENERAL

#### 10.1: Publications

#### 10.1.1 Research papers (NAAS rating>5)

- Raju, A.R., Manikandan, A., Narala, A., Rokde, S.H.K., Deshmukh, R., Tiwari, P., &Yesankar, M. 2023. Validation Cropping Systems and Input Management in Calcareous Vertisols. International Journal of Plant & Soil Science 35(22)761-778. (NAAS Rating: 5.07)
- M. Amutha and R.R. Rachana. 2023. A new host record for the invasive thrips, Thrips parvispinus (Karny) from India. Indian Journal of Entomology 85(4): 1009-1011. Doi: 10.55446/IJE.2021.354. (NAAS Rating: 5.08)
- M. Amutha. 2023. Efficacy of coloured sticky traps against thrips in cotton. Indian Journal of Entomology 85(2): 480-482. Dol. No.: 10.55446/IJE.2021.380. (NAAS Rating: 5.08)
- M. Amutha. 2023. Species diversity of thrips on cotton. Indian Journal of Entomology 85(1):78-82. Doi.:10.55446/IJE.2022.522. (NAAS Rating: 5.08)
- A. Sampathkumar, Venkatesh R. Kulkarni, J. M. Nidagundi and A. H. Prakash. 2023. Occurrence and Present Situation of Cercospora Leaf Spot Disease of Cotton in South Zone of India. Biological Forum - An International Journal 15 (4): 301-306. (NAAS Rating: 5.11)
- A. Sukrutha, S. Rajeswari, N. Premalatha, NM. Boopathi, K. Thirukumaran and A. Manivannan. 2023. Study on interplay of yield-related characteristics and fibre quality traits in arboreum cotton (Gossypium arboreum L.). Electronic Journal of Plant Breeding 14(2):633-645. (NAAS Rating: 5.14)
- 7. Ananda Lekshmi, L., Kumar, M., Rajeswari, S., Raveendran, M., Uma, D. and Manickam, S. 2023. 17. Unravelling seed oil, protein and fiber density in lintlessfuzzless upland cotton Gossypiumhirsutum L. through combining ability estimates and association studies. Electronic Journal of Plant Breeding 14 (3): 768-774. (NAAS Rating: 5.14)
- Baghyalakshmi, K., Manickam, S., Amutha, M., Sampathkumar, A., Yamuna M. G. and Prakash, A. H. 2023. Site regression and multivariate analysis for genetic diversity in Gossypium barbadense accessions. Electronic Journal of Plant Breeding 14 (3): 775-786. (NAAS Rating:
- Panda, D., Kumar, M. Mahalingam, L., Raveendran, M., 19. Velmourougane, K, Prasanna R. 2023. Trichoderma-Senguttuvan, K. and Manickam, S. 2023. Crossability relationship between wild cotton Gossypium armourianum and Gossypium gossypoides with American cotton. Electronic Journal of Plant Breeding 14(1): 1-7. (NAAS Rating: 5.14)
- 10. K. Sarala, K. Prabhakara Rao, C. Chandrasekhara Rao, D. Damodar Reddy and K. Baghyalakshmi 2023. 1/135 (IC0637598; INGR21082), a Tobacco (Nicotiana tabacum) Germplasm with High Solanesol (3.43%). Indian Journal of Plant Genetic Resource 36 (1): 192-193. (NAAS Rating: 5.16)
- 11. R. Lakshmi Swetha a\*, M. Thilagavathi a, Isabella Agarwal b, V. Karthick a, Patil Santosh Ganapati and S. Rajeswari.

- 2023. An Economic Analysis of Processing of Rainfed Cotton in Virudhunagar District of Tamil Nadu, India. International Journal of Environment and Climate Change 13 (10):1289-1297. (NAAS Rating: 5.16)
- 12. A. Sampathkumar and K. P. Raghavendra. 2023. Molecular identification and genetic diversity of Alternaria isolates causing leaf spot disease in cotton from major cotton growing areas of South Zone of India. Indian Journal of Agricultural Research A-6104 [1-7]. (NAAS Rating: 5.2)
- 13. A. Sampathkumar and A.H. Prakash. 2023. Cultural, morphological variability and pathogenic diversity of Alternaria isolates of cotton from major cotton growing areas of India. The Pharma Innovation Journal 12 (2): 3321-3329. (NAAS Rating: 5.23)
- 14. P Nalayini, D Blaise and HR Mundafale. 2023. Stale seed bed technique and leguminous cover crops as components of integrated weed management in irrigated cotton. Indian journal of weed science 55(1): 46-49. (NAAS Rating: 5.84)
- 15. Pande R and Verma, VK 2023. Indian Honey bee Apiscerana Himalaya - an efficient pollinator of underutilized horticulture crop, chow-chow in Meghalaya, India. Journal of Entomological Research 47 (1): 185-190. (NAAS Rating: 5.89)
- Krishna Sivarama M, Srujana Y., Kalyani Lakshmi D., Kumar Rishi and Venkateshwarlu N.C. 2023. Evaluation of some promising insecticides against sucking pest complex in cotton. Journal of Entomological Research47:950-953 or DOI: 10.5958/0974-4576.2023.00176.7. (NAAS Rating: 5.89)
- Sreenivasa V., Babu P.K., Sooganna, Chandra Subhash, Raghavendra N., Amaresh and Lal S.K. 2023. Standardization of new screening method and evaluation of soybean (Glycine max (L.) Merrill) genotypes for seedling stage drought tolerance under in-vitro conditions, AMA-Agricultural Mechanization in Asia Africa and Latin America 54(08):15061-15076. (NAAS Rating: 6.29)
- 18. Rishi Kumar, Amarpreet-Singh, R A Meena and Anil Kumar. 2023. Effect of attractants on activity and abundance of insect pollinators in cotton (Gossypium herbaceum). Indian Journal of Agricultural Sciences https://doi.org/ 10.56093/ijas.v93i5.100190. (NAAS Rating: 6.37)
- Azotobacter Biofilm-Based Formulation Enhance Natural Plant defense Enzyme Activities in Wheat and Cotton Seedlings. National Academy Science Letters https://doi.org/10.1007/s40009-023-01324-w. (NAAS Rating: 6.65)
- Aniruddha Maity, Debashis Paul, Amrit Lamichaney, Abhradip Sarkar, Nidhi Babbar, Nandita Mandal, Suman Dutta, Pragati Pramanik Maity and Shyamal Kumar Chakrabarty. 2023. Climate change impacts on seed production and quality: current knowledge, implications, and mitigation strategies. Seed Science and Technology 51(1): 65-96; https://doi.org/10.15258/sst.2023.51.1.07. (NAAS Rating: 6.8)





- 21. Satish K. Sain, Amarpreet-Singh, Debashis Paul, D. Monga, Rishi Kumar, S.K. Verma and O.P. Tuteja. 2023. Plant Stands and Gap-Filling Methods Affect the Productivity of Bt Cotton Hybrid In North-Western India. Scientist 2023; 2(1):47-57. DOI:https://doi.org/ 31. Vivek Shah, Rachna Pande, Pooja Verma, T. Prabhulinga, 10.5281/zenodo.7536187. (NAAS Rating: 6.85)
- 22. Madhu, B., Sivakumar, S., Manickam, S., Murugan, M., Rajeswari, S. and Boopathi, N. M. 2023. Improvising cotton (Gossypium hirsutum L.) genotypes for compact plant architecture traits suitable for mechanical harvesting. Indian Journal of Genetics and Plant Breeding 83(3): 398-406. (NAAS Rating: 7)
- 23. Vinita Gotmare, C. Rodge, P. Akhare, A. Jaunjal, K. 32. Gajghate, S.B. Singh, S.M. Palve, G. Balasubramani, H.B. Santosh, M. Saravanan, N. Chandrashekar, R. Pande, N. Hiremani, V.N. Waghmare and K.R. Kranthi 2023. Cotton Variety Vaidehi-1 (CICR- H NC Cotton 53) Naturally Colour Cotton. Indian Journal of Genetics and Plant 33. Sain SK, Dewasi, S and Singh AP. 2023. Combined Breeding Vol. 83, No. 2: 293. (NAAS Rating: 7)
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# 10.2: List of on-going projects

	Crop Improvement (24 projects)		EFC
	Project title and Investigators	Duration	
1	Development of broad based high yielding varieties of diploid and tetraploid cotton through recurrent selection. V.N. Waghmare (PI)	Institute (2020-2026)	4
2	Collection, conservation, evaluation, documentation and maintenance of germplasm of cultivated species of Gossypium. <b>Vinita Gotmare (PI)</b> , Sunil S. Mahajan, M. Saravanan, Neelakanth S. Hiremani, Manickam, A.H. Prakash, A. Manivannan, Debashis Paul, AnjaliKak	Institute (2018-2028)	1
3	Genetic diversity and utilization of wild germplasm for cotton improvement. <b>Vinita Gotmare</b> (PI), Rachna Pande, Neelkanth Hiremani, Rakesh Goswami, A.H. Prakash, J. Annie Sheeba, K. Baghyalakshmi, Subhash Chandra	Institute (2023-2028)	1
4	Development of heterotic pools in hirsutum cotton. D.V. Patil (PI), Rajkaumar Ramteke	Institute (2020- 2025)	1
5	Development of <i>Bt</i> hybids in tetraploid cotton with high yield, superior fibre quality and tolerance to jassids. <b>M. Saravanan (PI)</b> , Rahul M Phuke, Amudha J, Prabhulinga T.	Institute (2022-2027)	1
6	Screening of germplasm and induced mutagenesis for the development of herbicide resistant cotton. <b>M. Saravanan (PI)</b> , Vinita Gotmare	Institute (2021-2024)	1
7	Advancement of MAGIC population to development of core set for genetic mapping and identification of potential inbred lines. Rahul M. Phuke (PI), YG. Prasad	Institute (2022-2026)	1
8	Rapid development of high-yielding Bt cotton varieties amenable for high-density planting system. Rahul M. Phuke (PI), Ramkrushna GI, Raghavendra KP, Shah Vivek, Neelakanth S. Hiremani, S. Manickam, K. Bhaghyalakshmi, K. Rameash, A. SampathkumarSubhash Chandra, Debashis Paul	Institute (2023-2028)	1
9	AICRP on Seeds (Crops)  V. Santhy (PI), Sunil Mahajan, K. Rathinavel, Debashis Paul	AICRP (Seeds) (2007-2023)	1
10	Development of Quality Seed Production Protocol in Cotton. Sunil S. Mahajan (PI), V. Santhy	Institute (2022-2024)	1
11	Blindfold testing of RIB practice in Bt cotton. G. Balasubramani (PI)	Adhoc (2023-2024)	1
12	Validation of molecular markers and genes linked to drought tolerance in cotton. <b>J. Amudha</b> (PI), Jayant Meshram, M. Saravanan	Institute (2021-2024)	1
13	Exploration of genomic resources for identification of candidate genes and promoters for cotton improvement. Raghavendra KP (PI), Pooja Verma, Joy Das, Rakesh Kumar	Institute (2020-2025)	1
14	Identification, Cloning, and functional validation of genes / enzymes involved in chitin biosynthesis pathway of Cotton Pink Bollworm ( <i>Pectinophora gossypiella</i> ). <b>Joy Das (PI)</b> , Raghavendra KP, Rakesh Kumar	Institute (2021-2024)	1
15	Precise base editing in Acetolactate synthase gene (ALS Gene) for herbicide tolerance in Cotton. Rakesh Kumar (PI), Joy Das	Institute (2022-2027)	1
16	Development of high strength cotton genotypes by reducing the short fiber content.  S. Manickam (PI), A.H. Prakash, Gulzar Banu	Institute (2017-2025)	1
17	Breeding for high yielding, early maturing sucking pest tolerant extra-long staple G. barbadense genotypes with improved fibre properties. <b>A. Manivannan (PI)</b> , K. Rameash	Institute (2017-2025)	4
18	Induced Mutagenesis for Improvement of ELS ( <i>G. barbadense</i> ) cotton. <b>A. Manivannan (PI)</b> , S. Manickam, K. Rathinavel, K. Shankarganesh, A. Sampathkumar	Institute (2020-2025)	4
19	Unraveling the Differential Expressed Proteins (DEP) in cotton genotypes with contrasting resistance to leafhopper and development of the protein biomarkers/functional markers for leafhopper resistance. A Manivannan (PI), K Shankarganesh	DST-CRG (2021-2024)	2
20	Development and Evaluation of ELS interspecific hybrids with better yield and fiber quality.  K. Baghyalakshmi (PI), M. Amutha, A. Sampathkumar	Institute (2019-2024)	4
21	Implementation of PVP legislation 2001 and DUS testing of cotton under ICAR-SAU system.  K. Rathinavel (PI), V. Santhy	DUS, ICAR (2003-2023)	1

	Crop Improvement (24 projects)		EFC
	Project title and Investigators	Duration	
22	Development of varieties of upland cotton having better fibre traits and tolerance to CLCuD. Subhash Chandra (PI), V.N. Waghmare	Institute (2017-2025)	1
23	Physiochemical traits determining genotypic response towards Accelerated Ageing process in Cotton. <b>Debashis Paul (PI),</b> V Santhy, Sunil Mahajan	Institute (2021-2024)	1
24	Combating seedling burning in cotton through induction of early heat tolerance in North zone. <b>Debashis Paul (PI),</b> Subhash Chandra, Amarpreet Singh, K. Velmourougane	Institute (2023-2026)	1
	Crop Production (35 projects)		
25	ICAR-Network Project on Precision Agriculture. <b>Y.G. Prasad (PI)</b> , <b>Director</b> , <b>CICR</b> , Blaise Desouza, Gautam Majumdar, R. Raja, Amarpreet Singh, K. Rameash, Prabhulinga T, ShaileshGawande, DipakNagrale, N. Hiremani, P. Nalayini, A. Manikandan, D. Kanjana, J.H. Meshram, Pooja Verma	NePPA (2022-2027)	3
26	Long-term impacts of sub-soiling and cover crop rotation on soil properties and N requirement of cotton. <b>D. Blaise (PI)</b> , G. Majumdar, J. Somasundaram (ICAR-IISS, Bhopal)	Institute (2022-2024)	3
27	Quantitative estimation of carbon and moisture fluxes over the cotton based agro-ecosystem: Integrating ground observations, satellite data and modelling. <b>M.V. Venugopalan (PI)</b> , A. Manikandan, Ramkrushna GI	NCP (2017-2025)	3
28	Evaluation and validation of enriched pressmud cake, nano seed inoculants, soil and foliar nutrient formulations for rainfed cotton. A.R. Raju (PI)	Institute (2022-2025)	3
29	Validation and refinement of organic cotton production technology. Ramkrushna G.I (PI), RachnaPande, Neelakath S. Hiremani	Institute (2021-2027)	4
30	Landscape Diagnostic Survey of cotton production practices and crop performance in Maharashtra. Ramkrushna GI (PI), Y.G. Prasad, A.R. Reddy, M.V. Venugopalan, Jaya Kumaravaradan, ShaileshGawande, Rahul M. Phuke, M. Sabesh, Ranjit Kumar Paul (IASRI)	RGTC (2022-2024)	5
31	Assessment of field performance and effectiveness of hand held mechanical cotton picker <b>Co-PI</b> : G. Majumdar, Ramkrushna G.I., R. Raja (CIRCOT-CICR Collaborative project)	Institute (2022-2024)	3
32	Nutrient profile-based fertilizer management in rainfed Bt-Cotton -A. Manikandan (PI), K. Sankarnarayanan	Institute (2022-2025)	3
33	Response of Potassium Salt of Active Phosphorus to Cotton. A. Manikandan (PI), Rachana Pande	Isha Agro (2022-2024)	3
34	Establishment of Cosmic Ray Soil Moisture Instrument for Validation of Model Computed Soil Moisture Under National Hydrology Project. <b>A. Manikandan (PI)</b> , Y.G Prasad, Ramakrushna GI	NRSC (2023-2026)	3
35	Response of Nano DAP to Cotton. A. Manikandan(PI), D. Blaise	Coromandel (2023-2025)	3
36	Efficacy evaluation of ICAR-CIRCOT Nano-ZnO as Nano-fertilizer in field crops. <b>CCPIs: A. Manikandan, D. Kanjana</b>	CIRCOT (2021-2024)	3
37	Evaluation of chemical defoliants augmenting leaf senescence for mechanical picking in Bt Cotton. J.H. Meshram (PI)	DST-SERB (2022-2025)	3
38	Bioprospecting microbial volatiles for the management of major foliar and root diseases of cotton. <b>K. Velmourougane (PI), S</b> haileshGawande, Dipak T Nagrale	Institute (2023-2026)	2
39	Microbially mediated abiotic stress (drought and waterlogging) tolerance in cotton.  K. Velmourougane (PI), JH. Meshram, Raghavendra KP, J. Annie Sheeba	Institute (2023-2026)	3
40	Phytohormone profiling by targeted metabolomics in cotton. Pooja Verma (PI), Joy Das	Institute (2021-2024)	3
41	Land resource inventory of Pench National Park for ecological restoration (NBSS & LUP, Pench Tiger Reserve Project). <b>K.Velmourougane (Co-PI)</b>	Maharashtra Forest Dept. (2020-2024)	3
42	Evaluation of genotypes, defoliants, and growth regulators for different hybrids/varieties under HDPS for machine picking of cotton. <b>G. Majumdar (PI)</b> , J.H.Meshram, Blaise D, Ramkrushna GI, R. Raja, Amarpreet Singh	Institute (2019-2024)	3





	Crop Improvement (24 projects)		EFC
	Project title and Investigators	Duration	
43	Development of tractor operated brush type cotton harvester. Dr A.P. Pandirwar, ICAR-CIAE, Bhopal, <b>G. Majumdar (Co-PI)</b> , Ramkrushna Gl	Collaborative project (2021-2024)	3
44	Crop-weed interaction under ambient and elevated CO <sub>2</sub> conditions. <b>P. Nalayini(PI)</b> , A.H. Prakash, M. Amutha	Institute (2020-Aug 2023)	3
45	Integrated Nitrogen management under elevated CO <sub>2.</sub> <b>P. Nalayini (PI)</b> , K. Sankarnarayanan, A.H.Prakash, M. Amutha	Institute (2023-2026)	3
46	Evaluation of agro techniques to overcome the impact of weather aberrations (drought, water logging) in ELS cotton. <b>K. Sankarnarayanan(PI),</b> P. Valarmathi, J.H.Meshram	Institute (2020-2026)	3
47	Sustainable Intensification of Extra Long Staple Cotton Production in South Zone. R. Raja (PI), K. Rathinavel	Institute (2019-2024)	4
48	Active Optical Sensors based Yield Prediction in Cotton and Crop Canopy Management using Unmanned Aerial System. R. Raja (PI), D. Kanjana, T. Arumuganathan (SBI, Coimbatore)	Institute (2021-2024)	3
49	Effect of long-term application of organic and inorganic sources of nutrients on continuous cultivation of Bt and non Bt cotton with maize and wheat cropping system under irrigated conditions. <b>D. Kanjana (PI)</b> , Amarpreet Singh	Institute (2017-2024)	3
50	Formulation of Customized fertilizers for Cotton. D Kanjana (PI), R. Raja, Usha Rani	Institute (2021-2025)	3
51	Development of a nutrient and plant hormone- enriched foliar formulation for cotton. <b>J. Annie Sheeba (PI)</b> , D Kanjana	Institute (2021-2024)	3
52	Identification and characterization of germplasm lines and advance breeding with higher photosynthetic efficiency and harvest index for better yield in cotton. <b>J. Annie Sheeba (PI)</b> , S. Manickam	Institute (2023-2026)	3
53	Efficient resource allocation pattern for cotton farms in Tamilnadu - Fuzzy goal programming approach. Isabella Agarwal (PI)	Institute (2023-2026)	5
54	Technology Impact and Need Assessment to Address Productivity, Sustainability and Climate Change Challenges of Indian Cotton. S. Usha Rani (PI), J. Annie Sheeba, M. Amutha	Institute (2022-2024)	5
55	ICT Dissemination of Cotton Technologies for Production Augmentation and Knowledge Empowerment S. Usha Rani (PI), M. Sabesh, JH. Meshram, SK. Sain	Institute (2022-2025)	5
56	Pilot Project on "Awareness and Extension Services on Best Farm Practices for Cotton Farmers to Improve Quality, Yield and Sustainability. <b>S. Usha Rani (PI)</b> , A. Sampathkumar, A.H. Prakash, M. Sabesh, Head (Crop Production), Ramkrushna GI, A. Manikanadan, Jaya kumara Varadan, S. K. Sain, Amarpreet Singh	CCI (2023-2024)	5
57	Development of web-based Cotton data query system. M. Sabesh (PI), Sunil Mahajan, Isabella Agarwal	Institute (2021-2026)	5
58	Conservation agriculture practices for cotton-wheat system. Amarpreet Singh (PI), G. Majumdar	Institute (2022-2027)	3
59	Effect of monopodial removal practices on the hybrid Bt cotton. Amarpreet Singh (PI)	Institute (2023-2025)	3
	Crop Protection (23 projects)		
60	Crop pest surveillance and advisory project (CROPSAP) in Maharashtra. V. S. Nagrare (PI), Babasaheb B Fand	CROPSAP (2010 onwards, annual basis)	2
61	Insecticide Resistance Management (IRM): Dissemination of Pink bollworm Management Strategies. <b>V.S. Nagrare (PI)</b> , Rachana Pande, PrabhulingaT, Shivaji H. Thube, Neelkanth Hiremani, S.P. Gawande, B.B. Fand, Dipak.T. Nagrale, S.S. Patil, K. Rameash, Rishi Kumar, S.K. Sain, J.H. Meshram, K. Shankarganesh	IRM-DAC (2018 onwards, annual basis)	2





	Crop Improvement (24 projects)		EFC
	Project title and Investigators	Duration	
62	Neonicotinoid and pyridine carboxamide insecticides resistance monitoring in cotton Jassid, Amrasca biguttula biguttula (Ishida). <b>V.S. Nagrare (PI),</b> Rishi Kumar, K. Shankarganesh, Joy Das	Institute (2023-2026)	2
63	Identification of Host Cues from Cotton (Gossypium hirsutum) to elicit behaviour of female Pink bollworm (Pectinophora gossypiella). Rachna Pande (PI), Prabhulinga T, Pooja Verma	Institute (2022-2025)	2
64	Revisiting the ETLs and yield loss assessment for cotton pink bollworm and boll rot.  Babasaheb B Fand (PI), Vivek Shah, Dipak Nagrale	Institute (2021-2024)	2
65	Monitoring insecticide resistance in American bollworm, Helicoverpa armigera Hubner populations from cotton growing regions of Maharashtra and Gujarat. Shah Vivek(PI), Rachna Pande	Institute (2021-2026)	2
66	Multi-pronged bio-rational management of Pink bollworm (PBW), <i>Pectinophora gossypiella</i> (Saunders)on cotton in India. <b>Prabhulinga T (PI)</b> , YG Prasad, BB Fand, Rishi Kumar, K Rameash	Institute (2021-2024)	2
67	Investigations on host plant resistance mechanisms in cotton genotypes against thrips. <b>Prabhulinga T (PI)</b> , Shivaji Thube, Pooja Verma	Institute (2022-2025)	2
68	Evaluation of Rallis India protein against population pink bollworm ( <i>Pectinophora gossypiella</i> ) <b>Prabhulinga T (PI)</b>	Rallis India (2022-2024)	2
69	Development of EPF (Beauveria bassiana and Metarhizium anisopliae) & EPN based bie formulation for sustainable management of pink bollworm and sucking pest complex in cotton. ShivajiThube (PI), Y.G. Prasad, Prabhulinga T.	Institute (2022-2025)	2
70	Studies on Boll rot in cotton - Etiology and Management. Dipak T. Nagrale (PI), B.B.Fand	Institute (2020-2025)	2
71	Studies on target leaf spot of cotton caused by <i>Corynespora cassiicola</i> . <b>S.P. Gawande</b> (PI), Babasaheb B Fand, RakeshKumar, S.K. Sain	Institute (2020-2025)	2
72	Studies on grey mildew disease of cotton caused by Ramularia areola. Neelkanth Hiremani (PI), P. Valarmathi	Institute (2020-2025)	2
73	Development of AI enabled pheromone trap for lepidopteran pests and multi-fin glue trap for sucking pests on cotton. <b>K.Rameash (PI)</b> , M. Sabesh	Institute (2022-2025)	2
74	Biologyand holistic management strategies for emerging pest Tea mosquito Bug ( <i>Helopeltis</i> ) in Cotton. <b>M. Amutha(PI)</b>	Institute (2020-2025)	2
75	Development of sociochemical based attractants for sustainable management of cotton stem weevil <i>Pempherulus affinis</i> (Faust) Curculionidae: Coleoptera). <b>Shankarganesh (PI)</b>	SERB-DST (2022-2025)	2
76	Identification and genetic variability of Alternaria and Cercospora isolates of cotton using molecular markers. A. Sampathkumar (PI)	Institute (2021-2024)	2
77	Survey, molecular characterization, vector transmission and exploiting host plant resistance for tobacco streak virus (TSV) in cotton. A. Sampathkumar (PI), P. Valarmathi	Institute (2023-2026)	2
78	Studies on rust disease of cotton caused by <i>Phakopsora gossypii</i> and <i>cotton</i> necrosis <i>disease</i> caused by TSV, its management. <b>P. Valarmathi</b> ( <b>PI</b> )	Institute (2021-2024)	2
79	Studies on plant parasitic nematodes of cotton. J. Gulzar Banu (PI)	Institute (2020-2025)	2
80	Development of biocontrol consortia with multifaceted fungi for the management of important pests and nematodes of cotton. <b>Gulsar Banu (PI)</b> , Shivaji Thube	Institute (2020-2025)	4
81	Thermal stress induced effect on insecticide susceptibility and fitness traits in whitefly, Bemisia tabaci, a serious pest of worldwide concern. Rishi Kumar (PI), Debashis Paul, Baba Saheb Fand	DST-CRG (2022-2025)	2
82	Collection, characterization and evaluation of beneficial fungal microorganisms from North, Central and South Cotton growing zones. <b>S.K. Sain (PI)</b> , Shailesh P. Gawande, P. Valarmathi	Institute (2020-2025)	4





#### Special Project on Cotton (2023-24)

Ministry of Agriculture & Farmers Welfare and Ministry of Textiles, Govt. of India jointly launched a special project on cotton 'Targeting technologies to agro-ecological zones- large scale demonstrations of best practices to enhance cotton productivity' under National Food Security Mission (NFSM) for implementation during 2023-24 kharif season with an outlay of 41.87 crores. The project was implemented by ICAR-Central Institute of Cotton Research (CICR), Nagpur in Public-Private collaboration and partnership with Confederation of Textile Industry (CITI), South India Mills Association (SIMA), Federation of Seed Industry of India (FSII) and National Seed Association of India (NSAI). Field extension support for technology dissemination and farmers training on best practices is extended by 42 Krishi Vigyan Kendras (KVKs) of three Agricultural Technology Research Institutes (ATARIs at Pune, Hyderabad and Bengaluru), CITI and SIMA cotton development & research associations. CICR is providing technical backstopping and knowledge support on best practices for increasing productivity.

The Special Project envisages scaling up of three cotton technologies and has been launched in June 2023 for implementation in 61 districts of 8 states covering an area of 9064 ha involving10418 farmers. Farmer beneficiary validation was done by the officials of the state department of agriculture.

Farmers adopting High density planting system (HDPS) technology have used three times higher seed rate of 6 seed packets per acre against the current practice of 2 packets/acre to have a high-density plant stand of 74000 plants/ ha. The technology targets deployment of suitable compact seed variety in shallow soil areas along with need-based canopy management technique. HDPS field demonstrations in 3033 ha Area involving 2904 farmers were conducted in 38 districts across the states of Maharashtra, Telangana, Gujarat, Andhra Pradesh, Tamil Nadu and Karnataka. The target is nearly doubling the current low level of productivity. The average yield in the HDPS demonstrated plot was 8.68 g/acre over average yield of 6.60 g/acre in neighbouring conventional plots resulting in an increase of 30.40 % over Farmers Practices.

Farmers adopting Closer planting technology used two times higher seed rate of 4 seed packets per acre to have a mediumdensity plant stand of 37000 plants/ ha. The technology targets

medium soil areas along with need-based canopy and pest management techniques. Demonstrations in 3641.5 ha area involving 4231 farmers were conducted in 48 districts across the states of Gujarat, Rajasthan, Madhya Pradesh, Maharashtra, Telangana, Andhra Pradesh, Tamil Nadu and Karnataka. The average yield in the CS demonstrated plot was 9.91q/acre over average yield of 7.71q/acre in neighbouring conventional plots resulting in an increase of 39.15 % over Farmers Practices.

Partnership (PPP) mode in the identified clusters adopting a In order to boost the production of ELS cotton, demonstrations value chain approach. The holistic plan is being implemented in were conducted in 9 districts of Rajasthan, Madhya Pradesh and Tamil Nadu in over 2389.8 ha area involving more than 3283 farmers. The average yield in the ELS demonstrated plot was 6.11 q/acreover average yield of 5.73 q/acre in neighbouring conventional plots resulting in an increase of 6.81 % over Farmers Practices.

> During 2023-24, 262 Farmers trainings, 190 Field days, 132 Workshops and 25 Kisan Melas outreach activities were organized by KVKs, CITI, SIMA.

> As an incentive for adoption and scaling up of the HDPS, CS and ELS cotton technologies for increasing productivity, technology assistance to farmers for improved seed and critical inputs is provided to small & marginal farmers through direct benefit transfer (DBT) in the form of e-vouchers with a tie up with State Bank of India. Machinery assistance (10 Pneumatic planter & 42 Cotton Shredder) was also provided to KVKs for pneumatic planters to demonstrate precision sowing of seed and shredders for incorporation of cotton stalk after harvest for soil health improvement. Farmer registration was done through mobile app and a web portal showcases the multi-faceted activities and geo-fenced sites of the special project. Dashboard, tutorials and e-market module features in the web portal provide detailed information on project progress and market support for quality cotton produced by the project farmers.

> Concerted efforts under the Project to promote HDPS among the cotton farmers, especially in rainfed regions to increase the cotton yield and thereby the income and livelihood of the farmers yield positive results. Though HDPS has increased the cost of cultivation by around Rs. 4,000/ac due to increased seed rate and harvesting labour cost, farmers realized around Rs. 10,500 hike in their net income/ac over conventional. Yield distribution has shifted from a lower range of 6 to 10 Q/ac to a higher range of 7 to 12 Q/ac with 43% of farmers realizing 10 to









12 Q/ac. Overall, HDPS has increased the rainfed cotton yield achieved under HDPS and Closer planting compared to 1.6 in by 26% over CPS. At the disaggregated level, 34% of farmers conventional system of wider spacing. have realized 30 to 60 % increased yield and another 38% have A publication on success stories of farmers has been brought realized 20 to 30% hike in yield. Higher B:C ratio of >2.0 was

out by the Directorate of Cotton Development (DCD), Nagpur.

# 10.3: Consultancy, Patents, Commercialization of Technology

# 10.3.1: Contract Research / Revenue generation

ltems	Amount (Rs. in Lakhs)		
MoU signed with ICAR-CIRCOT, Mumbai & CNHI Industrial Technology Services (India) Private Limited (CNHI), Gurugram Haryana on 23 <sup>rd</sup> May 2023 for technical support for contract research in the form of "Technological Mentoring in field Evaluation and Optimization of Robotic Cotton Harvester"			
MoU signed with M/s. Evonik Indi a Pvt. Ltd., Mumbai on 5 <sup>th</sup> Oct 2023 to evaluate Adjuvants provided by Evonik India Pvt. Ltd. against thrips population.	8.57		
MoU signed with Rallis India Ltd. Bangalore on 22 <sup>nd</sup> Nov 2023 to "Evaluate Cry protein provided by Rallis India Ltd. against BG II resistant field population of Pink Bollworm, <i>Pectinophoragossypiella</i> (Saunders).	15.07		
MoU signed with Rasi Seeds (P) Ltd Coimbatore on 23rd Dec 2023 for two projects:			
<ol> <li>To research on Season long Monitoring and Management of Pink Bollworm in cotton crop in North Zone during 2024.</li> </ol>	79.14		
<ol> <li>Studies on dynamic of Boll Rot disease complex of upland cotton in India: Basic to integrated management approaches during the year 2024-27.</li> </ol>	82.85 (Total Rs. 161.99 lakh)		

#### 10.3.2: Patents

Title of Patent	Application/ Registration No.	Date of Filing/ Registration	Application Granted/ Registered**
Bacterial Based Volatiles Composition as Jassid Attractant	202321058813 (E-12/3638/2023/MUM)	12.09.2023	Patent Registered
Bacterial Based Volatiles Composition as Thrip Attractant	202321058814 (E-12/3635/2023/MUM)	01.09.2023	Patent Registered
Bacterial Based Volatiles Composition as Aphid Attractant	202321058816 (E-12/3637/2023/MUM)	01.09.2023	Patent Registered
Bacterial Based Volatiles Composition as Beneficial Insects Attractant	202321058817 (E-12/3640/2023/MUM)	12.09.2023	Patent Registered
Bacterial Based Volatiles Composition as Whitefly Attractant	202321058818 (E-12/3639/2023/MUM)	12.09.2023	Patent Registered

# 10.4 : Research Advisory Committee (RAC) meeting

The first meeting of the newly reconstituted Research Advisory Committee (RAC) of Indian Council of Agricultural Research-Central Institute for Cotton Research (ICAR-CICR), Nagpur was held during 18-19 December 2023 under the chairmanship of Dr. P.K. Chakravarthy, Former Member (Plant Science) of Agricultural Scientists Recruitment Board (MoA & FW, GOI) New Delhi and Former Assistant Director General (Plant Protection) ICAR New Delhi. Dr. Babasaheb B. Fand, Member Secretary, RAC presented the Action Taken Report (ATR) on the recommendations of the previous RAC meeting held during December 07-08, 2022. The RAC Chairman and Members expressed their satisfaction over the ATR.

Dr. Y.G. Prasad, Director, ICAR-CICR made a presentation on the salient research achievements of the Institute, and new initiatives taken by ICAR-CICR, Nagpur to meet the challenges



of cotton farming.

Dr. V.N. Waghmare, Head, Crop Improvement Division, Dr. A.S.





Tayade, Head Crop Production Division, Dr. Ganesh Behere, Head Crop Protection Division, Dr. A.H. Prakash Head, ICAR-CICR, RS Coimbatore and Dr. Rishi Kumar Head, ICAR-CICR, RS Coimbatore and Dr. Rishi Kumar Head, ICAR-CICR, RS Coimbatore and Dr. Rishi Kumar Head, ICAR-CICR, RS Coimbatore centre was held on 15 to 16 May, 2023 at ICAR-CICR, RS, Coimbatore. Dr. Y.G. Prasad, Director, Dr. V.N. Waghmare, Head, Crop Improvement Division, Dr. M.V. Venugopalan, Head, PME, Dr. G. Balasubramani, In-Divisions and stations during 2022-23.

The RAC committee visited the various research facilities of the institute like laboratories, poly house, germplasm unit and experimental fields.



# 10.5: Other Important Meetings / Events

#### 10.5.1: Meetings

#### Annual Institute Research Committee (IRC) meeting - 2023

The Annual Institute Research Committee (IRC) meeting of ICAR-CICR was conducted as combined IRC for CICR, Nagpur and CICR, RS, Sirsa from 14-17<sup>th</sup> March and 20<sup>th</sup> March 2023 at CICR, Nagpur. A total of 37 Scientists from CICR, Nagpur and CICR, RS, Sirsa attended the meeting. Professor Tekale Pradeep, Genetics and Plant Breeding, Professor Jayashankar Telangana State Agricultural University were invited as subject experts.





The Annual IRC meeting for Coimbatore centre was held on 15 to 16 May, 2023 at ICAR-CICR, RS, Coimbatore. Dr. Y.G. Prasad, Director, Dr. V.N. Waghmare, Head, Crop Improvement Division, Dr. M.V. Venugopalan, Head, PME, Dr. G. Balasubramani, In-Charge, IMTU, and Dr. K. Velmourougane, Secretary, IRC, attended the meeting from ICAR-CICR, Nagpur along with the scientists of regional station, Coimbatore. Dr. J. Annie Sheeba, local IRC Secretary welcomed the participants, followed by Director's speech. In the IRC Meeting, a total of 9 projects (1 closing and 8 ongoing projects) were presented in the Crop Improvement Division. In the Crop Production Division, a total of 16 projects (5 closing, 4 new, and 7 ongoing projects) were presented. In the Crop Protection Division, a total of 9 projects (1 closing, 2 new, and 6 ongoing projects) were presented.





# Pink bollworm management by timely sowing and harvesting

Director, ICAR-CICR, Nagpur, Dr. Y.G. Prasad, participated in a meeting on "Supply or timely Availability of Cotton Seeds in the Market" on 27.04.2023. Hon'ble Agriculture Minister, Govt. of Maharashtra Shri. Abdul Sattar graced the occasion. Director, Dr Y.G. Prasad delivered a lecture on "Pink Bollworm Management in Cotton."

# Interactive Meeting with Hon'ble Union Minister of Textiles

Director, ICAR-CICR Nagpur presented the progress of project 'Holistic Plan for Development of Cotton Economy' during the sixth Textile Advisory Group meeting as a part of Saurashtra Tamil Sangamam under the Chairmanship of Hon'ble Minister of Textiles, Shri. Piyush Goyal on 22<sup>nd</sup> April, 2023 at Rajkot Gujarat.





#### 10.5.2: Events

### 47th Foundation Day of ICAR-CICR, Nagpur

ICAR-CICR celebrated 47th Foundation day on 1st April, 2023.On this occasion, chief quest Dr. Deepak Pental, Ex-Vice-Chancellor, University of Delhi delivered the foundation day lecture. Dr. Y.G. Prasad, Director, ICAR-CICR, Nagpur gave an overview on significant achievements made by the Institute during the year and new project initiatives. Sh. Sunil Kedar ji, Hon'ble MLA and former cabinet minister, Govt. of Maharashtra graced the foundation day and complimented the country's agricultural sector for being more than self-sufficient and capable of increasing the per-capita income of farmers. Dr. D.K. Ghosh, Director, ICAR-CCRI and Dr. N.G. Patil, Director, NBSS & LUP, Nagpur complimented CICR on its efforts for farmers' welfare. Two publications namely "Kapasika" in Hindi and "Cotton Diseases and its management" were released by the dignitaries. Staff of CICR who excelled in various fields were felicitated by the guests. Among the participants were former directors, faculty, farmers, retired staff, research scholars, PG students and all the staff of the institute. The program was hosted by the Staff Recreation Club.







#### World Intellectual Property Day

ICAR-CICR – Institute Technology Management Unit, Nagpur conducted a World Intellectual Property Day on 26.04.2023. Dr YG Prasad, Director, ICAR-CICR, Nagpur chaired the meeting. Dr Priti Tayade (Gosavi), Registered Trade Mark Agent and Founder of IPR Training and Consultancy Firm, Patent Master key delivered a special lecture on "Women and Accelerating Innovation and Creativity"



#### Pre-Kharif Kisan Sammelan

"Pre-Kharif Kisan Sammelan" was organized for awareness of technologies and best practices for enhancing cotton productivity" under Development Action Plan for Scheduled Caste (DAPSC) on 19 May, 2023 at ICAR-CICR, Nagpur. Dr. C. D. Mayee, Former Chairman, ASRB, New Delhigraced the event as Chief Guest. More than 200 farmers from villages of Wardha and Nagpur district participated in the programme. Technical sessions for farmers included interactive lectures on weather-based crop management advisory, selection of cotton cultivars with high boll retention and good yield potential under rainfed and irrigated conditions, Pre-sowing operations, soil health management and nutrition management during the initial growth stage, Pest and Disease management strategies during pre-sowing and the initial growth stage of cotton crop and Scientist – Farmer interaction.

Farmers were also showcased with latest cotton technologies developed at ICAR-CICR through an exhibition and the inputs were distributed to the participating farmers.







#### Cotton Farmers' Workshop

ICAR-CICR, Nagpur organized Cotton Farmers' Workshop on Pre-Kharif consultation: Technologies and best management practices for enhancing cotton productivity under Development Action Plan for Scheduled Castes (DAPSC) on 30.05.2023 at ICAR-CICR, Nagpur. Dr. S.N. Puri, Ex Vice Chancellor, CAU, Imphal, Manipur presided the workshop as chief guest while Ms. Mittali Sethi (IAS), Director, VANAMATI, Nagpur and Dr. N.G. Patil, Director, ICAR-NBSS & LUP, Nagpur was the guest of honour for the programme. Technical sessions were conducted for the cotton growers followed by farmer- scientist interaction and input distribution. A total of 200 SC farmers from Nagpur district participated in the workshop.



## International Day of Yoga

The ICAR-CICR has observed 9<sup>th</sup>International Day of Yoga on 21<sup>st</sup> June, 2023 at its headquarters in Nagpur, and two regional





stations at Coimbatore (Tamil Nadu) and Sirsa (Haryana). The theme of the yoga for this year was 'Yoga for Vasudhaiva Kutumbakam' with a domestic tag line 'Har Aangan Yoga'. The program started with the live telecast of event with Sh. Jagdeep Dhankar, Hon'ble Vice President of India. The participants took the Yoga pledge and performed the Yoga asanas.

#### PM Kisan Samman Nidhi Programme

PM Kissan Samman Nidhi Programme live webcast was organized on 27th July 2023 at ICAR-KVK-CICR, Nagpur. In this programme 126 male farmers and 56 female farmers were present.

# Celebration of 77<sup>th</sup> Independence Day

ICAR-CICR, Nagpur and its two regional stations at Sirsa and Coimbatore celebrated 77<sup>th</sup> Independence Day on 15<sup>th</sup> August 2023oninstitute premises with great enthusiasm.

At HQ Nagpur, the program started at 8:30 am with the National Flag (tricolor) hoisting by Dr YG Prasad Director, ICAR-CICR. All the staff of ICAR-CICR sang the Rastragaan in unison. The Director addressed the gathering with his inspiring words and delivered a glimpse of the address of Shri Narendra Modi, Prime Minister of India. He also informed the staff about the achievement of the institute and urged all to work for the institute with a positive attitude and a feeling of oneness for the betterment of cotton farmers. This eloquence filled everyone's heart with pride and patriotism. The celebration was followed by several recreational competitions for the kids and the staff. All







distributed to the winners at the end of the celebration



# Farmers' Training cum Workshop on HDPS in Cotton held at **KVK Selsura**

A farmers' Training cum Workshop on High-Density Planting Systems (HDPS) was organised by CITI-CDRA & KVK, Selsura Taluk, Devali, District, Wardha in the premises of KVK Selsura on 24th August, 2023. Dr. Y.G. Prasad, Director, CICR, Nagpur in his inaugural address highlighted the immense potential of this project for revitalizing stagnated cotton yields. The program was attended by Dr Prashant Mohota (MD, CITI-CDRA), Dr. Rajkumar Ramteke, Dr. Ramkrushna Gl, Dr. Shailesh Gawande, Dr. Rachna Pande from ICAR-CICR, Dr Rupesh Zadode, and Dr. Govind Vairale from CITI-CDRA, Sh. Shivankar, DSAO, Dr.





the staff participated in the programwith great zeal. Prizes were Sameer Vadyalkar from Ankur Seeds and Mr. Dhaskat from Rasi Seeds. A total of 120 cotton farmers participated in this program.

#### Interactive meeting cum Input Distribution

An interactive meeting cum input distribution was organised on 31st August 2023 under National Food Security Mission (NFSM)-Special Project at ICAR-CICR, Regional Station, Coimbatore. The meeting was presided by Smt. PrajaktaL Verma, Joint Secretary (Fiber), Ministry of Textiles, Government of India. She explained about the special features of the project. Sh. Lalit Kumar Gupta, Chairman-cum-Managing Director, CCI, Mumbai in his special address stressed that India is the only country which has the capacity to double the productivity. Dr Y.G. Prasad, Director, ICAR-CICR, Nagpur explained in detail about the NFSM-funded special project on cotton where it was mentioned that it is the first project implemented under Public Private Partnership, involvement of Ministry of Agriculture, Ministry of Textiles along with other cotton stakeholders on one platform. A Bulletin "Think package of practices for ELS cotton" was released during the meeting.



#### Interaction Meeting on Dada Lad Cotton Technique

An Interaction meeting was held with the experts of Dada Lad Cotton Technique, district nodal officers of CICR, Nagpur pertaining to 10 districts of Maharashtra State and KVK nodal officers of ATARI, Pune on 07 September, 2023 through hybrid mode under the Chairpersonship of Director, ICAR-CICR, Nagpur to review the implementation of Dada Lad cotton technique under special project on cotton. Dr YG Prasad welcomed all the participants and made a brief presentation highlighting the progress made under the project. He elaborated on the mechanism of the Dada Lad cotton technique under the special project and set criteria for DBT to finalize the farmer list, i.e., small and marginal farmers (less than 5 acres of land holding), follow 90 cm x 30 cm spacing, and approved or







notified hybrids/varieties used. Sh. Dada Ji Lad, developer of the Dada Lad Cotton Technique, narrated a story about development of this technique and told about increase in cotton productivity due to adoption of this technique.

#### World Cotton Day 2023

World Cotton Day was celebrated at ICAR-CICR, Nagpur on October 7, 2023 with the theme "Making Cotton fair and sustainable for all from farm to fashion". Dr Y.G. Prasad Director, ICAR-CICR, Nagpur participated in the conference on "Enhancing Quality & Productivity of Indian Cotton through Policy, Innovation, & Technology Upgradation" organized by the Ministry of Textiles in collaboration with the Cotton Corporation of India (CCI) Ltd., Mumbai on the World Cotton Day 2023 at New Delhi. Brainstorming sessions was held during the conference which addressed the crucial topics including "Enhancing Sustainability & Circularity in the Cotton Value Chain" and "Cotton Mission for Enhancing Quality & Productivity." He attended as session panelist for Cotton Mission for Enhancing Quality & Productivity





# Field Visit to Demonstration Plots of Dada Lad Cotton Technology under Special Project on Cotton being implemented in Nandurbar District

Dr. Babasaheb B Fand and Dr Dipak Nagrale, Nodal officers of ICAR-CICR along with Sh. PC Kunde, Nodal officer, KVK Nandurbar and Sh. Prashant Ahire, District Nodal Officer for



Dada Lad cotton technology visited the plots in villages viz., Wavad, Akrale and Nhyahali in Nandurbar District on 08 September, 2023. The team verified the spacing requirement (3 ft x 1 ft), activities of monopodia removal at 45 DAS adopted by farmers selected under the project. Guidance was provided on identification and removal of monopodial branches and detopping and its role in improving cotton yield. Pest and disease diagnostics and management measures were suggested to the farmers.

# Cotton Production Technology Workshop

One-day workshop on Cotton Production Technology held on 28<sup>th</sup> October 2023 in partnership with the Confederation of Indian Textile Industry-Cotton Development & Research Association (CITI-CDRA). The program was tailored to cater to









the specific technological needs of the Vidarbha region's agroecological zones, including AER 6, 10, and 12. A total of 75 cotton farmers from Hingna and Umred of Nagpur district, Hinganghat and Chistur of Wardha district, as well as Palwadi and Akatwada of Amravati district participated in the event.

The workshop was inaugurated by Dr. T.R. Sharma, Deputy Director General (Crop Science), ICAR, New Delhi who encouraged farmers to make use of various modules and advisories developed by CICR, including Resistance Management, and Integrated Pest Management. Dr. Y.G. Prasad, Director, ICAR-CICR, Nagpur, provided insights into the implementation of innovative technologies such as, intercropping of legumes, nutrient expert, bed planting and mulching to boost cotton productivity.

#### Rashtriya Ekta Diwas (National Unity Day)

"Rashtriya Ekta Diwas (National Unity Day)" was celebrated by ICAR-CICR, Nagpur & Regional Station, Coimbatore on 31st October, 2023. Director ICAR-CICR and all the staff of ICAR-CICR Nagpur and Regional stations, Coimbatore, had taken the



## 81st ICAC Plenary Meeting

Dr Y.G. Prasad, Director, ICAR-CICR, Nagpur participated in the presentation on Climate-Smart Cotton Production 81st ICAC Plenary Meeting-Cotton Value Chain: Local Technologies for improved yields. ICAR-CICR technologies Innovation for Global Prosperity organized by Ministry of being exhibited during the event was led by Dr Ramkrushna Gl, Textiles, Government of India during 02-05 December 2023 at Senior Scientist (Agronomy) and Dr Shivaji Thube, Scientist Jio World Convention Centre, Mumbai. He delivered a (Agl. Entomology), ICAR-CICR, Nagpur.



# 9th World Soil Day

9th World Soil Day 2023celebratedat ICAR-CICR, Nagpur with farmers. A special guest lecture was delivered by Mr. Anand demonstrators, agricultural input dealers and organic cotton involving 450 students from 3rd to 8th standard.

theme for this year "Soil and Water: A Source of Life"in Gale, Coromandel International Limited, Hyderabad who collaboration with Coromandel International Limited, highlighted cutting-edge approaches such as Nano-Hyderabad and World Wide fund for Nature-India, New Delhi on formulations for enhancing soil health and crop production. An 5th December 2023. The program was attended by a total of 635 essay and drawing competitions were conducted at Bhavan's participants including students, farmers, frontline Bhagawandas Purohit Vidya Mandir, Civil lines, Nagpur,









# 9th Asian Cotton Research and Development Network International Cotton Advisory Committee (ICAC), Washington (ACRDN) Meeting & International Conference

ICAR-Central Institute for Cotton Research, Nagpur co-hosted the 9th ACRDN Meeting & International Conference on during 06-08 December 2023 at ICAR-CICOT, Mumbai. The Innovations for a Resilient and Sustainable Cotton Production and Viable Value Chain in association with Indian Society for

DC, ICAR-Central Institute for Research on Cotton Technology (CIRCOT), Mumbai and Indian Fiber Society (IFS), Mumbai program was inaugurated by Secretary DARE and DG ICAR. This event celebrates the Golden Jubilee of ISCI and marks the Cotton Improvement (ISCI), Mumbai, in cooperation with the beginning of ICAR-CIRCOT's centennial year celebrations.



#### Kisan Mela 2023

A Farmers meet cum input distribution programme was organized by ICAR-CICR, Nagpur under DAPSC Scheme on 19th December 2023 at ICAR-CICR Nagpur. The Organizational Secretary of Bhartiya Kisan Sangh (BKS), Maharashtra and member of CICR-Institute management committee (IMC) Shri. Dada Lad was the chief guest. Dr. P.K. Chakrabarti, former member ASRB and RAC chairman of CICR was the guest of honor. Other dignitaries present during the program include RAC members Dr. D.M. Hegde, Dr. P. Ramasundaram,

Dr. Kalpana Shastry, Dr.Pamkaj Rathod, CICR Director Dr. Y.G. Prasad, Dr. Jayant Meshram Pr. Scientist and Nodal Officer DAPSC.

A total of 150 Scheduled Caste farmers from Yavatmal (Malkapur, Sherad and Gandhinagar, Ta. Kalamb) and Wardha (Mangaon and Salapur, Ta. Samudrapur) district actively participated in Program. Critical inputs like Battery operated Knapsack Sprayer, LED rechargeable Torch and Irrigation Tube (Lapeta Pipe) were distributed to SC beneficiaries.







# 10.6 : Participation of Scientists in Symposia/Conference/Seminars/Webinar

Name of Scientist	Name of Seminar/Webinar/Conferenc e/Symposia/	Category	Place/Organized by	Start Date	End Date
Dr Blaise, Dr A. Manikandan	108th Indian Science Congress	Conference	RTM Nagpur University, Nagpur	03-01-2023	07-01-2023
Dr Subhash Chandra	International Conference on Vegetable Oils 2023 (ICVO 2023)-Research, Trade, Value Chain and Policy	Conference	ICAR-IIOR, Hyderabad by ICAR, ICAR-IIOR and IJOR	17-01-2023	21-01-2023
Dr Manickam, S.	"Future prospects of cotton farming in Tamil Nadu"	Conference	Cotton Research Station, TNAU, Veppanthattai	30-01-2023	30-01-2023
Dr Satish Kumar Sain	IPS Platinum Jubilee Conference on Plant and Soil Health Management: Issues and Innovations	Conference	University of Mysore, Mysuru, Karnataka, Indian Phytopathological Society, New Delhi	02-02-2023	04-02-2023
Dr Amarpreet Singh, Dr Debashis Paul	International Conference on "Climate Resilient Agriculture for Food Security and Sustainability"	Conference	CCSHAU, Hisar, Haryana 125 004	17-02-2023	19-02-2023
Dr Sunil S Mahajan	"Nursery a Profitable Agri Business"	Conference	Vidarbha Industries Association (VIA) Agro & Rural Development Forum at Aashapura Agro Industries, Chandrapur	17-02-2023	17-02-2023
Dr Satish Kumar Sain	International Conference on Biotechnology and Human Welfare: Vision 2030 and beyond"	Conference	CDLU, Sirsa	03-03-2023	04-03-2023
Dr Saravanan, M	National conference on Innovations In S & T For Future Sustainability (ISTFS- 2023) & Farmers Meet on Agri- Innovations For Sustainable Productivity	Conference	Dr. Ambedkar College, Nagpur	04-03-2023	04-03-2023
Dr K Shankarganesh	15 <sup>th</sup> IUPAC International Congress of Crop Protection Chemistry	Conference	NASC Complex, New Delhi, India	14-03-2023	17-03-2023
Dr S Usha Rani	39th Annual Conference of Association for International Agricultural Extension Education	Conference	University of Guelph, Guelph, Canada	26-04-2023	29-04-2023
Dr Joy Das	4 <sup>th</sup> International Conference on Environmental, Agricultural, Chemical and Biological Sciences	Conference	Voice of Indian Concern for the Environment (VOICE), Canada, AlITE, New Delhi and Dept. of Biotechnology, SrimadAndavan Arts and Science College, Trichy, Tamil Nadu	13-05-2023	13-05-2023
Dr K Shankarganesh	2 <sup>nd</sup> ICFPLS-2023	Conference	Pragati International Scientific Research Foundation, Meerut, India and ICAR -CI ARI, Port Blair	18-09-2023	20-09-2023



Name of Scientist	Name of	Category	Place/Organized by	Start Date	End Date
	Seminar/Webinar/Conferenc e/Symposia/				
Dr Vinita Gotmare	Enhancing Quality & Productivity of Indian Cotton through Policy, Innovation &Technology Upgradation	Seminar	Ministry of Textiles, New Delhi	07-10-2023	07-10-2023
Dr Amarpreet Singh	5th International Conference on "Sustainable Natural Resource Management under Global Climate Change"	Conference	NASC Complex, New Delhi, India. / Soil Conservation Society of India, (SCSI), New Delhi, India.	07-11-2023	10-11-2023
Dr Rishi Kumar, Dr V S Nagrare, Dr K Rameash, Dr SK Sain, Dr M. Amutha, Dr K Shankarganesh, Dr BabasahebFand	International Conference on Plant Health Management (ICPHM 2023): Innovation and Sustainability	Conference	NBPGR & TSAU Hyderabad	15-11-2023	18-11-2023
Dr V. Santhy	"DUS & PVP Data Management"	Webinar	PPV&FRA, New Delhi under Indo-German Co-operation on Seed Sector development	17-11-2023	17-11-2023
Dr YG Prasad, Dr Babasaheb B Fand, Dr Amarpreet Singh, Dr K. Baghyalakshmi, Dr V. Santhy, Dr A Manikandan, Dr S. Manickam, Dr Raja, R.,DrJ.GulsarBanu, Dr J Annie Sheeba, Dr SubhashChandra, Dr Isabella Agarwal, Dr Debashis Paul, Dr S Usha Rani, Dr Amudha J, Dr D.V. Patil, Dr P.Nalayini, Dr Joy Das, Dr Vinita Gotmare, Dr Ramkrushna G.I., Dr Rishi Kumar, Dr Rakesh Kumar, Dr K. Sankaranarayanan, Dr Saravanan, M	9th ACRDN Meeting and International Conference	Conference	Indian Society for Cotton Improvement (ISCI) in collaboration with ICAC, ICAR- CIRCOT, ICAR-CICR and Indian Fibre Society, Mumbai	06-12-2023	08-12-2023
Dr V. Santhy Dr Sunil S Mahajan	12th National Seed Congress 2023 "Innovations and Challenges in Quality Seed Availability under Changing Climate"	Symposia	Organised by ISST, New Delhi, NSRTC, Varanasi and VNMKV, Parbhani at Hotel Taj Vivanta Aurangabad Maharashtra	11-12-2023	13-12-2023
Dr K. Sankaranarayanan	Pioneering the future of Cotton Research	Conference	Attur, Salem	23-12-2023	24-12-2023
Dr Rishi Kumar	National Conference on Pioneering the future of Cotton Research in Conjucation with the Golden Jubliee of Rasi Seeds (P) Ltd.	Conference	Hotel Cenneys Gateway, Salem Tamil Nadu	24-12-2023	24-12-2023





# 10.7: Personnel

#### Director

Dr. Y. G. Prasad

#### **CROP IMPROVEMENT DIVISION**

#### **Genetics & Plant Breeding**

#### Nagpur

Dr. VN Waghmare, Head (Joined on 09.11.2023)

Dr. (Mrs.) Vinita Gotmare, Pr. Scientist

Dr. DV Patil, Pr. Scientist

Dr. Rajkumar Ramteke, Pr. Scientist (Joined on 29.03.2023)

Dr. M Saravanan, Sr. Scientist

Dr. RM Phuke, Scientist

#### Coimbatore

Dr. S Manickam, Pr. Scientist

Dr. Manivannan A, Sr. Scientist

Dr. (Mrs.) K Baghyalakshmi, Scientist

#### Sirsa

Dr. SK Verma, Pr. Scientist (Transferred to ICAR-IIWBR,

Karnal, Relieved on 23.03.2023) (Rejoined at ICAR-CICR

RS, Sirsa on 06.12.2023)

Dr. Subhash Chandra, Scientist

### Agril. Biotechnology

#### Nagpur

Dr. G Balasubramani, Pr. Scientist [Head (Acting), Crop

Improvement Division, w.e.f. 15.07.2023 to 08.11.2023]

Dr. (Mrs.) J Amudha, Pr. Scientist

Dr. KP Raghavendra, Sr. Scientist

Dr. Joy Das, Scientist

Dr. Rakesh Kumar, Scientist

#### Coimbatore

Dr. Chandrashekar N, Scientist (Transferred to ICAR-IIHR,

Bengaluru, Relieved on 16.05.2023)

# Seed Science & Technology

## Nagpur

Dr. (Mrs.) V Santhy, Pr. Scientist

Dr. SS Mahajan, Pr. Scientist

# Coimbatore

Dr. K Rathinavel, Pr. Scientist

Sirsa

Dr. Debashis Paul, Scientist

#### **CROP PRODUCTION DIVISION**

#### Agronomy

## Nagpur

Dr. AS Tayade, Head (Joined on 19.07.2023)

Dr. Blaise Desouza, Pr. Scientist

Dr. MV Venugopalan, Pr. Scientist (Retired on 31.10.2023)

Dr. AR Raju, Pr. Scientist

Dr. Ramkrushna I Gandhiji, Sr. Scientist

#### Coimbatore

Dr. (Mrs.) P Nalayini, Pr. Scientist

Dr. K Sankaranarayanan, Pr. Scientist

Dr. R Raja, Pr. Scientist

#### Sirsa

Dr. Amarpreet Singh, Scientist

#### Soil Science

#### Nagpur

Dr. A Manikandan, Sr. Scientist

#### Coimbatore

Dr. (Mrs.) D Kanjana, Sr. Scientist

#### Farm Machinery & Power

### Nagpur

Er. G Majumdar, Scientist (SG)

#### Plant Physiology

#### Nagpur

Dr. JH Meshram, Pr. Scientist

#### Coimbatore

Dr. AH Prakash, Head, RS Coimbatore (Joined on

#### 14.06.2023)

Dr. (Mrs.) Annie Sheeba, Sr. Scientist

#### **Plant Biochemistry**

Dr. (Mrs.) Pooja Verma, Scientist

#### Agricultural Microbiology

#### Nagpur

Dr. K Velmourougane, Senior Scientist

### Agricultural Extension

#### Coimbatore

Dr. (Mrs.) Usha Rani, Pr. Scientist

#### Agricultural Economics

#### Nagpur

Dr. R. Jaya Kumaravaradan, Scientist (Joined on 10.04.2023)

#### Coimbatore

Dr. (Mrs.) Isabella Agarwal, Pr. Scientist

# Computer Application in Agriculture

#### Coimbatore

Dr. M Sabesh, Sr. Scientist

#### **CROP PROTECTION DIVISION**

# Agricultural Entomology

### Nagpur

Dr. GT Behere, Head (Joined on 20.06.2023)

Dr. V S Nagrare, Pr. Scientist

Dr. Chinna Babu Naik V, Sr. Scientist, (Transferred to ICAR-

# IIRR, Hyderabad, Relieved on 15.03.2023)

Dr. (Mrs.) Rachna Pande, Sr.Scientist

Dr. Babasaheb Fand, Sr. Scientist

Dr. Prabhulinga Tenguri, Scientist (Transferred to ICAR-

#### NBAIR, Bengaluru, Relieved on 21.12.2023)

Dr. Shah Vivek Hanskumar, Scientist

Dr. Shivaji Thube, Scientist

#### Coimbatore

Dr. K Rameash, Pr. Scientist

Dr. (Mrs.) M Amutha, Sr. Scientist

Dr. K Shankarganesh, Sr. Scientist

#### Sirsa

Dr. Rishi Kumar, Pr. Scientist (Station I/c w.e.f. 24.03.2023)





Plant Pathology

Nagpur

Dr. SP Gawande, Sr. Scientist

Dr. DT Nagrale, Sr. Scientist

Dr. Neelakanth Hiremani, Scientist

Coimbatore

Dr. A Sampath Kumar, Sr. Scientist

Dr. P Valarmathi, Scientist

Sirsa

Dr. Satish Kumar Sain, Pr. Scientist

Nemotology

Nagpur

Dr. (Mrs.) N Narkhedkar, Pr. Scientist & Head (Incharge)

(Retd. on 28.02.2023)

Dr. Devindrappa Scientist (Joined on 18.12.2023)

Coimbatore

Dr. (Mrs.) J Gulsar Banu, Pr. Scientist

Krishi Vigyan Kendra

Scientist

Dr. S. N Rokde, Head KVK (Vol. Retd. on 08.11.2023)

Dr. Rakesh Kumar Singh, Head (KVK) (Joined on

21.09.2023)

**Technical Staff** 

T- 6 of Category III

Sh. SS Patil, T-9 SMS

Dr. UV Galkate, T-9 SMS

Mrs. Sunita N Chauhan, T-9 SMS

Dr. UA Nandankar, T-9, CTO

Dr. Deepa Lal, T-6 SMS

T-4 of Category II

Dr. PB Deulkar, T (7-8)

Dr. HB Kumbhalkar, T-6, Sr. Tech. Officer

Mrs. Vandana Satish, T-6, Sr. Tech. Officer

T-1 of Category I

Sh. AK Sherkar, T-5 Driver

Sh. Naresh Raut T-3 Driver

Skilled Support Staff

Sh. Naresh Gorghate

**ADMINISTRATION** 

Nagpur

Sh. A. A. Goswami, Chief Administrative Officer

Sh. Sanjay Kumar Singh, FAO

PR. PRIVATE SECY.

Sh. DB Mundharikar

PRIVATE SECY.

Smt. RG lyer Sh. MC Tiwari

AAO

Sh. Rakesh Tiwari

Sh. VD Bende

PERSONAL ASSISTANT

Sh. SS Chalkhure

Sh. PP Ambade

Sh. K Vedavyas

**ASSISTANT** 

Smt. SP Kharche

Sh. VM Waghmare

Sh. KB Nandeshwar

UDC

Sh. AM Kawale

LDC

Sh. Saurabh Patil

Sh. Shital Kumar Sharma

Coimbatore

ASSISTANT

Sh. N Ramesh

UDC

Miss RP Deepa

Miss R Ramya

Sirsa

AAO

Ms. Kalpna Singh

**ASSISTANT** 

Sh. Satbir Singh

Sh. Sanjay Kumar

TECHNICAL STAFF

Nagpur

CAT. III

Sh. Sanjay Kushwaha, CTO

CAT. II

Sh. CK Shastry, CTO

Smt. SU Dixit, CTO

Sh. RV Salame, ACTO

Sh. GV Deogirkar, TO

Smt. RS Deshmukh, TO

Smt. Chetali Rodge, TO Sh. MR Meshram, STA

Sh. HS Mundafale, STA

Dr. Vrushali Deshmukh, Tech. Asst.

Dr. Jimmy B. Vaidya, Tech. Asst.

Ms.Mithila Meshram, Tech. Asst.

Sh. Rohit Katiyar, Tech. Asst.

Sh. Ratnadeep Ramteke, Tech. Asst.

Dr. E. Raghu, Tech. Asst.

Mr. Atul Lende, Tech. Asst.

CAT. I

Sh. SN Ingle, T-5 (Driver)

Sh. Diwakar Sawaji, TO

Sh. RK Gaikwad, T-3 (Driver)

Sh. BA Fande, Sr. Tech

Sh. SH Kumbhare, Sr. Tech

Sh. SH Mandpe, Sr. Tech

Sh. Abdul Waseem, Sr. Tech

Sh. KH Mogre, Technician

Sh. AB Mate, Technician

Sh. Krushna Gajghate, Technician

Smt. Pooja Ghonge, Technician

Sh. Ajit Meshram, Technician

Sh. Pankaj Gadge, Technician

Sh. Kunal Gaikwad, Technician

Sh. Akshay Barahate, Technician

Sh. Akshay K. Kamble, Technician

Sh. Jaibhim S. Kambe, Technician

Sh. Chandrashekhar Mundafale, Technician



Sh. Paresh Bhoyar, Technician

Sh. Dineshkumar Mahule, Technician

Sh. Praful Margaye, Technician

Sh. Ajay Sirsam, Technician

#### Coimbatore

CAT. II

Sh. S Satyakumar, ACTO

Smt. KS Subasri, ACTO

Ms. V Anisha, TO

Sh. A Karthick, TO

Mr. K Muthukumar, TO

CAT. I

Sh. S Manikandan, T-4 (Driver)

Sh. J William Raja, Sr. Tech

Sh. Sabarinathan, Sr. Tech

Sh. M Sampath Kumar, Technician

Sh. Koppula Suresh, Technician

# Sirsa

CAT. II

Sh. Satpal Singh, Tech. Asst.

CAT. I

Sh. Sanjeev Kumar, Sr. Tech

Sh. Bhura Ram, Technician

Sh. Naresh Kumar, Technician

Sh. Satbir Singh, Technician

Sh. Pali Ram, Technician

## **Skilled Support Staff**

Nagpur

Smt. LS Kanfade

Sh. Rewnath S Ambarte

Smt. Kamala R. Kawale

Sh. Dhanraj S. Nagrare

Smt. Durga R. khandate

Sh. Kishor Barahate

Smt. Sulochana Tekam

Sh. Subhash R. Mankar

Sh. Haridas K. Dange

Sh. Anil B. Barahate

Sh. Kishor P. Bondade

Sh. Ankush V. Chaudhari

Smt. Chhaya R. Ganorkar

Sh. Damodar S. Chinurkar

Sh. Arun Wadguji Thool

Sh. Vijay Shyam Mogre

Sh. Indrapal R. Dhakne

Sh. Deocharan P. Barahate

Smt. Lilabai R. Ambarte

Smt. Subhadra B. Kawale

Smt. Panchfula H. Pandhram

Smt. Tanabai A. Puram

Smt. Pushpa S. Sarate

Smt. Shobha K. Kumbhare

Smt.Chandabai S. Chapekar

Smt. Nanda Ramesh Ukre

Smt. Indu I. Sayam

Smt. Chindhabai V. Wankhede

#### Coimbatore

Sh. Karuppasamy

Sh. Manimekalai Karuppusamy

Smt. Lakshmi Rangasamy

#### Sirsa

Sh. Balli Ram

Sh. Madan Gopal

Sh. Radhey Shyam

Sh. Ishwar Dutt

Sh. Anil Kumar

Sh. Subash Chander

Sh. Sharwan Kumar S/o Sh. Chandra Ram

Sh. Gurmeet S/o Sh. Ramkisan

Smt. Kesro W/o Sh. Gurmeet

Sh. Deepak Kumar S/o Sh. Nand Lal

Sh. Ram Avatar

Sh. Rajender Kumar

Smt. Kamla

#### Joined

Name and Designation	w.e.f.
Dr. Rishi Kumar, Principal Scientist as Station I/c, ICAR -CICR RS, Sirsa	24.03.2023
Dr. Rajkumar Ramteke, Principal Scientist joined at ICAR-CICR, Nagpur	29.03.2023
Dr. R. Jaya Kumaravaradan, Scientist joined at ICAR-CICR, Nagpur	10.04.2023
Dr. AH Prakash, Head of Regional Station, ICAR-CICR RS, Coimbatore	14.06.2023
Dr. GT Behere, Head, Crop Protection Division, ICAR-CICR, Nagpur	20.06.2023
Dr. G. Balasubramani, Principal Scientist as Head (Acting), Crop Improvement Division, ICAR-CICR, Nagpur	15.07.2023
Dr. AS Tayade, Head, Crop Production Division, ICAR -CICR, Nagpur	19.07.2023
Dr. Rakesh Kumar Singh, Senior Scientist-cum-Head, KVK, ICAR-CICR, Nagpur	21.09.2023
Dr. V.N. Waghmare, Head, Crop Improv ement Division, ICAR-CICR, Nagpur	09.11.2023
Dr. Devindrappa, Scientist (Nematology) joined at ICAR-CICR, Nagpur	18.12.2023
Dr. S.K. Verma, Principal Scientist rejoined at ICAR-CICR RS, Sirsa	06.12.2023





# Transfer

Name and Designation	From	То	w.e.f.
Dr. SK Verma, Pr. Scientist	ICAR-CICR RS, Sirsa	ICAR-IIWBR, Karnal	23.03.2023
Dr. V. Chinna Babu Naik, Sr. Scientist	ICAR-CICR, Nagpur	ICAR-IIRR, Hyderabad	15.03.2023
Dr. Chandrashekar N., Scientist	ICAR-CICR RS, Coimbatore	ICAR-IIHR, Bengaluru	16.05.2023
Sh. Eluka Sridher, Technician, T-1	ICAR-CICR, Nagpur	ICAR-IIOR, Hyderabad	31.05.2023
Sh. K. Vedavyas, PA	ICAR-CICR RS, Coimbatore	ICAR-CICR, Nagpur	16.11.2023
Dr. Prabhulinga T., Scientist	ICAR-CICR, Nagpur	ICAR-NBAIR, Bengaluru	21.12.2023

# **Promotions**

Name and Designation	Promoted to	w.e.f.
Dr. Vrushali Deshmukh, T-3	T-4	21.02.2023
Sh. KH Mogre, T-1	T-2	27.12.2022
Sh. AB Mate, T-1	T-2	27.12.2022
Sh. M. Sampathkumar, T-1	T-2	27.12.2022
Sh. Bhura Ram, T-1	T-2	27.12.2022
Sh. Naresh Kumar, T-1	T-2	27.12.2022
Sh. Satbir Singh, T-1	T-2	27.12.2022

# Regularization of DPL to Skilled Support Staff

Name of DPL	Place of Posting	w.e.f.
Sh. Dashrath Sampath Raut	Nagpur	12.04.2023
Sh. Deocharan Pandurang Barahate	Nagpur	12.04.2023
Smt. Lilabai Rewanath Ambarte	Nagpur	13.04.2023
Smt. Subhadra Baliram Kawale	Nagpur	17.04.2023
Smt. Panchfula Hariram Pandhram	Nagpur	17.04.2023
Smt. Tanabai Ankush Puram	Nagpur	17.04.2023
Smt. Pushpa Sheshrao Sarate	Nagpur	17.04.2023
Smt. Shobha Charandas Madavi	Nagpur	17.04.2023
Smt. Chandabai Suryabhan Chapekar	Nagpur	17.04.2023
Smt. Nanda Ramesh Ukre	Nagpur	18.04.2023
Smt. Indu Ishwar Sayam	Nagpur	18.04.2023
Smt. Chindhabai Vithoba Wankhede	Nagpur	18.04.2023

# Retirements

Name	Post held	Date of retirement	
Dr. Nandinni Gokte Narkhedkar	Principal Scientist	28.02.2023	
Smt. Nita Pradip Kate	CTO, T-9	31.03.2023	
Sh. GL Nawaye	SSS	30.04.2023	
Sh. Ramamurthy Krishan	SSS	30.04.2023	
Sh. Murugan Ammasai	SSS	30.04.2023	
Sh. Dilip Mohurle	SSS	30.06.2023	
Sh. Dilip Dhakne	SSS	30.06.2023	
Sh. Dashrath Sampath Raut	SSS	30.06.2023	
Sh. Chandan Taksande	SSS	30.09.2023	
Smt. Bhagwanti	SSS	30.09.2023	
Dr. M.V. Venugopalan	Principal Scientist	31.10.2023	
Dr. S.N. Rokde	Head, KVK	08.11.2023	





# 10.8: Other Information

#### 10.8.1: Mera Gaon Mera Gauray

Mera Gaon Mera Gaurav (MGMG) program has been implemented by ICAR-CICR Nagpur and its Regional Stations CICR, Coimbatore and CICR, Sirsa as per the guidelines during 2023. The program was implemented in 63 adopted villages in 13 clusters by 48 Scientists.

Details of Scientists involved and Villages adopted under MGMG during 2023

Team	Name of the Team Leader and Members	Villages / Clusters / Districts adopted
1	Dr. V. Santhy (Seed Technology) Dr. Dipak Nagrale (Plant Pathology), Dr. Prabhulinga Tengu ri (Entomology) Dr. Rakesh Kumar (Biotechnology)	Metaumari, Nildoh, Khari, Kinhi and Dhanoli Hingna Cluster District: - Nagpur
2	Dr. Sunil S. Mahajan (Seed Technology) Dr. Neelakanth Hiremani (Plant Pathology) Dr. Pooja Verma (Plant Biochemistry) Dr. Rachna Pande (Entomology)	Godhani, Dhurkheda, Thombra, Dodma Welsakhra Umred Cluster District: - Nagpur
3	Dr. Ramkrushna Gl (Agronomy) Dr. Shailesh Gawande (Pathology) Dr. Babasaheb Fand (Entomology) Dr. Rahul Phuke (Plant Breeding)	Bhadangi, Hardoli, Sonapar, Varoda, Adasa Kalmeshwar Cluster District:- Nagpur
4	Dr A.R. Raju (Agronomy) Dr. D.V. Patil (Plant Breeding) Dr Joy Das (Biotechnology) Dr. Shivaji Thube (Entomology)	Aakoli,Madani, Tamaswada, Jamni, Aamgaon, Masala Seloo Cluster, District: Wardha
5	Dr. Vishlesh Nagrare(Entomology) Dr. J. H. Meshrm (Plant Physiology) Er. G. Majumdar (Agril. Engg) Dr. Manikandan (Soil Science)	Wadegaon(Kale), Mohadi, Kuchadi, Dongargaon Hetameti Kuhi Cluster, District: - Nagpur
6	Dr. K. P. Ragh avendra (Biotechnology) Dr. M Saravanan (Plant Breeding) Dr. Vivek Shah (Entomology)	Ghatkukda, Salai, Dhwalapur, Ambazari, Saleghat, Ghatphendri Parsheoni cluster, District: Nagpur
7	Dr. Vinita Gotmare (Genetics & Cytogenetics) Dr. J. Amudha (Biotechnology) Dr. Chinna Babu Naik (Entomology	Bhivgad, Deori, Jamdapani, Bothli, Bendoli Umred Cluster, District: Nagpur
8	Dr. K. Rathinavel Dr. J. Gulsar Banu Dr. M. Sabesh Dr. J. Annie Sheeba	Villages: Allikulam, Pogalur Thokkupalayam, Lakeepalayam and Sellampalayam Cluster: Annur District: Coimbatore
9	Dr. P. Nalayini Dr. M. Amutha Dr. A. Manivannan Dr. Sampath Kumar	Villages: Tholampalayam, Neelampathy, Colony Pudur and Uggayanur Cluster: Karamadai District: Coimbatore
10	Dr. K. Sankaranarayanan Dr. K. Ramaesh Dr. D. Kanjana	Villages: Ettimadai, Malumichampatti, Mavuthampathy and Chettipalayam Cluster: Annur District: Coimbatore
11	Dr. S. Manickam Dr. S. Usha Rani Dr. Shankar Ganesh Dr. Baghyalakshmi	Villages: Devarayapuram, Kuppepalayam, Selambanur Zakinayakanpalayam and Thondamuthur Cluster: Annur District: Coimbatore



Team	Name of the Team Leader and Members	Villages / Clusters / Districts adopted
12	Dr. Isabella Agarwal Dr. R. Raja Dr. P. Valarmathi	Villages: Govindapuram, Devarayapuram, Muthur and Nallattipalayam Cluster: Annur District: Coimbatore
13	Dr Rishi Kumar Dr. S.K. Sain Dr. Amarpreet Singh Dr. Debashis Paul	Villages: Khedi, Chaharwala, Hanjira and Chadiwal District: Sirsa

# Training Programs Conducted under MGMG

- 1. Training cum distribution of Vegetable kit to SC farmers in MGMG-Umred cluster
- 2. Training on Integrated Cotton Production in Adasa-Kalmeshwar cluster

#### Awareness programs Conducted under MGMG

Six awareness programs were conducted in Seloo cluster on the following topics.

- 1. Use of Nano formulations rather than straight fertilizer.
- 2. Use released cotton varieties rather than company's seeds.
- 3. Stop the use of BG III cotton varieties sold illegally in market in the name of Herbicide tolerant (HT).
- 4. Use of old Sarees for crop protection from wild animals.
- 5. Timely application of irrigation and water stress management
- 6. Cultivation of cotton on poly mulch A new technology demonstrated in the farmer's field of Aakoli.

# Extension Activities conducted during the year 2023 under MGMG in the adopted villages



Training cum distribution of Vegetable kit to SC farmers at Village Thombra



Training cum distribution of Vegetable kit to SC farmers at Village Godhani



Training on Integrated Cotton Production in Village Adasa



Training on Integrated Cotton Production in Village Adasa





#### 10.8.2: Development Action Plan for Scheduled Caste

The central government sponsored and funded scheme, "Development Action Plan for Scheduled Caste (DAPSC) (formerly Scheduled Caste Sub Plan SCSP)" was implemented by the ICAR-CICR, Nagpur. The main objective of this plan is to emphasize the developmental programmes for the Scheduled Castes, in relation to their agribusiness pattern and the need to increase productivity and income from their limited resources.

The objective of the scheme was to increase the income levels of the targeted population through various income generating schemes, skill development and infrastructure development. The scheme was implemented in the selected PMAGY and other non-PMAGY villages in Six Districts of Maharashtra namely Nagpur, Wardha, Chandrapur, Amaravati, Yavatmal and Bhandara where the Scheduled Caste population is 50% or more by identifying the beneficiary families with the help of State Government Agencies. The program planning was done at the institute level and executed by the committee members in the adopted villages. The poor families were targeted to directly use the various agricultural related inputs provided by the Institute. The scientific inputs in terms of technology dissemination,

skill up gradation, timely solutions of the farmers problems, cleanliness of public premises, sanitization and providing information of various schemes implemented by state agricultural departments.

Various activities were carried out in the adopted villages to provide direct benefit to the scheduled caste beneficiaries under the DAPSC. These includes, organization of skill development programmes, trainings and workshops, distribution of Goat & Goat Feed, improved Cotton cultivation practices, Paddy seed, Red Gram seed, Soybean seed, Gram seed (Chickpea), Wheat seed, Crop protection Kit (Insecticide & Fungicide Kit), Tarpaulin, Sickle, Pesticide Protection Kit, Irrigation pipe (Lapeta pipe), Battery Operated Knapsack Sprayer, Cattle feed & Mineral Salt Block, Cotton picking bags and printed cotton cultivation practices. Also recognizing the crucial role of women farmers in agriculture, concerted efforts were made to mobilize women from SC families and facilitate the formation of self-help groups (SHGs) through awareness programs. These SHGs received technical assistance through capacity building, entrepreneurship development and empowering them to generate year-round income vegetable cultivation and nutri-gardens. The farmers were sensitized on technological interventions, capacity building, showcasing round the year for Cotton production and its scientific technologies, exposure visits, interface meetings and trainings, cultivation, with complete package of practices and seeds.

# The details of various training programmes carried out under the DAPSC during 2023.

S. No.	Name of programme	Venue and Date	No of SC beneficiaries	Programmes Details
1.	Farmer Science Congress on the occasion of Indian Science Congress	Rashtrasant Tukdoji Maharaj Nagpur University Campus, Nagpur 05 January 2023.	100	Farmers meet and training.
2.	Farmers Meet on Agri-Innovations for Sustainable Productivity	Dr. Ambedkar College, Dekshabhoomi, Nagpur 04 March 2023.	60	Interface Farmers Meeting on Agri-Innovations for Sustainable Productivity"
3.	Health Camp	ICAR-CICR, Nagpur 24 March 2023	140	One Day workshop on Cardiac arrest cum Health Check up Camp
4.	Cotton farmers wrokshop, Pre-Kharip Consultation	ICAR- Central Institute for Cotton Research, Nagpur. 19 May 2023.	183	Conducted Workshop on "Pre-Kharif Consultation: Technologies & Best Management Practices for Enhancing Cotton Productivity".
5.	Cotton farmers wrokshop, Pre-Kharip Consultation: Technologies & Best Management Practices for Enhancing Cotton Productivity	ICAR- Central Institute for Cotton Research, Nagpur. 30 May 2023.	166	One day Farmer's training program on 'Integrated Cotton Crop management'.
6.	"One day Workshop for Women Farmers" "Training for capacity building and entrepreneurship development of farm women"	Durgada Ta. Deoli, Dist. Wardha 23 June 2023	60	One day Workshop for Women Farmers on Ambar Charkha (Cotton Spinning machine) Unit.
7.	PM-Kisan Samman Nidhi Programme, Input distribution- cum training on cotton crop	ICAR- Central Institute for Cotton Research, Nagpur. 27 July 2023.	80	Farmers training on Cotton cultivation cum exposure visit at CICR Cotton fields.

S. No.	Name of programme	Venue and Date	No of SC beneficiaries	Programmes Details
8.	Training on "Cotton technology outreach and interventions for Cotton productivity, Enhancement and Livelihood Improvement of Farmers of Selected Villages in Perambalur District, Tamilnadu"	ICAR-KVK Valigandapuram, Perambalur, Tamilnadu 06 November 2023	50	Farmers meet cum training on Pest and Disease management.
9.	Kisan Mela	ICAR- Central Institute for Cotton Research, Nagpur. 19 December 2023.	139	Farmers meet cum training on Pest and Disease management.

# The details of Critical input distribution carried out under the SCSP schemes for the year 2023

Sr. No.	Name of Item	Venue and Date	No of SC beneficiaries	Input distributed/ skill imparted
1.	Cattle feed & Mineral Salt Block	Dhurkheda, Ta. Umred & Mendhepathar (Jungali), Ta. Katol, Dist. Nagpur  15 February 2023 & 09 March 2023	120	One day Training on  "Milch animal feeding management" and Distribution of Cattle feed & Mineral Salt Block to SC beneficiaries from Pipardol, Amboli, Welsakhara, Godhani, Wadegaon, Tirkhura and Dhurkheda, Ta. Umred & Chikhali Maina, Mendhepathar and Wadvihara, Ta. Katol Dist. Nagpur.
2.	Vegetable Seed Kit	Welsakhara. Godhani Thombra, Pipardol, Mendhepathar, Hingna, Amti, Durgada, Khadki, Rampuri, Wadvihara, Parsodi, Khobna, Bodkhipeth, Pavani, Wadegaon, Palwadi, Sultanpur April to June 2023	494	Vegetable seed kit having 8 Type of seeds namely Coriander Spinach (Palak) Pumpkin Ridge Gourd Bottle Gourd Bitter Gourd Cowpea Chillies Distributed to SC beneficiaries
3.	Osmanabadi Goat	ICAR- Central Institute for Cotton Research, Nagpur. 12 April 2023.	4	7 Female and 1 Male Osmanabadi Goat distributed to SC beneficiary from Chikhali Maina, Ta. Katol, Dist. Nagpur
4.	Goat and Goat feed	Punyashlok Ahilyadevi Mendhi Va Sheli Vikas Prakshetra, Bondri, Taluka. Ramtek, Dist. Nagpur 01 May 2023	85	Vaccinated two female goats & 50 Kg Goat Feed distributed to each Scheduled caste Beneficiary from Chikhali Maina, Mendhepathar, Ta. Katol, Dhurkheda, Ta. Umred. Dist. Nagpur. Parsodi, Ta. Pauni, Dist. Bhandara and Tekri, Ta. Nagbhir, Dist. Chandrapur.



Sr. No.	Name of Item	Venue and Date	No of SC beneficiaries	Input distributed/ skill imparted
5.	Battery Operated Knapsack Sprayer	Pipardol, Pavani, Wadegaon, Khobna, Bodkhipeth, Amti, Mendhepathar, Wadvuhara, Hingna, Rampuri, Khadki, Durgada, Parsodi, Gandhinagar, Malkapur, Sherad, Mangaon, Salapur	490	Distributed Battery-Operated Knapsack Sprayer to SC beneficiaries used for spraying liquids such as pesticides, insecticides, herbicides, fungicides, etc., in fields to protect the crop from pest attack and provide crop nutrients.
6.	Crop Protection Kit	Pipardol, Wadegaon, Pavani, Amti, Khobna,Bodakhipeth,Chikhali Maina,Mendhepathar,Waadvihara, Khadki, Parsodi, Rampuri, Hingna, Durgada, Husenpur, Sultanpur, Katsur Kharif season	500	Crop Protection kit contain Fungicides & Insecticides namely Neem Oil Flonicamid (50WG) Profenofos (50%EC) Propiconazole (25EC) Propineb (70WP) Metiram 55% + Pyraclostrobin 5% WG
7.	Nutrient kit	Pipardol, Mendhepathar, Hingna, Amti, Durgada, Khadki, Rampuri, Wadvihara, Parsodi, Khobna, Bodkhipeth, Pavani, Wadegaon, Chikhali Maina, Husenpur, Sultanpur, Katsur Kharif season	500	Nutrient kit contain fertilizer and micro nutrient namely; Zinc Sulphate Monohydrate (33% Zinc) Boron Fertilizer (20%) Mono Potassium Phosphate (0:52:34) NPK Fertilizer (19:19:19) Nano Urea
8.	Soybean Seed	Wadegaon, Khadki, Wadvihara, Mendhepathar, Parsodi, Durgada, Palwadi, Husenpur, Sultanpur, Katsur, Chikhali Maina Kharif season	200	Soybean Seed variety Phule Sangam distributed to farmers.
9.	Tur Seed	Wadegaon, Pipardol, Khadki, Wadvihara, Khobna, Parsodi, Hingna, Rampuri, Durgada, Pavani, Palwadi, Chikhali Maina, Sawarkhanda, Tirkhura Kharif season	300	Tur (PKV - TARA) Seed distributed for Cotton intercropping to Scheduled caste farmers for Kharif season. PKV-TARA variety of tur having 2 kg packing (4 Kg to each) distributed to the farmers.
10.	Paddy Seed	Wadegaon, Pipardol, Khobna, Bodkhipeth, Amti, Sawarkhanda. Kharif season	106	PDKV-Tilak variety of Paddy seed distributed to Scheduled caste farmers for Kharif season.
11.	Cotton Seed	Gram Panchayat Khobna, Ta. Kuhi, Dist. Nagpur 28 June 2023	49	One Day Farmers Field Training on "Improved Cotton Production Technology". Moksha & Jai ho variety of Cotton distributed to Scheduled caste farmers from Khobna, Bodkhipeth, Amti, Sawarkhanda Ta. Kuhi, Dist. Nagpur for Kharif season.
12.	Pendimethalin	Gram Panchayat Khobna, Ta. Kuhi, Dist. Nagpur 28 June 2023	30	Pendimethalin herbicide distributed to Scheduled caste farmers from Khobna, Bodkhipeth, Amti, Ta. Kuhi, Dist. Nagpur for Kharif season.

Sr. No.	Name of Item	Venue and Date	No of SC beneficiaries	Input distributed/ skill imparted
13.	Bio-Fertilizers Kit	Wadegaon, Pipardol, Khadki, Wadvihara, Mendhepathar, Khobna, Parsodi, Hingna, Rampuri, Durgada, Pavanai, Palwadi, Husenpur, Sultanpur, Katsur, Chikhali Maina, Sawarkhanada, Tirkhura. Kharif Season	500	Bio-Fertilizer kit having powder based and liquid based fertilizers namely; Rhizobium Trichoderma
14.	Pesticide Protection Kit	Husenpur, Sultanpur, Katsur, Mangaon, Salapur, Gandhinagar, Malkapur, Sherad September to November 2023	171	Pesticide protection kits including Safety jackets, goggle, hand gloves, face mask, gum boots, safety helmet etc. were distributed among SC farmers.  Useful for safe handling of pesticides in agriculture field.
15.	Tarpaulin	Husenpur, Sultanpur, Katsur, Mangaon, Salapur, Gandhinagar, Malkapur, Sherad September to November 2023	171	Standard size Tarpaulins distributed among SC farmers to protect the crop/seed from rain.
16.	Sickle	Sultanpur, Ta. Teosa, Dist. Amravati 12 September 2023	16	Distributed 2 Sickles to each SC beneficiary.
17.	Vermicompost Bed	12 September 2023  of Vermicompost principle distributed to SC fator vermicompost bed to turn waste into o compost to promot farming.		Standard size 12"4"2" beds of Vermicompost pits were distributed to SC farmers.  Vermicompost bed provided to turn waste into organic compost to promote organic farming.
18.	Cotton Picking Bag	Malkapur, Sherad Picking bag dist November 2023 among SC bene Useful in clean a		KVK-CICR innovated Cotton Picking bag distributed among SC beneficiary. Useful in clean and easy way of cotton picking.
19.	Gram Seed(Chickpea)	Palwadi, Husenpur, Sultanpur, K atsur, Parsodi, Rampuri, Pavani, Mangaon, Salapur, Durgada, Gandhinagar, Malkapur, Sherad, Wadegaon, Amboli, Tirkhura, Pipardol, Amti, Bodkhipeth, Khobna, Sawarkhanda, Wadvihara, Khadki, Khairi Punjab, Hingna, Mendhepathar. October & November 2023	500	Gram seed Distributed to Scheduled caste farmers for Rabi season. Gram Variety, Jaki - 9218 having packing 30 Kg bag. (one bag to each farmer)
20.	Wheat Seed	Palwadi, Husenpur, Sultanpur, Katsur, Parsodi, Rampuri, Pavani, Durgada, gandhinagar, Malkapur, Sherad, Wadegaon, Amti, Bodakhipeth, Sawarkhanda, Khadki, Khairi Punjab, Mendhepathar. October & November 2023	250	Wheat seed Distributed to Scheduled caste farmers for Rabi season. Wheat variety 'MACS-6222' having packing 20 kg bag. (two bag to each farmer)
21.	Bio-Fertilizer Kit	Palwadi, Husenpur, Sultanpur, Katsur, Parsodi, Rampuri, Pavani, Mangaon, Salapur, Durgada, Gandhinagar, Malkapur, Sherad, Wadegaon, Amboli, Tirkhura, Pipardol, Amti, Bodkhipeth, Khobna, Sawarkhanda, Wadvihara, Khadki, Khairi Punjab, Hingna, Mendhepathar. October & November 2023	750	Bio-Fertilizer kit having powder based and liquid based fertilizers namely Rhizobium PSB Azatobacter Tricoderma





Sr. No.	Name of Item	Venue and Date	No of SC beneficiaries	Input distributed/ skill imparted
22.	Irrigation Pipe (Lapeta Pipe)	ICAR- Central Institute for Cotton Research, Nagpur.  19 December 2023.	140	60 Meter Irrigation Tube (Lapeta Pipe) distributed to SC farmers from Malkapur, Sherad, Gandinagar, Ta.Kalamb, Dist. Nagpur and Mangaon, Salapur, Ta. Samudrapur, Dist. Wardha on the occasion of Kisan Mela.
23.	Crop Protection Kit	ICAR-KVK Valigandapuram, Perambalur, Tamilnadu	50	Distributed input namely Ullala 60g, Emamectin Benzoate 100g, Cabrio top 300g, Planifix 100ml, All19 - 4kg, PN- 4kg, Westa boran - 2kg, MAP - 2kg, NSKE 1L, Pseudomonas 1 kg, Imidacloprid 17.8 % SL 250ml, Lambdacyhalothrin 5% EC 500ml, Profenofos 50 % EC 500ml, Carbendazim 50 % WP 1 kg,

Glimpses
of activities undertaken in
SCSP Scheme, ICAR-CICR, Nagpur





























#### 10.8.3: Tribal Sub Plan

The "Development Action Plan for Schedule Tribe" (DAPST) program is an initiative of the Government of India aimed at promoting the economic development of Scheduled Tribes (ST's) through family-oriented schemes. The Planning commission established an Inter-Ministerial Committee chaired by the Secretary of the Planning Commission to effectively implement the DAPST as a crucial instrument for accomplishing socio-economic growth among tribal farmers. The primary objective of the DAPST scheme is to empower scheduled tribe farmers through various means, such as training, exposure visits, education, and resource provision. During 2023, several activities were conducted to achieve this goal. Notably, capacity building sessions were organized, offering training on improved production and protection techniques for crops, including cotton, paddy and vegetable cultivation. Additionally, exposure visits and awareness training were arranged to acquaint the farmers with the latest advancements in agriculture and allied activities. Farmers trainings and workshops were also held, focusing on promoting integrated pest and disease management (IPM and IDM) practices for crops. Moreover, farmers were duly informed about the significance of reduced tillage or conservation tillage farming and educated on personal

protection during agrochemical spraying. Also recognizing the crucial role of women farmers in agriculture, concerted efforts were made to mobilize women from ST families and facilitate the formation of self-help groups (SHGs) through awareness programs. These SHGs received technical assistance through capacity building, empowering them to generate year-round income via activities such as vegetable cultivation and nutrigardens.

In line with the DAPST program, several inputs were distributed to the ST farmer beneficiaries in the project areas and villages. These inputs encompassed improved seeds of crops like paddy, chickpea, summer green gram along with vegetable seeds kit. Furthermore, the provision of fungicides and pesticides, including cotton picking bags, mineral lick blocks, tarpaulins, agricultural hand cum battery operated sprayers, and pink bollworm pheromone traps, for sucking pests management, aimed to agricultural practices and enhance productivity. Overall, the endeavours of the DAPST program in 2023 were geared towards elevating tribal farmers, optimizing their agricultural practices, and empowering them to achieve socio-economic growth, thereby nurturing the comprehensive development of the Scheduled Tribes in India.













Farmers Training, workshop and outreach program under DAPST/TSP 2023 (January-December, 2023)

Name of	Coordinator	Dr. V. Chinna Babu Naik	Dr. V. Chinna Babu Naik	Dr. V. Chi nna Babu Naik	Dr. Chinna Babu Naik	Dr. V. Chinna Babu Naik & Dr. D. T. Nagrale	Dr. V. Chinna Babu Naik	Dr. V. Chinna Babu Naik & Dr. D. T. Nagrale	Dr. V. Chinna Babu Naik	Dr. D. T. Nagrale
Venue		RTMNU, Nagpur (MS)	ICAR-CICR, Nagpur	KVK-CICR, Nagpur	KVK, Palem, Nagarkurnool, Telangana.	KVK, Sonapur, Gadchiroli	At Dr. Ambedkar College, Deekshabhoomi, Nagpur	ICAR-CICR, Nagpur	ICAR-CICR, Nagpur	ICAR-CICR, Nagpur
Duration	of training (Days)	1 day	1 day	3 days	1 day	1 day	1 day	1 day	1 day	1 day
Date of	training	5-01-2023	5-01-2023	23 <sup>rd</sup> to 25 <sup>th</sup> January, 2023	30-01-	2-03-2023	4-03-2023	9-03-2023	13-03-	28-04-2023
Total		25	20	09	30	06	20	15	30	18
No. of	participants lale Female	0	7	0	20	60	0	0	03	0
Z	parti	25	43	09	23	81	50	15	27	18
Category of	participant	Farmers	Farmers	Farmers	Farmers	Farmers	Farmers	Farmers	Farmers	Farmers
Description of	activity	Exposure visits to new farm technologies	CICR-KVK cotton picking bags distribution	Training cum exposure visit	Training and tarpaulin distribution	Summer moong seeds distribution program	Training program	Training and tarpaulin distribution	Distribution of tarpaulin Battery operated sprayer and pesticide protection kit	Distribution of vegetable seeds kit & agricultural sprayer
Name of training		Exposure visit	Farmers' training, input distribution cum exposure visit	Training cum exposure visit programme on the topic 'Need for soil testing and fertilizer management'	"Farmers training cum input distribution" program	"Farmers training cum seed distribution" program	Training programme in farmer's meet during national conference Nagpur	Farmers training cum critical input distribution	Training cum critical input distribution	ICAR-CICR organized one day "Farmers Training, Exposure visit cum Input Distribution" program
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s o	Name of training	Description of activity	Category of participant	No	No. of participants	Total	Date of training	Duration of training	Venue	Name of Coordinator
				Male	Female			(Days)		
10.	One Day "Farmers' Training, Awareness camp cum Input Distribution Programme"	Vegetable seed, nutribricks & tarpaulins	Farmers	39	18	22	26-05- 2023	1 day	KVK, Sonapur, Gadchiroli	Dr. D. T. Nagrale
÷	ICAR- KVK, Nagpur organized training on "Nutrition Garden for Nutritional Sustainability"	Distribution of seedling of cowpea, okra, brinjal etc.	Farmers	1	T T	T .	22-06- 2023	1 day	ICAR-CICR Nagpur	Dr. D. T. Nagrale
12.	One day "Farmer Training, Awareness camp cum Paddy Seeds Distribution" program	Distribution of paddy seed (PKV-HMT)	Farmers	48	02	50	23-06-2023	1 day	Village- Khapa (Khurd), Taluka-Tumsar DistBhandara	Dr. D. T. Nagrale
13.	One day "Farmers Training, Awareness Camp and Improved Paddy Seeds Distribution "program	Distribution of Paddy Seeds (PKV-Tilak)	Farmers	84	16	100	27-06-	1 day	KVK Sonapur (Gadchiroli)	Dr. D. T. Nagrale
14.	"Field day cum farmers workshop and vegetable seed kit distribution" Program	Distribution of vegetable Seeds	Farmers	15	31	15	18-07-2023	1 day	Village-Salaimendha, Taluka-Hingna, Nagpur	Dr. D. T. Nagrale
15.	"Farmers training cum mineral lick block & vegetable seed kit distribution" program	Distribution of mineral lick block & vegetable seed kit	Farmers	25	ī	25	9-08-2023	1 day	Village-Bendoli, Umred, Nagpur	Dr. D. T. Nagrale
16.	"Field Day Training, Awareness camp Cum Agricultural Battery Cum Hand Operated Sprayer Distribution "Program	Distribution of Agricultural Cum Hand Operated Sprayer	Farmers	20	Ü	20	25-08-	1 day	Village- Malanda, Taluka- Dhanora Dist Gadchiroli	Dr. D. T. Nagrale
17.	Farmers Training on Cotton Production Technology, Awareness Camp Cum Input Distribution, Program	Distribution of NPK (13:00:45) and Phosphate Solubilizing Bacteria	Farmers	28	70	35	6-09-2023	1 day	Village- Mendhepathar, Taluka - Katol Dist Nagpur	Dr. D. T. Nagrale



#### Name of Coordinator Dr. D. T. Nagrale Dr. D. T. Nagrale Dr. D. T. Nagrale Dr. U. V. Galkate Village- Mendhepathar Bothali, Taluka-Umred Village- Mudholi chak Taluka-Katol Dist.-Village-Chargaon, Chamorshi, Dist.-Venue KVK Sonapur Gadchiroli no. 1, Taluka-Dist Nagpur Gadchiroli Nagpur of training Duration (Days) 1 day 1 day 1 day 1 day Date of training 29-11-2023 20-10-2023 21-11-2023 29-09-Total 100 15 25 09 Female participants 16 10 2 No. of Male 20 84 15 20 Category of participant Farmers Farmers Farmers Farmers Distribution chickpea fluorescens 0.5% WP Distribution of N:P:K Monitoring of cotton Description of Pheromone trap, Pectino Lure, P. seed bag (JAKIchickpea seeds (JAKI-9218), P. activity Distribution of (500g packet) fluorascens formulation (13:00:45)9218) field Survey and monitoring of cotton and Swacchata "Farmers Workshop cum Awareness Camp Cum "Farmers Training Cum Name of training "Farmer Workshop, Seeds distribution" Input Distribution" Seed Distribution" campaign Program program program s è 21. 19 20















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## 10.8.4: Library

In the year 2023, in view of the upcoming academic sessions to be conducted at the Institute, the Library procured 226 new books for students. The library also procured the *E-book series* of *Advances in Agronomy 2023* thus adding to its existing e-book collection.

27 Hindi books were procured. The library also subscribed to 11 Indian Journals. Annual Report 2022 was distributed to ICAR Institutes and dignitaries.

#### **DOCUMENTATION SERVICES**

 The library has started a monthly documentation service to highlight the worldwide ongoing research and development in cotton science in the name "Gleanings in Cotton Research". 12 issues of this monthly publication were compiled for the year 2023 and e-mailed to all scientists.

- Library provides E-Reference Service by virtue of which, important information vital for research such as, alerts, bulletins, articles and circulars received by the library in electronic format are immediately circulated to all scientists by sending regular E-mails.
- The library also acts as a Repository for scholarly papers published by the scientists of the institute. Soft copies of the research papers are stored in the library and are made available as and when required in multiple formats.





- Articles appearing in newspapers on Cotton are digitally scanned and the copy is emailed to all scientists for information. A collection of all news items appearing in 2022 was compiled and published by the name "CICR in News 2022".
- The library is actively participating in the E-Journal Consortium by responding regularly through E-mails and thus also receiving updates. More than 2000 on-line journals on agriculture and crop science are made
   available over the network through this consortium.
- Four User Terminals installed in the library have facilitated the library users to access the databases uploaded in the Library Server. Users can also access the Internet on these

- terminals. Similarly the entire catalog of the library has been downloaded on these terminals for ease of use.
- Taking into account the upcoming Academic hub, five desktop computers and one printer were installed in the library along-with four air-conditioners for the Library Hall. Three cupboards to accommodate print material were also added to the library.
- KOHA Library software was installed in the library and the data comprising the entire Library collection that includes books, bound volumes, Annual Reports, Hindi books and Gratis publications was migrated on the new platform. The library catalog is available on LAN terminals of the Institute.

## 10.8.5: Progressive Use of Hindi

• राजभाषा कार्यान्वयन समिति की बैठकों की तिथि :

화.	दिनांक	विषय
1	09 फरवरी, 2023	वर्ष—2023 की राजभाषा कार्यान्वयन समिति की प्रथम बैठक
2	02 मई, 2023	वर्ष—2023 की राजभाषा कार्यान्वयन समिति की द्वितीय बैठक
3	06 सितम्बर, 2023	वर्ष—2023 की राजभाषा कार्यान्वयन समिति की तृतीय बैठक
4	19 अक्टूबर, 2023	वर्ष—2023 की राजभाषा कार्यान्वयन समिति की चतुर्थ बैठक

# • हिंदी सप्ताह -2023

भा.कृ.अनु.प.—केन्द्रीय कपास अनुसंधान संस्थान, नागपुर में बड़े ही उत्साहपूर्ण वातावरण में 'हिंदी सप्ताह (दिनांक : 14 — 22 सितंबर, 2023) समारोह' का विधिवत् उद्घाटन दिनांक : 14 सितम्बर, 2023 कोडॉ. वाय.जी. प्रसाद, निदेशक, भा.कृ.अनु.प.—केन्द्रीय कपास अनुसंधान संस्थान, नागपुर के शुभहस्ते दीप प्रज्ज्वलित कर किया गया।

कार्यक्रम का संचालन करते हुए डॉ. महेंद्रकुमार साहू, सहायक मुख्य तकनीकी अधिकारी (रा.भा.) ने इस सुअवसर पर उपस्थित अधिकारियों एवं कर्मचारियों का संस्थान की राजभाषा कार्यान्वयन समिति की ओर से हार्दिक स्वागत करते हुए उन्हें 'हिंदी सप्ताह (दिनांक : 14–22 सितंबर, 2023) समारोह' के अंतर्गत आयोजित किए जानेवाली विभिन्न हिंदी प्रतियोगिताओं (हिंदी गीत गायन, चित्र आधारित कहानी लेखन प्रतियोगिता, हिंदी शुद्ध लेखन प्रतियोगिता, शब्दानुवाद प्रतियोगिता, सामान्य ज्ञान/हिंदी बह्विकल्पी प्रश्नोत्तरी प्रतियोगिता, हिंदी निबंध

प्रतियोगिता एवं हिंदी काव्य पाठ प्रतियोगिता) की जानकारी अधिकारियों एवं कर्मचारियों को देते हुए उनसे यह आग्रह किया कि वे इन विभिन्न हिंदी प्रतियोगिताओं में अधिक—से—अधिक की संख्या में भाग लेकर इस आयोजन को सफल बनाएँ।











# हिंदी कार्यशाला - 2023

केन्द्रीय कपास अनुसंधान संस्थान, नागपुर तथा क्षेत्रीय केन्द्र, कोयंबदुर एक दिवसीय कार्यशालों का आयोजन किया गया। संस्थान में इस वर्ष के कार्यालय में वैज्ञानिक / प्रशासनिक / तकनीकी अधिकारी संवर्ग हेतु निम्नलिखित विषयों पर कार्याशालाओं का प्रस्तुतीकरण किया गया।

豖.	दिनांक	विषय	वक्ता				
1	21 मार्च, 2023	सभी इंसान जुड़े हुए है धरती पर, इस विश्व में : एक वैज्ञानिक दृष्टिकोण	डॉ. जयंत मेश्राम , प्रधान वैज्ञानिक, फसल उत्पादन विभाग, केन्द्रीय कपास अनुसंधान संस्थान, नागपुर				
2	18 अप्रैल, 2023	कार्यालय प्रशासन में हिंदी का प्रचार-प्रसार क्यों और कैसे?	प्रथम व्याख्यान सत्र : डॉ. महेंद्र कुमार साहू, सहायक मुख्य तकनीकी अधिकारी(रा .भा), केन्द्रीय कपास अनुसंधान संस्थान, नागपुर				
		'राजभाषा नीति' और उसका अनुपालन	द्वितीय व्याख्यान सत्र : श्री अ .अं. गोस्वामी, मुख्य प्रशासनिक अधिकारी, केन्द्रीय कपास अनुसंधान संस्थान, नागपुर				
3	20 सितंबर, 2023	कार्बनिक कृषि : अमृत पोषण	श्रीमती सुनीता चौहान, विषय विशेषज्ञ, कृषि विज्ञान केन्द्र, नागपुर				
4	28 दिसंबर, 2023	कपास के परिप्रेक्ष्य में	डॉ. रचना पाण्डे, वरिष्ठ वैज्ञानिक, फसल संरक्षण विभाग, केन्द्रीय कपास अनुसंधान संस्थान, नागपुर				



#### प्रकाशन :

संस्थान की वार्षिक हिंदी कृषि पत्रिका 'कपासिका-2023' का प्रकाशन कार्य । संस्थान की वार्षिक हिंदी गृह पत्रिका 'श्वेत स्वर्णिमा-2023' का प्रकाशन कार्य ।

# 10.8.6: Sports

and Sh. Sujit Kumbharewon gold medal in Table-tennis team events.

ICAR-CICR participated in the ICAR zonal sports tournament event. Mr. Dineshkumar Mahurle baged Silver Medal in Cycle (West Zone) at ICAR-IGFRI, Jhansi during 16-19 December, Race (5000 Mtrs) and Mrs. Shobha Kumbhare bagged Silver 2023. Sh Samir Chalkhure, Dr. SS Patil, Sh. Kunal Gaikawad Medal in Discuss throw and Bronze Medal in Javelin throw















# 10.9: Weather

# Nagpur

Month	Temperature (°C)		Relative Humidity (%)		Rainfall (mm)	No. of Rainy
	Max	Min	Max	Min		Days
January, 2023	29.2	13.9	68.9	42.0	0.8	1
February, 2023	33.6	14.5	65.2	30.7	0	0
March, 2023	34.7	27.1	65.2	34.7	7	6
April, 2023	37.1	23.1	68.9	36.4	75.2	10
May, 2023	39.8	25.3	63.5	31.5	48.6	6
June, 2023	38.8	27.7	67.1	40.8	176.0	9
July, 2023	31.8	25.1	72.6	55.5	556.6	22
August, 2023	31.6	24.5	69.8	56.3	167.0	14
September, 2023	31.5	24.4	69.9	60.1	302.2	20
October, 2023	33.8	20.5	65.0	40.8	3.4	2
November, 2023	30.5	16.7	69.6	44.6	26.4	2
December, 2023	27.4	14.5	70.2	46.7	12.4	1
Total					1375.6	93





# Coimbatore

Month	Temperature (°C)		Relative Humidity (%)		Rainfall	No. of Rainy
	Max	Min	Max	Min	(mm)	Days
January, 2023	29.5	19	84	40	0.5	0
February, 2023	32.2	18.9	80	27	1.5	0
March, 2023	33.9	22.1	80	33	15	2
April, 2023	35.7	24	80	37	34.7	3
May, 2023	34.3	24.2	88	57	182.7	12
June, 2023	33.8	24	83	51	14.6	3
July, 2023	31.2	23.4	83	57	47.5	4
August, 2023	33.5	23.5	83	48	1.3	0
September, 2023	32.5	23.8	83	55	11.8	2
October, 2023	32.9	23.6	85	47	34.5	4
November, 2023	30	22.9	91	61	391.7	13
December, 2023	28.9	22.2	90	63	60.6	3
Total					796.4	46

# Sirsa

Month	Temperature (°C)		Relative Humidity (%)		Rainfall (mm)	No. of Rainy
	Max	Min	Max	Min		Days
January, 2023	16.7	3.6	89.9	62.4	11.6	2
February, 2023	25.8	8.6	88.3	47.0	0.0	0
March, 2023	28.3	13.7	89.6	48.1	34.8	3
April, 2023	34.5	17.7	68.0	30.6	11.2	4
May, 2023	37.1	22.5	65.3	37.5	41.4	4
June, 2023	38.3	27.4	76.7	53.1	50.9	3
July, 2023	35.1	26.8	86.0	66.8	183.7	6
August, 2023	36.9	27.4	78.9	57.3	0.0	0
September, 2023	35.4	24.4	80.9	61.6	52.6	3
October, 2023	33.1	17.8	77.4	55.8	7.5	1
November, 2023	27.6	13.6	82.4	56.6	0.0	0
December, 2023	21.4	6.9	88.0	60.5	0.0	0
	393.7	26				

# 10.10: Cotton Scenario

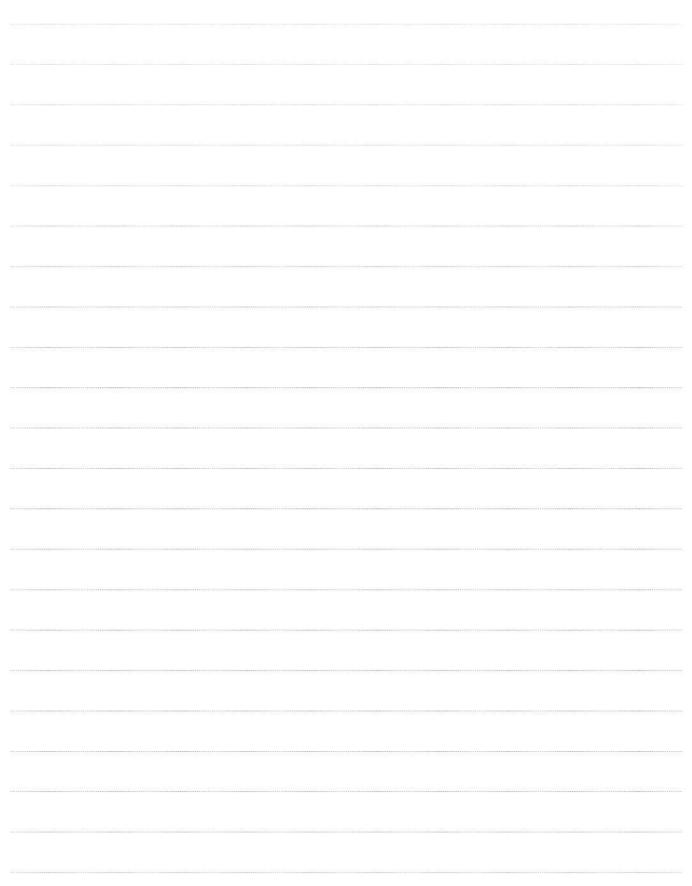
Area: in Lakh Hectares Production: in Lakh bales of 170 kg.

State-wise area, production and productivity of cotton in India (2022-23) \*

State	Area (Lakh ha)	Production (in Lakh bales of 170 kg)	Yield (Kg/ha)
Punjab	2.49	4.60	314.06
Haryana	5.75	10.00	295.65
Rajasthan	8.15	27.74	578.63
North Zone total	16.39	42.34	396.11
Gujarat	25.54	94.97	632.14
Maharashtra	42.29	84.09	338.03
Madhya Pradesh	5.95	17.22	492.00
Central Zone total	73.78	196.28	487.39
Telangana	20.25	53.13	446.03
Andhra Pradesh	6.99	15.79	384.02
Karnataka	9.23	25.41	468.01
Tamil Nadu	1.62	3.56	373.58
South Zone total	38.09	97.89	408.54
Odisha	2.16	6.65	523.38
Others	0.19	0.31	277.37
All India	130.61	343.47	447.06







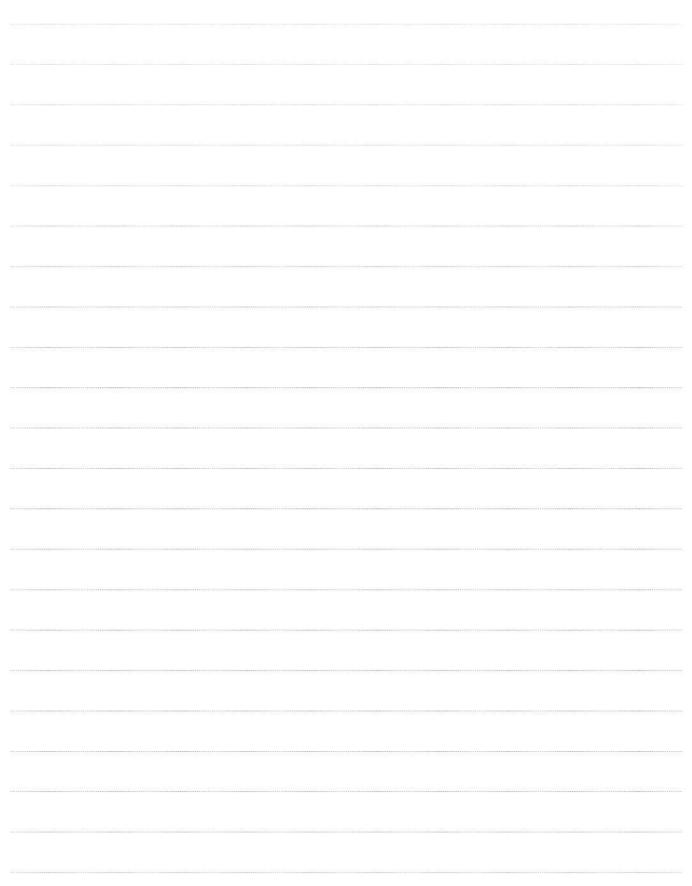


























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