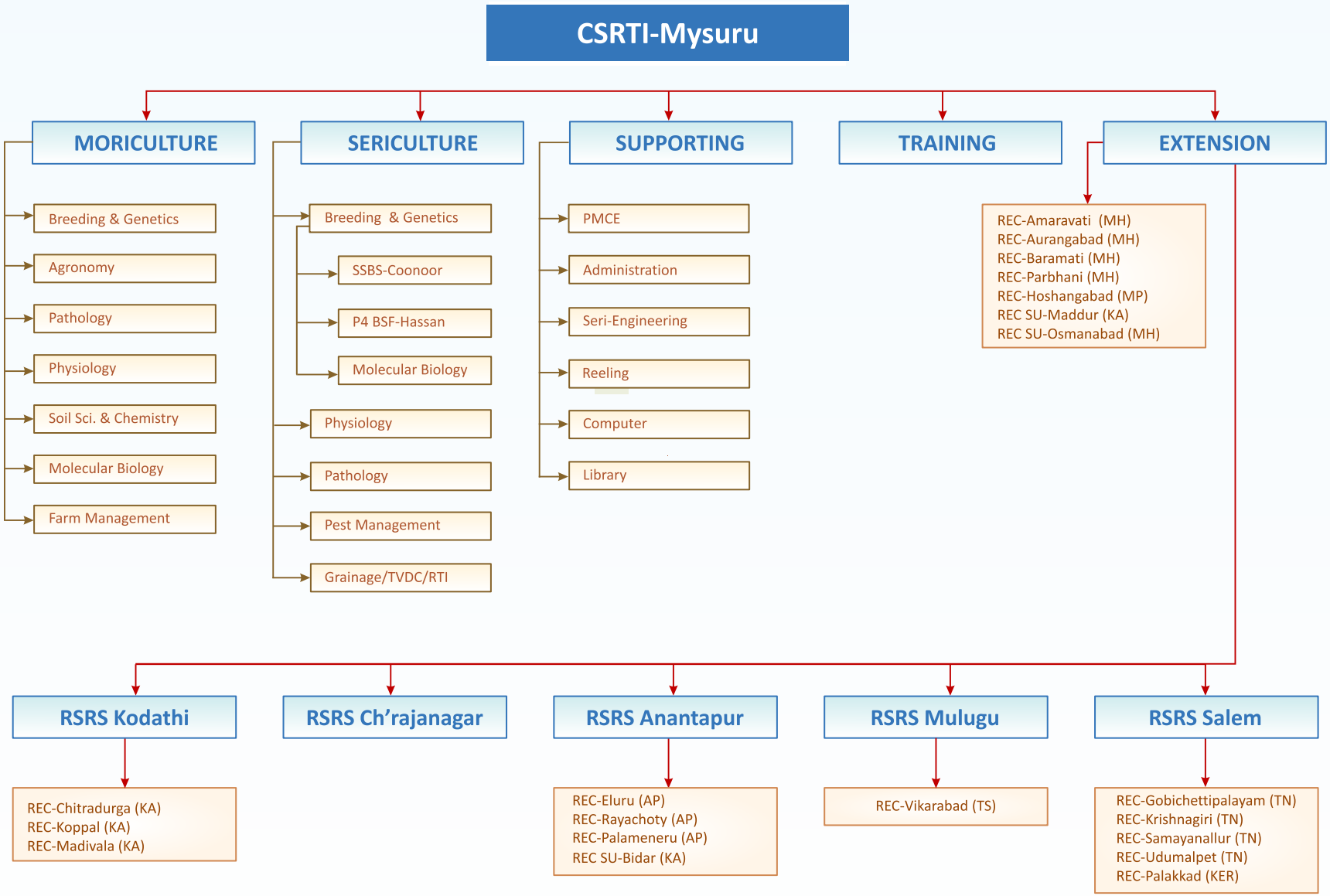
वार्षिक प्रतिवेदन
ANNUAL REPORT
2021-22

केंद्रीय रेशम उत्पादन अनुसंधान एवं प्रशिक्षण संस्थान
केंद्रीय रेशम बोर्ड, वस्त्र मंत्रालय, भारत सरकार, मैसूरु – 570 008
Central Sericultural Research and Training Institute
Central Silk Board, Ministry of Textiles, Government of India, Mysuru - 570 008

CSRTI-Mysuru Organizational set-up



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प्रकाशक
डॉ मेरी जोसेफा (शेरी) ए वी
निदेशक प्रभारी
केंरेअप्रसं, मैसूरु

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श्री जस्टिन कुमार जे
डॉ बालसरस्वती एस
सुश्री रेखा एम
श्री चए मए मुनिकृष्णप्पा

हिंदी अनुवाद
श्री एस के उपाध्याय
सुश्री शचि. के

पुस्तक लेआउट और सज्जा
श्री जस्टिन कुमार जे

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डिजिटल प्रीप्रेस
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Content

प्रस्तावना

केंद्रीय रेशम उत्पादन अनुसंधान एवं प्रशिक्षण संस्थान, मैसूरु दक्षिण भारतीय राज्यों एवं मध्य प्रदेश और महाराष्ट्र में रेशम उत्पादन और उत्पादकता बढ़ाने के उद्देश्य से लगातार अनुसंधान कार्य में लगा हुआ है । इस संस्थान ने पिछले छ: दशकों में अनुसंधान व विकास के क्षेत्र में कई योगदान दिए हैं यथा नई शहतूत उपजातियों, उन्नत रेशमकीट नस्लों/संकरों, उत्पादकता बढ़ाने वाली तकनीकों और फसल संरक्षण प्रौद्योगिकियों का विकास, श्रम-दक्षता की दृष्टि से क्षेत्र एवं क्षेत्रेतर गतिविधियों को सुकर एवं सुगम बनाने हेतु कई उपकरण और मशीनरी की परिकल्पना आदि । रेशम उत्पादन क्षेत्र में शामिल कर्मियों के क्षमता निर्माण पर भी संस्थान का ध्यान केंद्रित है । संस्थान और इसके संबद्ध इकाइयों द्वारा आयोजित विस्तार संचार कार्यक्रमों के माध्यम से प्रयोगशालाओं में विकसित प्रौद्योगिकियों का प्रचार-प्रसार किया जा रहा हैं। इससे किसानों को रेशम उत्पादन प्रौद्योगिकियों को अपनाने में काफी मदद मिली है और इसके परिणामस्वरूप देश में द्विप्रज कोसा उत्पादन में पर्याप्त वृद्धि हुई है। आंध्र प्रदेश, कर्नाटक, मध्य प्रदेश, महाराष्ट्र, तमिलनाडु और तेलंगाना राज्यों में केंरेअप्रसं-मैसूर द्वारा चलाए जा रहे केंद्रीय रेशम बोर्ड के समूह संवर्धन कार्यक्रम की देन महत्वपूर्ण है । इन राज्यों में पिछले कुछ वर्षों में हो रहे बेहतर द्विप्रज उत्पादन इसकी सबूत है ।

संस्थान द्वारा अनुसंधान व विकास परियोजनाओं के माध्यम से विकसित तीन एफटीपीईपीसी ट्रान्सजेनिक शहतूत वंशों ने बेहतर वायु विनिमय प्राचल, बेहतर पोषण स्थिति एवं अजैविक तनाव सहिष्णुता दर्शाई । हाइड्रोपॉनिक और मृदा संवर्धन प्रणाली से शहतूत उगाने हेतु पोषण विलयन को मानकीकृत किया गया । प्यूपे से काइटिन निकालने हेतु आशोधित रासायनिक निष्कर्षण प्रौद्योगिकी/प्रोटोकॉल विकसित किया गया और कोसे से सेरिसिन और फाइब्रोइन प्रोटीन निष्कर्षण क्रियाविधि को मानकीकृत किया गया । आण्विकी जीव विज्ञान प्रयोगशाला ने द्विप्रज रेशमकीट नस्लों में पाराक्राट/ओक्सीकारी सहिष्णुता से संबद्ध उत्तरजीविता से जुडे थैयोरेडोक्सिन पेरोक्सिडेस जीन में एस एन पी को पहचाना । रेशमकीट रोग विज्ञान प्रयोगशाला ने रेशमकीटों व पीडकों और उनके प्रबंधन पर एक वेब पृष्ठ विकसित किया गया । बी एम एन पी वी प्रबंधन हेतु डेक्लाटासविर को प्रभावशाली ड्रग के रूप में पहचाना गया । सूक्ष्म जीवाणुओं से उत्पन्न खतरे को नियंत्रण में रखने के लिए संस्थान द्वारा पेब्रिन रोग की निगरानी की जा रही है। संस्थान ने रेशमकीट प्यूपा के लिंग वर्गीकरण के लिए एक उपकरण का सफलतापूर्वक विकास और प्रदर्शन किया जो रेशमकीट अंड उत्पादन एककों के लिए उपयोगी होगा।

सीपीपी की सफल गतिविधियों के परिणामस्वरूप 26 मेगा क्लस्टरों के माध्यम से 5832.82 मीट्रिक टन द्विप्रज (बाइवोल्टाइन) कच्चे रेशम का रिकॉर्ड उत्पादन हुआ । इस अवधि के दौरान किसानों/चाकीकें की सफलता की गाथा का चित्रण करने वाली "सेरीकल्चर सक्सेस स्टोरीज़" पुस्तक का खंड 3 प्रकाशित किया गया । संस्थान ने किसानों, अधिकारियों, उद्यमियों, शोधकर्ताओं और रोजगार के इच्छुक सहित 2618 अभ्यर्थियों को प्रशिक्षित किया और केंरेअप्रसं, मैसूरु के वैज्ञानिकों के मार्गदर्शन में 96 छात्रों को अपनी स्नातकोत्तर उपाधि पाठ्यचर्या के क्रम में अपनी परियोजना/इंटर्नशिप करने की सुविधा भी प्रदान की। "मूल्य वर्धित उप-उत्पादों के उत्पादन के लिए स्पेन्ट रेशमकीट शलभों के उपयोग की प्रक्रिया" पर अभिनवकरण हेतु पेटेंट सं. 365781 आबंटित करते हुए एक पेटेंट की स्वीकृति प्राप्त हुई ।

संस्थान ने रेशम उद्योग को सुदृढ बनाने, चाकीकें उद्यमियों, छात्रों और हितधारकों को समर्थन देने तथा रेशम उत्पादन से जुड़े किसानों की आर्थिक स्थिति में सुधार हेतु अधिक सरल और प्रभावी तकनीकों को विकसित करने के उद्देश्य से कई परियोजनाओं एवं कार्यक्रमों का प्रस्ताव किया हैं ।

Foreword

The Central Sericultural Research and Training Institute, Mysuru has been incessantly pursuing research aimed at enhancing the production and productivity of silk in the South Indian states and the states of Madhya Pradesh and Maharashtra. The institute in its existence for the last six decades have come out with many new mulberry varieties, silkworm breeds/hybrids, productivity enhancing and crop protection technologies, ergonomically designed equipment and machinery for manpower saving and ease of work in the on farm and off farm activities. The institute also is a centre focusing on capacity building development of personnel involved in the sericulture field. The extension communication programmes organized by the institute and its nested units have been disseminating technologies developed in the laboratories. This has tremendously helped the farmers in imbibing the sericulture technologies and resulting in the increased bivoltine cocoon production in the country. The Cluster Promotion Programme of Central Silk Board, piloted by CSRTI-Mysuru in the states of Andhra Pradesh, Karnataka, Madhya Pradesh, Maharashtra, Tamil Nadu and Telangana has paid rich dividends, which is evident from the improved bivoltine production in these states over the last few years.

Through R&D projects and programmes the institute has developed three FtPEPC transgenic mulberry lines with better gas exchange parameters, three co-expressing transgenic mulberry lines with better tolerance to drought, salinity and oxidative stresses. A formulation of Nutrient solution for growing mulberry under hydroponic and sand culture system was also standardised. The Institute has developed a modified chemical chitin extraction protocol from pupae and standardized extraction procedures of sericin and fibroin proteins from cocoon. The molecular biology lab has identified SNPs in *Thioredoxin peroxidase* gene (*Tpx*) linked to longevity associated with Paraquat/Oxidative stress tolerance in bivoltine silkworm breeds. The Silkworm Pathology lab has developed a web page with information on silkworm diseases & pests and their management. The lab also identified Declatasvir as a potential drug for the management of BmNPV. Pebrine disease monitoring is being carried out by the institute to keep the threat posed by the microsporidian under check. The Institute has successfully developed and demonstrated an equipment for gender classification of silkworm pupa which will be beneficial for the silkworm egg production units.

The successful CPP activities has resulted in the record production of 5832.82 MT bivoltine raw silk through 26 mega clusters. Sericulture Success stories Vol. 3 with success saga of farmers/CRC was published during the period. The institute trained 2618 personnel, including farmers, officials, entrepreneurs, researchers and employment seekers and also facilitated 96 students to carry out their project/internship as part of their Masters Degree under the guide ship of CSRTI Scientists. One patent granted with Patent No.365781 for the innovation “Process for the utilization of spent silkworm moths for producing value added by-products”.

The institute has proposed projects and programmes aiming to develop more simple and effective technologies for higher productivity to help the sericulture industry to be more productive and act as a strong support to the stake holders including farmers, CRC entrepreneurs, students, *etc*. and also for uplifting the economic condition of Sericulture farmers.

के रे अ प्र सं, मैसूरु के बारे में

केंद्रीय रेशम उत्पादन अनुसंधान एवं प्रशिक्षण संस्थान, मैसूरु की स्थापना केंद्रीय रेशम बोर्ड, वस्त्र मंत्रालय, भारत सरकार के नियंत्रण में वर्ष 1961 में सर्वप्रथम चन्नपट्टणा में किया गया और बाद में 1963 में इसे मैसूरु स्थानांतरित किया गया । प्रशिक्षण घटक को सम्मिलित करने के बाद इस संस्थान का वर्ष 1965 में **केंद्रीय रेशम उत्पादन अनुसंधान एवं प्रशिक्षण संस्थान, मैसूरु (कें रे अ प्र सं)** के रूप में पुनर्नामकरण किया गया । यह संस्थान देश में रेशम उद्योग के विकास के लिए पिछले 60 सालों से अनवरत सेवाएं समर्पित कर रहा है ।आज यह संस्थान अनुभवी वैज्ञानिकों, समस्त आधुनिक सुविधाओं एवं अवसंरचनायुक्त रेशम उत्पादन अनुसंधान के उत्कृष्ट प्रमुख संस्थान के रूप में विख्यात है । केंरेअप्रसं, मैसूरु उच्च अध्ययन एवं उन्नत प्रशिक्षण केंद्र के रूप में मान्यता प्राप्त है । यह संस्थान कर्नाटक, आंध्रप्रदेश, तमिलनाडु, तेलंगाना, केरल, महाराष्ट्र एवं मध्यप्रदेश में शहतूत रेशम उद्योग के क्षेत्र में अनुसंधान एवं विकास संबंधी समग्र आवश्यकताओं की पूर्ति करता है। अभी तक इस संस्थान ने रेशम उत्पादन प्रौद्योगिकी के विभिन्न पहलुओं में 800 विदेशियों सहित करीब 53,000 व्यक्तियों को प्रशिक्षित किया है । यह संस्थान अनुसंधान, प्रशिक्षण एवं विस्तारण कार्य संचालित करने के अलावा राष्ट्रीय एवं अंतर्राष्ट्रीय अभिकरणों को परामर्श एवं सलाहकारी सेवाएँ भी प्रदान करता है ।

दृष्टि

ग्रामीण विकास एवं उन्नयन हेतु रेशम संवर्धन में अनुसंधान एवं विकास संबंधी सेवाएं प्रदान करने वाले आदर्श संगठन के रूप में कार्य करने के अलावा विशेषकर उष्णकटिबंधीय देशों को ध्यान में रखते हुए देशी और वैश्विक स्तर पर मानव संसाधन का सृजन ।

लक्ष्य

- उत्पादन लागत कम करने के साथ-साथ उत्पादकता एवं गुणवत्ता मे वृद्धि ।
- संसाधन की प्रभावी उपयोगिता हेतु पर्यावरण अनुकूल और गरीबों एवं महिलाओं की हितैषी परियोजनाएं विकसित करना ।
- हितधारकों की सामाजिक आर्थिक स्थिति में सुधार हेतु कम लागत वाली-नई प्रौद्योगिकियां विकसित करना ।
- गुणवत्तापूर्ण रेशम के उत्पादन में वृद्धि हेतु क्षेत्र में प्रभावी प्रौद्योगिकियां विकसित करके उन्हें लोकप्रिय बनाना ।
- हर पहलू से सम्बंधित मानव-संसाधन के विकास हेतु गतिविधियां संचालित करना ।

अधिदेश

- विभिन्न कृषि-जलवायु स्थितियों/क्षेत्रों के लिए उचित शहतूती रेशम उत्पादन प्रौद्योगिकियां विकसित करना ।
- विभिन्न विषयों पर आधारभूत एवं अनुप्रयुक्त अनुसंधान संचालित करना ताकि उपयुक्त प्रौद्योगिकियां विकसित की जा सके ।
- सिद्ध प्रौद्योगिकियों को क्षेत्र स्तर पर अपनाए जाने की क्षमता की जांच व सत्यापन करना ।
- विकसित प्रौद्योगिकियों का क्षेत्र स्तर पर प्रारंभिक प्रदर्शन ।
- मानव संसाधन विकास एवं प्रशिक्षण कार्यक्रम का संचालन ।
- शहतूत रेशम उत्पादन से संबंधित कीटपालन उपस्कर, मशीन, उत्पाद एवं केंरेबो के संस्थानों में विकसित या अन्य एजेंसियों द्वारा रेफर किए गए प्रौद्योगिकियों के परीक्षण केंद्र के रूप में कार्य करना ।
- सहयोगात्मक अनुसंधान एवं प्रौद्योगिकी स्थानांतरण हेतु राज्य सरकारों, स्वैच्छिक संगठनों, गैर सरकारी संगठनों, विश्वविद्यालयों और अन्य राष्ट्रीय संस्थानों से समन्वयन करना ।

संगठनात्मक रचना

केंद्रीय रेशम उत्पादन अनुसंधान एवं प्रशिक्षण संस्थान, मैसूरु, देश में रेशम उत्पादन अनुसंधान विकास कार्य में लगा हुआ सबसे बड़ा और अधिक वैविध्यपूर्ण संस्थान है जो कृषि इंजीनियरों, समाजशास्त्रियों एवं अर्थशास्त्रियों सहित करीब 80 वैज्ञानिकों से समर्थित है । ये कार्मिक कर्नाटक, तमिलनाडु, आंध्रप्रदेश, तेलंगाना, केरल, महाराष्ट्र और मध्यप्रदेश राज्यों के मुख्य संस्थानों और संबद्ध एककों के माध्यम से समुचित प्रौद्यौ्गिकियों के विकास और उनके स्थानांतरण हेतु समन्वय से कार्य कर रहे हैं । अनुसंधान व विकास कार्यकलाप और प्रौद्योगिकी विकास कार्य चार प्रमुख प्रभागों यथा परपोषी पादप उत्पादन एवं संरक्षण, रेशमकीट उत्पादन एवं संरक्षण, विस्तार एवं प्रशिक्षण के विभिन्न अनुभागों

में किए जा रहे हैं । कें रे अ प्र सं, मैसूरु अधिदेशात्मक कार्य निपटाने हेतु कई योग्य तकनीकी एवं प्रशासनिक कर्मचारियों की सेवा का भी उपयोग करता है । योजना, अनुवीक्षण, समन्वयन एवं मूल्यांकन कक्ष की सहायता से निदेशक, संस्थान और इसके संबद्ध एककों के अनुसंधान व विकास कार्यकलापों की प्रगति का अनुवीक्षण करते हैं । पी-4 मूल बीज फार्म, हासन एवं उप रेशमकीट प्रजनन केंद्र, कूनूर यथाक्रम प्रजनक स्टॉक एवं का प्रजनन स्टॉक का अनुरक्षण करते हुए रेशमकीट प्रजनन कार्यक्रमों में समर्थन दे रहे हैं । संस्थान को पीपीवी व एफआरए, नई दिल्ली द्वारा शहतूत उपजातियों के नोडल केंद्र के रूप में मान्यता प्राप्त हुई है । संस्थान द्वारा नियमित रूप से पुस्तकें, बुल्लेटिन, पुस्तिकाएं एवं तकनीकी पैम्फलेट और रेशम उत्पादन विज्ञान पर दस्तावेज़ी साहित्य सेरिडॉक प्रकाशित किए जा रहे हैं ।

विस्तार कार्य-तंत्र

प्रयोगशाला उपलब्धियों के मान्यकरण एवं उन्हें क्षेत्र में प्रभावी ढंग से स्थानांतरित करने को सुगम बनाने हेतु इस संस्थान के तीन स्तरीय विस्तारण कार्य-तंत्र हैं - क्षेत्रीय रेशम उत्पादन अनुसंधान केंद्र (क्षे रे अ कें), अनुसंधान विस्तारण केंद्र (अ वि कें) और उप एकक । दक्षिणी राज्यों के मुख्य रेशम उत्पादन अंचलों में स्थित क्षेत्रीय रेशम उत्पादन अनुसंधान केंद्र क्षेत्र विशेष के अनुकूल और प्रायोगिक अनुसंधान संचालित करते हैं । कृषकों को प्रशिक्षित करने और बुनियादी स्तर पर विस्तार सेवाएं उपलब्ध कराने के अतिरिक्त क्षेत्रीय आवश्यकताओं के लिए उपयुक्त प्रौद्योगिकियों की सिफारिश करने हेतु प्रौद्योगिकी परीक्षण किया जाता है । लाभार्थियों को प्रौद्योगिकी का स्थानांतरण करना और उनकी सहायता के लिए सभी प्रौद्योगिक निवेश देने का उत्तरदायित्व अनुसंधान विस्तारण केंद्र एवं उप-एककों का है । महाराष्ट्र एवं मध्यप्रदेश के साथ दक्षिण राज्यों में भी द्विप्रज रेशम उत्पादन को बढ़ावा देने हेतु कें रे अ प्र सं, मैसूरु, समूह संवर्धन कार्यक्रम (सीपीपी) और सं ग्रा सं का (आई.वी.एल.पी) केंद्रों का समन्वयन करता है । राज्य रेशम उत्पादन विभागों के पदधारियों के समन्वयन से संबंधित राज्यों में प्रौद्योगिकियों का प्रभावी स्थानांतरण किया जाता है ।

प्रशिक्षण केंद्र

इस संस्थान को उष्णकटिबंधीय रेशम उत्पादन के क्षेत्र में प्रशिक्षित मानव संसाधन विकसित करने हेतु अग्रगामी केंद्र के रूप में मान्यता प्राप्त है । यह राष्ट्रीय एवं अंतर्राष्ट्रीय स्तर पर उष्णकटिबंधीय रेशम उत्पादन में प्रशिक्षण देता है । यह संस्थान रेशम उत्पादन प्रौद्योगिकी एवं जैव सूचना विज्ञान में अनुसंधान एवं रेशम उत्पादन में पीएच डी कार्यक्रम संचालित करने हेतु मैसूर विश्वविद्यालय से संबद्ध है । यह संस्थान ग्रमीण गरीब लोगों, कमज़ोर वर्गों और महिला रेशम उत्पादकों के सामाजिक-आर्थिक विकास के लिए और प्रौद्योगिक सशक्तिकरण हेतु जैव प्रौद्योगिकी विभाग एवं विज्ञान व प्रौद्योगिकी विभाग, भारत सरकार द्वारा प्रायोजित विभिन्न प्रशिक्षण कार्यक्रम संचालित करते है। यह संस्थान राज्य रेशम उत्पादन विभागों की मानव संसाधन विकास आवश्यकताओं को पूरा करने के अलावा जापान अंतर्राष्ट्रीय सहकारिता अभिकरण(जाइका) और विदेश मंत्रालय, भारत सरकार(आईटीईसी) जैसे संगठनों के माध्यम से अंतर्राष्ट्रीय छात्रों/कर्मिकों को रेशम उत्पादन प्रशिक्षण कार्यक्रम संचालित कर रहा है । प्रशिक्षण स्कंध में दृश्य-श्रव्य शिक्षण उपस्करों से सुसज्जित कक्षाएँ और प्रशिक्षणार्थियों को ठहराने हेतु छात्रावास सुविधाएँ उपलब्ध हैं ।

अवसंरचना सुविधाएँ

- रेशम उत्पादन विज्ञान में उन्नत अनुसंधान संचालित करने हेतु सुसज्जित प्रयोगशालाएँ, शहतूत बाग़ और कीटपालनगृह ।
- प्रौद्योगिकी मान्यकरण एवं किसानों को प्रशिक्षण देने हेतु बड़े पैमाने पर कीटपालन गृह ।
- चॉकी कीटपालन केंद्र संकल्पना को बढ़ावा देने हेतु आदर्श चॉकी कीटपालन केंद्र ।
- यंत्रों/उपस्करों की अभिकल्पना एवं विकास तथा मशीनों/उपस्करों की संरचना को समर्थित करने हेतु सभी सुविधाओं से युक्त रेशम उत्पादन अभियांत्रिकी प्रभाग ।
- संबद्ध एककों, रेशम उत्पादन विभागों और अन्य संगठनों के साथ तेजी से संप्रेषण सुनिश्चित करने हेतु विडियो सम्मेलन स्टुडियो ।
- कंप्यूटर सेन्टर द्वारा लान के माध्यम से प्रिंट / फाइल शेयर समर्थन सहित सभी को इन्टरनेट कनेक्शन दिया जाता है ।
- पुस्तकालय सेवाएँ (11298 पुस्तकें, 8239 वैज्ञानिक पत्रिकाओं का बंध खंड, 5 अंतर्राष्ट्रीय इलेक्ट्रॉनिक पत्रिकाएँ, 7 इंडियन एलेक्ट्रॉनिक पत्रिकाएं, 35 इंडियन एवं अंतर्राष्ट्रीय पत्रिकाओं की मुद्रित प्रतियां, 320 शोध पत्र, 55 पीएचडी प्रबंध; तकनीकी रिपोर्ट एवं सीडी रॉम डेटा बेस-एग्रिस ।

ABOUT CSRTI-MYSURU

The Central Sericultural Research and Training Institute (CSRTI), Mysuru was established under the aegis of Central Silk Board, Ministry of Textiles, Govt. of India. The institute started functioning at Channapattana in the year 1961 after taking over the Sericulture Research Institute of erstwhile Mysuru province and later was shifted to Mysuru in the year 1963. With the inclusion of training component, the Institute was renamed as Central Sericultural Research & Training Institute (CSRTI), in the year 1965. The Institute has completed 60 years of dedicated service for the development of sericulture industry in the country and has the distinction of being the premier institution for tropical sericultural research par excellence with modern facilities and infrastructure including experienced scientific and technical personnel. CSRTI-Mysuru is recognized as a center for higher learning and advanced training. It caters to the need of on farm mulberry sericulture sector in Karnataka, Andhra Pradesh, Tamil Nadu, Telangana, Kerala, Maharashtra and Madhya Pradesh. CSRTI-Mysuru has imparted training to more than 53,000 persons including 800 foreign nationals in various aspects of sericulture technology. Besides conducting research, training and extension activities, the institute also offers consultancy and advisory services to national and international agencies.

Vision

To be a model organization for providing R&D services in sericulture for rural development and upliftment besides generation of human resources both at domestic and global level with special reference to tropical countries.

Mission

- To improve the productivity and quality of silk, besides reducing the cost of production
- To generate pro-environment, pro-poor and pro-women technologies for effective resource utilization
- To develop low cost innovative technologies for overall improvement of socio-economic condition of stakeholders
- To promote and popularize the cutting edge technologies in the field to increase production base of quality silk.
- To undertake Human Resource Development at all levels of operation

Mandate

- To develop mulberry sericultural technologies suitable to different agro-climatic conditions /zones.
- To conduct basic and applied research in various disciplines leading to the development of appropriate technologies
- To test verify the proven technologies at field level for their adoptability
- To conduct front-line demonstration of developed technologies in the field
- To conduct human resource development and training programmes
- To serve as a testing centre for mulberry sericulture related rearing equipments, machines, products and technologies evolved in CSB Institute or referred by other agencies
- To coordinate with State Govts., Voluntary organisations NGOs, universities and other National institutes for collaborative research and technology transfer.

Organizational Setup

CSRTI-Mysuru is the largest and most diversified institution engaged in sericulture R & D in the country, supported by 80 scientists of various disciplines including agricultural engineers, sociologists and economists. These personnel working in close coordination for the development of suitable technologies and its transfer through the main institute and its nested units in the states of Karnataka, Tamil Nadu, Andhra Pradesh, Telangana Kerala, Maharashtra and Madhya Pradesh. R & D activities and technology development are carried out in major divisions: Host Plant Production & Protection, Silkworm Production & Protection, Extension and Training. CSRTI-Mysuru has technical and administrative staff to undertake the mandated activities. The Director monitors the progress of R & D activities of Institute and nested units with the support of Planning, Monitoring, Coordination and Evaluation cell. The P4 BSF, Hassan and SSBS, Coonoor support in the silkworm breeding programmes by maintaining breeders stock. The institute is recognized as a nodal centre by PPV & FRA, New Delhi, for mulberry varieties. Institute regularly publishes books, bulletins, leaflets and technical pamphlets helpful for the stake holders. The institute publishes Seridoc a half yearly compilation, presenting the research papers published in sericulutral science across the world.

Extension Network

CSRTI-Mysuru has a three-tier system of extension network: Regional Sericultural Research Stations (RSRS), Research Extension Centres (REC) and REC-Sub-Units to facilitate validation and transfer of laboratory findings effectively to the field. RSRSs are located in major sericultural zones of southern states to carryout region-specific adaptive and applied research. Technology trials are also conducted to suit the regional requirements besides providing training to farmers and grass root level extension services. RECs and sub-units share the major responsibility of technology transfer to the stake holders and also provide technological inputs and support services. CSRTI-Mysuru coordinates Cluster Promotion Programme (CPP) and IVLP programme for the promotion of bivoltine sericulture in Southern States and Maharashtra and Madhya Pradesh. Effective transfer of technologies is undertaken in close coordination with officials of Department of Sericulture of respective states.

Training Centre

CSRTI-Mysuru is recognized as flagship centre for generation of trained human resource in tropical sericulture at national and international level. The institute also conducts training programmes sponsored by DBT, DST and Ministry of Textiles (Govt. of India) for socio-economic and technological empowerment of sericulturists. Besides catering to the HRD needs of the state departments of sericulture in the country, CSRTI-Mysuru also conducts sericulture training programmes for international candidates through various organizations such as JICA and Ministry of External Affairs, Govt. of India (ITEC). The training hub houses well-equipped classrooms with hostel facilities for the trainess.

Infrastructure Facilities

- Well-equipped laboratories, well maintained mulberry gardens and rearing houses to carry out advanced research
- Large scale rearing houses for technology validation and farmers' training
- Model chawki rearing centre (CRC) to demonstrate the concept of CRC
- Engineering Division with excellent facilities to support designing, development and fabrication of machines/equipments suitable for sericulture

- Video Conference facility ensure faster communication with nested units, DOSs and other organizations
- Computer center provides internet connectivity to all through LAN with print/file share support
- Library Services includes 11298 books; 8239 bound volumes of scientific journals; 5 Internationl Electronic journals; 7 Indian Electronic journals and 35 Indian & International print version journals; 320 dissertations; 55 Ph.D. theses; technical reports and CD-ROM database-AGRIS.

मुख्यांश

परपोषी पादप

- तीन एफटीपीईपीसी ट्रान्सजेनिक शहतूत वंशों ने अन्य वन्य पौधों की तुलना में 60% क्षेत्र क्षमता के अधीन बेहतर वायु विनिमय प्राचल, बेहतर पोषण स्थिति एवं अजैविक तनाव सहिष्णुता दर्शाई ।
- समान अभिव्यक्ति वाले तीन ट्रान्सजेनिक शहतूत वंशों (सीए एम वी 35, एस, एटी, एस एच एन 1 और एटी डी आर ई बी 2 ए) ने वन्य पौधों की तुलना में सूखा, लवणता एवं ओक्सीकारी तनाव दर्शाया ।
- छ: शहतूत जीनप्ररूपों यथा डी 16, डी 21, डी 22, डी 23, डी 28 एवं डी 34 ने इष्टतम एवं उप इष्टतम स्थितियों में मानक उपजातियों के समतुल्य पत्ती उपज, वृद्धि प्राचल,रेशमकीट निर्मोक प्राचल और कार्बन आइसोटोप विभेदन मूल्य दर्शाया ।
- इष्टतम एवं उप इष्टतम स्थितियों में त्रिगुणित जीनप्ररूप क्रमश: टीआरआई-10, टीआरआई-8 टीआरआई-9 का निष्पादान मानक उपजातियों की तुलना में बेहतर रहा ।.
- हाइड्रोपॉनिक और मृदा संवर्धन प्रणाली से शहतूत उगाने हेतु पोषण विलयन को मानकीकृत किया गया ।
- रेशम उत्पादन कृषकों से प्राप्त 536 मृदा प्रतिदर्शों का विश्लेषण करके मृदा आधारित उर्वरक की संस्तुति की गई ताकि मृदा उर्वरता एवं शहतूत पत्ती गुणवत्ता बढ़ाया जा सके ।
- नाइट्रोजन, फोस्फरस,सल्फर और ज़िंक उपयोग क्षमता परखने हेतु 230 विविध जननद्रव्य प्रभेदों का लक्षणप्ररूपी (फीनोटाइपिक) मूल्यांकन किया गया ।
- 52 प्रभेदों को तीन प्रतिकृतियों में डीयूएस परीक्षण भूखंड में पाला गया और 35 लक्षणों के लिए नमूना जीनप्ररूपों (34) का डीयूएस अभिलक्षणन किया गया । पांच एसएसआर चिह्नकों के सहारे रेफरंस और कैंडिडेट उपजातियों का अभिलक्षणन किया गया ।
- सहाना और वी-1 के बीच 17 मार्कर बहुरूपी पाए गए और एमआर-2 और वी-1 के बीच पंद्रह बहुरूपी पाए गए।
- मानचित्रण जीवसंख्या के जीनोटाइप तैयार करने हेतु शुद्ध संकरों (मोरस मल्टिकौलिस × थाइलैंड मले) का पता लगाने हेतु पोलिमोर्फिक एस एस आर को पहचाना गया ।
- कर्नाटक, तमिलनाडु, आंध्र प्रदेश और तेलंगाना से प्राप्त मृदा प्रतिदर्शों से प्रतिरोधी जीवाणुओं एवं फफूंदियों को पृथक किया गया और यह पहचान की गैइ कि ये स्यूडोमोनास एग्रोजेनोसा, बैसिल्लस सब्टिल्लस और फफूंदी जैव नियंत्रण कारक ट्राइकोडेर्मा हर्जियानम है ।
- टी.हर्जियानम पृथककृत को 0.1, 0.2 & 0.3% सांद्रता में कोप्पर ओक्सीक्लोराइड और 0.1% सांद्रता में मैन्कोज़ेब के विरुद्ध प्रभावी पाया गया ।
- एजीबी-8 शहतूत उपजाति से अल्प निवेशी स्थितियों अर्थात 60% सिंचाई एवं उर्वरक अनुप्रयोग में अधिक पत्ती उपज की प्राप्ति दर्ज की गई ।
- एजीबी-8 शहतूत उपजाति में अल्प निवेशी स्थितियों के अधीन पर्याप्त अधिक नाइट्रोजन उपयोग क्षमता (53.6%) दर्ज की गई उसके बाद यथाक्रम जी-4 (39.1%), वी-1 (36.7%) और एम एस जी-2 (27.7%) में अधिक मूल्य दर्ज किया गया ।

- जी 4, वी 1, मोरस मल्टिकौलिस, और जी 2 में उच्च प्राथमिक चयापचयज दर्ज किया गया जबकि एम आर 2 और मैसूरु लोकल में निम्नतम चयापचयज पाया गया ।
- उच्च अधित्वचीय मोम अंश युक्त 15 जीनप्ररूपों और अधिक रंध्र (स्टोमाटा) युक्त 12 जीनोटाइपों की उच्च डब्ल्यूयूई प्राचल वाले शारीरिक रूप से सक्षम जीनप्ररूपों के रूप में पहचाना की गई ।
- शहतूत पत्तियों में एलसी-एमएस और एचआरएमएस द्वारा द्वितीय चयापचयों का अभिलक्षणन किया गया और 11 संयुक्तों को पहचाना गया ।
- वर्षाश्रित स्थितियों के अधीन 7 जीनप्ररूपों (एमआई-0006, एमआई-0504, एमआई-0753, एमआई-0285, एमआई-0577, एमआई-0028 और एमआई-0108) में भूतल उपरि जैव द्रव्यमान (बायोमास)/प्रति पौधा अधिक पाया गया ।

रेशमकीट

- प्यूपे से काइटिन निकालने हेतु आशोधित रासायनिक निष्कर्षण प्रौद्योगिकी/प्रोटोकॉल को मानकीकृत किया गया ।
- प्यूपा, निर्मोक और शल्कों से सूक्ष्माणुओं को निकालने हेतु सूक्ष्माणु निष्कर्षण प्रौद्योगिकी को मानकीकृत किया गया ।
- कोसा से सेरिसिन एवं फाइब्रोइन प्रोटीन निष्कर्षण प्रक्रिया का मानकीकरण किया गया
- मूलमंडल (राइज़ोस्फियर) और रेशमकीट के मध्यांत्र से चौदह 16 एस आर आर एन ए जीन अनुक्रमों को पृथक करके एन सी बी आई डेटाबेस में दर्ज किया गया ।
- रेशमकीट काइटिन और काइटोसन ने शुद्धता और क्रिस्टलीयता दर्शाई जबकि श्रिम्प अक्रिस्टलीय रहा ।
- रेशमकीट की विभिन्न अवस्थाओं में काइटिन की क्रिस्टलीयता में भिन्नता पाई गई ।
- द्विप्रज रेशमकीट नस्लों में पाराक्राट/ओक्सीकारी सहिष्णुता से संबद्ध उत्तरजीविता से जुडे थैयोरेडोक्सिन पेरोक्सिडेस जीन में एस एन पी को पहचाना गया ।
- अल्पायु परिपक्व सी एस आर 17 द्विप्रज रेशमकीट नस्ल में थैयोरेडोक्सिन पेरोक्सिडेस जीन की विलुप्ति पहली बार रिपोर्ट की गई ।
- आर टी-पीसीआर विश्लेषण और कॉपी संख्या में विभिन्नता के आधार पर अनुपरति से संबद्ध जीनों को एम ए एस-1, एम ए एस-2, एम ए एस-3, एम ए एस- 4, एम ए एस- 5 और एम ए एस- 6 के रूप में पहचाना गया और पैतृक वंशों यथा एम वी 1 ओर एच बी 4 तथा विकसित संकर वंशों के बीच सह-संबंध का विश्लेषण किया गया ।
- बिलिदेवालय के उन्नत पी एम-4 में मूल्यांकन करने पर कोसा कवच में 12% कोसा कवच वजन में 8% और अंडजनन क्षमता में 5% वृद्धि पाई गई ।बिलिदेवालया में पालित वंशों की तुलना में उपज/10000 लार्वे भी अधिक पाया गया ।
- पीएम4×सीएसआर 2 की तुलना में संकर नस्ल पीएम 4×सीएसआर 2 ने कोसा कवच में 7% उपज/100 रो मु च और कोसा कवच वजन में 4% वृद्धि दर्शाई । कोसा कवच प्रतिशत, औसतन तंतु लंबाई, टिकाऊ तंतु लंबाई, धागाकरण क्षमता, रेंडिट्टा, कच्चा रेशम प्राप्ति, कच्चा रेशम प्रतिशत, औसतन आकार की डेनियर आदि प्राचलें भी परंपरागत संकर नस्ल की तुलना में बेहतर पाए गए ।
- रेशमकीटों और उनके लक्षण एवं रेशमकीट पीडकों और उनके प्रबंधन पर एक वेब पृष्ठ विकसित किया गया जिसका हितधारकों द्वारा उपयोग किया जा सकता है ।
- इन सिलिको विश्लेषण द्वारा पहचाने गए सात ड्रग्स के लिए जैव आमापन संचालित किया गया और बी एम एन पी वी प्रबंधन हेतु डेक्लाटासविर को प्रभावशाली ड्रग पाया गया ।
- शहतूत और वन्या सेक्टर में एम-लैम्प प्रौद्योगिकी का मान्यकरण किया गया और पाया गया कि शहतूत, तसर,एरी और मूगा रेशमकीटों में यह प्रौद्योगिकी कार्यकारी है और शहतूत रेशमकीटों में 99.94 % संवेदनशीलता दर्ज की गई ।

- रेशमकीट रोगों से संबंधित 21क्षेत्र समस्याओं का समाधान निकाला गया और उचित रोग प्रबंधन हेतु कृषकों को मार्गदर्शन प्रदान किया गया । कृषकों से संपर्क करते हुए अनुवर्ती कार्रवाई भी की गई ।
- रेशमकीट रोग विज्ञान अनुभाग द्वारा वाणिज्यीकृत उत्पादों के लिए 41 गुणवत्ता विश्लेषण् रिपोर्ट ज़ारी की गई ।
- रेशमकीटों पर संक्रमण करने वाले फफूंदियों के 27 पृथकों को बाहरी रूप के आधार पर पृथक किया गया ।आण्विकी अभिलक्षणन करके अनुक्रमों को एन सी बी आई को भेजा गया ।
- प्रजनक स्टॉक, मूबीफा, उरेप्रकें, पी 1 बीजागारों एवं केंरेउजअकें, होसूर में पेब्रिन अनुवीक्षण किया गया ।
- शहतूत रेशमकीट बोम्बिक्स मोरि में उत्पादकता बढाने हेतु प्रोबायोटिक संकुल की पहचान की गई ।.
- विभिन्न निष्कर्षण विधियों के माध्यम से रेशमकीट प्यूपा तेल का निष्कर्षण करके ए. एल. ए का परिमाणन किया गया ।
- रेशमकीट प्यूपे को एक संघटक के तौर पर मिलाकर पास्ता, बिवरेज मिश्रण, कुकिज़ और मयोन्नाइज़ तैयार किया गया ।
- रेशमकीट प्यूपे से मछली खाद्य सम्मिश्रण तैयार किया गया ।
- चॉकी आहार अनुपूरक सम्मिश्रण (सीएफएसएफ) के मान्यकरण परीक्षण में चॉकी निष्पादन में सुधार हुआ और कोसा उपज में वृद्धि हुई (6.28%)
- ऊजी मखी प्रबंधन हेतु कुल 1791 नेसोलिंक्स पाउचों की आपूर्ति की गई ।
- पत्ती रोलर (डाय्फेनिया पल्वेरुंटालिस) के प्रबंधन हेतु कर्नाटक, तमिलनाडु और आंध्र प्रदेश के शहतूत कृषकों को 45 यूनिट अंड परजीव्याभों (ट्राइकोग्रामा किलोनिस) और 39 यूनिट लार्वीय परजीव्याभों (ब्राकॉन ब्रेविकोर्निस) की आपूर्ति की गई ।
- शहतूत थ्रिप्स (प्स्यूडोडेन्ट्रोथ्रिप्स मोरि) के जैव नियंत्रण हेतु कर्नाटक और तमिलनाडु के कृषकों को 31 यूनिट ब्लाटोस्टीथस पल्लेसीन्स की आपूर्ति की गई । परभक्षियों को छोडने से थ्रिप्स का प्रकोप 36% से 10% तक कम हुआ ।
- पत्ती रोलर अंडे, लार्वे एवं प्यूपे पर पत्ती रोलर अंड परजीव्याभ फानेरोटोम स्पीशीज़, लार्वीय परजीव्याभ डोलिकोगेनिडिया स्पीशीज़ और प्यूपीय परजीव्याभ टेट्रास्टिकस होवार्डियै (हिम्नोप्टेरी:यूलोफिडे) के व्यापक उत्पादन को मानकीकृत किया गया ।
- पपाया मिलि बग के नियंत्रण हेतु 1,04,000 एसेरोफैगस पपायै तमिल नाडु के रेउवि/क्षेरेअकें और इसके संबद्ध एककों के 104 कृषकों को वितरित किया गया ।
- इमिडाक्लोप्रिड, डिनोटेफुरन, एसिटामप्रिड, क्लोरफेनापायर, फेनोबुकार्ब, इंडोक्साकार्ब और इमामेक्टिन बेन्ज़ोएट +त्यामेथोक्सम और तीन वनस्पतियों यथा विडी ग्रीनपाथ, विडी कोसिपिल और अज़ाडिराक्टिन नीम सुपर टी को लीफ रोलर डायफेनिया पल्वरुलेंटालिस के प्रबंधन के लिए चुना गया ।
- रेशमकीट प्यूपे के लिंग वर्गीकरण हेतु एक उपस्कर विकसित किया गया और रेबीउकें, मैसूरु में सफलतापूर्वक प्रदर्शन संचालित किया गया ।

विस्तारण

- नियंत्रणाधीन क्षेत्र में 13069 किसानों को सम्मिलित करते हुए 17989.62 एकड़ में शहतूत का पौधारोपण किया गया ।
- आंध्र प्रदेश, कर्नाटक, तमिलनाडु, तेलंगाना, महाराष्ट्र में 26 मेगा क्लस्टरों में क्रियान्वित द्विप्रज समूह संवर्धन कार्यक्रम के माध्यम से 5832.82 मीट्रिक टन द्विप्रज कच्चे रेशम का उत्पादन किया गया और स्वतंत्र क्षेत्र में 495.04 लाख रोमुबीच से 77.3 किग्रा/100 डीएफएल औसतन कोसा उपज प्राप्त हुई ।
- एम-किसान पोर्टल के तहत हर पखवाड़े में कर्नाटक, आंध्र प्रदेश, तेलंगाना, तमिलनाडु, महाराष्ट्र और मध्य प्रदेश के 76200 पंजीकृत किसानों को कन्नड़, तेलुगू, तमिल में 56 संदेश भेजे गए ।
- 288 विस्तार संचार कार्यक्रम आयोजित किए गए और 18,064 हितधारकों को प्रेरित किया गया ।

- प्रगतिशील रेशम उत्पादकों की विवरणिका "सेरीकल्चर सक्सेस स्टोरीज़" पुस्तक प्रकाशित किया गया जिसमें रेशम उत्पादन को स्थायी आजीविका के रूप में अपनाए जाने वाले 69 प्रगतिशील किसानों की जीवन गाथा पर प्रकाश ड़ालते हुए उनकी सराहना की गई हैं।

प्रशिक्षण

- कुल 2618 प्रशिणार्थियों यथा रेशम उत्पादन विभाग के अधिकारियों/कर्मचारियों, रेशम उत्पादकों, उद्यमियों, शोधकर्ताओं और अनुकंपा के आधार पर रोजगार चाहने वालों को संरचित और आवश्यकता आधारित प्रशिक्षण सहित विभिन्न प्रशिक्षण कार्यक्रमों के तहत प्रशिक्षित किया गया जबकि लक्ष्य 2010 था और इस प्रकार 130% लक्ष्य प्राप्त हुआ ।
- विभिन्न विश्वविद्यालयों/कॉलेजों के छियानवे छात्रों ने केंरेअप्रसं के वैज्ञानिकों के मार्गदर्शन में अपनी स्नातकोत्तर डिग्री के एक भाग के रूप में अपनी परियोजना/इंटर्नशिप पूरी की।

एकस्व व वाणिज्यीकरण

- "मूल्य वर्धित उप-उत्पादों के उत्पादन के लिए स्पेन्ट रेशमकीट शलभों के उपयोग की प्रक्रिया" पर अभिनवकरण हेतु पेटेंट सं. 365781 आबंटित करते हुए एक पेटेंट की स्वीकृति प्राप्त हुई ।
- विजेता पूरक-रेशमकीट शय्या विसंक्रमण्कारी का एनआरडीसी, नई दिल्ली के माध्यम से सर्वश्री सेरियो केयर, कोलार और सर्वश्री कावेरी एग्रो प्रोडक्ट्स मैसूरु के साथ वाणिज्यीकरण किया गया था।
- शहतूत के मूल विगलन रोग के नियंत्रण के लिए पौध आधारित सूत्रीकरण-नवीनिया के लिए लाइसेंस का नवीनीकरण(लाइसेंस) एनआरडीसी, नई दिल्ली के माध्यम से मैसर्स नंदी एग्रोवेट, बैंगलूर को किया गया (लाइसेंस की तारीख: 06.8.2021)
- शहतूत में पोषक तत्वों की कमी को दूर करने के लिए एक बहु-पोषक सूत्रीकरण का एनआरडीसी, नई दिल्ली के माध्यम से मैसर्स कावेरी एग्रो प्रोडक्ट्स मैसूर के साथ वाणिज्यीकरण निष्पादन किया गया ।

HIGHLIGHTS

HOST PLANT

- Developed three FtPEPC transgenic mulberry lines with better gas exchange parameters under 60% field capacity and better nutritional status and tolerance to abiotic stress than wild type plants.
- Developed three co-expressing transgenic mulberry lines (CaMV35S, AtSHN1 and AtDREB2A) with better tolerance to drought, salinity and oxidative stresses than wild type plants.
- Under sub-optimal and optimal conditions shortlisted six mulberry genotypes *viz.,* D16, D21, D22, D23, D28 and D34 with leaf yield, growth parameters, silkworm moulting parameters, leaf nutritional parameters and carbon isotope discrimination value on par with check varieties.
- In optimal and sub-optimal conditions, triploid genotype TRI-10 followed by TRI-8 and TRI-9 are found to be performing better over the check varieties.
- Standardized the nutrient solution for growing mulberry under hydroponic and sand culture system.
- Analyzed 536 soil samples of sericulture farmers and provided test based fertilizer recommendation to improve the soil fertility and mulberry leaf quality.
- Carried out the phenotypic evaluation of 230 diverse mulberry germplasm accessions for nitrogen, phosphorus, sulphur and zinc use efficiency.
- DUS test plot with 52 accessions in three replications was maintained and 34 example genotypes were DUS characterized for 35 characters and the reference and candidate varieties were characterized with five SSR markers.

- 17 markers polymorphic between Sahana and V-1 and 15 polymorphic between MR-2 and V-1 were identified.
- Polymorphic SSR's were identified for detection of true hybrids (*Morus multicaulis* x Thailand Male) for genotyping mapping population.
- Isolated bacterial antagonists *Pseudomonas aerogenosa* and *Bacillus subtillus* and fungal antagonist *Trichoderma harzianum* from the soil samples of Karnataka, Tamil Nadu, Andhra Pradesh and Telangana.
- *T. harzianum* isolate was found compatible with copper oxy chloride at 0.1, 0.2 & 0.3% concentrations and also with Mancozeb at 0.1% concentrations.
- AGB-8 mulberry variety recorded higher leaf yield under low input conditions *ie*, 60% irrigation and fertilizer inputs.
- Nitrogen use efficiency was recorded significantly higher value in AGB-8 (53.6%) followed by G-4 (39.1%), V-1 (36.7%) and MSG-2 (27.7%) respectively under low input conditions.
- Higher primary metabolites were recorded in V1, *Morus multicaulis*, G4 and G2; whereas least metabolites were observed in MR2 and Mysore Local.
- 15 genotypes with high epicuticular wax content and 12 genotypes with high stomatal frequency were identified as physiologically efficient genotypes with high WUE parameters.
- Secondary metabolites were characterized and 11 compounds were identified in mulberry leaves by LC-MS and HRMS.
- Under rain-fed conditions, 7 genotypes (MI-0006, MI-0504, MI-0753, MI-0285, MI-0577, MI-0028 and MI-0108) were identified with higher total above ground biomass per plant.

SILKWORM

- Modified chemical extraction Technology/protocol for chitin from pupae was standardized.
- Standardized microbial extraction protocol chitin from pupae, exuviae and scales.
- Standardized extraction procedures of sericin and fibroin proteins from cocoon.
- Fourteen 16S rRNA gene sequences of bacteria isolated from rhizosphere and midgut of silkworm deposited to NCBI database.
- Silkworm Chitin and Chitosan showed purity and crystallinity whereas shrimp chitin and chitosan were amorphous in nature.
- Variation in the crystallinity of Chitin in different stages of silkworm was observed.
- Identifed SNPs in *Thioredoxin peroxidase* gene (*Tpx*) linked to longevity associated with Paraquat/Oxidative stress tolerance in bivoltine silkworm breeds.
- Reported for the first time a specific major deletion in *Thioredoxin peroxidase* gene in CSR17 BV silkworm breed with shorter adult lifespan.
- Based on the RT-PCR analysis and variations in copy number, genes related to non-diapause were identified in MAS-1, MAS-2 MAS-3, MAS-4, MAS-5 and MAS-6 utilizing Marker Assisted Selection (MAS) and correlated among the developed hybrid lines in comparison to parental lines MV1 and HB4. Obtained 3A grade silk from MAS-3 x S8 hybrid.

- Evaluation of the improved PM-4 at Bilidevalaya revealed 12% improvement in shell weight, 8% in cocoon weight and 5% in fecundity. The yield/10000 larvae as also high compared to the lines maintained at Bilidevalaya.
- The cross breed PM-4 x CSR2 has shown 7% improvement in shell weight, 6% improvement in yield/100 dfls and 4% increase in cocoon weight when compared to PM x CSR2. Parameters like shell percentage, average filament length, non-breakable filament length, reelability, renditta, raw silk recovery, raw silk percentage, average size denier *etc*., also were better, in comparison to the traditional cross breed.
- Developed one web page with informations on silkworm diseases and their symptoms and silkworm pests and their management which can be used by the stakeholders.
- Bioassay conducted for seven drugs identified through *in silico* analysis and Declatasvir is identified as a potential drug for the management of BmNPV.
- Validated the M-LAMP technology in both mulberry and Vanya sector and found that the technology works in mulberry, Tasar, Eri and Muga silkworms with a sensitivity of 99.94% in mulberry silkworms.
- Resolved 21 field problems related to silkworm diseases and provided guidance for the farmers for proper disease management. Follow up action was also done by contacting the farmers.
- Issued 41 quality analysis reports for the products commercilaized by Silkworm Pathology.
- Twenty seven isolates of fungi infecting silkworms were identified morphologically and molecular characterization was also done and submitted the sequences to NCBI
- Pebrine monitoring was carried out in the Breeders stock, BSFs, SSBS, P1 grainages and CSGRC Hosur.
- A Probiotic consortium was identified for improving productivity in mulberry silkworm, *Bombyx mori.*
- Silkworm pupae oil was extracted by different extraction methods and quantified ALA.
- Food products pasta, beverage mix, cookies and mayonnaise were prepared by using silkworm pupae as an ingredient.
- Fish feed formulations have been prepared with silkworm pupae.
- In the validation trial of the chawki feed supplement formulation (CFSF), improvement in chawki performance and increase in cocoon yield (6.28%) was observed.
- A total of 1791 pouches of *Nesolynx thymus* were supplied for the management of uzi fly.
- For the management of Leaf roller (*Diaphania pulverulentalis*) supplied 45 units of egg parasitoid (*Trichogramma chilonis*) and 39 units of larval parasitoid (*Bracon brevicornis*) to mulberry farmers of Karnataka, Tamil Nadu and Andhra Pradesh.
- For the biological control of mulberry thrips (*Pseudodendrothrips mori*), supplied 31 units of *Blaptostethus pallescens* to the farmers of Karnataka and Tamil Nadu. Following the introduction of the predator the thrips incidence reduced from 36 per cent to 10 per cent.
- Standardized mass production of leaf roller egg larval parasitoid *Phanerotoma* sp., larval parasitoid *Dolichogenidea* sp. and pupal parasitoid *Tetrastichus howardi* (Hymenoptera: Eulophidae) on leaf roller egg, larvae and pupae.
- 1,04,000 nos of *Acerophagus papayae* distributed to 104 farmers through DoS/RSRS and its nested units of Tamil Nadu for the control of papaya mealy bug.

- Imidacloprid, Dinotefuran, Acetamprid, Chlorfenapyr, Fenobucarb, Indoxacarb and Emamectin Benzoate + Thiamethoxam and three botanicals namely Vidi greenpath, Vidi Kossipil and Azadirachtin Neem super T were shortlisted for the management of leaf roller *Diaphania pulverulentalis*.
- Developed one equipment for gender classification of silkworm pupa and the demonstration has been conducted at SSPC Mysuru successfully.

EXTENSION

- Mulberry plantation extended in 17989.62 acres in the command area covering 13069 farmers.
- A record quantity of 5832.82 MT bivoltine raw silk was produced through Bivoltine Cluster Promotion Programme implemented in 26 mega clusters in Andhra Pradesh, Karnataka, Tamil Nadu, Telangana, Maharashtra and non captive area from 495.04 lakh dfls with an average cocoon yield of 77.3 kg/100 dfls.
- Under M-kisan Portal 56 Messages were sent in every fortnight to 76200 registered farmers from Karnataka, Andhra Pradesh, Telangana, Tamil Nadu, Maharashtra and MP in Kannada, Telugu, Tamil & Hindi.
- Conducted 288 extension communication programmes and sensitized 18,064 stakeholders.
- A compilation depicting flourishing sericulturists titled "Sericulture Success Stories" was published – a collection of 69 sericulturists narrating their saga of sericulture life and appreciation on taking it as their way of life for sustainable livelihood.
- A total of 1032 persons including 320 farmers, 669 students and 43 others have visited the institute during the year.
- A virtual workshop on Mites and Thrips management was organised on 5th October 2021.

TRAINING

- A total of 2618 persons including officers/officials from DoS, sericulturists, entrepreneurs, researchers and employment seekers on compassionate ground were trained under various training programmes, including Structured and Need Based training, achieving 130% target of 2010 persons.
- Ninety Six students from different universities/colleges carried out their project/internship as a part of their Masters Degree under the guide ship of CSRTI Scientists.

Patents and commercialization

- One patent granted with Patent No.365781 for the innovation "Process for the utilization of spent silkworm moths for producing value added by-products".
- Vijetha Supplement- Silkworm Bed Disinfectant was commercialized through NRDC, New Delhi - to M/S.Serio Care, Kolar and M/S. Kaveri Agro Products Mysore.
- License was renewed for Navinya-A Plant-Based Formulation for Control of Mulberry Root Rot Disease (date of license: 06.8.2021) through NRDC, New Delhi to M/S.Nandi Agrovet, Bangalore.
- Commercialized Poshan - A Multi-nutrient Formulation for Correcting the Nutrient Deficiencies in Mulberry through NRDC, New Delhi to M/S.Kaveri Agro Products Mysore.

राजभाषा कार्यान्वयन संबंधी गतिविधियाँ

केंद्रीय रेशम उत्पादन अनुसंधान एवं प्रशिक्षण संस्थान, मैसूरु में वर्ष2021-22 के दौरान राजभाषा नीति का पूर्णत: अनुपालन किया गया। राजभाषा अधिनियम की धारा 3(3) का शत प्रतिशत अनुपालन सुनिश्चित किया गया है। संस्थान में हर तिमाही में नियमित रूप से राजभाषा कार्यान्वयन समिति की बैठक का आयोजन कर राजभाषा प्रगति के बारे में समीक्षा की गई । हिंदी कार्यशालाओं का आयोजन, हिंदी दिवस/पखवाड़े का आयोजन,हिन्दी पत्रिका एवं तकनीकी साहित्य का प्रकाशन तथा हिंदी टिप्पण-आलेखन प्रोत्साहन योजना का कार्यान्वयन किया गया है ।

संस्थान द्वारा उक्त अवधि के दौरान राजभाषा कार्यान्वयन के विभिन्न बिन्दुओं पर की गई कार्रवाई का संक्षिप्त विवरण निम्नानुसार है:

1. **धारा 3(3) का अनुपालन:** राजभाषा अधिनियम 1963 की धारा 3(3) के अधीन आने वाले सभी कागज़ात द्विभाषी में जारी किए गए।
2. **नियम 11 का अनुपालन:** सभी फार्म, पत्रशीर्ष, रबड़ की मोहरें, सूचनापट्ट, नामपट्ट, लिफाफे, पहचान-पत्र, परिचय-पत्र आदि द्विभाषी में तैयार किए गए है इन्हें सुनिश्चित करने हेतु जाँचबिंदु (भंडार अनुभाग, प्रेषण कक्ष और संबंधित अधिकारी स्तर पर) बनाए गए हैं ।
3. **हिंदी पत्राचार:** वर्ष के दौरान क, ख तथा ग क्षेत्र स्थित केंद्रीय सरकारी कार्यालयों को क्रमश: 80%, 80 % और 71% पत्र हिंदी में भेज कर पत्राचार लक्ष्य से अधिक प्रतिशत प्राप्त किया है।
4. **राजभाषा कार्यान्वयन समिति की बैठकों का आयोजन:** संस्थान में हर तिमाही में राजभाषा कार्यान्वयन समिति की बैठक का आयोजन कर राजभाषा प्रगामी प्रयोग के बारे में समीक्षा की गई । वर्ष 2021-22 के अंतर्गत दिनांक **09.07.2021, 06.09.2021, 16.12.2022 एवं 11.03.2022 को** राजभाषा कार्यान्वयन समिति की बैठकें आयोजित की गई तथा बैठकों में लिए गए निर्णय पर अनुवर्ती कार्रवाई की गई।
5. **हिंदी कार्यशालाओं का आयोजन :** संस्थान के पदधारियों को सरकारी काम-काज में हिंदी का प्रयोग करने और साथ-साथ राजभाषा नीति की जानकारी देने के लिए प्रत्येक तिमाही में हिंदी कार्यशाला का आयोजन किया गया। तकनीकी तथा प्रशासनिक पदधारियों के साथ-साथ वैज्ञानिकों के लिए भी इस वर्ष के दौरान दिनांक 16.07.2021, 08.09.2021, 17.12.2021 और 11.02.2022 को अलग-अलग एक दिवसीय हिंदी कार्यशाला का आयोजन कर कुल 42 अधिकारियों व 41 कर्मचारियों को प्रशिक्षित किया गया ।
6. **हिंदी टिप्पण-आलेखन प्रोत्साहन योजना का कार्यान्वयन:** संस्थान एवं इसके अधीनस्थ केंद्रों में कार्यरत अधिकारियों तथा कर्मचारियों को हिंदी में मूल रूप से काम करने को प्रोत्साहित करने के लिए केंद्रीय रेशम बोर्ड की उधारीकृत टिप्पण-आलेखन प्रोत्साहन योजना लागू की गई है जिसके अंतर्गत निर्धारित शब्द लिखने पर नकद पुरस्कार दिया जाता है। इस वर्ष के दौरान इस योजना के अंतर्गत संस्थान के 13 पदधारियों को दिनांक 14.09.2021 को आयोजित राजभाषा पखवाड़ा समापन समारोह में नकद पुरस्कार वितरित किए गए, उनके अलावा अधीनस्थ कार्यालयों के 9 पदधारियों को भी इस योजना के अंतर्गत पुरस्कार प्राप्त हुआ है।
7. **हिंदी प्रकाशन:** संस्थान की वार्षिक रिपोर्ट अंशत: द्विभाषी में प्रकाशित की गई । इसके अलावा शहतूत में मूल विगलन रोग प्रबंधन एवं शहतूत उत्पीड़क ब्रोड़ माइट का संक्रमण और इसका प्रबंधन शीर्षक पैम्फलेटों का हिन्दी में अनुवाद किया गया ।
8. **राजभाषा नियम 10(4) के अंतर्गत अधीनस्थ कार्यालयों को अधिसूचित किया जाना:** जिन कार्यालयों में हिंदी में कार्यसाधक ज्ञान रखने वालों का प्रतिशत80 हो जाता है उन कार्यालयों को मंत्रालय द्वारा राजभाषा नियम 10(4) के अधीन अधिसूचित किया जाता है । इस दिशा में इस संस्थान के अलावा 06 अधीनस्थ कार्यालयों को अधिसूचित कराया जा चुका है।
9. **हिंदी दिवस/ पखवाडे का आयोजन:** संस्थान में दिनांक 01.09.2021 से 14.09.2021 तक राजभाषा पखवाड़ा मनाया गया जिस दौरान 4 विभिन्न हिंदी प्रतियोगिताओं यथा सहीलेखन, श्रुतलेखन, स्मृति परीक्षण, शब्दावली, प्रतियोगिताओं का आयोजन किया गया । प्रत्येक प्रतियोगिता के विजेताओं को प्रथम, द्वितीय, तृतीय एवं सांत्वना पुरस्कार नकद रूप में दिया गया।
10. **राजभाषा शील्ड:** वैज्ञानिक/अधिकारी/कर्मचारी संवर्ग में श्रेष्ठ राजभाषा कार्य निष्पादन हेतु राजभाषा शील्ड वैयक्तिक स्तर पर प्रदान किया जाता है । यह शील्ड सर्वश्रेष्ठ कार्य निष्पादन करने वाले अनुभागों के अतिरिक्त दिया जाता है । इससे वैज्ञानिकों/अधिकारियों/कर्मचारियों में उत्साह का संचार हुआ है एवं बेहतर कार्यान्वयन एवं परिणाम सामने आए है ।

11. **कंप्यूटर पर हिंदी में कार्य:** धारा 3(3) का अनुपालन, फार्म/प्रपत्र,मानक मसौदे, तिमाही रिपोर्ट तथा मूल्यांकन रिपोर्ट, बैठकों की कार्रवाई संबंधी कार्य कंप्यूटर पर सुचारू रूप से किया जा रहा है। संस्थान में सभी अभिकलित्रों में यूनिकोड की व्यवस्था है जिससे हिंदी,अंग्रेजी तथा अन्य भारतीय भाषाओं में काम करने में सुविधा हुई है।
12. **निरीक्षण:** अधीनस्थ कार्यालयों में राजभाषा कार्यान्वयन की प्रगति की समीक्षा करने और तदनुसार आवश्यक सुझाव और मार्गदर्शन देने के लिए उनका निरीक्षण किया जाता है। रिपोर्टाधीन वर्ष में कुल 2 कार्यालयों का निरीक्षण किया गया है।
13. **प्रशिक्षण:** रेशम उत्पादन से संबंधित कुल 10 तकनीकी प्रशिक्षण कार्यक्रम हिन्दी के माध्यम से आयोजित किया गया ।
14. **द्विभाषी मनक प्रपत्र:** हिन्दी पत्राचार में वृद्धि करने हेतु कुल 50 द्विभाषी मानक पत्र तैयार कर 9 अधीनस्थ कार्यालयों के उपयोगार्थ भेजे गए ।
15. **वेबसाइट का द्विभाषीकरण:** संस्थान का विबसाइट पूर्णत: द्विभाषी में बनाई गई है ।

ACTIVITIES REGARDING OFFICIAL LANGUAGE IMPLEMENTATION

During 2021-22 Official Language policy was implemented successfully at Central Sericultural Research and Training Institute, Mysuru. Compliance of section 3(3) of the Official Languages Act was ensured. The progress in implementation of Hindi was reviewed regularly by conducting quarterly meeting of the Official Language Implementation Committee. Organisation of Hindi workshops, Hindi Day, Fortnight, Publication of Hindi magazine/Technical literature were carried out and Hindi Noting drafting scheme was popularised and implemented in the Institute. The details of action taken on various items of Official Language Implementation during the period is as follows:

1. **Compliance of Section 3(3)**: All the papers coming under section 3(3) of the Official Language Act 1963 were issued in bilingual.
2. **Compliance of Rule 11**: All types of forms, letter heads, Rubber Stamps, Sign Boards, Name plates, Envelopes, Identity Cards, Visiting cards etc are prepared in bilingual. Check points (at Stores Section, Despatch Section and at concerned officer level) have been devised to ensure issuance of the same in bilingual.
3. **Hindi Correspondence**: During the year prescribed targets for correspondence in Hindi were achieved by sending 80%, 80% and 71% letters in Hindi to Central Govt. Offices located in A, B and C regions respectively.
4. **Organisation of meetings of the Official Language Implementation Committee**: The progress of implementation of the Official Language was reviewed regularly from time to time by conducting OLIC meeting in every quarter. During the year 2021-22 Official Language Implementation Committee meetings were organised on 09.07.2021, 06.09.2021, 16.12.2021 and 11.03.2022 and follow up action were taken on the decisions of the meeting.
5. **Organisation of Hindi Workshops**: Hindi workshop was organised in every quarter for the officials of the Institute to provide information related to use of Hindi in the Official work and also to extend information about Official Language Policy. During the year, 42 Officers and 41 staff have been trained in Hindi workshops organised on 16.07.2021, 08.09.2021, 17.12.2022 and 11.02.2022 for technical and administrative officials and scientists.

6. **Implementation of noting-drafting incentive scheme**: To encourage the officers and staff of this Institute and its subordinate offices to do their work originally in Hindi. CSB's liberalised noting-drafting incentive scheme was implemented in which cash awards are given for writing prescribed words in Hindi. During the year cash awards were given to 13 officials in the valedictory function of Official Language fortnight held on 14-09-2021. Apart from this, 9 officials of subordinate offices were also awarded prizes under this scheme.
7. **Publications in Hindi**: Annual report of the Institute was published partly in bilingual and two pamphlets *viz*., Management of Root rot disease and Broad mite infestation in mulberry and its control were also published in bilingual.
8. **Notification of the sub-ordinate offices under 10(4) of the Official Languages rules**: The Offices in which 80% of the staff are having working knowledge in Hindi are notified under 10(4) of the official languages rules. In this direction, apart from this office, 6 sub-ordinate offices have also been notified.
9. **Organisation of Hindi competitions**: Official Language Fortnight was organised from 01.09.2021 to 14.09.2021 during which 4 different Hindi competitions *viz*., 1. Correct writing 2. Dictation, 3. Memory test, 4. glossary competitions were organised. The winners of the competitions were awarded with first, second, third and consolation prizes.
10. **Rajbhasha Shield:** Rajbhasha Shield is awarded at individual level in scientific/officer/employee cadre for their best performance in official language work.. This shield is given in addition to the award for the best performing sections which aroused enthusiasm among the scientists/officers/employees and resulted in better performance in implementation.
11. **Work on Computers in Hindi:** Compliance of Section 3(3), forms, standard drafts, quarterly progress report and evaluation report, work related to meetings are carried out smoothly on computers. Unicode system is activated in all computers which facilitates employees to do work in Hindi, English and other Indian languages.
12. **Training**: 10 Training programmes related to Sericulture were conducted through Hindi medium.
13. **Inspection**: Sub-ordinate offices were inspected for reviewing the progress made regarding implementation of Official Language Policy and extending necessary suggestions & guidance accordingly. During the year under report 2 offices have been inspected.
14. 50 billingual standard drafts were prepared and sent to 9 different Sub-ordinate offices so as to increase Hindi correspondence.
15. Website of the Institute has been totally made in bilingual format.

1. MULBERRY BREEDING AND GENETICS

Concluded Research Project

PIC3620: Engineering photosynthesis in mulberry for resilience to climate change: A C4 approach (Aug. 2017-Dec. 2021)

Tanmoy Sarkar, A. S. Raghavendra (Univ. of Hyderabad), T. Mogili (upto Feb. 2018), S. Gandhi Doss (up to Mar. 2021), M. K. Raghunath (from Apr. 2021), T. Gayathri, G. S. Arunakumar, K. N. Ravindra and Babulal

Major objective

- To develop transgenic mulberry with C4 traits through *Agrobacterium* mediated genetic transformation for climate resilience.

Specific objectives

- Construction of gene constructs containing C4 photosynthetic genes (*viz*., PEPC, CA and PEPC+PEPCK) and selectable marker gene in binary vector backbone and mobilization of recombinant binary vector in *Agrobacterium tumefaciens*.
- Genetic transformation and molecular characterization of transgenic Arabidopsis and/ tobacco co-expressing C4 photosynthetic genes and selectable marker gene.
- Genetic transformation and molecular characterization of transgenic diploid mulberry co-expressing C4 photosynthetic genes and selectable marker gene.

In the study, a protocol for *in vitro* regeneration for obtaining complete plantlets from cotyledon and hypocotyl explants of G-4 mulberry has been optimized. Genetic transformation was carried out by using 1192 cotyledon and hypocotyl explants of G-4 mulberry with FtPEPC, FbCA and ZmPEPC+UpPEPCK gene constructs. Total 105 putative transformed mulberry shoots containing FtPEPC, FbCA and ZmPEPC+UpPEPCK genes were selected on hygromycin containing selection medium. A total of 28 putative transgenic plants with three gene constructs *viz*., ZmPEPC+UpPEPCK (designated as M_C6 series), FbCA (designated as M_C7 series) and FtPEPC (designated as M_C10 series) were hardened in earthen pots. Two transgenic mulberry lines were confirmed by PCR using CA gene-specific primers and two transgenic mulberry lines were confirmed by PCR using PEPCK gene-specific primers. Similarly, three transgenic mulberry lines were confirmed by PCR using PEPC gene-specific primers. Quantitative PCR (qRT-PCR) showed 1-1.48 fold expression of heterologous CA gene in two transgenic lines and 1-1.56 fold expression of PEPC gene in three transgenic lines. Transgenic lines expressing the FtPEPC and ZmPEPC+UpPEPCK genes exhibited variation in PEPC enzyme activity (0.067-0.10 units/mg). Three FtPEPC transgenic lines (M_C10_1, M_C10_3 and M_C10_16) showed 1.91 to 2.66 fold increased PEPC activity than wild-type (WT) plants. Most of the transgenic mulberry lines showed better total soluble protein (35.09 to 39.29 mg/g FW) and soluble sugar (30.35 to 36.01 mg/g FW) (Fig. 1.1) than wild type (WT) mulberry plants under well-watered condition. Transgenic mulberry lines showed better net photosynthetic rate (8.98-11.53 µmol CO_2 m^{-2} s^{-1}) (Fig. 1.2), instantaneous water use efficiency (5.57 to 6.05 mmol CO_2 mol^{-1} H_2O) and SPAD value than WT plants under 60% field capacity (60% FC). The relative water content (RWC) (Fig.1.3) and proline content of transgenic mulberry and WT plants remained the same under 100% FC. Eventhough, under 60% FC, RWC of transgenic mulberry and WT plants got reduced (Fig.1.3) it was comparatively higher in transgenic plants.

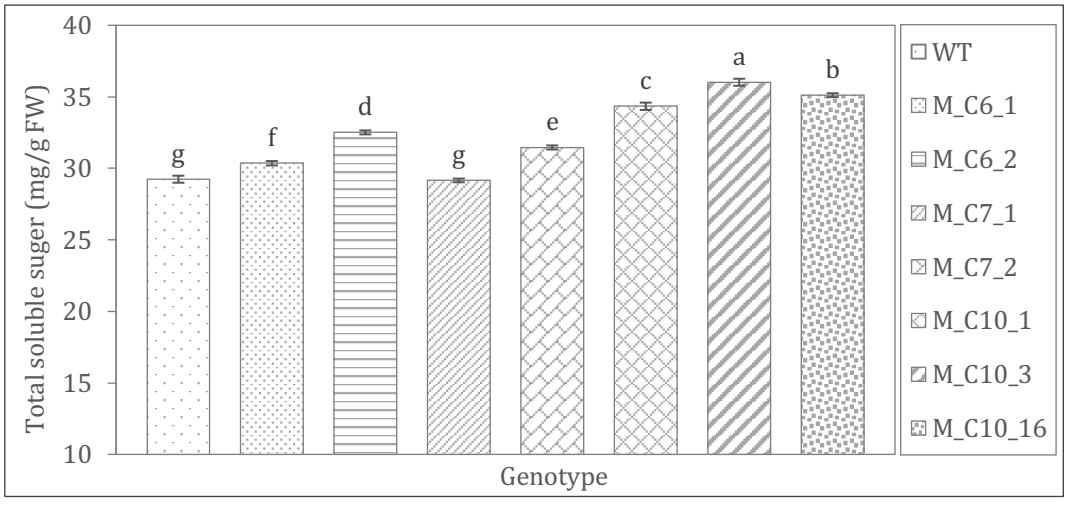


Fig. 1.1: Total soluble sugar in transgenic mulberry and WT plants

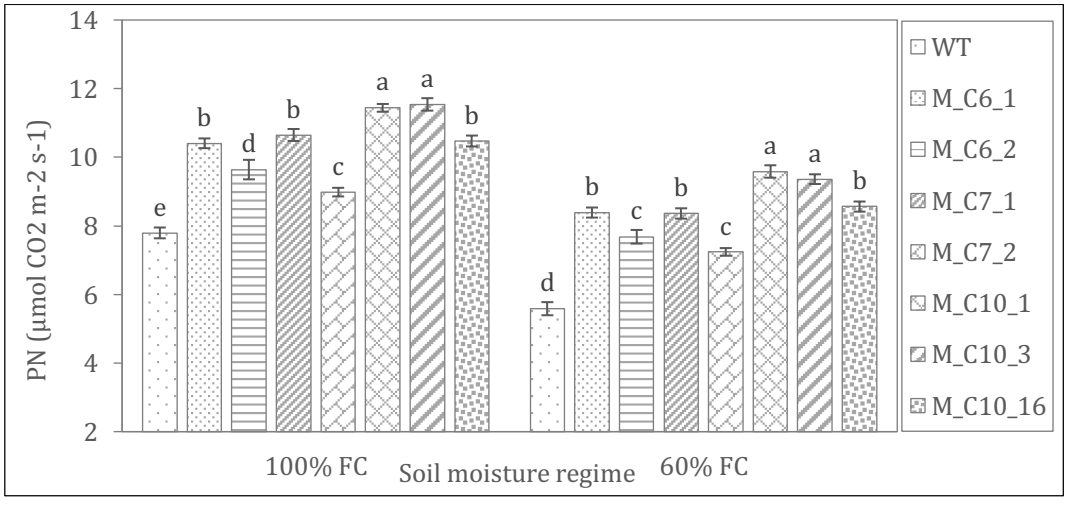


Fig. 1.2: Photosynthetic rate of transgenic and WT plants under 100% and 60% FC

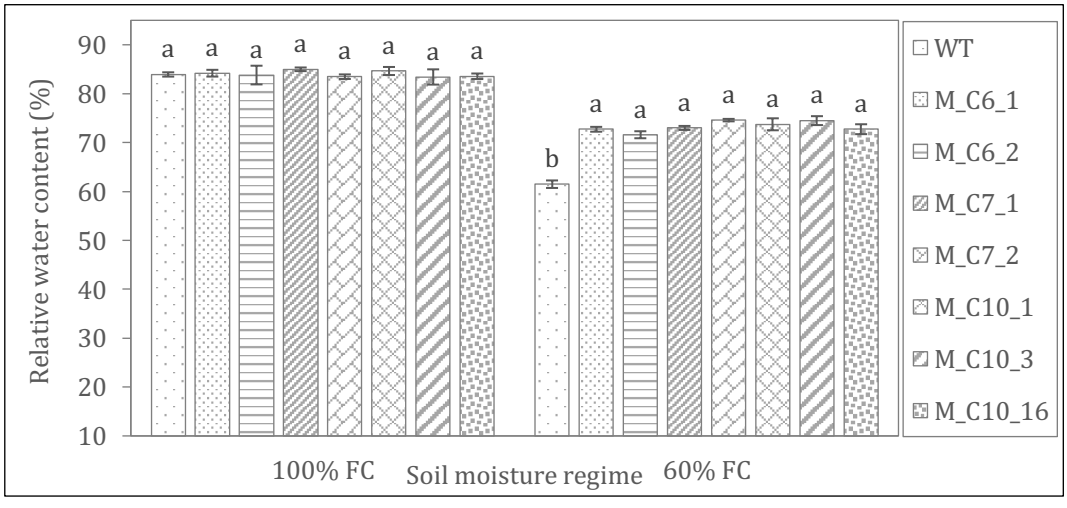


Fig.1.3: Relative water content of transgenic and WT plants under 100% and 60% FC

Conclusion

Based on data analysis it was found that three *FtPEPC* transgenic mulberry lines showed better gas exchange parameters under soil moisture deficit stress, PEPC enzyme activity, nutritional status and tolerance to abiotic stress than other transgenic lines and wild type plants. Hence, these three *FtPEPC* transgenic lines could be further characterized at molecular and physio-biochemical levels under containment facility and confined field trial for event selection as per RCGM/Govt. of India, State Govt. guidelines in collaboration with Research Institute/University.

PIC 01003CN: Genetic enhancement of mulberry by genomics approach: a multi-component project

Sub-component-NW3b: Development of new generation transgenic mulberry for drought stress tolerance and characterization of existing transgenic mulberry for confined field trials (Jun.2018 - Dec. 2021)

Tanmoy Sarkar, N. Nataraja Karaba (UAS-Bengaluru), S. Gandhi Doss (upto Mar. 2021), M. K. Raghunath, (from Apr. 2021), Lalitha Kumari and Babulal

Overall objective

- Development of transgenic mulberry co-expressing transcription factors for drought stress tolerance and characterization of existing transgenic mulberry for confined field trials.

Specific objectives

- Development of new generation transgenic mulberry expressing stress-responsive regulatory genes to improve drought and salinity stress tolerant traits.
- Molecular characterization and evaluation of new generation transgenic mulberry and analysis of existing transgenic lines for confined field trials.
- Development of proposal/application for event evaluation/confined field trials of existing transgenic lines

A total 1622 cotyledon and hypocotyl explants were used for genetic transformation experiment using three multi-gene constructs (nptII + AtSHN1 + AtDREB2A, igRA + EcZF+ AhBTF3 + AhNFYA7, AKR1 + EcNAC1 + EcMYC57 + EcBzip60). Total 184 putative transformed mulberry shoots containing (CaMV35S::AtSHN1:CaMV35S:AtDREB2A) were selected on kanamycin containing selection medium. A total of 48 putative transgenic plants containing three gene constructs were hardened in earthen pots. Three transgenic mulberry plants (M_C1-2, M_C1-5 and M_C1-13) co-expressing AtDREB2A and AtSHN1 were developed, these transgenic lines confirmed by PCR. The qPCR analysis showed expression of DREB2A genes (1.0-1.82 fold) and SHN1 genes (1.0-2.01fold) in three transgenic mulberry lines. Detached leaf disc assay of three transgenic lines showed less chlorophyll degradation under 25% PEG (polyethylene glycol), 200 mM NaCl and 10 µM methyl viologen compared to non-transgenic mulberry and less electrolyte leakage under 25% PEG, 200 mM NaCl compared to non-transgenic mulberry. The transgenic lines also showed less membrane damage, accumulation of superoxide radicals and better chlorophyll retention capacity than WT under drought (25% PEG), salinity (200 mM NaCl) and oxidative (10 µM methyl viologen) stresses.

The transgenic mulberry lines showed better leaf moisture retention capacity (62.02 to 69.53%) compared to wild type (55.08%), 5 h of after harvest, slower and less chlorophyll leaching (33.82 to 40.06%) compared to non-transgenic mulberry plants (47.33 to 55.79%) (Fig. 1.4) and better relative water content and proline content under 60% field capacity (FC) compared to non-transgenic mulberry in earthern pots (Fig. 1.5 & 1.6). *In situ* localization of reactive oxygen species assay showed less oxidative damage in transgenic lines compared to non-transgenic plant under 10 µM Methyl viologen. Further, these

transgenic lines showed better gas exchange parameters (net photosynthetic rate, transpiration rate, stomatal conductance and WUEi) than non-transgenic plant under 60% FC.

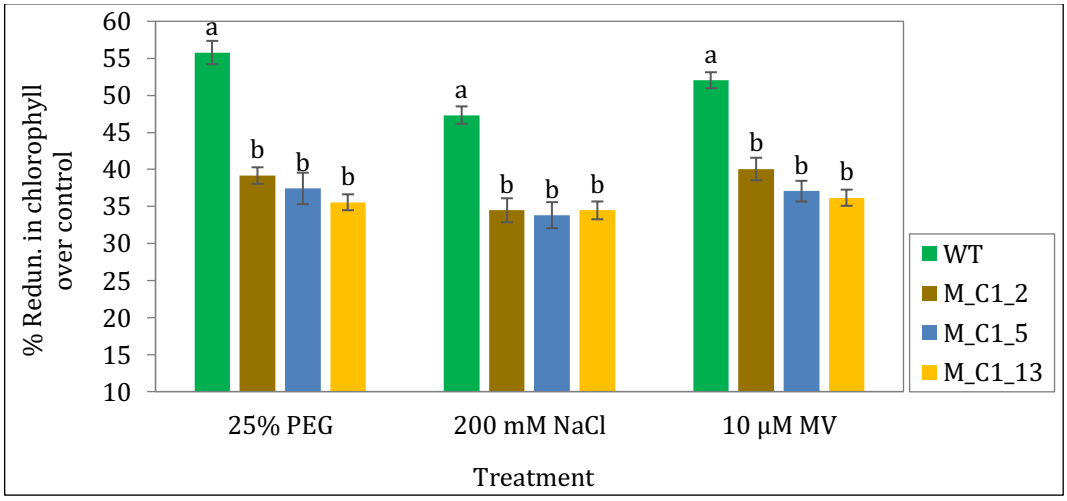


Fig. 1.4: Chlorophyll degradation rate in transgenic and WT plants exposed to treatments

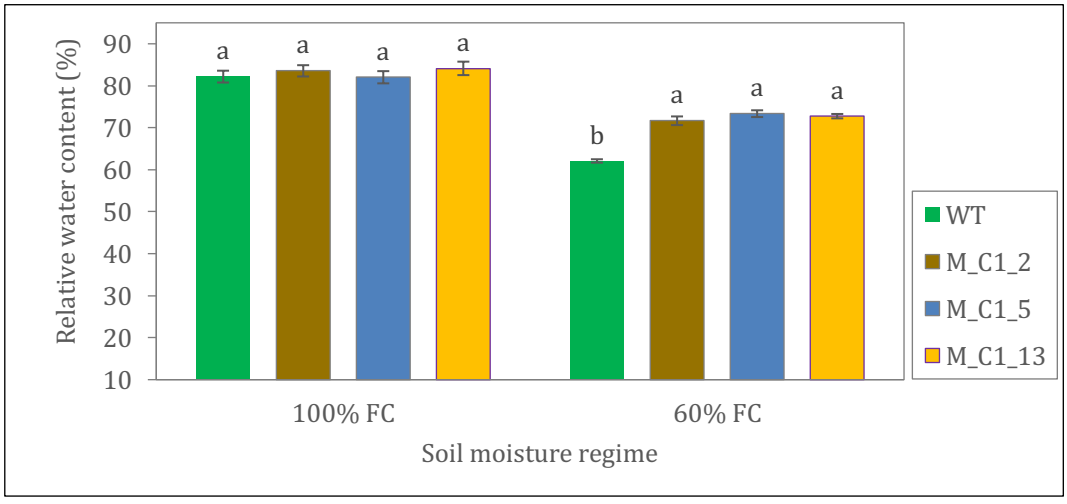


Fig.1.5: Relative water content (RWC) of transgenic and WT plants under 100% and 60% FC

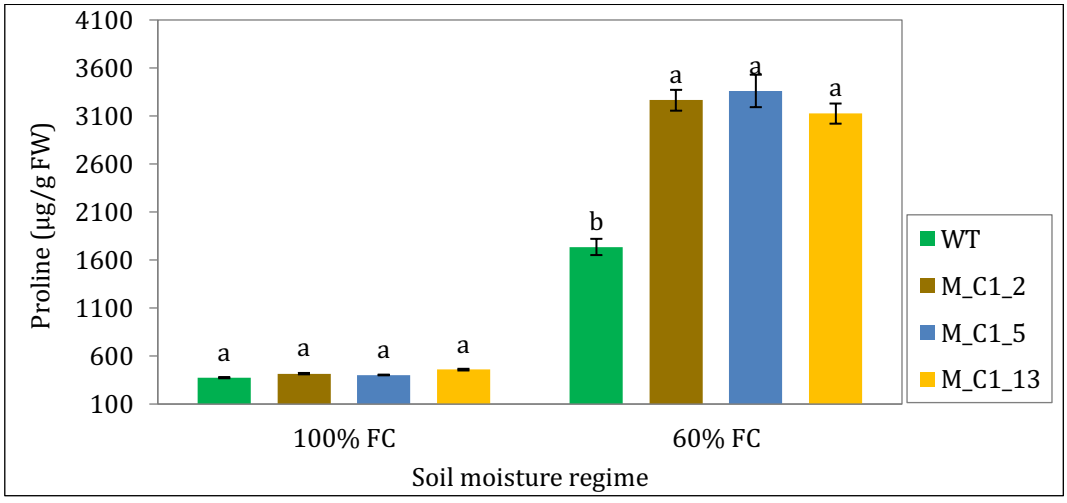


Fig.1.6: Proline content of transgenic and WT plants under 100% and 60% FC

Conclusion

Based on data analysis it was found that transgenic lines (CaMV35S::AtSHN1:CaMV35S::AtDREB2A) showed tolerance to drought, salinity and oxidative stress. Hence, these three transgenic lines could be further evaluated under confined field trials/containment facility for event selection in the future in collaboration with other collaborating University, after obtaining all clearances from regulatory bodies such as RCGM, DBT, India and State Govt.

PIB3631: Primary yield evaluation for identification of superior mulberry hybrids with drought adaptive traits under sub-optimal irrigated conditions (Mar. 2018-Feb.2022)

Tanmoy Sarkar, T. Mogili (upto Feb. 2018), V. Girish Naik (upto May 2019), S. Gandhi Doss (up to Mar. 2021), M. K. Raghunath (from Apr. 2021) G. S. Arunakumar (from Jun. 2019), Manjappa (from Jul. 2021), R. N. Bharath Gowda and Babulal

Objective

- To identify superior genotypes with drought adaptive traits under sub-optimal irrigation condition
- Evaluation of introgression lines/mapping populations developed for drought adaptation using molecular markers/carbon isotope discrimination-Δ13C

Experimental plot with 21 mulberry genotypes along with respective check varieties was maintained in 3 replications under optimal and sub-optimal conditions. Recorded the data on growth, leaf yield, leaf moisture content and leaf moisture retention capacity. Based on the data, it was found that out of 21 test genotypes, seven genotypes such as D16, D21, D22, D23, D24, D28 and D34 showed leaf yield, above ground biomass and total shoot length on par with the check varieties (Vishala, RC-1, AGB-8) under sub-optimal irrigated condition (Table 1.1), with a leaf yield improvement 12.23% to 28.03% over check variety, Vishala under sub-optimal condition. Similarly, out of 21 test genotypes, eight genotypes D16, D21, D22, D23, D24, D28, D34 and D67 showed leaf yield, above ground biomass, total shoot length on par with check varieties (Vishala, G-4, V-1) under optimal irrigated condition (Table 1.2) and showed 1.02 % to 19.39% yield improvement over check variety Vishala.

Carbon isotope ratio ($\delta^{13}C$) is having a strong inverse relationship with water use efficiency (WUE). Hence, it is considered as an indirect selection criterion for water use efficiency (WUE). In this study, mulberry check variety, Vishala showed least positive δ13C value (-30.312) among seven test genotypes (D16, D21, D22, D23, D24, D28 and D34) and other two check varieties (AGB8 and RC1) maintained under sub-optimal condition. The $\delta^{13}C$ value of D23 (-30.243) is on par with Vishala. The $\delta^{13}C$ values of six mulberry genotypes D16, D21, D22, D24, D28 and D34 were better than that of the check variety RC1 (-29.289). Silkworm moulting test showed that most of the moulting parameters were higher in case of all seven test genotypes (D16, D21, D22, D23, D24, D28 and D34) than the check variety Vishala for sub-optimal and optimal conditions. Under optimal condition, two mulberry genotypes D23 and D28 showed moulting performance on par with check varieties V1 and G4. Total sugar, protein and chlorophyll content of two test genotype D23 and D28 were on par with AGB8 and G4 under sub-optimal and optimal conditions.

Table 1.1: Growth and yield parameters of selected mulberry genotypes and three check varieties under Sub-optimal irrigated conditions

Genotype	LY (g/pl)	AGB (g/ pl)	Leaf: shoot ratio	NS	LLS (cm)	TSL (cm)	LMC (%)	MRC (%)
D5	168.37	360.56	0.47	8.56	85.68	582.39	68.65	64.76
D16	404.48	834.78	0.48	8.31	113.79	879.39	74.56	77.36
D21	514.86	1042.56	0.49	9.78	127.48	1063.94	77.74	76.03
D22	388.37	796.89	0.49	10.14	137.62	1122.00	74.92	77.14
D23	465.84	964.33	0.48	10.63	127.72	1125.06	72.78	74.08
D24	348.57	735.78	0.48	13.81	107.43	1158.06	70.23	73.02
D25	290.17	601.33	0.48	11.12	115.26	1098.78	73.75	63.75
D28	542.31	1111.00	0.49	9.66	122.83	1059.67	73.83	77.95
D34	343.75	712.56	0.48	8.80	110.49	882.44	71.41	70.45
D35	248.23	515.78	0.48	7.82	109.14	665.50	71.11	70.87
D40	207.94	454.67	0.46	8.19	128.58	832.33	77.68	70.74
D48	209.59	448.56	0.47	13.20	111.96	990.61	75.81	65.77
D56	267.13	575.67	0.47	11.86	121.49	1164.17	72.10	61.83
D57	299.62	624.56	0.48	8.31	115.99	1037.06	74.63	67.38
D59	183.86	392.94	0.47	8.07	116.36	997.94	71.97	64.80
D61	206.26	440.00	0.47	7.94	140.43	955.78	75.54	73.96
D62	167.55	370.33	0.45	7.21	96.80	475.44	73.69	73.38
D63	226.99	486.44	0.47	7.94	122.34	697.89	75.32	74.68
D65	212.25	460.78	0.46	7.58	110.37	705.22	76.55	74.55
D67	259.82	499.89	0.55	11.12	112.81	1082.89	73.23	72.94
D82	208.12	442.44	0.47	8.68	99.37	786.50	74.05	73.14
Vishala	340.05	723.56	0.47	8.80	122.22	988.78	73.15	75.70
AGB8	415.29	855.56	0.49	9.78	123.20	1068.83	73.22	78.67
RC1	355.40	756.56	0.47	8.19	121.37	930.11	73.56	75.39
CD at 5%	46.12	97.27	0.03	2.88	25.90	291.71	3.97	7.35
CV%	16.36	16.51	6.78	18.64	13.50	19.06	3.28	6.21
Significance	**	**	**	**	*	**	**	**

Table 1.2: Growth and yield parameters of selected mulberry test genotypes and three check varieties under Optimal irrigated conditions

Genotype	LY (g/pl)	AGB (g/pl)	Leaf: shoot ratio	NS	LLS (cm)	TSL (cm)	LMC (%)	MRC (%)
D5	183.05	387.44	0.47	10.02	113.79	749.22	71.30	65.31
D16	540.53	1079.83	0.50	8.56	115.87	1029.72	75.60	77.16
D21	539.43	1093.89	0.49	10.02	128.94	1110.39	78.23	77.01
D22	546.48	1113.64	0.49	10.39	140.80	1134.83	75.39	77.74
D23	594.92	1182.50	0.50	11.49	131.88	1156.83	73.83	77.52
D24	527.49	1082.89	0.49	15.89	111.96	1175.17	73.97	74.17
D25	320.91	641.81	0.50	11.37	119.90	1114.67	75.22	65.13
D28	647.70	1286.85	0.50	10.39	130.78	1183.11	75.25	78.69

Genotype	LY (g/pl)	AGB (g/pl)	Leaf: shoot ratio	NS	LLS (cm)	TSL (cm)	LMC (%)	MRC (%)
D34	523.97	1063.33	0.49	9.17	137.99	1012.61	74.64	74.58
D35	274.78	549.56	0.50	8.07	116.11	674.06	72.62	71.31
D40	246.17	521.89	0.47	8.07	134.81	846.39	76.95	71.59
D48	272.38	554.89	0.49	13.57	132.73	1210.00	79.62	67.89
D56	346.59	699.72	0.49	11.98	133.96	1207.56	73.36	70.08
D57	365.08	740.91	0.49	8.68	119.29	1059.06	75.29	71.18
D59	246.00	506.00	0.48	8.19	119.41	1002.83	73.08	65.67
D61	263.01	537.78	0.49	8.07	143.37	983.89	76.31	73.21
D62	323.19	658.78	0.49	7.33	127.48	539.00	74.47	74.31
D63	285.05	608.67	0.47	8.19	126.74	727.83	76.03	74.46
D65	283.46	584.22	0.49	7.94	120.39	748.00	76.89	74.85
D67	529.17	1058.35	0.50	11.73	134.81	1174.56	74.31	73.55
D82	257.57	535.46	0.48	8.80	113.79	837.83	74.98	73.73
Vishala	522.08	1062.11	0.49	9.41	126.01	1071.28	76.63	76.78
V1	560.56	1121.12	0.50	10.14	124.67	1108.56	78.08	78.58
G4	583.86	1165.27	0.50	10.39	126.87	1156.83	75.68	77.12
CD at 5%	40.05	79.52	0.01	1.05	11.75	76.72	3.97	4.75
CV %	10.56	10.34	2.45	11.44	10.00	8.24	3.21	3.94
Significance	**	**	**	**	**	**	**	**

Conclusion

Based on analysis of growth and yield parameters, six genotypes D16, D21, D22, D23, D28 and D34 were identified as suitable varieties for sub-optimal and optimal conditions. Similarly, seven genotypes D16, D21, D22, D23, D28, D34 and D67 were identified as suitable varieties for optimal irrigated condition.

PIB 3632: Evaluation of superior triploid genotypes for yield and adaptability under varied agro-climatic conditions (Mar. 2018-Feb. 2024)

M. K. Raghunath (from Apr. 2021), Manjappa (from Apr. 2021), S. Gandhi Doss (upto Mar. 2021), Vijaya Naidu (upto March 2021), Tanmoy Sarkar, G. S. Arunakumar, S. K. Hanumantharayappa, K. P. Kiran Kumar (from Apr. 2021), S. Kamaraj and Babulal

Objective

- Evaluation of identified triploid genotypes for development of superior variety with high yield and quality for optimal input conditions.
- Evaluation of identified triploid genotypes for development of superior variety with high yield and quality for sub-optimal input conditions.

Three crops data (*i.e.*, 3rd, 4th and 5th) pertaining to growth and yield data were recorded at CSRTI, Mysuru for the first year along with major foliar and root diseases under optimal condition. Likewise, 4 crops data (*i.e.*, 2nd, 3rd, 4th and 5th crops) on growth and yield attributing characters was recorded in the experimental garden under sub-optimal condition (Table 1.3 & 1.4).

Table 1.3: Growth and yield parameters of triploid genotypes under optimal conditions
(Pooled data of 3 crops)

Genotype	No. of Shoots	Length of longest shoot (cm)	Total shoot length (cm)	Above ground biomass/ plant (g)	Leaf Wt./plant (g)	Moisture content (%)	Moisture retention capacity (%)
Tri-1	11.7	103	1042	683	348	72.2	85.8
Tri-5	10.8	104	1145	887	434	69.9	82.6
Tri-6	14.3	109	1189	936	422	70.6	79.2
Tri-8	10.7	101	946	808	418	70.8	84.1
Tri-9	10.7	110	1063	951	489	71.6	85.2
Tri-10	16.5	114	1363	1101	585	72.4	83.1
G-4	10.1	106	954	955	492	72.4	84.4
Vishala	10.2	114	942	936	439	72.3	85.3
CD at 5%	2.1		185	123	66	1.6	3.3
C.V.(%)	10.2	5.5	9.7	7.7	8.2	1.2	2.3
Significance	**	NS	**	**	**	*	**

*Significance at 0.05 level of probability; **Significance at 0.01 level of probability

Table 1.4: Growth and yield parameters of triploid genotypes under sub-optimal conditions
(Pooled data of 4 crops)

Genotype	No. of Shoots	Length of Longest Shoot (cm)	Total Shoot Length (cm)	Moisture Content (%)	Moisture Retention Capacity (%)	Above Ground Biomass/ plant (g)	Leaf Wt./plant (g)
Tri-1	10.3	112	1091	76.0	84.9	1381	807
Tri-5	13.4	102	1014	76.5	82.4	1149	695
Tri-6	27.5	117	3625	77.4	81.4	2014	971
Tri-8	15.3	123	1741	77.4	84.8	2365	1291
Tri-9	17.3	105	1924	77.5	84.8	1662	911
Tri-10	33.5	120	3520	77.7	86.3	2698	1485
G-4	18.0	101	1849	75.6	86.4	1049	764
Vishala	15.1	92	1259	78.5	84.8	1338	800
CD at 5%	3.2	14.3	418.6	1.8	2.8	572.9	205.3
CV (%)	9.6	7.4	11.8	1.3	1.9	19.0	12.0
Significance	**	**	**	*	*	**	**

*Significance at 0.05 level of probability; **Significance at 0.01 level of probability

Analysis of pooled data reveals that triploid genotypes TRI-10 followed by TRI-8 and TRI-9 showed better performance over the check varieties in both optimal and suboptimal irrigated conditions.

AICEM Phase-IV: PIE13001 MI: All India Coordinated Experimental Trials for Mulberry (Apr. 2019-Mar. 2025)

Manjappa (from Apr. 2021), S. Gandhi Doss (up to Mar.2021), P. Sudhakar, S. K. Hanumantharayappa, A. Venugopal, B. Srinath (up to Mar. 2021), S. Rajadurai, (from Apr. 2021), J. B. Narendrakumar, K. Jhansilakshmi and Babulal

PI: K. Vijayan (upto May 2021), S. Nazeer Ahmed Saheb (from Jun. 2021)

Facilitators: M. K. Raghunath, G. S. Arunakumar, M. R. Bhavya, V. Shobana and K. Jhansilakshmi

Objective

- Identification of suitable mulberry variety for regional, zonal and national use based on their performance.

Three test genotypes CMY01, CBP01 and CPP01 have been evaluated at seven test centers of South India along with check varieties G4 and V1. Analysis of pooled data over three crops revealed that CMY01 genotype has shown significantly highest leaf yield per plot over other test genotypes and check varieties V1 and G4 (Table 1.5).

Table 1.5: Performance of test genotypes and checks for growth, leaf yield and leaf moisture parameters (Pooled data of three crops).

Genotype	Total shoot length (cm)	Nodes/m shoot engths	Leaf: Shoot ratio	Leaf Moisture (%)	Leaf Moisture (%) after 6 h	Leaf yield/plot (kg)
CMY 01	843	20.13	0.55	76.3	71.6	20.8
CBP 01	839	16.19	0.50	76.3	71.5	18.3
CPP 01	455	15.13	0.52	74.8	69.9	11.8
V1	791	20.22	0.54	75.6	71.8	17.5
G4	809	21.13	0.56	76.4	72.0	18.6
CD at 5%	119	0.89	0.02	0.82	1.24	1.6
CV (%)	18.0	5.4	0.2	1.2	2.0	10.7
Significance	**	**	**	**	**	**

**Significance at 0.01 level of probability

Survivability and rooting ability of test genotypes and checks were evaluated under nursery condition by following Randomized Block Design with five replications. CMY01 (84.8%) and CBP01 (83.4%) genotypes shown statistically on par with the checks with respect to survivability of cuttings (Table 1.6). CMY01 and CPP01 shown on par fresh shoot weight of saplings with the checks and CMY01 and CBP01 shown on par root weight with G4 variety.

Table 1.6: Survivability and rooting ability of different genotypes

Genotype	Survivability 90 DAP (%)	Fresh Shoot Wt. (g)	Fresh Root Wt. (g)	Shoot: Root Ratio
CMY 01	84.8^{a}	75.1^{a}	7.2^{a}	10.68^{bc}
CBP 01	83.4^{a}	66.2^{b}	7.3^{a}	9.64^{c}
CPP 01	76.6^{b}	68.1^{a}	4.5^{b}	15.06^{b}
G4	88.8^{a}	89.7^{a}	7.0^{a}	12.86^{bc}
V1	83.8^{a}	86.7^{a}	4.2^{b}	20.90^{a}
CV (%)	3.7	15.2	19.4	18.8
Significance	**	**	**	**

**Significance at 0.01 level of probability; Values with different letters are significantly different

PIE 01022 SI: Evaluation of promising mulberry genotypes for higher leaf yield and resistance to root rot and root knot diseases in primary yield trial (Dec. 2021-May 2026)

Manjappa, G. S. Arunakumar and M. K. Raghunath

Objectives

- Identification of superior genotypes with higher yield, quality and resistance to Root rot & Root knot nematode diseases.
- Confirmation of resistance levels in superior genotypes under artificial inoculation conditions.

Multiplication of 22 test genotypes and 3 checks (V1, G4 and BR8) undertaken by planting the cuttings in the nursery bed.

Continuous/Other activities

Maintenance of mulberry germplasm, Breeder Seed Plot and demonstration plot

Manjappa (from Apr. 2021), M. K. Raghunath (from Apr. 2021), S. Gandhi Doss (up to Mar. 021), Tanmoy Sarkar and Babulal (from Jan. 2021)

A working germplasm with 28 accessions was maintained for future hybridization programmes. Nineteen elite varieties were also maintained in the demonstration plot. Breeders' seed plot of six mulberry varieties *viz.,* G4 (for late age silkworm rearing), G2 (for young age silkworm rearing), MSG2 (for soil moisture stress environments) AGB8 (for sub-optimal irrigated conditions) and AR-12 (alkaline soil resistant) and Sahana (Shade tolerance) were maintained for multiplication.

Meteorological Observatory

Honorary Superintendent : M. K. Raghunath, Sci-D (from Apr. 2021)

Observers : Muthappa, STA (from Jan. 2020)

: Ramesh, AT (from Jan. 2020)

The Part-time observatory of India Meteorological Department [IMD] has been functioning at the Institute and keeping records and communication to IMD, Bengaluru (Table 1.7).

Table 1.7: Meteorological data for the year 2021

Month	Temperature [°C]			Humidity [%]			Rainfall [mm]	No of rainy days (d)
	Max.	Min.	Mean	Max.	Min.	Mean		
Januray	32.40	20.00	26.20	98.00	85.00	91.50	25.00	1.00
February	33.10	19.80	26.45	96.00	89.00	92.50	22.00	2.00
March	45.10	33.90	39.50	93.00	64.00	78.50	0.00	0.00
April	36.90	22.20	29.55	84.00	69.00	76.50	31.00	3.00
May	35.20	21.80	28.50	93.00	85.00	89.00	41.00	3.00
June	33.80	21.80	27.80	90.00	79.00	84.50	151.00	8.00
July	32.60	21.80	27.20	93.00	87.00	90.00	144.00	12.00
August	31.10	22.00	26.55	98.00	88.00	93.00	82.00	7.00
September	33.00	22.20	27.60	93.00	79.00	86.00	39.00	4.00

October	31.10	22.40	26.75	95.00	91.00	93.00	485.00	21.00
November	30.40	22.00	26.20	100.00	92.00	96.00	292.00	15.00
December	31.00	22.40	26.70	95.00	84.00	89.50	18.00	3.00
Mean	33.81	22.69		94.00	82.67			
Extm.High	45.10	33.90		100.00	92.00			
Extm.Low	30.40	19.80		84.00	64.00			
						Total rainfall (mm)		1330.00
						No. of rainy days (d)		79.00

2. MULBERRY MOLECULAR BIOLOGY

Concluded Research Projects

PIC3615: Mapping QTLs for alkalinity tolerance in Mulberry (*Morus* spp.)(Aug. 2017 - Dec. 2021)

M. R. Bhavya, T. Gayathri, Y. N. Sanath Kumar, K. C. Mahalingappa and S. Bharatesh

Objectives

- To validate the response of accessions contrasting for alkalinity stress and development of mapping population
- Identification of QTLs controlling alkalinity tolerance in mulberry
- To validate the response of accessions contrasting for alkalinity stress

The stress response of already identified contrasting accessions (20 tolerant and 18 susceptible, Table 2.1) was examined by evaluating them in hot-spots at REC-sub unit Kinakanahalli and REC-Koppal, along with two checks- AR12 (resistant check), V1 (susceptible check) under RCBD design with 90cm × 90cm spacing. Data has been recorded on number of branches, length of the longest shoot and total biomass, total leaf weight and total shoot weight.The study was also carried out under artificial stress using pot culture techniques at CSRTI, Mysuru for reconfirmation. These genotypes were evaluated under alkaline soil with pH 9 and also in soil with optimum pH (7.0-7.2) as a control.

Though the performance of the tolerant check was more than all other genotypes included in the experiment, due to its triploid nature, it was not considered as a parent for crossing. However, the genotypes MR-2 and Sahana which are not significantly different in performance from tolerant check AR12 were selected as alkaline tolerant female parents for development of mapping population.

The susceptible check V-1 produced total biomass and total leaf weight per plant at Kinakanahalli is 330g and 181.66g, respectively and at Koppal is 213.75 g and 80 g, respectively. The total biomass and total leaf weight of V1 is significantly different from AR12, Sahana and MR2. Therefore, V-1 was considered as susceptible male parent for development of mapping population by expecting some transgressive segregants in the progeny which are tolerant to alkaline stress and also high yielding.

The study conducted under artificial stress using pot culture techniques at CSRTI-Mysuru reconfirmed the field results based on SPAD chlorophyll meter reading, glycine betaine content and genotypic score based on leaf yield. Comparison between genotypes in control and alkaline treated condition, efficient genotypes for alkaline tolerance showed a lesser reduction in SPAD values, while higher reduction among inefficient genotypes. SPAD value more than 30 recorded by the genotypes was TR-7 (MI-0190):35.50 > MR-2 (MI-0025):35.00 > AR-12 (MI-0799):34.50 > Hosur C16 (MI-0836):32.43 > Sahana (MI-

0524):31.75 and L-4 (MI-0641):31.73 under alkaline treatment of pH 9 (Fig. 2.1). SPAD value of susceptible check V-1 (MI-0308) is 20.20 under pH 9. The significant reduction in the SPAD value indicates susceptibility of genotypes to the alkaline stress.

Significant increase in glycine betaine content under alkaline treatment compare to control, indicates tolerance of those genotypes to alkaline stress. The genotypes identified are MI-0263, MI-0512, MI-0677, MI-0190, MI-0226, MI-0437, MI-0449, MI-0716, MI-0788, MI-0822, MI-0836, MI-0025, MI-0524 and MI-0799(Fig. 2.2). The genotypes tested for alkalinity stress having genotypic score based on leaf weight above 0.8 are MI-0799, MI-0025, MI-0524, MI-0226 and MI-822, which indicates that the leaf weight reduction was low in these genotypes under alkaline stress.

Development of mapping population (by crossing contrast genotypes) for alkalinity stress trait

Parents were selected based on performance under alkaline stress, ploidy and sex expression of genotypes. MR-2 and Sahana were selected as a female tolerant parents, V-1 as a male susceptible parent. After repeated hybridization, two mapping population namely, MR-2(MI-0025) (R) × V-1 (MI-0308) (S) with 19 progenies, Sahana (MI-0524) (R) × V-1 (MI-0308) (S) with 144 F1 progenies were developed and established in the field. In addition to that 250 seedlings in MR-2×V-1 cross and 600 seedlings in Sahana ×V-1 cross also developed.

Identification of QTLs controlling alkalinity tolerance in mulberry

70 SSR markers were synthesized out of 1800 primers from *Morus alba* genome.

Isolation of genomic DNA from the parents and mapping population

Isolated genomic DNA from leaf samples of parents (MR-2, Sahana and V-1) and one hundred and fourty four F_1 progenies of Sahana×V-1 cross and 19 F1 progenies of MR-2×V-1 cross.

Identification of polymorphic markers between the parents

A total of seventy SSR markers were used for identification of polymorphic markers. Fifteen markers were found polymorphic between MR-2 and V-1 viz., MaSSR3, MaSSR4, MaSSR20, MaSSR26, MaSSR30, MaSSR36, MaSSR38, MaSSR39, MaSSR44, MoSo288, MulSSR258, MoSo-157-2, MulSSR85, MulSSR96B and M2SSR82. Seventeen markers were found polymorphic between Sahana and V-1 viz. MaSSR3, MaSSR13, MaSSR14, MaSSR17, MaSSR24, MaSSR30, MaSSR37, MaSSR38, MaSSR39, MaSSR45, MaSSR48, MoSo288, MulSSR258, MoSo-157-2, MulSSR85, MulSSR96B and M2SSR82. These polymorphic markers were used for genotyping of mapping population.

Table 2.1: List of accessions showing contrasting alkalinity stress

Alkaline tolerant accessions	Alkaline susceptible accessions
MI-0190, MI-0226, MI-0248, MI-0437, MI-0449, MI-0499, MI-0466, MI-0643, MI-0652, MI-0670, MI-0702, MI-0716, MI-0762, MI-0764, MI-0788, MI-0822, MI-0836, MI-0025, MI-0524, MI-0158	MI-0119, MI-0263, MI-0308, MI-0370, MI-0491, MI-0512, MI-0523, MI-0544, MI-0580, MI-0641, MI-0677, MI-0775, MI-0846, MI-0863, MI-0868, MI-0869, MI-0871, ME-0006
AR-12: MI-0799 (Tolerant check)	V-1: MI-0308 (Susceptible check)

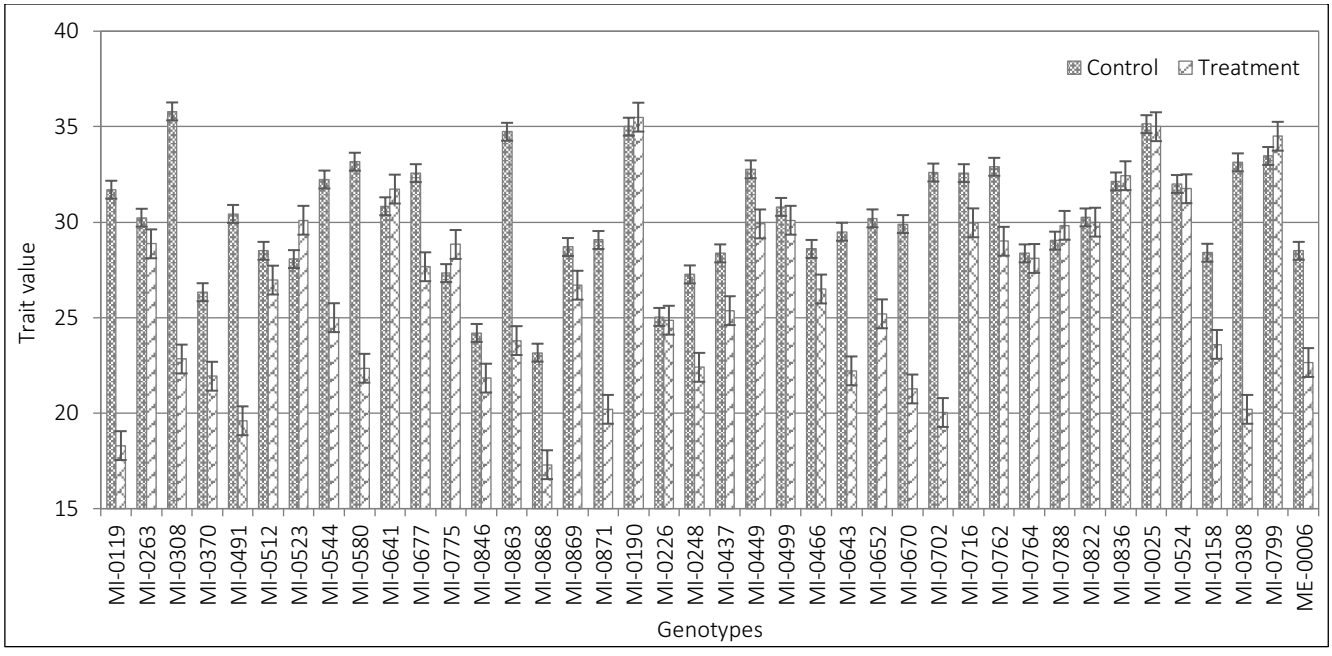


Fig. 2.1: SPAD chlorophyll meter reading of 40 mulberry genotypes in control and alkaline treatment

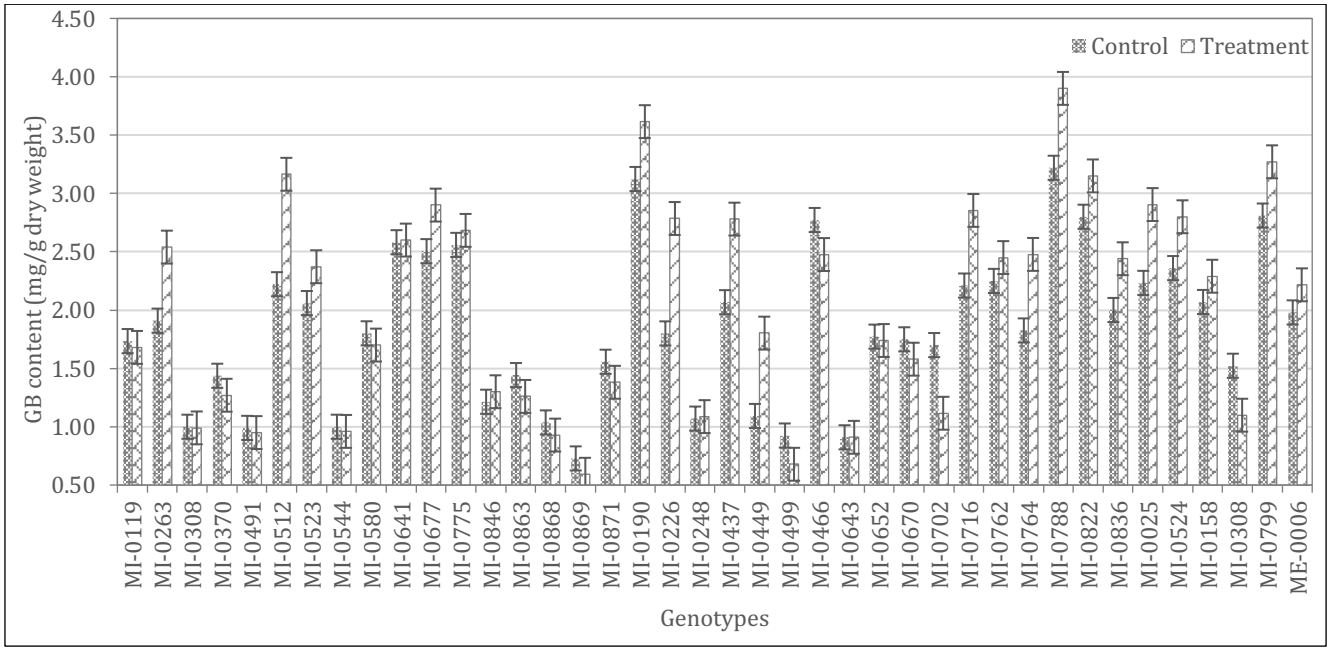


Fig. 2.2: Glycine betaine (GB) contents in leaves of 40 mulberry genotypes under control and alkaline treatment

Conclusion

The study revealed that AR-12, MR2, Sahana, Bheriadangi-1, TR-7, T-36, Saranath-3, Kanthaloor-2, C-776 and Khodol were alkaline tolerant genotypes and V-1 and other genotypes were alkaline susceptible genotypes. In the study 50 novel SSR markers were identified which can be used for molecular characterization, DNA finger printing, linkage map development, QTL identification and gene tagging in mulberry. Also identified fifteen polymorphic markers between MR-2 and V-1 (MaSSR3, MaSSR4, MaSSR20, MaSSR26, MaSSR30, MaSSR36, MaSSR38, MaSSR39, MaSSR44, MoSo288, MulSSR258, MoSo-157-2,

MulSSR85, MulSSR96B and M2SSR82). Seventeen polymorphic markers found between Sahana and V-1 (MaSSR3, MaSSR13, MaSSR14, MaSSR17, MaSSR24, MaSSR30, MaSSR37, MaSSR38, MaSSR39, MaSSR45, MaSSR48, MoSo288, MulSSR258, MoSo-157-2, MulSSR85, MulSSR96B, M2SSR82).Two different mapping population of MR-2×V-1 and Sahana×V-1 were developed which can be used for development of QTLs for alkaline tolerance trait.

PIC01003 CN (NW2a): Validation of a high-density SNP genotyping array for QTL discovery by association mapping and bi-parental analysis in Mulberry (Sep. 18-Dec. 21)

G. S. Arunakumar, B. N. Gnanesh, Tanmoy Sarkar, L. Satish (From 21.05.2021) and H. B. Manoj Kumar

Objectives

- SNP genotyping of panel of diverse germplasm and mapping population
- Construction of a genetic linkage map using SNP markers
- QTL discovery by marker-trait association and linkage mapping using phenotypic data for different traits.

A collection of 400 indigenous and exotic mulberry germplasm is being conserved at CSRTI, Mysuru. Among them 172 accessions were genotyped using twenty SSRs markers.

Genetic diversity and cluster analysis

Genetic diversity parameters such as percentage of polymorphic loci, effective allele number (Ne), gene diversity (H), Shannon's information index (I), gene frequency, and gene flow (Nm) were computed.

Results

The genomic DNA of 172 mulberry germplasm was amplified with MulSSR, MoSo, MEST and M2SSR series of SSR markers and these markers revealed 96 different SSR bands. Out of 96 markers used in the study, 20 markers (20.83%) M2SSR81, Moso340-2, M2SSR87, Moso288, MULSSR 25, M2SSR112A, MULSSR26, M2SSR68, MULSSR313, MULSSR258, MoSo-157-2, M2SSR36, M2SSR1, MULSSR85, MULSSR96B, M2SSR10, M2SSR89A, M2SSR107, M2SSR82 and M2SSR20 have been polymorphic between the diverse mulberry germplasm.

Genetic diversity parameters and Polymorphism Information Content (PIC)

In total 20 SSRs were expedited to measure genetic diversity inferences among 172 mulberry accessions which were indigenous and exotics from Burma, France, Indonesia, Japan, China, *etc*. Among 172 accessions, a total of 94 SSR alleles were detected as marker loci with an average of 4.5 alleles per SSR ranging from 2 (M2SSR112A) to 7 (MULSSR258,MULSSR85 and M2SSR20) alleles. The value of PIC ranged from 0.21 to 0.87 with a mean of 0.57 on average. Sixteen markers such as M2SSR10, M2SSR89A, MULSSR313, M2SSR36, M2SSR87, MULSSR26, M2SSR20, MULSSR 253, Moso288, M2SSR1, MoSo-157-2, MULSSR96B, Moso340-2, M2SSR82, MULSSR258 and MULSSR85 were highly informative with PIC value > 0.5 indicates their utility for diversity analysis. Mean Shannon's Information index (I) value of 1.21 was observed for all the markers varying from 0.58 to 1.98. The value of Nei's index for each marker ranging from 0.14 to 0.88 with a mean of 0.55 was observed, while the value of expected heterozygosity varied from 0.28 to 0.89 with a mean of 0.61. A summary of marker statistics for 172 mulberry accessions is listed in Table 2.2.

Table 2.2: Genetic diversity of 20 SSR loci among the selected mulberry germplasm

#	Marker name	No. of alleles	Effective no. of alleles	Expected hetero-zygosity	Shannon's index	Nei's index	PIC
1	M2SSR81	3	1.48	0.31	0.58	0.17	0.24
2	Moso340-2	6	3.96	0.72	1.61	0.62	0.74
3	M2SSR87	3	2.93	0.68	1.18	0.52	0.59
4	Moso288	4	1.99	0.51	0.91	0.69	0.62
5	MULSSR 253	4	2.93	0.72	1.36	0.68	0.61
6	M2SSR112A	2	1.56	0.34	0.58	0.32	0.29
7	MULSSR26	4	3.01	0.72	1.26	0.61	0.59
8	M2SSR68	3	1.81	0.44	0.78	0.42	0.47
9	MULSSR313	5	3.34	0.69	1.41	0.58	0.56
10	MULSSR258	7	4.26	0.76	1.59	0.88	0.86
11	MoSo-157-2	6	3.61	0.75	1.42	0.31	0.69
12	M2SSR36	5	2.74	0.68	1.21	0.18	0.58
13	M2SSR1	5	3.32	0.71	1.32	0.14	0.65
14	MULSSR85	7	6.52	0.89	1.98	0.48	0.87
15	MULSSR96B	5	3.39	0.74	1.66	0.68	0.69
16	M2SSR10	4	2.82	0.66	1.28	0.76	0.52
17	M2SSR89A	5	2.52	0.62	1.18	0.41	0.53
18	M2SSR107	3	1.31	0.28	0.58	0.52	0.21
19	M2SSR82	6	4.46	0.76	1.62	0.35	0.74
20	M2SSR20	7	2.58	0.68	1.36	0.71	0.59
	Mean	4.55	2.953	0.6175	1.2145	0.493	0.57

Molecular variation observed in diploid and colchi-tetraploids of mulberry

Genetic variation in DNA was evaluated by SSR genotyping and comparison of both diploid and tetraploid genomes of RFS-135, V-1, K-2 and S-34 germplasm (tetraploids are developed through colchicine treatment at CSRTI, Mysuru). The results revealed that M2SSR81 alleles of 220bp and 210bp were observed in germplasm RFS-135 (diploid) and RFS-135 (tetraploid), respectively. Similarly, with MoSo340_2 obtained allele sizes of 120bp and 80bp for K-2 diploid but with the same marker alleles of 120bp and 100bp obtained for K-2 tetraploid. However, with M2SSR82 alleles at 220bp and 210bp for K-2 diploid and K-2 tetraploid at 220bp and 200bp. Whereas, for RFS-135 diploid the alleles size was 220bp and 210bp and 210bp and 200bp for RFS-135 tetraploid. MULSSR253 marker when used against the genotypes, K-2 diploid allele size was 240bp and 230bp, whereas for K-2 tetraploid it was 240bp and 210bp. With the marker MULSSR26, K-2 diploid and K-2 tetraploid one allele obtained. Same result was with MULSSR96B. In contrast, all the markers didn't show any variation between S-34 diploid and tetraploids. Whereas the marker MoSo280, reported the alleles at the same base pair in case of diploid and tetraploid genomes of RFS-135, V-1, K-2 and S-34 germplasm. It is generally assumed that the colchicine is mainly associated with chromosome doubling, with no other effect on the genetic structure. However, our finding on the disappearance of certain DNA markers in tetraploids when compared to the diploid progenitors leads to the assumption that genetic changes may take place in colchicine treatment.

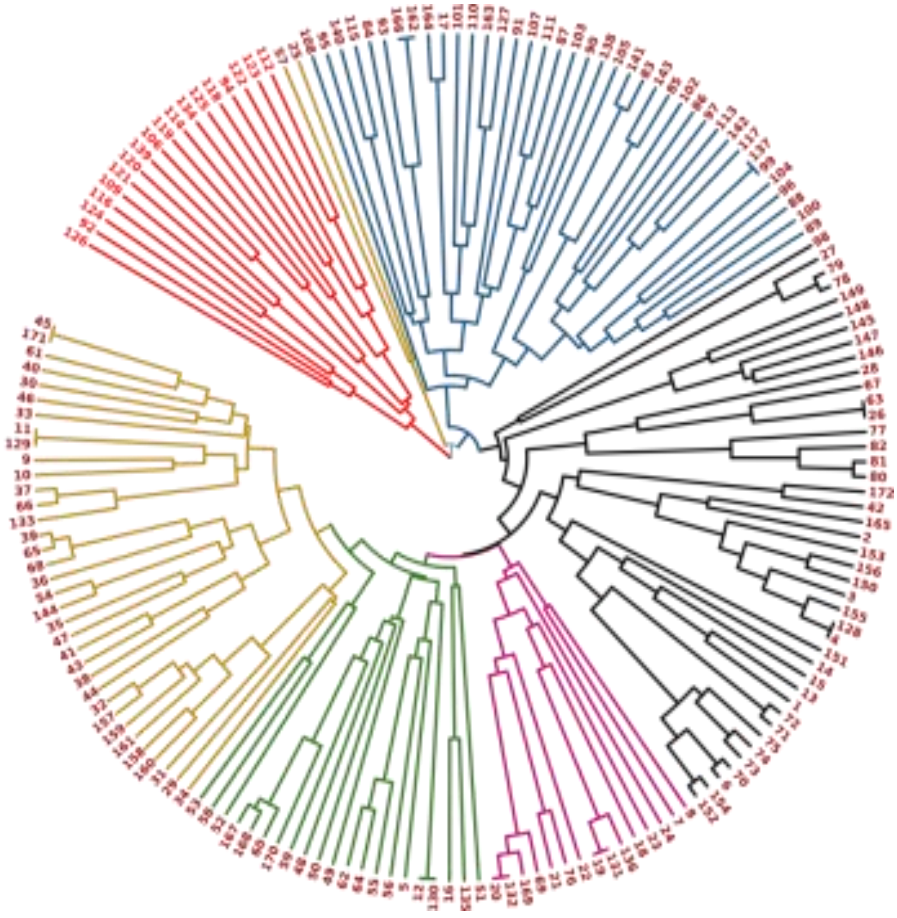


Fig. 2.3: Distribution of the selected 172 muberry germplasm generated from UPGMA dendro software by using SSR data

In the phylogeny study, the branching delineated the germplasm into two major clusters; Cluster-I with two sub clusters (sub clusters IA and IB), cluster-II with two sub clusters (Sub clusters IIA and IIB) similarly sub cluster IIB divided into IIB-1 and IIB-2, also IIB-2 sub cluster having several super subcluster where admixtures of different *Morus* species and developed varieties of *Morus* are distributed within the cluster (Fig 2.3). The details about the germplasm in each cluster are mentioned in Table 2.3. Different species are selected for SSRs studies, the majority of them are *M. indica* (66)*, M. alba* (39), *M. laevigata* (16) and *M. latifolia* (22), remaining species are selected from other species, *M. cathayana*(01), *M. atropurpurea*(01), *M. macroura* (01), *M. rotundiloba* (02), *M. sinensis* (01) *M. serrata* (01) and unknown species of 22 mulberry germplasm also included.

Mulberry variety C-776 has been obtained by crossing *M. multicaulis* and Black Cherry. The relationship is depicted by the proximity of the parents and the offspring in the dendrogram. On the other hand, Variety V-1, was developed by crossing two highly diverse germplasms C-776 (Male parent) and S-30 (Female parent). The genetic variation observed in this study revealed that V-1 and S-30 have very little variation and are thus present together in sub cluster IIB-2a and C-776 had a greater distance from V-1 and S-30. These results confirm the markers that are used for this study and about their ability to illustrate the genetic relationship among the selected diverse *Morus* germplasm. Mulberry varieties G-4 was developed from the cross, *M. multicaulis* × S-34 and G-2 from the cross *M. multicaulis* × S-13. All these individual germplasm are placed under sub cluster IIB-2a. Even though G2 and G4 are obtained from the same female parent, they show great variation because of the different male parents.

Table 2.3: Clustering pattern of 24 mulberry genotypes using SSR markers

Cluster/Subcluster number		No. of germ-plasm	Name of the germplasm
Cluster I	Cluster IA	06	Thailand male, Kollegal, Baragarh-3, Thailand lobed, C-18 and Mandalaya
	Cluster IB	12	SRDC-3, Gamettee, Himachal local, Acc. 8, Calabresa, Vietnam-1, Lisbon, Karanjtoli-1, China-27, BR-8, Dehradun Local-4 and Papua New Guinea
Cluster II	Cluster IIA	02	*M. macroura* and *M. serrata*
	Cluster IIB	-	
Cluster IIB	Sub cluster IIB-1	39	Mysore local, KPG-11, Cuckpilla, UP-5, Reblaira, S-523, Tippu, Acc. 115, T-18, ERRC-103, ERRC-106, Monla-I, SRDC-2, ERRC-215, ERRC-180, Acc-118, UP-9, BR-2, Kota-4, S-1708, Acc. 165, R-1, Acc. 56, Semmedu, C-15, S-1635, Dhudia White, Australia, Bilidevalaya, English Black, Guzziola, ERRC-57, M. tiliaefolia, ERRC-73, C-6, S-763, Pillighat, Chekmajra and BU-33.
	Sub cluster IIB-2	42	US-51 (OPH), S-242, S-642, S-741, Rostelli, Japan, China Hybrid – 2, Phillipines, Acc. 134, Suvarna-1, Suvarna-2, Suvarna-3, Vishwa, M. cathayana (Hybrid), Morus cathayana, Sahana, Chandrapuri, Hosur-C3, Meergund-6, Zimbabwe-8, Hairythick, MVK-1, Hosur C8, Suwong Pong, Madhopur-1, Pannear Estate,S-13, MSG-2, China Black-A, Fukushima-OHA, Kokuso, Kokuso-20, Furcata, Moretti, Lun 40-2, Valparai-05, Thai pecah, Dharatwala, Nagpur-3, New Delhi, Lava Forest-1and Serpentina
	Sub cluster IIB-3	15	V-1, V-1 tetra, Bullato, Vishala, S-1, S-41, Pouri-1, KNG, AGB-8, Ankara, Seekupari, Jabalpur, Saranath-1, Belona and Ujjain-2
	Sub cluster IIB-4	21	RFS-135, RFS-135 tetra, Kanva-2, K-2 tetra, AR-12, Palsana-3, Keeraithodu, Haridwar-4, G-4, RC-2, S-30, M. rotundiloba, M.lhouseringe, Nao Khurkul, AR-11, UP-22, Majhkhali, RC-1, Roso, MR-2 and Goshoerami
	Sub cluster IIB-5	35	Sabbawala-2, Nellathana Estate, Malkai Local, MS-3, Laholi-1, Kajali, Sangsey, Vadapuram, BagabanMasijd, Bonniampadi, S-36, School, Salem, Thattahalli Villa -1, Sujanpur-5, Punjab local, Nowshera-1, Palampur Local, M. multicaulis (ME-0168), M. multicaulis (ME-0006), Naudan-1, Kosen, Birds Foot, L-6, Nalhdwara-1, Ranchi-5, ChuraiMohal, C-776, Farabori, S-34, S-34 tetra, G-2, Pouri-2, Assama Bola, Thandikudi and Jalalgarah-3

Population structure of selected mulberry germplasm

Assessment of the genetic diversity and population structure of a species is essential to evaluate the application potential of a new germplasm resource. An admixture model-based approach was implemented to investigate the population structure of 172 mulberry germplasm.

The present study provides an overall assessment of the genetic diversity and structure of 172 *Morus* germplasm. Medium and high level of genetic diversity and genetic variation was present within and between the species accordingly. The population structure of 172 germplasm revealed that the background of species used was admixture between the groups, suggesting that this is due to mulberry crop maintaining a high level of heterozygosity due to the outcross breeding reproductive system and also germplasm may

have undergone gene exchange between the species. Germplasm was collected from different countries and they are continuously used for mulberry breeding programs, and these results in mixed populations. Furthermore, these results can be considered as a powerful tool for exploring genetic diversity, as well as a new source for efficient conservation and breeding programs of mulberry in the future.

SNP genotyping

A total of 650 genotypes were finalized for SNP genotyping, which includes 450 diverse accessions selected under different traits (Drought, Yield and Nutrient use efficiency) for association studies and 200 F_1 progenies for linkage mapping for root rot disease trait. Among 450 accessions for different traits, 63 are common across the three different traits and 85 accessions are common between drought and yield traits. Whereas, 21 accessions were common between yield and Nutrient use efficiency. Similarly, 13 accessions were common between drought and Nutrient use efficiency. Finally, 208 accessions for drought, 233 accessions under yield and 258 accessions under Nutrient use efficiency were finalized for SNP genotyping. Unique SNPs were identified to 21 accessions based on the reference K2 and compared with *M. rotundiloba*.

Conclusion

A total of 20 SSR markers were used against 172 mulberry germplasm and they produced distinct SSR bands between the mulberry germplasm. The genomic DNA of 172 mulberry germplasm was amplified with MulSSR, MoSo, MEST and M2SSR series of SSR markers and these markers revealed 96 different SSR bands. Among 172 accessions, a total of 94 SSR alleles were detected as marker loci with an average of 4.5 alleles per SSR ranging from 2 (M2SSR112A) to 7 (MULSSR258, MULSSR85 and M2SSR20) alleles. The value of PIC ranged from 0.21 to 0.87 with a mean of 0.57 on average. Sixteen markers were highly informative with PIC value > 0.5 that indicates their utility for diversity analysis

The genetic similarity and phylogenetic relationship existing among the germplasm were analysed. The genetic variation observed in this study revealed that V-1 and S-30 have very little variation and are thus present together in sub cluster IIB-2a and C-776 which had a greater distance from V-1 and S-30. These results emphasize enough about the efficiency of the markers that are used for this study and about their ability to illustrate the genetic relationship among the selected diverse *Morus* germplasm.

PIC 01 003CN (NW 2c): Identification of QTLs for yield associated traits in mulberry (Sep. 2018-Dec. 2021)

M. R. Bhavya, Tanmoy Sarkar, M. Y. Jagadambha and B. V. Sushmitha BV

Objective

- To evaluate the panel of diverse germplasm (~350 entries) for yield and associated traits

The 203 germplasm accessions including checks (V-1 and Kosen) were planted in an augmented randomized block design (experimental plot contains 13 blocks with V-1 border) with 4 feet inter and intra row spacing. Replicated treatments (checks) were tested in each block as in a RCBD, unreplicated treatments (other genotypes excluding checks) occur only in one block - so each block has a different set of unreplicated treatments. After ten months of establishment period, first basal pruning was completed. Subsequent crop harvest was taken up in 70 days interval and observations were recorded on 5 plants in each genotype for growth and yield associated traits *viz*., Number of shoots/plant, Length of longest shoot (cm), Average shoot length (cm), Number of leaves in longest shoot, Internodal length (cm), Shoot yield/plant (g), Leaf yield/plant (g), Hundred leaf weight (g), Leaf area (sq. cm), Moisture content (%), Moisture retention capacity (%) and SCMR.

Analysis of variance was carried out for growth and yield attributing traits. The adjusted block effects were non-significant for all traits except SCMR indicating homogeneity of evaluation blocks. Mean sum of squares of progenies exhibited highly significant difference for number of leaves in the longest shoot, internodal length, weight of hundred leaves, leaf area, moisture retention capacity and SCMR which indicates presence of significant variation for these traits among the progenies.

In the study the number of shoots/plant ranges from 3.56 to 20.52 and mean is 10.82. High PCV (30.5%), moderate GCV (18.03%) and heritability (34.95%) coupled with high genetic advance as per cent mean (22) was noticed for number of shoots per plant. Length of longest shoot ranges from 92.21 cm to 263.39 cm and mean is 179.91 cm. Moderate values of GCV (11.85 %) and PCV (16.41%), moderate heritability (52.15 %) coupled with moderate GAM (17.65%) was observed for length of longest shoot. Average shoot length ranges from 68.86 cm to 244.63 cm and mean is 162.59 cm. Moderate values of GCV (12.23%) and PCV (18.19%), moderate heritability (45.19%) coupled with moderate GAM (16.96%) was observed for average shoot length.Number of leaves in longest shoot ranges from 15.63 to 55.48 and mean is 30.17 leaves. High PCV (22.13%), high GCV (20.78%) and heritability (88.22%) coupled with high genetic advance as per cent mean (40.27) was noticed for number of leaves. Internodal length ranges from 3.78cm to 8.16cm and mean is 5.95cm. Moderate values of GCV (13.29%) and PCV (14.83%), high heritability (80.26%) coupled with high GAM (24.55%) was recorded for internodal length. Shoot yield per plant ranges from 111.64g to 4124.97g and mean is 1678.18g. Leaf yield per plant ranges from 83.32g to 1807.3g and mean is 762.98g.

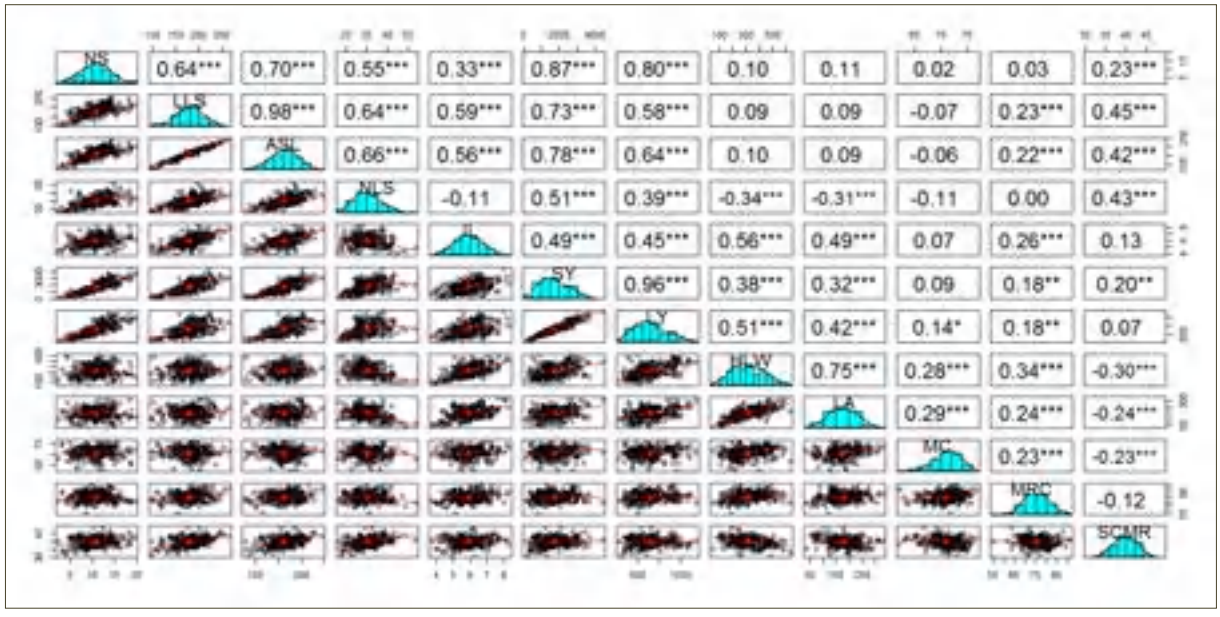
Hundred leaf weight ranges from 39.62g to 617.54g and mean is 299.17g. High PCV (39.48%), high GCV (31.79%) and heritability (64.84%) coupled with high genetic advance as per cent mean (52.82) was noticed for hundred leaf weight. Leaf area ranges from 3.49sq.cm 321.00 sq.cm and mean is 169.91sq.cm. High PCV (32.9%), high GCV (28.11%), high heritability (73.00%) coupled with high genetic advance as per cent mean (49.54) was noticed for leaf area. Moisture content ranges from 61.21% to 79.35% and mean is 70.81%. Low PCV (3.7%), low GCV (1.65%), low heritability (19.91%) coupled with high genetic advance as per cent mean (1.52) was noticed for moisture content of leaf. Moisture retention capacity ranges from 54.63% to 92.88% and mean is 75.18%. Low PCV (7.83%), low GCV (6.53%), high heritability (69.7%) coupled with medium genetic advance as per cent mean (11.25) was noticed for moisture retention capacity of leaf. SPAD chlorophyll meter reading ranges from 31.4 to 48.79 and mean is 40.17. Low PCV (7.38%), low GCV (6.9%), high heritability (87.3%) coupled with medium genetic advance as per cent mean (13.3) was noticed for SPAD chlorophyll meter.

Higher estimates of PCV and GCV were observed for hundred leaf weight, leaf area and number of leaves in longest shoot. The high estimates of GCV and PCV for the traits suggests the presence of higher magnitude of variation and narrow difference between the PCV and GCV implies lesser impact of environment in the expression of characters. Thus, selection can be practiced for these characters. But lower estimates of PCV and GCV were recorded for moisture content, moisture retention capacity and SPAD chlorophyll meter reading. This indicates lower magnitude of variation for these traits. High estimates of broad sense heritability accompanied with high genetic advance as *per cent* mean was recorded for number of leaves in longest shoot, internodal length, leaf area and hundred leaf weight. This indicates that most likely the heritability is due to additive gene effects and there is lot of scope for improvement of these traits in future breeding programme and selection will be effective and may rapidly contribute to yield. High heritability accompanied with low to moderate genetic advance as *per cent* of mean was noticed for traits like moisture retention capacity and SPAD chlorophyll meter reading. This indicates the presence of non-additive gene action and narrow range of variation for these traits. This suggests that limited scope for further improvement of these characters.

All the traits considered for recording data have moderate to high significant positive correlation with leaf yield per plant except moisture content (%), moisture retention capacity (%) and SCMR, they showed negligible correlation (Fig. 2.4). Shoot yield per plant exhibited maximum direct effect (1.052) on leaf yield per plant indicates greater contribution of this trait towards leaf yield per plant and all other significantly correlated traits exhibited maximum indirect effect through shoot yield per plant.

Thirty-five genotypes recorded high leaf yield per plant i.e. more than population mean+1standard deviation (1. MI-0290, 2. ME-0246, 3. ME-0214, 4. MI-0011, 5. ME-0169, 6. MI-0523, 7. MI-0029, 8. VISHALA, 9. MI-0041, 10. MI-0580, 11. ME-0005, 12. MI-0699, 13. MI-0017, 14. MI-0158, 15. ME-0223, 16. MI-0672, 17. MI-0777, 18. MI-0066, 19. MI-0082, 20. MI-0828, 21. ME-0232, 22. MI-0024, 23. V-1, 24. MI-0799, 25. ME-0256, 26. MI-0665, 27. RC-2, 28. MI-0173, 29. MI-0730, 30. MI-0527, 31. MI-0105, 32. MI-0310, 33. MI-0557, 34. MI-0416 and 35. MI-0393). The genotypes *viz*., MI-0066, ME-0005, ME-0246, Vishala, MI-0310 and ME-0169 were selected based on optimum combination of hundred leaf weight, leaf area and number of leaves in longest shoot among high yielding genotypes.

The PCA scores for 203 mulberry genotypes in the first two principal components were computed and plotted in graph to get two-dimensional scatter diagram (Fig. 2.5). Different color to genotypes was given based on performance for leaf yield per plant. Red was given to genotypes having leaf yield per plant more than population mean+1standard deviation, yellow to genotypes having leaf yield per plant less than population mean-1standard deviation and blue to genotypes having leaf yield per plant within population mean±1standard deviation. A perusal of these results revealed genotypes plotted to the left (1. MI-0290, 2. ME-0246, 3. ME-0214, 4. MI-0011, 6. MI-0523, 7. MI-0029, 10. MI-0580, 13. MI-0017, 14. MI-0158, 16. MI-0672) and right (184. ME-0093, 187. MI-0410, 189. MI-0440, 198. ME-0254, 199. MI-0382, 202. ME-0220) extreme on PC1 to be most diverse for shoot yield, leaf yield, number of shoots, length of the longest shoot and average shoot length. Hybridization of these diverse genotypes is therefore predicted to result in desirable transgressive segregants.



* Significant at 0.05 probability level, ** Significant at 0.01 probability level, *** Significant at 0.001 probability level

NS: Number of shoots/plant, LLS: Length of longest shoot (cm), ASL: Average shoot length (cm), NLS: Number of leaves in the longest shoot, IL: Internodal length (cm), SY: Shoot yield/plant (g), LY: Leaf yield/plant (g), HLW: Hundred leaf weight (g), LA: Leaf area (cm^2), MC: Moisture content (%), MRC: Moisture retention capacity (%), SCMR: SPAD chlorophyll meter reading

Fig. 2.4: Phenotypic correlation coefficient for growth and yield attributing traits in mulberry along with scatter plot and frequency distribution

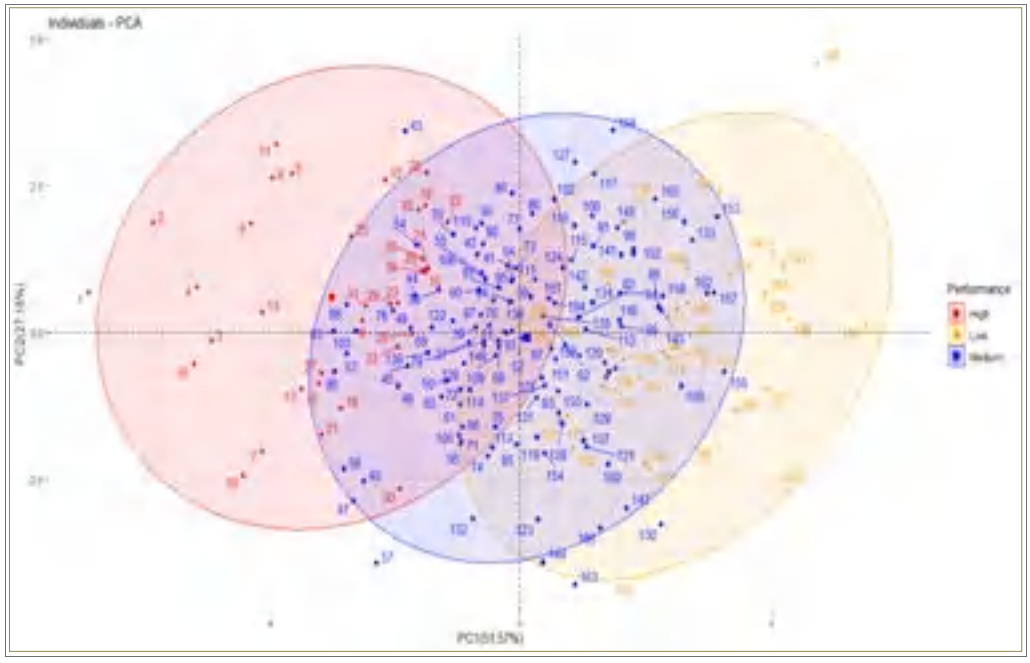


Fig. 2.5: Two-dimensional graph showing relative positions of 203 mulberry genotypes based on PCA scores

Conclusion

Traits namely hundred leaf weight, leaf area and number of leaves in longest shoot recorded high PCV and GCV, high heritability and high genetic advance over mean. This indicates presence of higher magnitude of variation, lesser impact of environment in the expression of characters and heritability is due to additive gene effects. Thus, there is lot of scope for improvement of these traits in future breeding programme and selection based on these traits will be effective and may rapidly contribute to yield. Thirty-five genotypes recorded high leaf yield per plant i.e. more than population mean+1standard deviation. The genotypes viz., MI-0066, ME-0005, ME-0246, Vishala, MI-0310 and ME-0169 were selected based on optimum combination of hundred leaf weight, leaf area and number of leaves in longest shoot among high yielding genotypes. These genotypes can be used directly as a variety after bioassay and further confirmation for yield and quality traits. Contrasting genotypes for shoot yield, leaf yield, number of shoots, length of the longest shoot and average shoot length can be used in breeding program for production of desirable transgressive segregants.

PIC-01003CN (NW2e) - Sustaining Mulberry Yield: Identification of QTLs Conferring Resistance to Root Rot Disease by Linkage Mapping and Trait Introgression (Sep. 2018 - Dec. 2021)

G. S. Arunakumar, B. N. Gnanesh, M. Supriya and M. M. Harshitha

Objectives

- To develop mapping populations (by crossing of contrasts) for root rot resistance by pseudo-test cross strategy.
- Evaluation of segregating F1 progeny for disease resistance phenotype.
- QTL analysis for disease resistance by linkage mapping (genotypic data input from the subprogram NW2a).

Three mapping populations were developed for root rot disease resistance using divergent contrasting parental lines by adopting pseudo-test cross strategy for heterozygous perennial mulberry. Contrasting sets [resistance (R) and susceptible (S) for root rot resistance] *viz*., (R) *M. multicaulis* (ME-0006) × (S) Thailand Male, (R) *M. multicaulis* (ME-0168) × (S) Thailand Male and (S), Punjab Local × (R) *M. cathayana* (Hybrid) of mulberry genotypes were selected based on the sex, genetic divergence and ploidy for hybridization. Ultimately, about 2-3 crossings involving different parents contrasting for the trait were carried out. The seeds were collected after crossing. F_1 segregating progenies were raised in the glasshouse condition. Seedlings of four months old were transplanted for establishment in the field. After one year of establishment, selected the best established mapping population developed from the cross (R) *M. multicaulis* (ME-0168) × (S) Thailand Male for further evaluation against root rot pathogens and genotyping.

Two highly pathogenic isolates of *F. solani* (MRR81-MRR84) and *L. theobromae* (MRR74 and MRR75) causing dry and black rot respectively were used in this study for inoculation (Table 2.4). Besides, the morphological, microscopic and cultural characteristics of the selected isolates, molecular characterization was conducted using primer pairs ITS1 and ITS4 (Table 2.4).

Table 2.4: Molecular confirmation of *Fusarium solani* & *Lasiodiplodia theobromae* isolates

Source of collection and isolate code	NCBI GenBank accession numbers	Name of the pathogen
Mulberry Root_MRR81	MH844984	*Fusarium solani*
Mulberry Root_MRR82	MH844985	*Fusarium solani*
Mulberry Root_MRR83	MH845179	*Fusarium solani*
Mulberry Root_MRR84	MH879808	*Fusarium solani*
Mulberry Root_MRR74	MH400067	*Lasiodiplodiatheobromae*
Mulberry Root_MRR75	MH393225	*Lasiodiplodiatheobromae*
Mulberry Root_MRR41	MH385360	*Lasiodiplodiatheobromae*

Methods of inoculation

Thirty days old inoculums of *F. solani* grown on boiled sorghum grains were ground in a mixer and 30 g of the inoculums was mixed in the 3 kg capacity earthen pots filled with 1 kg sterilized soil mixture (Sandy loam/Sand, 2:1). The 120 days old mulberry plants pots transplanted in pots and remaining part of the pots were filled with sterilized soil mixture. Uninoculated control treatments were also maintained by placing a 30 g sterile sorghum coarse grain powder per plant.

The 120 days old plants were uprooted carefully, the roots were slightly damaged and dipped in the conidial suspension of *L. theobromae* overnight with the spore load of 1×10^6 CFU/plant. Next morning the plants were transplanted to earthen pots filled with sterile soil mixture. Similarly, the control plants were slightly damaged, dipped overnight in sterile water and transplanted to earthen pots.

The evaluation of the mapping population for resistance trait was carried out in earthen pots under glasshouse condition. Four months old saplings of F_1 progenies were transplanted to earthen pots and arranged in Completely Randomized Design (CRD). Five replications of each progeny were maintained. The fungal pathogens were inoculated as detailed above. These inoculated saplings were examined for the root rot symptoms and observation was continued up to 180 days after inoculation. The data on total biomass, healthy and rotted root weight were recorded. The wilting (%), rotting (%) and plant survival (%) were calculated. Based on the wilting and rotting indices, the disease reaction of the germplasm accessions were categorized.

Disease Severity Index	Wilting (%)	Rotting (%)	Disease Reaction
1	No wilting	No rotting	Highly resistant
2	1-25%wilting	1-25%rotting	Resistant
3	26-50%wilting	26-50%rotting	Moderately resistant
4	51-75%wilting	51-75%rotting	Susceptible
5	> 75% wilting	> 75% rotting	Highly susceptible

Based on the disease expression, the resistant and susceptible progeny were categorized for genetic analysis.

Results

Development of mapping populations for root rot resistance by pseudo-test cross strategy

Out of 200 F_1 progenies developed by crossing (R) *M. multicaulis* (ME-0168) × (S) Thailand Male for identification of root rot resistance trait were evaluated in two seasons, results showed that 2 progenies were found highly resistant (1.0 %), 58 progenies as resistant (29.0 %), 61 progenies as moderately resistant (30.50 %), 40 progenies as susceptible (20.0 %) and 39 progenies as highly susceptible (19.50 %) to *Fusarium solani*. The checks for highly resistant (ME-0168) and highly susceptible (ME-0033) were maintained in each experiment.

The evaluation of 200 F_1 progenies against *Fusarium solani* in two seasons showed more or less similar disease reaction in frequency distribution as shown in Fig. 2.6 & 2.7. Similarly it was observed that polynomial distribution of progenies in each reaction varies (Fig. 2.8).

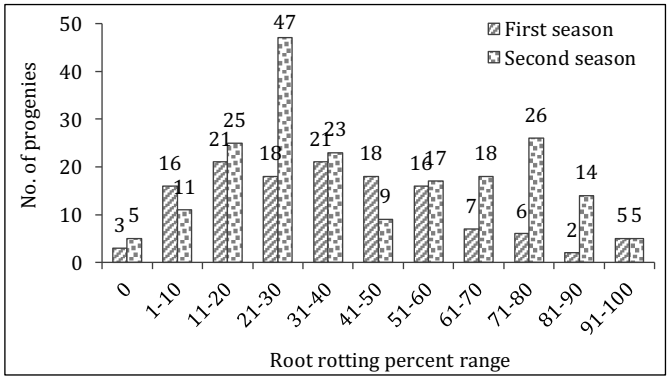


Fig. 2.6: Rotting percent

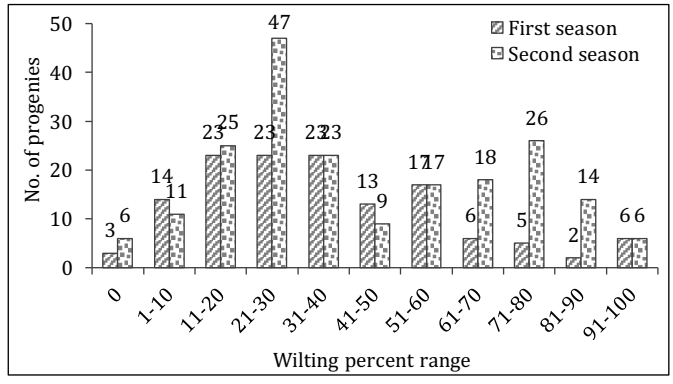


Fig. 2.7: Wilting percent

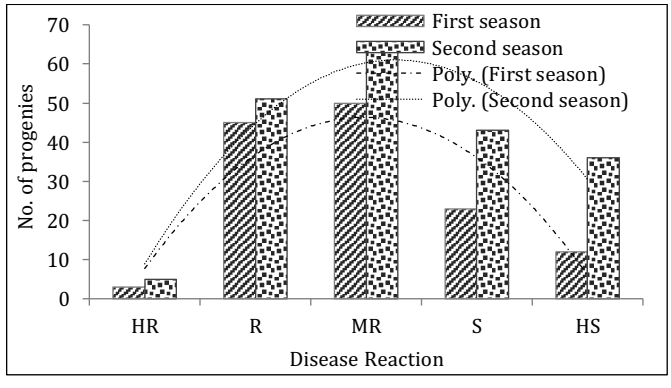


Fig. 2.8: Polynomial distribution of F_1 progenies against *Fusarium solani* in five disease reaction grades.
HR: Highly resistant, R: Resistant, MR: Moderately resistant, S: Susceptible, HS: Highly susceptiblee

The progenies were showed high rate of segregation and resulted in good number of highly resistant and highly susceptible progenies along with intermediate disease reaction grades. It was also observed the highly significant (*P>0.0001*) positive correlation between wilting and rotting percent (Fig. 2.9). When it was considered only two disease reaction grades as resistant and susceptible, it was noticed that the segregation ratio is more or less 1:1 in second season (Fig. 2.10).

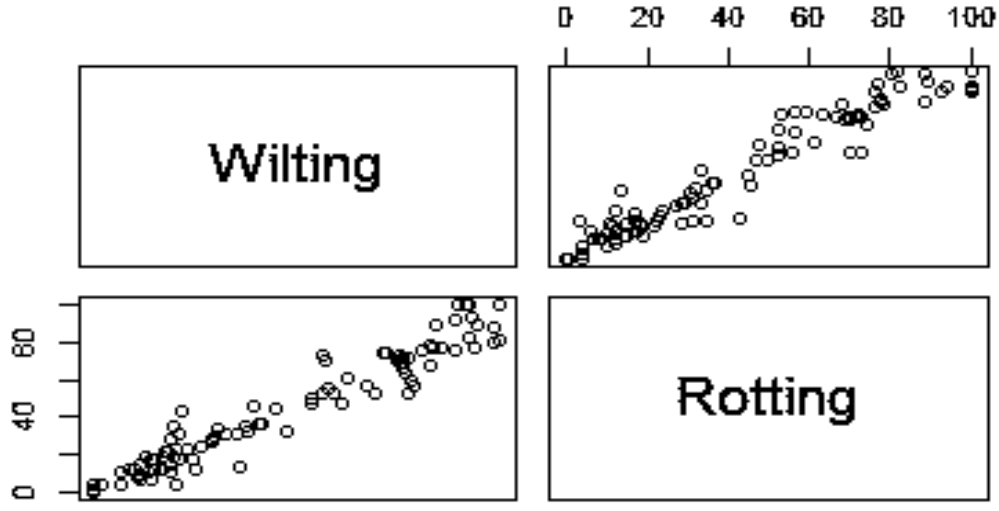


Fig. 2.9: Correlation coefficient between data on wilting and rotting

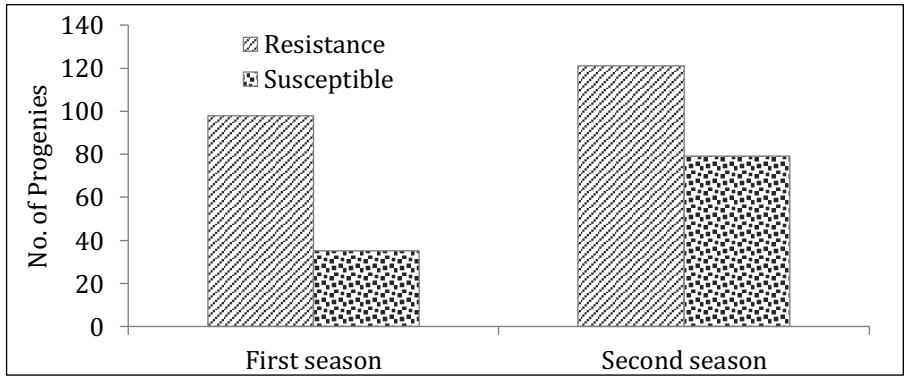


Fig. 2.10: Comparison of percent distribution of F_1 Progenies among resistance and susceptible disease reactions in both the season.

Out of 200 F_1 progenies evaluated in two seasons against *Lasiodiplodia theobromae*, 11 progenies were found highly resistant (5.5 %), 50 progenies as resistant (25.0 %), 77 progenies as moderately resistant (38.50 %), 35 progenies as susceptible (17.5 %) and 27 progenies as highly susceptible (13.5 %) disease reaction to *Lasiodiplodia theobromae*. The checks for highly resistant (ME-0168) and highly susceptible (ME-0033) were maintained in each experiment.

The evaluation of 200 F_1 progenies against *Lasiodiplodia theobromae* in two seasons showed more or less similar disease reaction as shown in Fig. 2.11 & 2.12. Similarly it was observed that polynomial distribution of progenies in each reaction varies (Fig. 2.13).

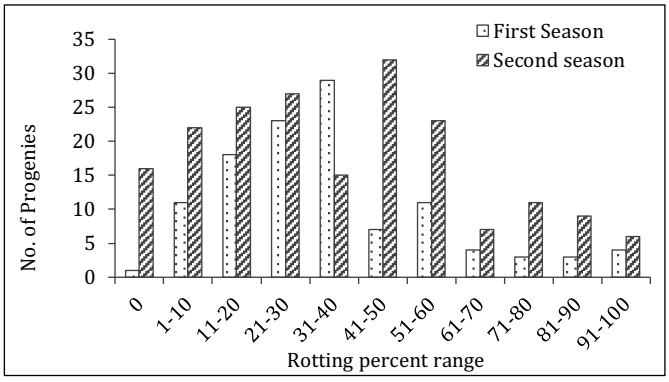


Fig. 2.11: Comparison of first and second season data on rotting percent

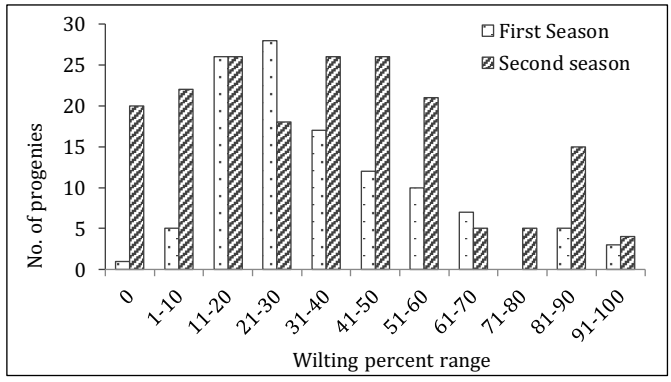


Fig. 2.12 Comparison of first and second season data on wilting percent

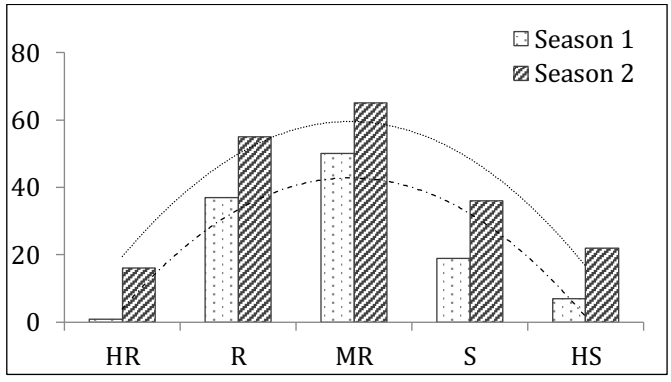


Fig. 2.13: Polynomial distribution of F_1 progenies against *Lasiodiplodia theobromae* in five disease reaction grades. HR: Highly resistant, R: Resistant, MR: Moderately resistant, S: Susceptible, HS: Highly susceptible

The progenies were showed high rate of segregation and resulted in good number of highly resistant and highly susceptible progenies along with intermediate disease reaction grades. When it was considered only two disease reaction grades as resistant and susceptible, it was noticed that the segregation ratio is more or less 1:1 in both the season.

Yield and growth parameters relationship with root rot disease reaction groups: The variation in the yield and growth parameters with respect to root rot disease reaction groups were performed using box plots. There was no significant variation observed between yield and growth parameters *viz*., longest shoot length (LSL, cm), number of leaves in longest shoot (LLS), number of shoots per plant (NS), Shoot yield (SY, g), stem weight (SW, g) and Leaf yield (LY, g) with root rot disease reaction groups namely resistant (2), moderately resistant (3), susceptible (4) and highly susceptible (5). The descriptive statistics for growth and yield parameters were given in table 2.5.

Pooled data analysis

The positive and highly significant correlations were observed between yield and growth parameters. The yield and growth parameters like LSL, LLS, NB, AGBM and SW were highly significant and positively correlated with each other.

Of the total 70 SSR primers used for parental polymorphism, 12 produced polymorphic bands between parents and these were used to screen the mapping population consisting 200 progenies.

Maximum polymorphic SSRs were produced multi allelic loci which clearly distinguished the parents due to high heterozygosity of the parents.

Table 2.5: Descriptive statistics for pooled data on growth and yield parameters

Growth and yield parameters	Min.	Max.	Mean	SEm±	SD	CV%	P value
Length of longest shoot (cm)	10.00	408.00	170.99	1.54	48.92	28.61	*
No. of leaves in longest shoot	2.00	80.00	21.36	0.36177	10.28	48.13	NS
No. of branches	1.00	25.00	7.82	0.12	3.81	48.72	***
Shoot weight (g)	15.00	8500.00	1313.44	36.92	1173.32	89.33	***
Stem weight (g)	5.00	7200.00	788.83	24.15	767.42	97.29	***
Leaf weight (g)	10	3000	525.21	14.02	445.49	84.82	***
Survival percentage	5.00	100.00	77.42	0.98	20.42	26.38	*

True hybrids were selected depending on the banding pattern produced in agarose gel and selected markers used in the genotyping of 200 DNA samples of F_1 progenies showed specific banding patterns and identified the true hybrids. The number of alleles varied in the range of 1-4. Marker MESTSSR31 and MASSR33 revealed the maximum number (four) of alleles while the marker MULSSR96B and MASSR05 resulted in three alleles per locus and MULSSR96A, M2SSR68, M2SSR23 MASSR05, MASSR13, MASSR25 and MASSR38 revealed two alleles pert per locus. M2SSR89A (one) showed the least number allele per locus.

The complementary banding pattern of both parents made a way to identify the hybrids. The marker MULSSR96A obtained the allele size at 180 bp for female parent (*M. multicaulis*) and allele 210 to 180 bp for male parent (Thailand male). M2SSR68 obtained the allele size at 210bp to 190 bp for female parent and 190bp for male parent. M2SSR23 obtained the allele size at 240 to 230 bp for female parent and 240bp for male parent. MESTSSR31 obtained the allele size at 240 to 210 bp for female parent also 220 and 200 bp for male parent. MULSSR96B obtained the allele size for female parent at 320 and 290 bp similarly for male parent two alleles produced with 300 and 290 bp. MULSSR89A obtained the allele size at 160 bp female and 180 bp for male parent. The marker MASSR05 obtained the allele size at 290bp, 260bp, 240bp for female parent and allele 240bp for male parent. MASSR13 obtained the allele size at 290bp to 240bp for female parents and 240bp for male parents. MASSR25 obtained the allele size at 160bp to 140 bp for female parents and 140bp for male parents. MASSR38 obtained the allele size at 210bp for female parents and 210bp to 190bp for male parents. MASSR33 obtained the allele size at 220bp and 230bp for females and 210bp and 280bp for male parents and MASSR41 generates 210bp in females, 210bp, and 200bp in males.

The male and female allele's combination of different markers has been expressed in different progenies. The list has been mentioned in table 2.6 which was expressed by specific polymorphic markers. Based on the alleles generated on the agarose gel was scored also the percentage of male, female, and hybrid plant types have been shortlisted. The distribution differentiating progenies as recombinants have been shown in Fig. 2.14.

Table 2.6: Percentage of Parent 1(*M. multicaulis),* Parent 2 (Thailand male) and hybrid plant type with respect to a specific marker

Markers	Parent 1 type (%)	Parent 2 type (%)	Hybrid type (%)
MULSSR96A	0.00	57.70	42.30
M2SSR68	0.00	37.70	62.30
MESTSSR31	2.22	2.22	95.50
MULSSR96B	2.22	31.10	46.60
M2SSR23	8.88	28.80	62.20
M2SSR89A	28.80	13.30	57.70
MASSR13	37.50	58.34	04.16
MASSR05	08.34	33.34	58.34
MASSR25	20.84	37.50	41.66
MASSR38	14.58	83.34	02.08
MASSR33	26.26	31.82	41.92
MASSR41	02.08	54.16	43.76

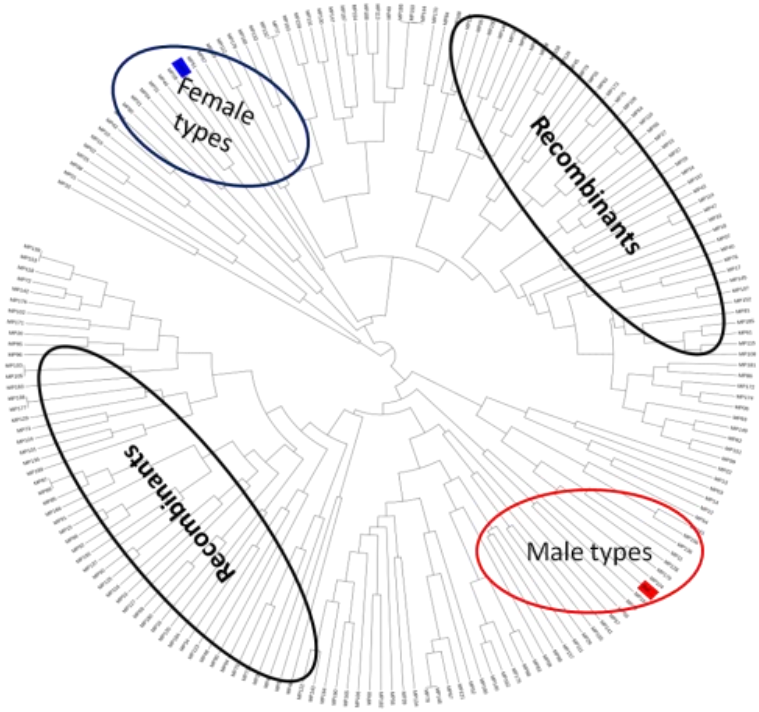


Fig. 2.14: Distribution differentiating progenies as recombinants, male and female types generated from UPGMA dendro software by using SSR data

The obtained marker information from the current study helps in the confirmation identifying QTL'S. Further it helps in the linkage mapping. The molecular data information could help in the confirmation of true mapping population and also correlating with root rot disease phenotypic data for identifying QTL further helps in the development of linkage map. In addition to that, the identified SSRs will assist to distinguishing in the mulberry germplasm which is an aid for future breeding programs using genetically distant germplasm of mulberry.

Conclusion

Developed three root rot disease resistance mapping populations and established in the field. Evaluated the selected mapping population consisting 200 F1 progenies against *Fusarium solani* and *Lasiodiplodia theobromae* in two seasons under glasshouse condition. Identified 45 resistant progenies to both the pathogens based on the wilting and rotting data. Identified twelve parental polymorphic SSR markers and completed the genotyping of the mapping population. Additionally, 200 F_1 progenies were subjected for progeny row trial (PRT) and harvested five crops data on growth and yield parameters and found six progenies with higher yield and growth parameters among 45 resistant progenies. These progenies can be further evaluated under Primary Yield trial (PRT).

On-going Research Projects

PIB 3633: Development of highly productive and widely adapted mulberry using exotics and wild germplasm (Jul. 2018 - Jun. 2023)

G.S. Arunakumar and M.R. Bhavya

Objectives

- To generate divergent hybrid populations using exotics, wild related accessions and cultivated mulberry varieties.
- To identify highly productive and adaptive hybrids at PRT.

Field experiments

The experimental garden with 947 F1 hybrids developed from six cross combinations and 755 OPH from G2 and G4 varieties were maintained regularly. Recorded fourth, fifth crops of first year data and first crop data of second year on the growth and yield parameters *viz*., length of longest shoot, leaves in longest shoot, shoot weight, stem weight, no. of branches on five hybrid populations. During the reporting period, three crosses and two OPH F1 hybrids were established in the experimental field. It was found that morphological variation between hybrids is very high in the cross Hosur C3 × V1 (Fig. 2.15).

Survivability and rooting evaluation

The rooting and survivability evaluation showed that 30 hybrids have more than 75 percent of survivability and nine hybrids were found above 15 cm root length among Hosur C3 × V1 cross. Similarly, 34 hybrids showed more than 75 percent of survivability and 11 hybrids were found above 15 cm root length among G4 OPH (Table 2.7).

Table 2.7: Details of survivability and rooting evaluation

Index	% survival range	Number of hybrids		Avg. Root length (cm)	Number of hybrids	
		Hosur C3 × V1	G4 OPH		Hosur C3 × V1	G4 OPH
1	0-25	3	3	0-5	13	7
2	26-50	9	30	5.1 to 10	27	39
3	51-75	29	41	10.1 to 15	22	51
4	> 75	30	34	above 15	9	11


Erect unlobed leaves


Droopy unlobed leaves


Semi-erect multi-lobed leaves

Fig. 2.15: Morphological variability of F1 hybrids in the cross Hosur C3 × V1

PIE 01014SI: Development of Distinctiveness, Uniformity and Stability guidelines for Mulberry (*Morus* spp.) and their validation (Phase III). (Apr. 2020 - Mar. 2023)

Babulal (from Jan. 2021), M. R. Bhavya and P. Sowbhagya

Objectives

- Establishment and maintenance of example and reference varieties in DUS test plot.
- Morphological and molecular characterization of example and reference varieties using DUS descriptors and SSR/SNP markers, respectively and generation of manual cultivar identification diagram.
- DUS testing and registration of mulberry varieties (G2, AR12, Sahana, RC1 and MSG2) under PPV & FRA.
- Collect and characterize mulberry varieties (other than CSB released varieties) from South India (from State Research Institutes like KSSRDI, Universities, *etc*.)
- Establishment of Co-nodal DUS test centre at CSR&TI, Berhampore.

Thirty-four Example genotypes were DUS characterized for 35 characters. Candidate varieties, *viz*., G-4, G-2, AR-12, RC-1, MSG-2 and Sahana were planted in three replications with 8 plants in each replication at DUS test plot. One round of DUS testing of candidate (G4, G2, RC1, AR12, Sahana and MSG2) and reference varieties at demonstration plot for 35 DUS characteristics was completed. The dendrogram divided the genotypes into three main clusters at a rescaled distance of over 20 based on 30 DUS characteristics. Cluster 1 consists of 12 genotypes, cluster 2 consists of 6 genotypes and Sahana in cluster 3 (Fig. 2.14). The distribution of genotypes into different clusters indicates the presence of diversity and distinctiveness among 19 varieties (reference and candidate varieties). Raised the nursery for 13 reference and 6 candidate varieties in RCBD with 3 replications for recording survival % and rooting % of genotypes. Recorded survival data of genotypes after 90 days of growth. Isolated genomic DNA from 52 accessions which include example genotypes, reference and candidate varieties. Reference and candidate varieties were characterized with 5 SSR markers.

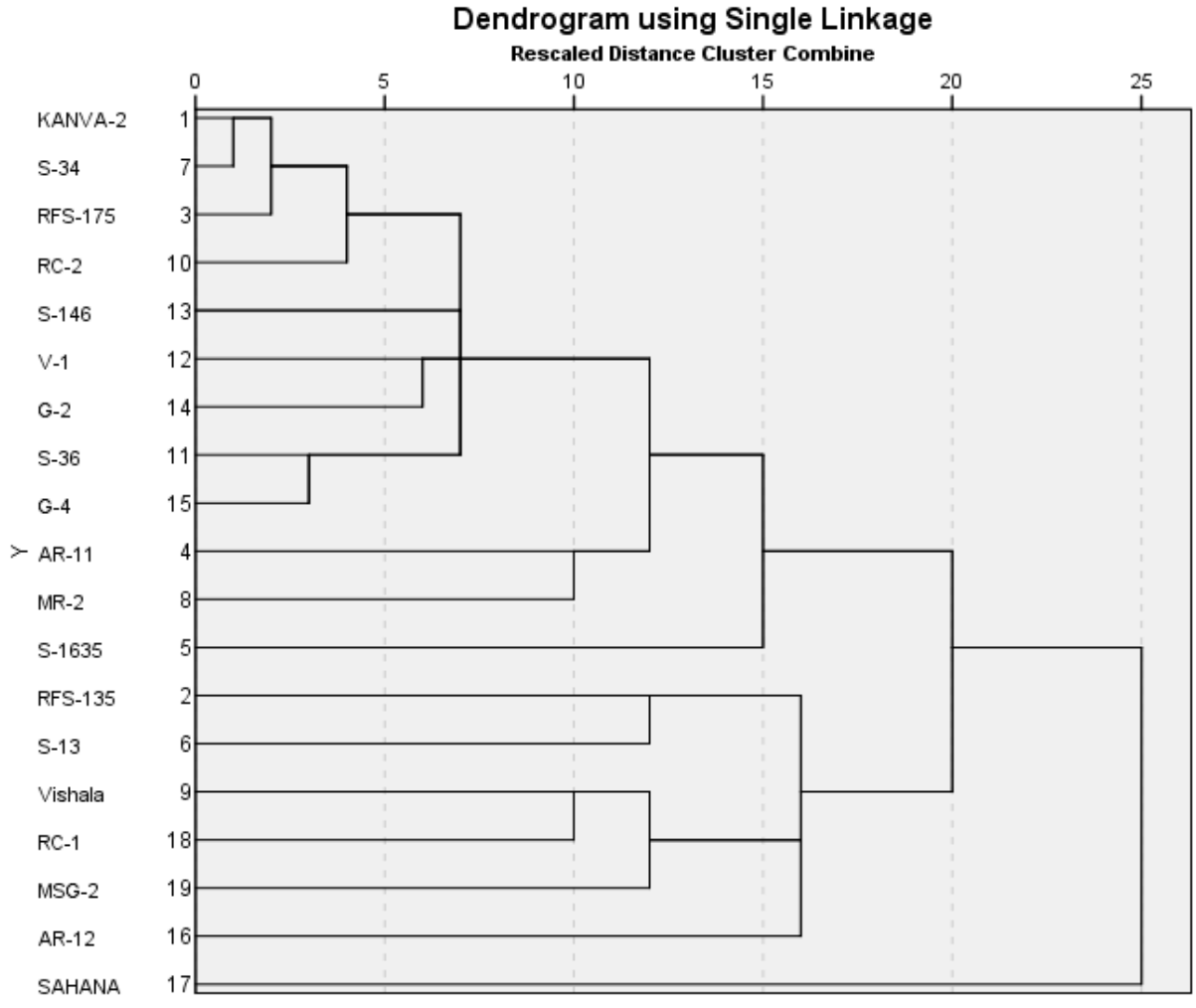


Fig. 2.16: Dendrogram of 19 mulberry genotypes using nearest neighbor cluster method, generated by SPSS Hierarchical Cluster analysis based on 30 DUS characters

Continuous/Other Activities

- Regular maintenance of 400 Panel of Diverse Germplasm
- Development and maintenance of mapping resources

3. SOIL SCIENCE & CHEMISTRY

Concluded Research Project

PIC 01003 CN: Genetic enhancement of Mulberry through Genomic approaches

Sub Component: Identification of QTLs for Nutrient Use Efficiency (NW2d) (Sep. 2018 - Dec. 2021)

V. Sobhana, Ravindra and Dhaneshwar Padhan

Objectives

- To evaluate the panel of diverse mulberry genetic resources for uptake and utilization efficiency of Nitrogen, Phosphorous, Zinc and Sulphur

Diverse mulberry germplasm accessions shortlisted were collected from CSGRC, Hosur and the nursery was raised at CSRTI, Mysuru for phenotypic evaluation of nutrient uptake and utilization efficiency with respect to nitrogen, phosphorus, sulphur and zinc for two trials. Four month old saplings were transplanted to the pots for phenotypic evaluation of nutrient use efficiency. In this experiment, 230 accessions were considerd for pot study. Two levels of fertilizer dosages were imposed – one with recommended dose of fertilizer (RDN) and another one with low dose of fertilizer (LDN) with 30% of recommended dose by maintaining three replications. Growth and yield parameters were recorded for phenotypic evaluation of diverse germplasm accessions for nutrient use efficiency. Nitrogen use efficiency and its components (NUpE and NUtE) were calculated as follows (Moll *et al*., 1982).

$$\text{Nitrogen Uptake Efficiency (NUpE)} = \frac{\text{Total plant N}}{\text{Soil N}}$$

$$\text{Nitrogen Utilization Efficiency (NUtE)} = \frac{\text{Dry matter weight}}{\text{Total plant N}}$$

$$\text{Nitrogen Use Efficiency (NUE)} = \text{NUpE x NUtE}$$

Similarly Phosphorus use efficiency also was calculated.

Zinc efficiency was calculated as follows:

$$\text{Zinc efficiency} = \frac{\text{Yield at -Zn}}{\text{Yield at +Zn}} \times 100$$

Phenotypic evaluation for Nitrogen use efficiency

Overall, accessions grown in LDN were shorter with pale green leaves and thinner stems compared to the ones grown in RDN. However, differences between accessions varied. Fig. 3.1 shows an example of the observed morphological differences under recommended dose of nitrogen and low dose of nitrogen.

Fig. 3.1: Morphological differences between plants grown under recommended and low dose nitrogen supply

The mulberry germplasm accessions performed differently in terms of growth, yield and nutrient use efficiency parameters both under RDN and LDN. Under LDN high variability were observed among the mulberry accessions for biomass yield (35.6%), nitrogen uptake efficiency (46.5%), nitrogen utilization efficiency (31.9%) and nitrogen use efficiency (37.7%) indicating the differential ability of the genotypes in utilising applied nitrogen (Table 3.1). Recommended dose of nitrogen enhanced the shoot length, root weight, biomass yield and harvest index in comparison to plants grown under low dose of nitrogen conditions. But the highest nitrogen uptake efficiency, nitrogen utilization efficiency and nitrogen use efficiency were recorded with LDN (Table 3.1). The distribution of diverse mulberry germplasms accessions with respect to nitrogen use efficiency under low dose of nitrogen is given in Fig. 3.2.

Table 3.1: Nitrogen use efficiency among 230 mulberry accessions

Parameters	Range		Mean		SD		CV (%)	
	RDN	LDN	RDN	LDN	RDN	LDN	RDN	LDN
Shoot length (cm)	28.0-125.0	21.0-83.0	58.4	43.5	15.9	11.0	27.3	25.4
Root length (cm)	12.0-56.0	3.0-61.0	31.9	25.2	8.0	7.3	24.9	28.9
Root weight (g/plant)	0.5-47.0	0.1-27.0	12.2	4.4	7.7	4.4	63.6	100.6
Biomass yield (g/plant)	32.0-185.0	13.5-120.0	90.3	51.0	21.5	18.2	23.8	35.6
Harvest Index (%)	15.0-52.5	10.0-59.2	34.1	24.1	6.78	6.84	19.9	28.4
SPAD value	14.5-40.3	13.1-36.0	30.0	24.8	4.9	4.1	16.8	16.4
Total chlorophyll (mg/g)	1.30-2.25	0.65-1.41	1.64	0.94	0.17	0.12	10.2	12.9
Nitrogen content (%)	2.30-6.44	1.07-4.71	3.60	2.98	0.60	0.76	16.8	25.5
NUpE	0.04-1.59	0.12-2.62	0.57	1.06	0.23	0.50	40.2	46.5
NUtE	15.53-40.91	21.23-93.5	28.3	35.6	4.68	11.4	16.6	31.9
NUE	1.24-39.87	4.42-77.9	15.8	34.8	5.71	13.1	36.2	37.7

NUpE: Nitrogen uptake efficiency; NUtE: Nitrogen utilization efficiency; NUE: Nitrogen use efficiency

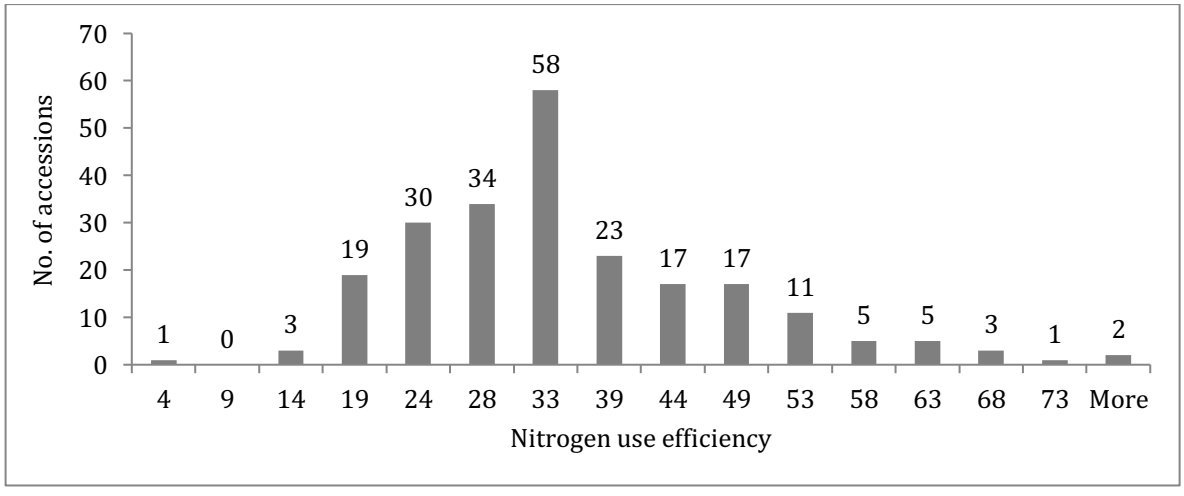


Fig. 3.2: Distribution of mulberry germplasm accessions with respect to nitrogen use efficiency under LDN

Phenotypic evaluation for phosphorus use efficiency

Recommended dose of phosphorus (RDP) enhanced the shoot length, root weight, biomass yield, harvest index and phosphorus use efficiency in diverse mulberry germplasms as compared to plants grown under low phosphorus conditions (LDP) (Table 3.2). The mean biomass yield of 90.3 and 73.7 g/plant were recorded with RDP and LDP respectively. More than 18% reduction in biomass yield was observed with LDP. The phosphorus content in total plant ranged from 0.15-1.05% with RDP and 0.11-0.90% with LDP. The average value of phosphorus uptake efficiency and phosphorus utilization efficiency was 0.16 g P uptake/g P applied and 279.1 g dry matter yield/g P uptake with RDP and 0.44 g P uptake/g P applied and 306.6 g dry matter yield/g P uptake with LDP respectively. The distribution of diverse mulberry germplasms accessions with respect to phosphorus use efficiency under low dose of phosphorus is given in Fig. 3.3.

Table 3.2: Phosphorus use efficiency among 230 mulberry accessions

Parameters	Range		Mean		SD		CV (%)	
	RDP	LDP	RDP	LDP	RDP	LDP	RDP	LDP
Shoot length (cm)	28.0-125.0	19.0-122.0	58.4	60.0	15.9	17.8	27.3	29.6
Root length (cm)	12.0-56.0	3.5-62.0	31.9	27.3	8.0	10.3	24.9	37.8
Root weight (g/plant)	0.5-47.0	0.5-41.0	12.2	11.8	7.7	7.39	63.6	62.6
Biomass yield (g/plant)	32.0-185.0	13.5-165.5	90.3	73.7	21.5	27.7	23.8	37.6
Harvest Index (%)	15.0-52.5	10.0-71.5	34.1	30.0	6.78	9.19	19.9	30.6
Phosphorus content (%)	0.15-1.05	0.11-0.90	0.41	0.37	0.15	0.12	37.8	33.8
PUpE	0.02-0.51	0.08-1.36	0.16	0.44	0.09	0.22	56.4	50.8
PUtE	94.8-682.6	111.11-897.9	279.1	306.6	100.5	115.8	36.0	37.8
PUE	6.04-82.7	25.0-324.3	37.8	122.2	12.4	50.9	32.9	41.7

PUpE: Phosphorus uptake efficiency; PUtE: Phosphorus utilization efficiency; PUE: Phosphorus use efficiency

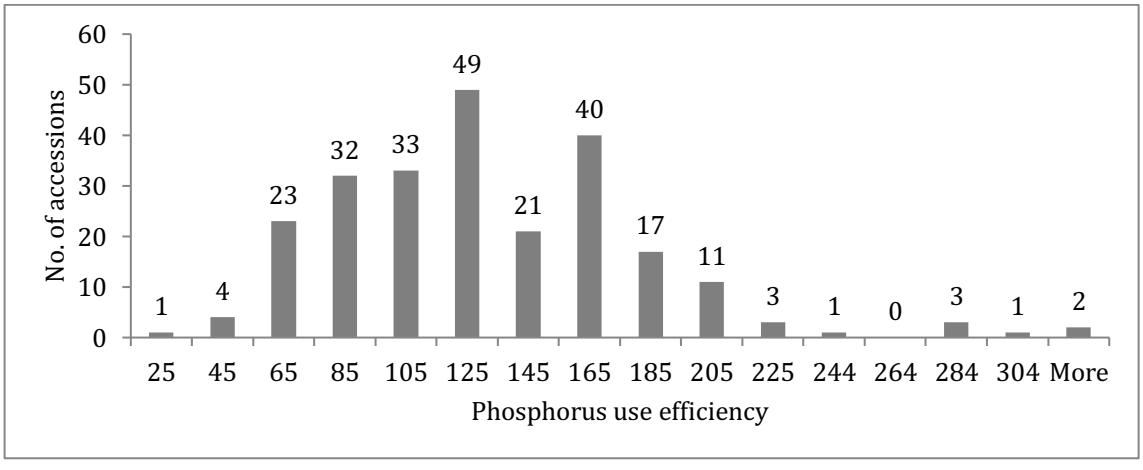


Fig. 3.3: Distribution of mulberry germplasm accessions with respect to phosphorus use efficiency under low dose of phosphorus

Phenotypic evaluation for zinc efficiency

Considerable reductions in biomass yield at LD Zn compared with RD Zn were observed among the diverse mulberry germplasms. The mean biomass yield of 90.3 and 58.7 were recorded with RD Zn and LD Zn respectively (Table 3.3). The zinc efficiency of diverse mulberry germplasms ranged from 20.7-98.9 with a mean value of 66.5 %. The distribution of diverse mulberry germplasms accessions with respect to zinc efficiency is given in Fig. 3.4.

Table 3.3: Zinc use efficiency among 230 mulberry accessions

Parameters	Range		Mean		SD		CV (%)	
	RDZn	LDZn	RDZn	LDZn	RDZn	LDZn	RDZn	LDZn
Shoot length (cm)	28.0-125	20.0-83.0	58.4	48.7	15.9	10.7	27.3	21.9
Root length (cm)	12.0-56.0	10.0-53.0	31.9	28.3	8.0	8.4	24.9	29.6
Root weight (g/plant)	0.5-47.0	0.5-31.0	12.2	10.8	7.7	6.19	63.6	57.5
Biomass yield (g/plant)	32.0-185.0	14.0-117.5	90.3	58.7	21.5	19.2	23.8	32.7
Harvest Index (%)	15.0-52.5	10.0-53.8	34.1	27.2	6.8	8.0	19.9	29.3
Zinc efficiency (%)	20.7-98.9		66.5		19.8		29.7	

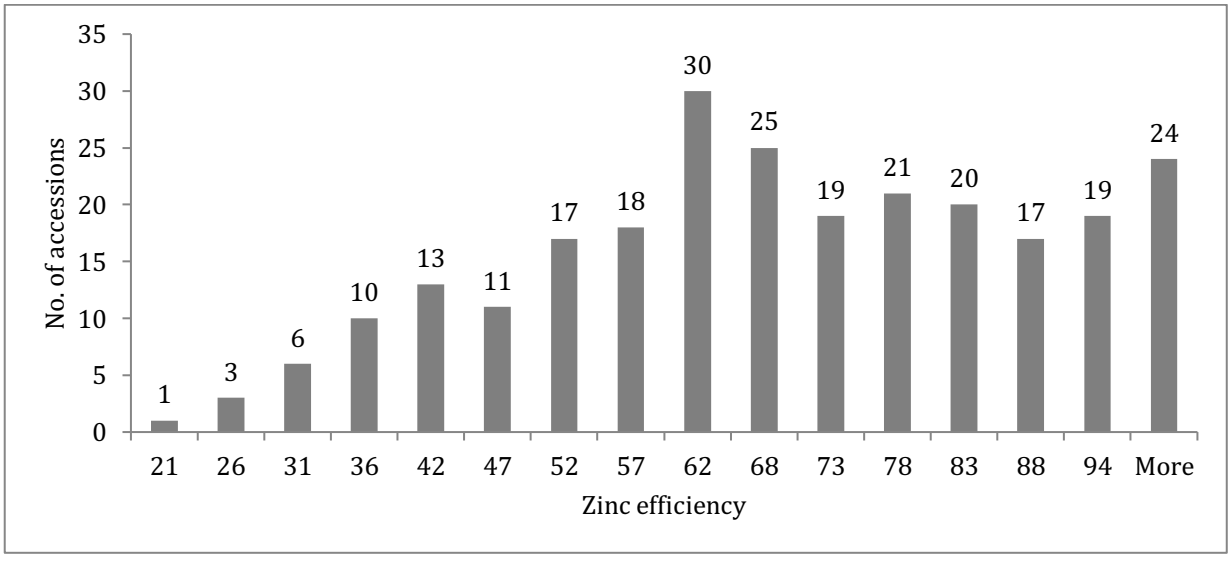


Fig. 3.4: Distribution of mulberry germplasm accessions with respect to zinc efficiency

Phenotypic evaluation for Sulphur efficiency

The sulphur efficiency of diverse mulberry germplasms ranged from 22.7-98.7 with a mean value of 68.8 % (Table 3.4). The distribution of diverse mulberry germplasms accessions with respect to sulphur efficiency is given in Fig. 3.5.

Table 3.4: Sulphur use efficiency among 230 mulberry accessions

Parameters	Range		Mean		SD		CV (%)	
	RDS	LDS	RDS	LDS	RDS	LDS	RDS	LDS
Shoot length (cm)	28.0-125.0	20.0-90.0	58.4	49.7	15.9	11.6	27.3	23.3
Root length (cm)	12.0-56.0	9.0-55.0	31.9	29.9	8.0	7.88	24.9	26.4
Root weight (g/plant)	0.5-47.0	0.5-40.0	12.2	10.3	7.7	6.1	63.6	59.3
Biomass yield (g/plant)	32.0-185.0	14.0-117.5	90.3	61.0	21.5	19.1	23.8	31.3
Harvest Index (%)	15.0-52.5	10.0-64.8	34.1	29.8	6.78	7.9	19.9	26.5
Sulphur efficiency (%)	22.7-98.7		68.8		18.9		27.5	

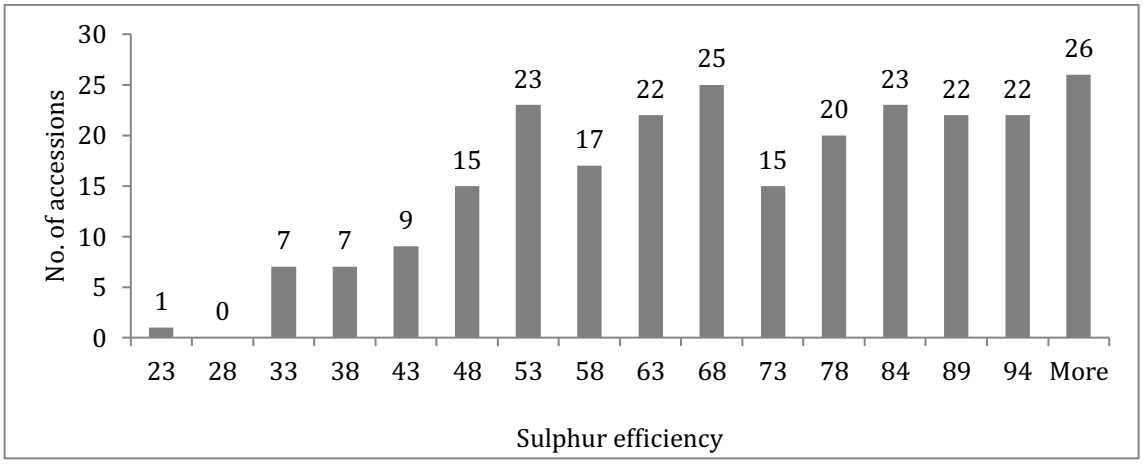


Fig. 3.5: Distribution of mulberry germplasm accessions with respect to Sulphur efficiency

The diverse mulberry germplasms accessions performed differently in terms of growth, yield and nutrient use efficiency parameters both under recommended dose of nutrient and low dose of nutrient. A good variation in growth parameters was observed in diverse mulberry accessions both under recommended dose of nutrient and low dose of nutrient. The better performing genotypes under low nitrogen, phosphorus, zinc and sulphur can be used in for crop improvement programmes to develop mulberry variety with high nutrient use efficiency.

On-going Research Projects

PIC 01007 SI: Development of protocol for production of medically fit silk (sericin, fibroin, cocoon) for clinical purposes (Feb. 2020-Jan. 2023)

Ravindra, Dhaneshwar Padhan, Divya Singh, Y. Thirupathaiah, V. Sobhana, T. Gayathri and S. M. Hukkeri

Specific objective

- Purification and characterization of sericin and fibroin from organic cocoon

Objectives

- Production of mulberry leaf through organic cultivation practices/hydroponics/sand culture.

- Rearing of silkworm by using the leaf produced under such system and production of organic cocoons and silk.
- Development of protocol for production of heavy metal and other toxic free/permissible limit in cocoon/silk.

Production of cocoon through organanic management practices

The organic mulberry garden was maintained through organic management practices. The data on shoot height, no of shoots, shoot weight, no of leaf, leaf weight, *etc*., were recorded for three crops during the year. Biochemical parameters (total moisture, protein, carbohydrates and chlorophyll content) and heavy metals and pesticide residues were estimated in the organically produced mulberry leaf. The results showed that Pb, Cd, As, Hg and Co are below detection limit, whereas Ni, Cr, and Cu are within the permissible limit. The organically produced leaf was utilized for silkworm rearing during Jul.-Aug. 2021, Oct.-Nov. 2021 and Jan.-Feb. 2022. The cocoon shell was used for the extraction of sericin and fibroin. Sericin and fibroin protein were extracted with milliQ water and tested for the presence of heavy metals and pesticide residues if any. The results showed that Cd, As, Hg and Co are below detection limit, whereas Ni, Cr, and Cu are within the permissible limit in cocoon shell, sericin and fibroin samples (Table 3.5). Similarly, the samples were tested for pesticide residues if any and no organophosphates, organochlorines and carbamates were detected.

Table 3.5: Analysis of leaf, cocoon shell, sericin and fibroin samples for heavy metals and pesticide residues

Parameters	Leaf (organic garden) (mg/kg)	Organic Cocoon shell (mg/kg)	Sericin (mg/kg)	Fibroin (mg/kg)
Heavy metals				
Pb	BDL	0.30	0.10	0.70
Cd	BDL	BDL	BDL	BDL
As	BDL	BDL	BDL	BDL
Hg	BDL	BDL	BDL	BDL
Co	BDL	BDL	BDL	BDL
Ni	0.70	0.80	BDL	0.70
Cr	0.70	0.50	0.20	0.60
Cu	3.90	5.00	4.00	6.00
Pesticide residues				
Organophosphates	BDL	BDL	BDL	BDL
Organo chlorines	BDL	BDL	BDL	BDL
Carbamates	BDL	BDL	BDL	BDL

BDL: Below detection limit

Hydroponic Nutrient Flow Technique (NFT)

One hundred and twenty one V1 mulberry plants were grown on hydroponic method in the polyhouse. The hydroponically grown mulberry leaf was tested for heavy metals and pesticide residues and it was found that Pb, Cd, As, Hg and Co are below detection limit, where as Ni, Cr and Cu are within permissible limit. Similarly, it was also observed that pesticides such as organophosphates, carbamates and organochlorines were not detected in hydroponically grown leaf.

Table 3.6: Growth and yield parameters of mulberry plants grown on hydroponic system

Longest shoot length (cm)	Avg. plant height (cm)	No. of shoots/ plant	No. of leaf/ shoot	Shoot weight/ plant (g)	Leaf weight/ plant (g)
104.6 ±3.9	88±2.8	2.9±0.34	25.1±1.2	60.4±6.1	115.7±10.4

Table 3.7: Analysis of hydroponically grown mulberry leaf for heavy metals and pesticide residues

Heavy metals		***Pesticide residues***	
Pb	BDL	Organophosphates	BDL
Cd	BDL	Organo chlorines	BDL
As	BDL	Carbamates	BDL
Hg	BDL		
Co	BDL		
Ni	0.34		
Cr	0.40		
Cu	4.00		

BDL: Below detection limit

Sand bed culture

Mulberry plants (280) of V1 varity grown in sand culture technique was harvested and growth and yield parameters were recorded (Table 3.8). Heavy metals and pesticide residues were analysed in V1 mulberry leaf produced through sand culture experiment and it was observed that heavy metals *viz*., Pb, Cd, As, Co and Hg and pesticides were below detection limit, whereas Ni, Cr and Cu are within the permissible limit. Simlarly, cocoon shell was analysed for heavy metals if any and it was observed that Cd, As, Co and Hg were below detection limit (Table 3.9).

Table 3.8: Growth and yield parameters of mulberry plants grown through sand bed culture

Longest shoot length (cm)	Avg. plant height (cm)	No. of shoots/ plant	No. of leaf/ shoot	Shoot weight/ plant (g)	Leaf weight/ plant (g)
96.9±5.5	87.3±5.7	4.1±0.34	20.6±1.6	44.5±5.0	64.5±5.9

Table 3.9: Analysis of mulberry leaf and cocoon shell produced by sand culture

Parameters	Leaf (ppm)	Coocon shell (ppm)
Heavy metals		
Pb	BDL	0.32
Cd	BDL	BDL
As	BDL	BDL
Hg	BDL	BDL
Co	BDL	BDL
Ni	0.71	0.5
Cr	0.48	2.4
Cu	4.9	3.4
Pesticide residues		
Organophosphates	BDL	Not done
Organo chlorines	BDL	Not done
carbamates	BDL	Not done

Continuous/Other activites

Quality Analysis and Sample Testing

Commercialized products developed by CSRTI-Mysuru were analysed in the laboratory to check the quality parameters. Samples of water, soil and FYM were also tested for macronutrients. Based on the test results, technical guidance was provided to the farmers and stake holders.

Table 3.10: Analysis of products/samples and revenue generated

Products/samples	No. of samples	Revenue generated (Rs.)
Soil	*426	5229/-
Water	06	426/-
FYM	02	826/-
Asthra	14	13216/-
Vijetha	04	14160/-
Vijetha supplement	10	11800/-
Sanitech	03	2832/-
Ankur	01	3540/-
Ankush	08	33040/-
Amruth	02	2360/-
Poshan	06	21240/-
Dr.Soil	01	3540/-
Serichlore	01	944/-
Bleaching powder	01	944/-
Total (Rs.)		114097/-

*44 soil samples were tested against payment

4. AGRONOMY

Concluded Research Project

PIN 3563: Evaluation of improved mulberry genotypes for yield potential, nutrient uptake and nitrogen use efficiency under varied cultivation practices (Feb. 2016-Mar. 2022)

Dhaneshwar Padhan, V. Sobhana, E. Bhuvaneshwari and Y. Thirupathaiah

Objectives

- To evaluate yield potential, nutrient uptake efficiency of new mulberry genotypes under varied levels of irrigation and fertilizer inputs.
- To evaluate new mulberry genotypes cultivated under varied conditions for their efficacy in silkworm rearing.
- To determine nitrogen use efficiency from soil to cocoon production.

The study has been undertaken at CSRTI, Mysuru to evaluate the improved mulberry genotypes *viz*., AGB-8, MSG-2, G-4 and V-1 for their yield potential, nutrient uptake and nitrogen use efficiency under varied cultivation practices. The experiment was laid down in split-split plot design with three replications comprising two levels of irrigations (I_0= 100% and I_1= 60%) and three levels of fertilizer doses (F_0- 350:

140: 140 kg/ha/yr; F_1- 280: 112: 112 kg/ha/yr and F_2- 210: 84: 84 kg/ha/yr). FYM @ 25 MT/ha/yr was applied uniformly to all the treatments.

The analysis of pooled data for the three years revealed that AGB-8 variety recorded significantly higher leaf yield (35.8 MT/ha/yr) in the treatment I_1F_2 *ie*., 60% irrigation and 60% fertilizer followed by V-1 (26.5 MT/ha/yr), G-4 (25.7MT/ha/yr) and MSG-2 (25.2 MT/ha/yr). However, there was no significant difference in the leaf yield among the two genotypes *viz*., G-4 and MSG-2 under low input conditions. The data revealed that V-1 and G-4 performed with higher leaf yield in the treatment I_0F_0 where recommended package and practices was followed (Fig. 4.1).

The soil samples were analyzed for its physical and chemical properties and the data revealed that there were no significant changes in soil pH and organic carbon content over the period of three years (Table 4.1). However, there was significant depletion of available nitrogen and potassium in all the treatments compared to initial level. On the contrary, there was noticeable built-up in the case of available phosphorus in the soil (Table 4.2).

Leaf nitrogen uptake was calculated and the highest level of nitrogen uptake was found in AGB-8 variety (310.4 kg/ha/year) followed by G-4 (284.5 kg/ha/year), V-1 (284.3 kg/ha/year) and MSG-2 (202.2 kg/ha/year) under low input condition (treatment I_1F_2) (Fig. 4.2). Similarly, the nitrogen use efficiency was estimated for all genotypes showed significantly higher use efficiency in AGB-8 (53.6%) under low input condition (Fig. 4.3). The data on the bioassay study also confirmed the quality performance of AGB-8 under low input conditions.

Conclusion

The AGB-8 mulberry cultivar can be adopted for cultivation under low input conditions due to its high nitrogen use efficiency and high yield.

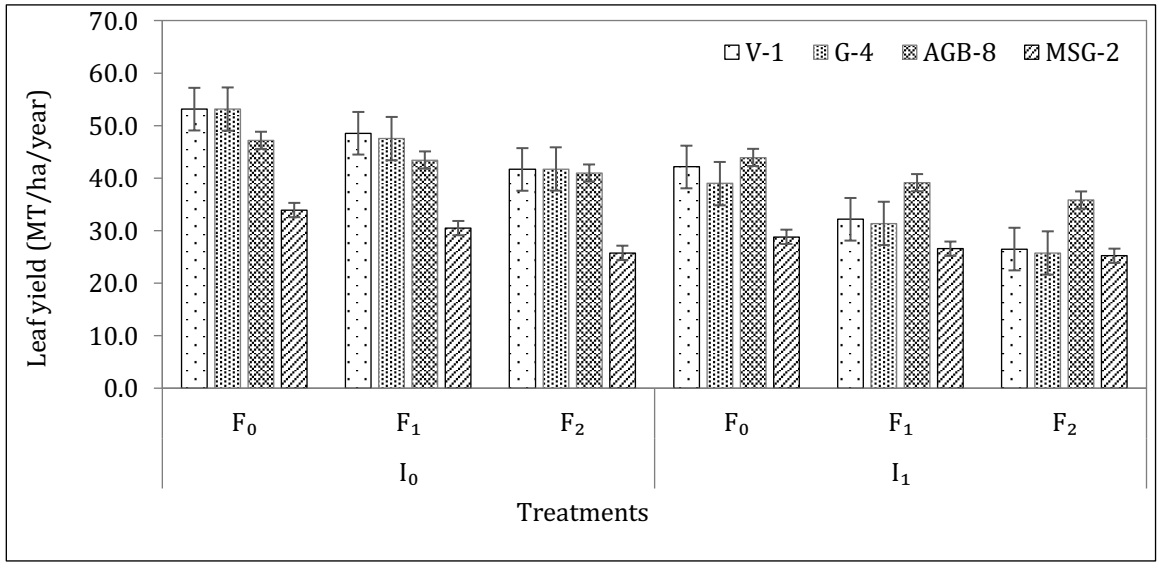


Fig. 4.1: Leaf yield of different mulberry varieties under various treatments

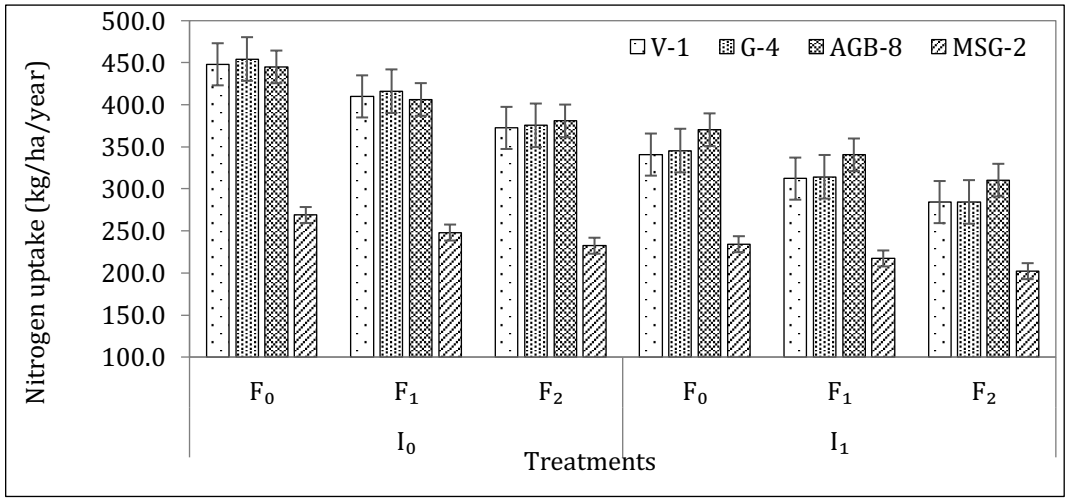


Fig. 4.2: Leaf nitrogen uptake of different mulberry varieties under various treatments

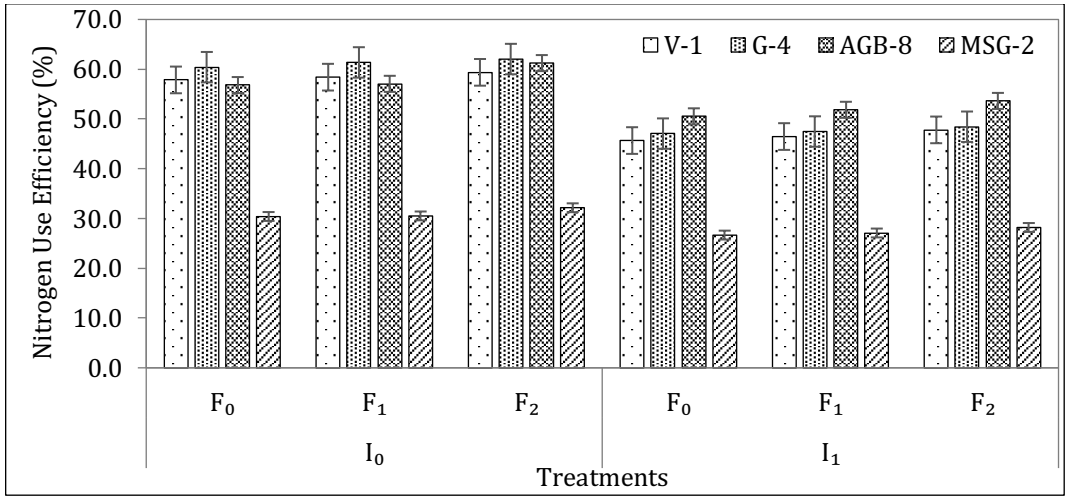


Fig. 4.3: Nitrogen use efficiency of different mulberry varieties under various treatments

Table 4.1: Impact of two levels of irrigation and three fertilizers doses on changes in soil pH and organic carbon content

Treatments		V-1		G-4		AGB-8		MSG-2	
		pH	OC	pH	OC	pH	OC	pH	OC
I0	F0	6.38	7.10	6.36	7.20	6.36	6.98	6.44	6.92
	F1	6.42	6.86	6.41	6.79	6.46	6.84	6.45	6.82
	F2	6.46	6.51	6.44	6.45	6.48	6.71	6.47	6.63
Irrigation mean		6.42	6.82	6.40	6.81	6.43	6.84	6.45	6.79
I1	F0	6.36	6.91	6.32	6.86	6.42	6.84	6.43	6.81
	F1	6.40	6.74	6.39	6.71	6.44	6.78	6.44	6.74
	F2	6.43	6.48	6.41	6.42	6.45	6.68	6.46	6.56
Irrigation mean		6.40	6.71	6.37	6.66	6.44	6.77	6.44	6.70
Fertilizer mean	F0	6.37	7.01	6.34	7.03	6.39	6.91	6.44	6.87
	F1	6.41	6.80	6.40	6.75	6.45	6.81	6.45	6.78
	F2	6.45	6.50	6.43	6.44	6.47	6.70	6.47	6.60

Varietal mean			6.41	6.77	6.39	6.74	6.44	6.81	6.45	6.75
CD (P=0.05)	pH	I	0.37	I * F	0.63	OC	I	0.41	I * F	0.71
		F	0.45	F * V	0.90		F	0.50	F * V	1.01
		V	0.52	I * V	0.73		V	0.58	I * V	0.82
	Initial		6.50	6.80	6.50	6.80	6.50	6.80	6.50	6.80

Table 4.2: Impact of two levels of irrigation and three fertilizers doses on changes in soil available nitrogen, phosphorus and potassium content

Treatments		V-1			G-4			AGB-8			MSG-2		
		N	P	K	N	P	K	N	P	K	N	P	K
I0	F0	370.6	26.3	401.1	367.2	25.9	402.9	371.4	27.7	398.8	367.9	28.4	391
	F1	346.2	23.1	379.9	350.1	22.7	370.4	353.8	24.3	384.7	361.1	24.9	389.9
	F2	327.5	22.2	336.0	342.5	21.8	338.8	340.3	23.4	354.6	348.0	24.0	368.7
Irrigation mean		348.1	23.9	372.3	353.2	23.4	370.7	355.2	25.1	379.4	359.0	25.8	383.5
I1	F0	363.3	27.5	398.4	365.3	26.8	400.2	358.0	29.2	412.1	361.1	26.7	416.6
	F1	342.3	23.1	358.4	334.4	23.7	349.4	328.7	22.0	362.9	346.2	21.6	386.7
	F2	321.6	22.3	346.2	328.5	22.9	344.6	312.8	21.2	322.1	334.2	20.8	362.6
Irrigation mean		342.4	24.3	367.7	342.7	24.5	364.7	333.2	24.1	365.7	347.2	23.0	388.6
Fertili-zer mean	F0	366.9	26.9	399.8	366.2	26.3	401.6	364.7	28.5	405.5	364.5	27.6	404.2
	F1	344.3	23.1	369.2	342.2	23.2	359.9	341.3	23.1	373.8	353.7	23.2	388.3
	F2	324.5	22.2	341.1	335.5	22.3	341.7	326.6	22.3	338.4	341.1	22.4	365.7
Varietal mean		345.2	24.1	370.0	348.0	23.9	367.7	344.2	24.6	372.5	353.1	24.4	386.1
CD (P=0.05)		N			P			K					
		I	19.3	I * F	33.5	I	1.54	I * F	2.68	I	21.0	I * F	36.3
		F	23.7	F * V	47.3	F	1.89	F * V	3.78	F	25.7	F * V	51.4
		V	27.3	I * V	38.6	V	2.18	I * V	3.09	V	29.6	I * V	41.9
	Initial	403.8	19.5	430.7	403.8	19.5	430.7	403.8	19.5	430.7	403.8	19.5	430.7

Ongoing Research Projects

PPA 01016SI: Development of an agronomical package for tree mulberry cultivation for wide acceptance among the seri-farmers of Southern India (Nov. 2020-Feb. 2023)

Dhaneshwar Padhan, C.M. Babu, V. Sobhana, J.B. Narendra Kumar, T. Sivasubramonian and D. Guruswamy

Objectives

- To evaluate the optimum requirement of nutrients for mulberry under tree cultivation.
- To work out the techno-economics of the mulberry under tree cultivation.

The experiment to study the optimum nutrient requirement for mulberry under tree cultivation has been undertaken with farmer's participatory mode in three locations *viz*., Maddur, Chamarajnagara and Kolar areas. There were four treatments for the nutrient management practices. They are T1: NPK @ 207:83:83 g + 15 kg FYM/plant/year; T2: NPK @ 155:62:62 g + 15 kg FYM/plant/year; T3: NPK @ 258: 103: 103 g + 15 kg FYM/ plant/year; T4: NPK @ 103: 83: 83 g + 15 kg FYM/plant/year + Green manuring along with farmer's practice as control (T5). During the period under report, three crops were harvested and the data revealed that significantly higher leaf was recorded in T3 treatment in all the three locations (Table 4.3, 4.4 and 4.5).

Table 4.3: Effect of different doses of fertilizers on growth and yield of mulberry (Location: Maddur)

Treatments	Longest shoot length (cm)	No. shoots/plant	No. leaves/shoot	Leaf weight (kg)/plant	Shoot weight (kg)/plant
T1	184	26	35	3.70	2.99
T2	166	22	28	3.09	2.42
T3	193	29	37	3.87	3.20
T4	174	24	30	3.06	2.39
T5	167	22	27	2.85	2.24
SEd	16	2.34	3.11	0.245	0.323
CD at 5%	7.96	1.16	1.54	0.121	0.159

Table 4.4: Effect of different doses of fertilizers on growth and yield of mulberry (Location: Chamarajnagara)

Treatments	Longest shoot length (cm)	No. shoots/plant	No. leaves/shoot	Leaf weight (kg)/plant	Shoot weight (kg)/plant
T1	194	27	35	3.81	3.09
T2	172	24	30	2.97	2.41
T3	202	29	36	3.96	3.33
T4	173	24	32	3.16	2.73
T5	171	24	31	2.81	2.39
SEd	8.71	2.11	2.92	0.234	0.311
CD at 5%	17.6	1.04	1.45	0.115	0.164

Table 4.5: Effect of different doses of fertilizers on growth and yield s of mulberry (Location: Kolar)

Treatments	Longest shoot length (cm)	No. shoots/plant	No. leaves/shoot	Leaf weight (kg)/plant	Shoot weight (kg)/plant
T1	196	31	39	4.47	3.28
T2	175	26	32	3.91	2.80
T3	201	31	40	4.67	3.47
T4	176	25	34	3.91	2.77
T5	169	25	30	3.51	2.62
SEd	16.4	2.29	3.64	0.398	0.264
CD at 5%	8.11	1.13	1.81	0.196	0.131

MOE 01021SI: Evaluation and popularization of improved technologies developed in the field of mulberry sector for South India (Nov. 2021-Oct. 2023)

Component-9: Impact of drip fertigation on mulberry productivity

M. Muthulakshmi, R. Mahesh, T. Sivasubramonian, S.B. Kulkarni, N. Dhahira Beevi and P. Sudhakar

Objectives

- To validate the drip fertigation technology for mulberry at different locations.

The experiment has been undertaken to validate the drip fertigation on growth and yield of mulberry as OST programme at four RSRSs and also at main Institute. Initiated the installation of drip irrigation system in the experimental mulberry garden at Institute as well as at different test centres. The experimental garden is maintained as per the protocol.

Collaborative Research Project (CSTRI, Bengaluru)

CYF 07011SI: New methods of recycling of discarded silk materials/waste for sustainability (Oct. 2019-Sep. 2021)

S. Nivedita, Y. C. Radhalakshmi, Kiran B. Malali, S. A. Hippargi, M. A. Moon and C.M. Babu

Objectives

- To develop mill spun yarns from pre and post consumer silk waste and characterize them.
- To prepare other new products like silk waddings and silk powder from left over fibres and explore their application.
- To study the compostability of unusable silk waste and to estimate its nutritional value.

The silk waste samples received from the CSTRI, Bengaluru were subjected for composting under 5 different treatment combinations in the compost pots to study the composting feasibility of silk waste for a period of 8 months. It was observed that the silk waste is not fully decomposed in any of the treatment. However, in treatment T2 (Mixture of Soil + partially decomposed compost + cowdung slurry) it was estimated that 79.6 % of silk waste was decomposed followed by 77.2 % in T3 (Mixture of soil + rearing waste+ cowdung slurry). A vermicomposting technology was standardized for the effective conversion of the unusuable silk waste into organic rich manure.

Similarly, the Vermicomposting experiment on silk waste was undertaken by preparing the vermi-bed with fresh cow dung and silk waste in the ratio of 2:1 (v/v). A pit measuring 6 x 2.5 x 2 feet was made in an elevated area and cemented the surface to avoid the migration of worms. The area was protected from sunlight and rain by making a thatched shed over the pit. The vermi-beds prepared in the pit by adding a layer of fresh cow dung of 4-5 inches. This layer was followed by spreading of juvenile earthworm. Then layers of silk waste and cow dung were spread alternately till the heap become 1.5 feet. About one kg of vermiculture required for 6 x 2 x 1.5 feet vermi-bed. The potential earthworms used for vermicomposting were the mixture culture of *Perionyx excavatus, Eudrillus euginae* and *Eisenia foetida*. The beds were covered with dry leaves and straws *etc,.* The beds were sprinkled with water in alternate days. The whole material was converted into vermicompost within a period of 2-3 months. The nutritional status of the vermicompost was assessed (Table 4.6).

Table 4.6: Nutritional status of vermicompost prepared out of silk waste

#	Contents	Quantity
1	Nitrogen (%)	1.9 – 2.2
2	Phosphorus (%)	0.9 -1.0
3	Potash (%)	0.7 -0.8
4	Manganese (ppm)	678 - 689
5	Zinc (ppm)	134 - 148
6	Copper (ppm)	150 -157
7	Iron (ppm)	1114 - 1179

CED 07007: Development of Sericin/polysachharide encapsulated fertilizer for crop management and growth (Jul. 2019-Dec. 2021)

R. R. Shailaja (The Energy and Resources Institute (TERI)-Bengaluru, Srinivasa (CSTRI-Bengaluru), C. M. Babu, Abhilasha (CSTRI-Bengaluru) and H. H. Ningasetty (TERI-Bengaluru)

Objectives

- Development of sericin / polysaccharide encapsulating matrices for encapsulation of fertilizer.
- Study the effect on plant growth by incorporating/mixing sericin along with fertilizers

A pot experiment has been undertaken to study the effect of Sericin encapsulated fertilizers on the growth and yield of mulberry. The mulberry plants were supplied by fixing the NPK fertilizer @ 350:140:140 kg/ha/yr for both sericin encapsulated fertilizer as well as for control. The data revealed that there was no significant difference in the growth and yield of mulberry grown with sericin encapsulated fertilizer as well as with the conventional package.

Continuous/Other activites

- Engaged the classes for trainees/students under different training programmes
- Maintained 2 acre seed mulberry garden with G-4 variety
- Maintained the seri-compost and vermicompost units for demonstration

5. MULBERRY PHYSIOLOGY

Concluded Research Project

PIC-01003CN: Genetic enhancement of mulberry by genomics approaches: Multi-Component Network Project

***Subproject: NW2b*: Discovery of QTL to drought adaptive traits by association mapping in Mulberry: in collaboration with GKVK, UAS, Bengaluru (Sept. 2018 to Dec. 2021).**

M. S. Sheshshayee (UAS, Bengaluru) and T. Gayathri

Objectives

- Extensive phenotypic characterization of the panel of diverse germplasm for drought adaptive traits.
- To identify QTLs for drought adaptive traits by association mapping.

CSRTI, Mysuru

Extensive phenotypic characterization of the panel of germplasm for drought adaptive traits

Phenotyping for drought adaptive traits and WUE parameters were completed in 208 germplasm accessions during first season (Oct. 2019) and in 204 germplasm accessions during second season (March 2021). Saplings of germplasm accessions were raised in nursery (2 sets) and transplanted the saplings to specially designed root structures and maintained for recording observations on drought adaptive traits and water use efficiency parameters. Phenotypic data were recorded using standard procedures in all these germplasm accessions *viz*., chlorophyll, epicuticular wax, specific leaf weight, area and number of stomata. Growth parameters (shoot length, shoot weight, leaf weight, *etc*.) and root traits (number of roots, root weight, length and weight of longest root, *etc*.) were recorded in all these genotypes during 2 seasons.

Table 5.1: Variation of specific leaf weight among diverse germplasm accessions

Season	Leaf position	Mean (mg/cm²)	SE	SD	CV%	Sample Variance	Minimum	Maximum
Oct. 2019 (1st)	Top leaves	4.519	0.061	0.885	19.58	0.784	2.555	7.333
	Middle Leaves	5.49	0.068	0.983	17.9	0.968	1.777	8.833
	Bottom Leaves	5.967	0.084	1.214	20.34	1.474	2.02	10.25
Mar. 2021 (2nd)	Top leaves	3.802	0.053	0.73	19.2	0.532	2.138	6.944
	Middle Leaves	4.72	0.061	0.848	17.96	0.719	2.722	8.222
	Bottom Leaves	5.078	0.067	0.923	18.17	0.853	2.916	8.833

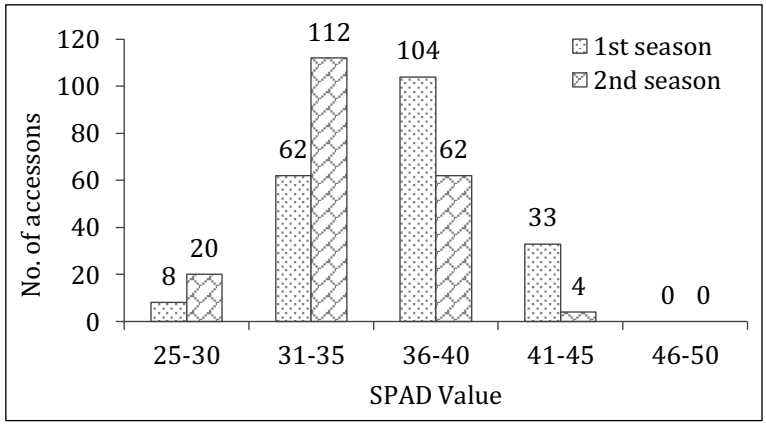


Fig. 5.1: Chlorophyll content (SPAD value) of diverse germplasm accessions

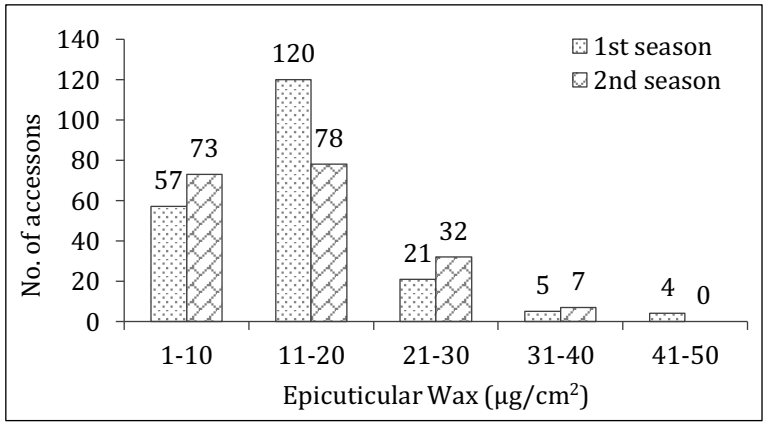


Fig. 5.2: Epicuticular wax content of diverse germplasm accessions

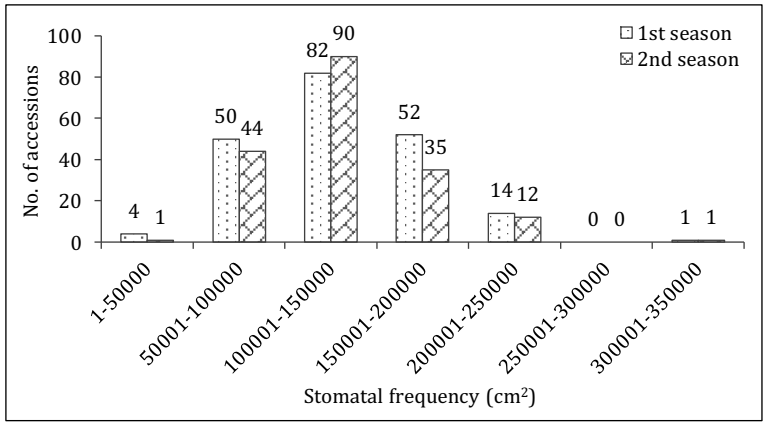


Fig. 5.3: Stomatal frequency of diverse germplasm accessions

Table 5.2: Root weight of diverse germplasm accessions

Season	Mean (g)	SE	SD	CV%	Sample Variance	Minimum	Maximum
1st	39.68	1.573	22.584	56.91	510.06	6.7	118.63
2nd	47.51	2.611	36.38	76.57	1323.55	2.5	248.7

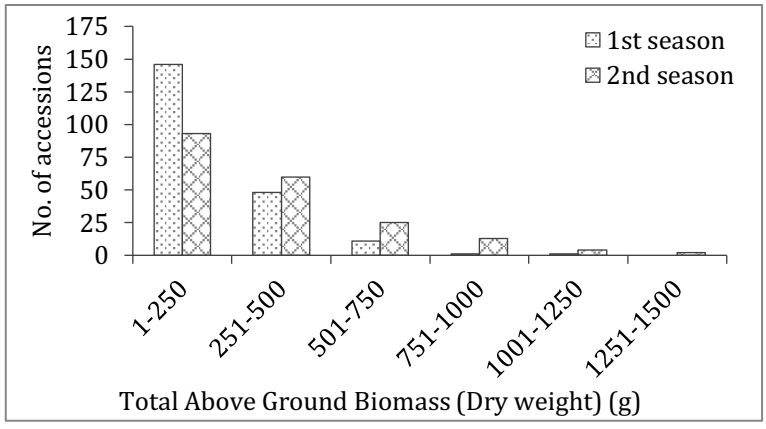


Fig. 5.4: Total above ground biomass of diverse germplasm accessions

Diverse set of mulberry germplasm accessions were screened and phenotyped for drought adaptive traits and water use efficiency parameters during 2 seasons and based on phenotyping data 26 germplasm accessions were short-listed for field phenotyping exeriments. These 26 germplasm accessions showed contrasting root traits were evaluated under irrigated and rain-fed conditions at RSRS, Ananthapur as part of field phenotyping experiments. These genotypes showed significant difference in total above ground biomass and leaf yield under irrigated and rain-fed field conditions. Among the 26 genotypes, under rain-fed conditions, the genotypes MI-0006, MI-0504, MI-0753, MI-0285, MI-0577, MI-0028 and MI-0108 showed higher total above ground biomass per plant. Phenotyping data of drought adaptive traits and WUE parameters achieved in this project would form the most crucial input for genotyping and crop improvement research (drought stress tolerance traits). Two season phenotyping data on epicuticular wax content and stomatal frequency has also provide a crucial input for selecting drought stress tolerant genotypes. Two season phenotyping data on epicuticular wax content and stomatal frequency has also provide a crucial input for selecting drought stress tolerant genotypes. Among the 208 germplasm accessions screened, 12 genotypes were identified with higher stomatal frequency and 15 genotypes were identified with high epicuticular wax as physiologically efficient genotypes.

PIC-01003CN: Genetic enhancement of mulberry by genomics approaches: Multi-Component Network Project

Subproject: NW4a: **Comparative quantitative and qualitative analysis of secondary metabolites for identification of biomarkers responsible for feed quality in mulberry. [Collaboration with CSIR-National Chemical Laboratory (NCL), Pune] (Sept. 2018 to Dec. 2021)**

H. V. Thulasiram (CSIR-NCL, Pune), T. Gayathri and E. Bhuvaneswari

Objective

- To develop biomarkers with respect to secondary metabolites responsible for nutritive quality of mulberry for facilitating easy selection of the genotype with desired traits responsible for high nutritive quality

Metabolomics approach for nutritious and less nutritious mulberry with respect to the secondary metabolites (responsible for the selection behaviour or feeding preferences of the insects) would provide a strong tool for selection of desired germplasm in breeding programmes aimed at developing varieties with high yield and leaf quality. A very few secondary metabolites have been identified in mulberry and no reports are available till now for the feeding preference of *Bombyx mori* on mulberry varieties depending on their secondary metabolites. On this background the present study undertaken is an attempt to analyze and quantify the primary and secondary metabolites in short-listed ten mulberry genotypes and to correlate the metabolites with silkworm feed efficiency parameters for identifying the nutritious mulberry genotypes and the metabolites present in this superior varieties.

Ten mulberry genotypes namely G2, G4, S13, K2, V1, S36, MS2 (MI-0027), MR2, Mysore Local and *Morus multicaulis* (ME-0168) were selected for biochemical analysis of metabolites and silkworm bioassay experiments. All these genotypes raised with (150 + 90) 60 cm or (5'+ 3') X 2' spacing in the experimental plot of Mulberry Physiology Laboratory, CSRTI, Mysuru in RBD layout and all these genotypes were grown under optimal growth conditions (Fig. 5.5). Fresh leaves were collected from the healthy plants of ten genotypes at 45th-60th day after pruning (6 crops) and used for biochemical analysis of metabolites and silkworm bioassay experiments.

Primary metabolites (total protein, carbohydrate, total free amino acids, ascorbic acid and tocopherols) were analysed in the leaves of ten genotypes using standard procedures. Quantification of micronutrient (Zinc, Copper, Magnesium, Iron) was carried out in dried leaves of ten genotypes by Atomic Absorption Spectroscopy.

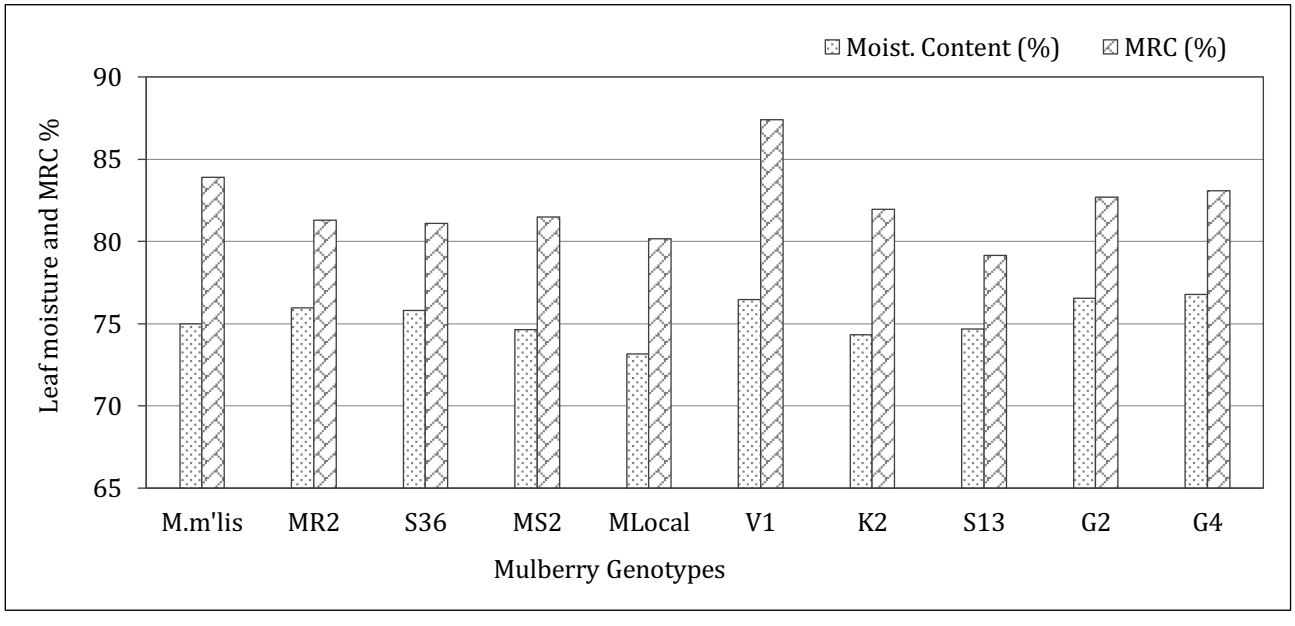


Fig. 5.5: Leaf moisture content and moisture retention capacity (MRC) in different mulberry genotypes

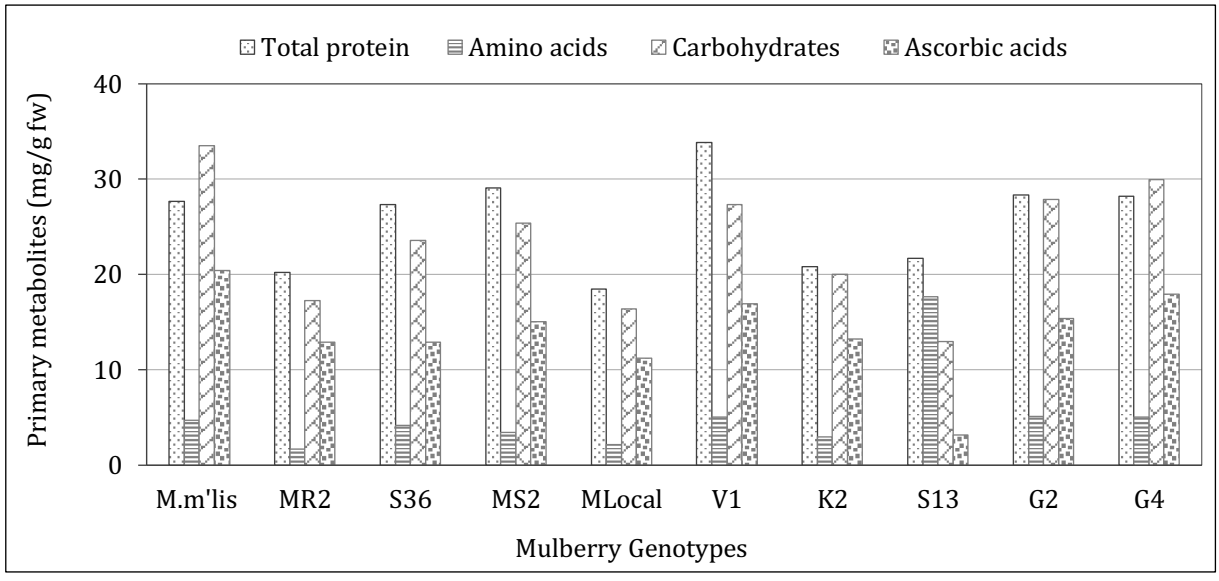


Fig. 5.6: Primary metabolites in different mulberry genotypes

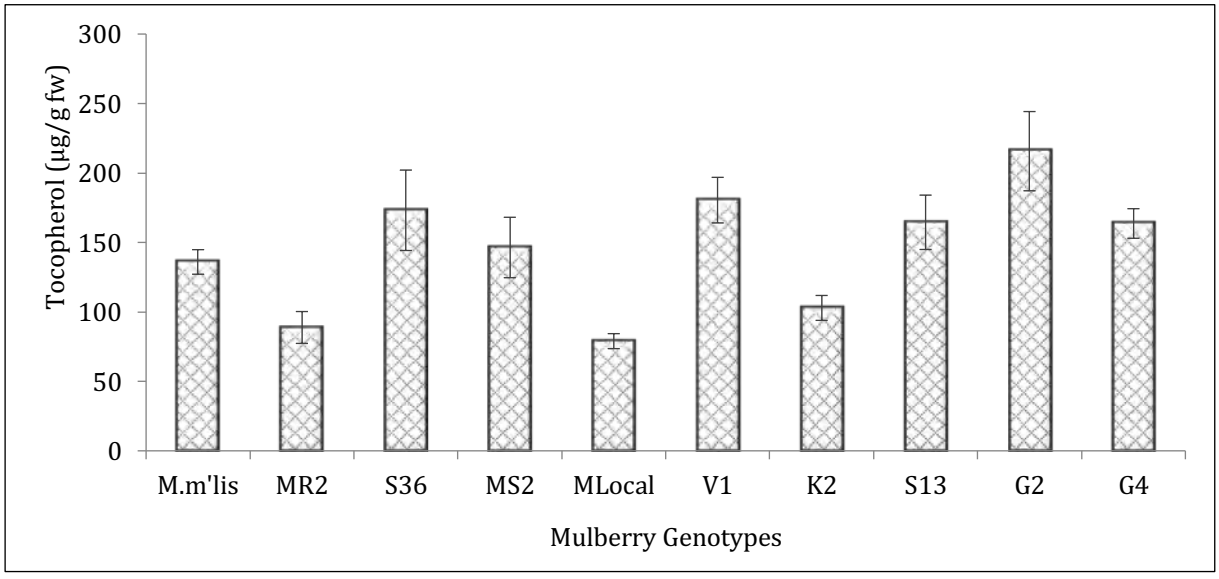


Fig. 5.7: Tocopherols in different mulberry genotypes

Table 5.1: Micronutrients in different mulberry genotypes

Genotype	Copper (ppm)	Manganese (ppm)	Zinc (ppm)	Iron (ppm)
Mysore Local	20.55±1.10^{b,c,d}	142.93±7.45^{a}	45.85±2.81^{c}	180.1±16.38^{d}
MR2	18.25±1.32^{d}	92.91±3.50^{d}	44.7±4.03^{c}	176.73±2^{d}
K2	22.96±0.98^{b,c,d}	109.31±3.75^{b,c,d}	51.43±2.30^{b,c}	245.78±10.71^{a,b}
G2	23.06±0.54^{b,c,d}	105.23±9.37^{c,d}	63.46±3.64^{a}	202.9±16.33^{c,d}
V1	37.15±0.61^{a}	103.81±2.32^{c,d}	56.1±1.15^{a,b}	176.5±6.37^{d}
S36	18.78±3.83^{c,d}	132.71±12.72^{a,b}	55.9±2.43^{a,b}	267.23±27.64^{a}
MS2	23.96±0.95^{b}	124.23±5.36^{a,b}	51.63±2.17^{b,c}	173.81±2.99^{d}
Morus multicaulis	22.25±1.81^{b,c,d}	92.18±9.38^{d}	44.41±2.82^{c}	196.86±6.37^{c,d}
G4	34.88±0.29^{a}	107.3±8.44^{c,d}	50.08±2.32^{b,c}	159.33±2.28^{d}
S13	23.71±0.59^{b,c}	141.5±12.27^{a}	43.95±1.14^{c}	224.58±21.94^{b,c}

Data are the mean value of replicates of six independent analysis (2 trials) and SE within a column followed by same letter, are not significantly different ($p<0.05$) as determined by DMRT.

Primary metabolites (proteins, carbohydrates, amino acids, ascorbic acids and tocopherol) were estimated in fresh leaves of ten genotypes (V1, G2, G4, S13, K2, Mysore Local, S36, MR2, MS2, *Morus multicaulis*) during 6 crops. Results showed higher primary metabolites in V1, *Morus multicaulis*, G4 and G2; whereas least metabolites were observed in MR2 and Mysore Local. Total protein ranged from 18.46 -33.87 mg/g fw, amino acids: 1.47-5.05 mg/g fw, carbohydrates: 16.37-33.51 mg/g fw, ascorbic acids: 11.24-20.39 mg/g fw, and tocopherols: 78.96-215.7 µg/g fw (Fig. 5.6 and Fig. 5.7). Four micronutrients (Cu, Mn, Zn and Fe) were analysed and data showed variation among the ten genotypes. Higher copper content was found in V1 (37.15 ppm) and G4 (34.88 ppm). Least copper content was observed in MR2 (18.25 ppm). Higher quantity of manganese was observed in Mysore Local and S13 (142 ppm) whereas least quantity was observed in MR2 and *Morus multicaulis* (92 ppm). High zinc content was recorded in G2 (63.46 ppm), V1 (56.1 ppm), S36 (55.9 ppm), MS2 (51.63 ppm) and K2 (51.43 ppm). Least quantity of zinc was observed in S13 (43.95 ppm). High amount of iron was found in S36 (267.23 ppm) and K2 (245.78 ppm); whereas least amount was observed in G4 (159.33 ppm) (Table 5.1). V1, *Morus multicaulis*, G4 and G2 leaves had high nutritive quality and MR2 and Mysore Local had low quality leaves.

The feed conversion, bioassay and reeling studies were carried out with the productive bivoltine double hybrid silkworms (FC1 x FC2) during winter, summer and rainy seasons and the average showed significant difference among the mulberry verities. The data was subjected to statistical analysis and a significant difference is identified in the two-way ANOVA results of nutritional consumption, conversion and bio assay traits between all genotypes, having F value with the significance of $p<0.05$. The genotypes such as V1, G4 followed by K2 and *Morus multicaulis are* identified as superior varieties among the tested mulberry genotypes. The nutritional consumption traits such as ingesta, digesta and approximate digestibility were compared to their conversional traits such as efficient conversion of ingesta (ECI) of larvae, cocoon and shell. The average ingesta per larvae of V1 is 4.032 g/larvae and G4 is 3.806 g, 4.176 g, 4.265 g showing lowest ingesta compared to other mulberry genotypes with their highest ECI shell of 11.734%, 11.578%, 19.911% and 19.2% respectively (Fig. 5.8). Similarly, the highest single cocoon weight was observed in worms fed with V1 (1.98 g) followed by G4 (1.89 g), *Morus multicaulis* (1.80 g) and K2 (1.79 g) and noticed similar trend in their single shell weight, shell ratio and also production efficiency of cocoon shell (PECS). The post cocoon evaluation studies also revealed that worms fed with V1 has improved reeling parameters 85.34% reelability, 841.75 m average filament length and the lowest rendita of 7.43 kg with 67.46% of raw silk recovery followed by G4, K2 and *Morus multicaulis.*

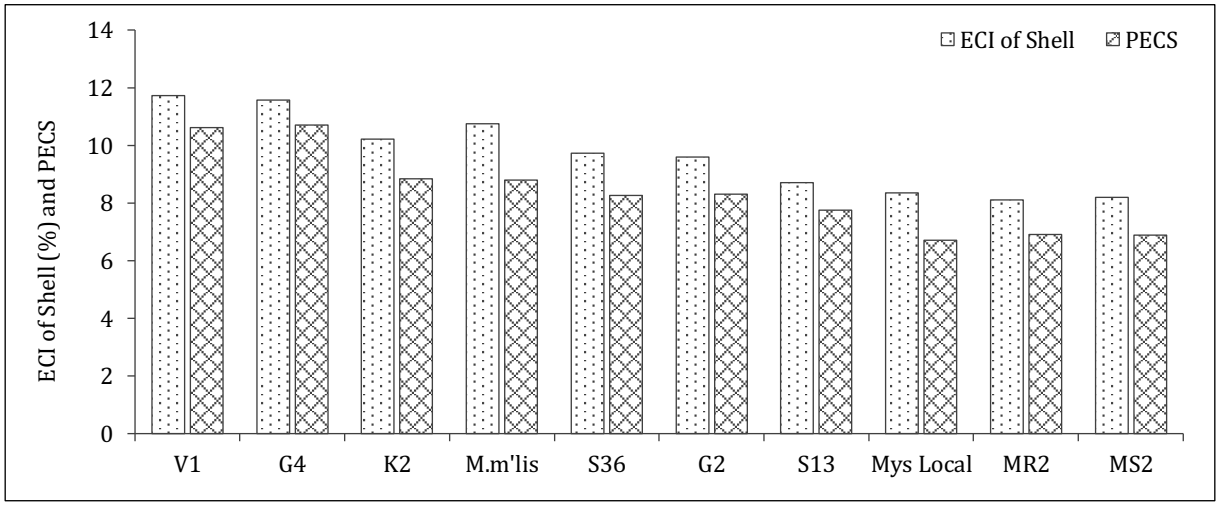


Fig. 5.8: ECI and its PECS of different Mulberry genotypes

Secondary metabolites extraction methods were standardized with three mulberry varieties (V1, G4 and G2). Secondary metabolites were extracted from these 3 varieties under different conditions and subjected to GC-MS analysis. TBME extracts under sonication showed better metabolite levels. TBME of sonicated methanol crude extract showed better levels of fatty acids derivatives (Fig. 5.9).

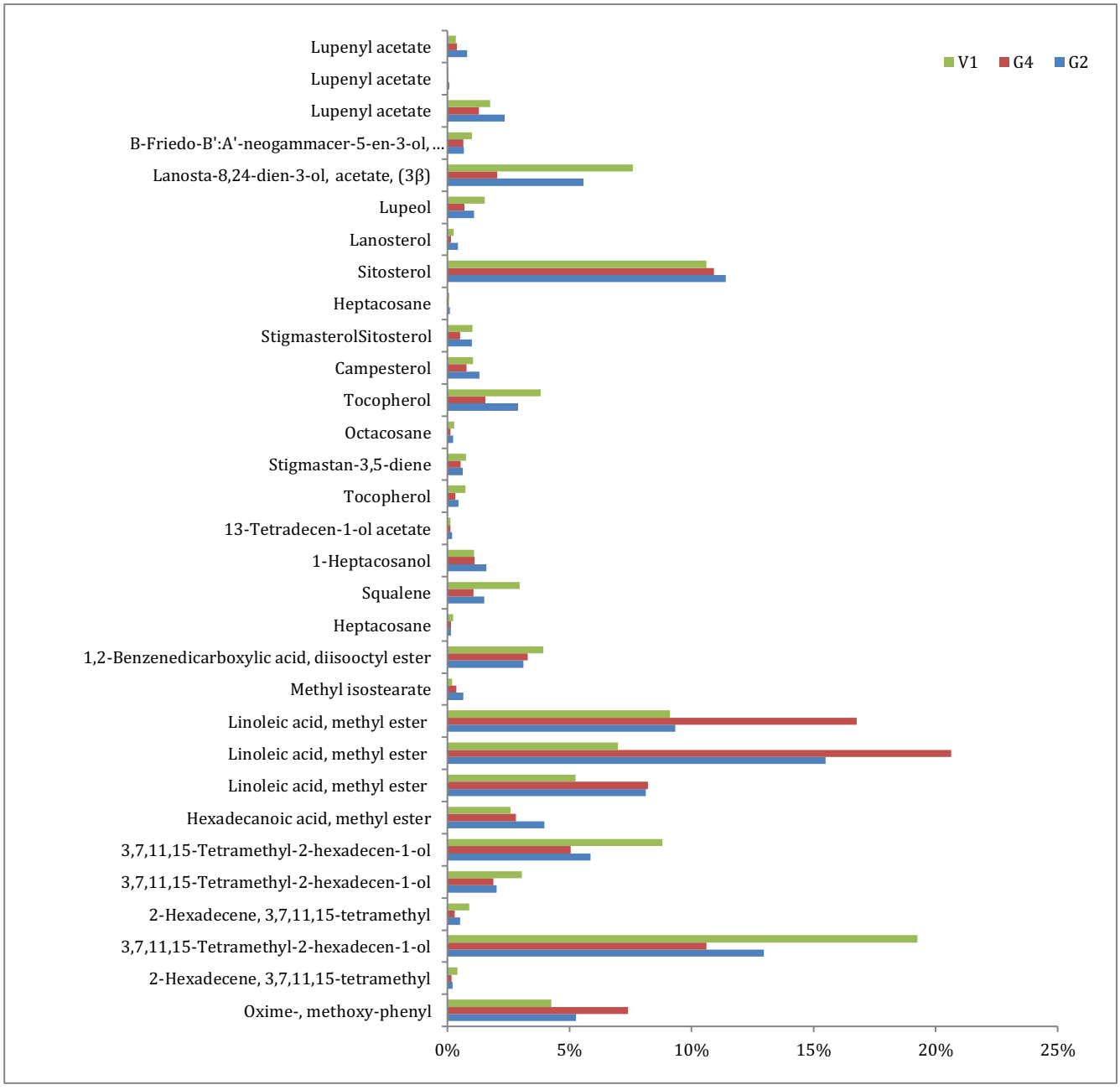


Fig. 5.9: Qualitative and quantitative GCMS analysis of Methanol-TBME extract

A method for GC-MS analysis has been standardized with multiple parameters for the analysis of total volatiles present in the leaf extracts. Secondary metabolites were extracted and characterized from ten mulberry genotypes with the standardized procedures (Fig. 5.10 and Fig. 5.11) and 11 compounds (Ribitol, Arabinitol, 1-deoxynojirimycin, Morusimic acid A/C, Morusimic acid B/D, Fagomine, Caffeoylquinic acid isomer I/II, Cyanidin hexoside, Dihydrokaempferol-hexoside, Quercetin-hexoside and Kaempferol malonyl hexoside) were identified in mulberry leaves by LC-MS and HRMS.

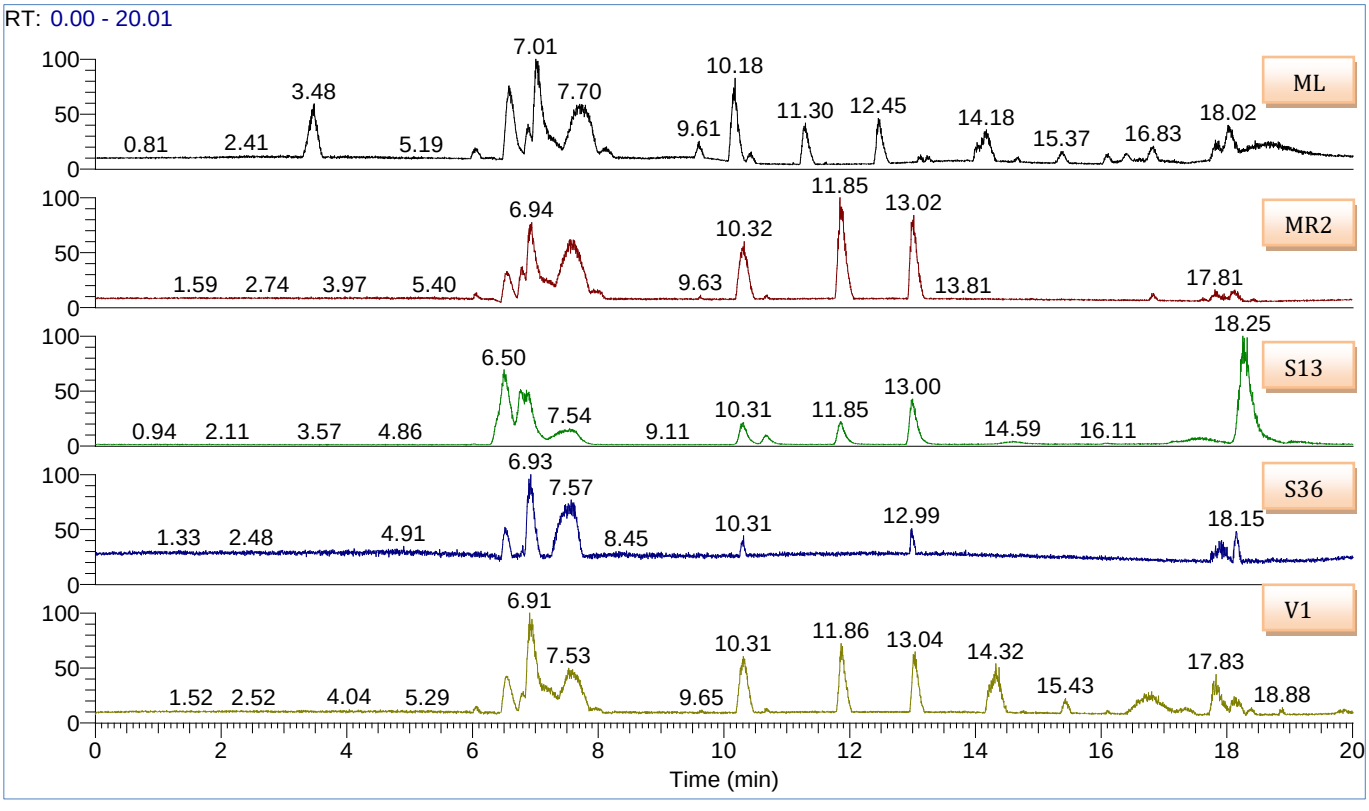


Fig. 5.10: LC-MS Chromatograms of mulberry leaf (Mysore Local, MR2, S13, S36 and V1) methanolic extract

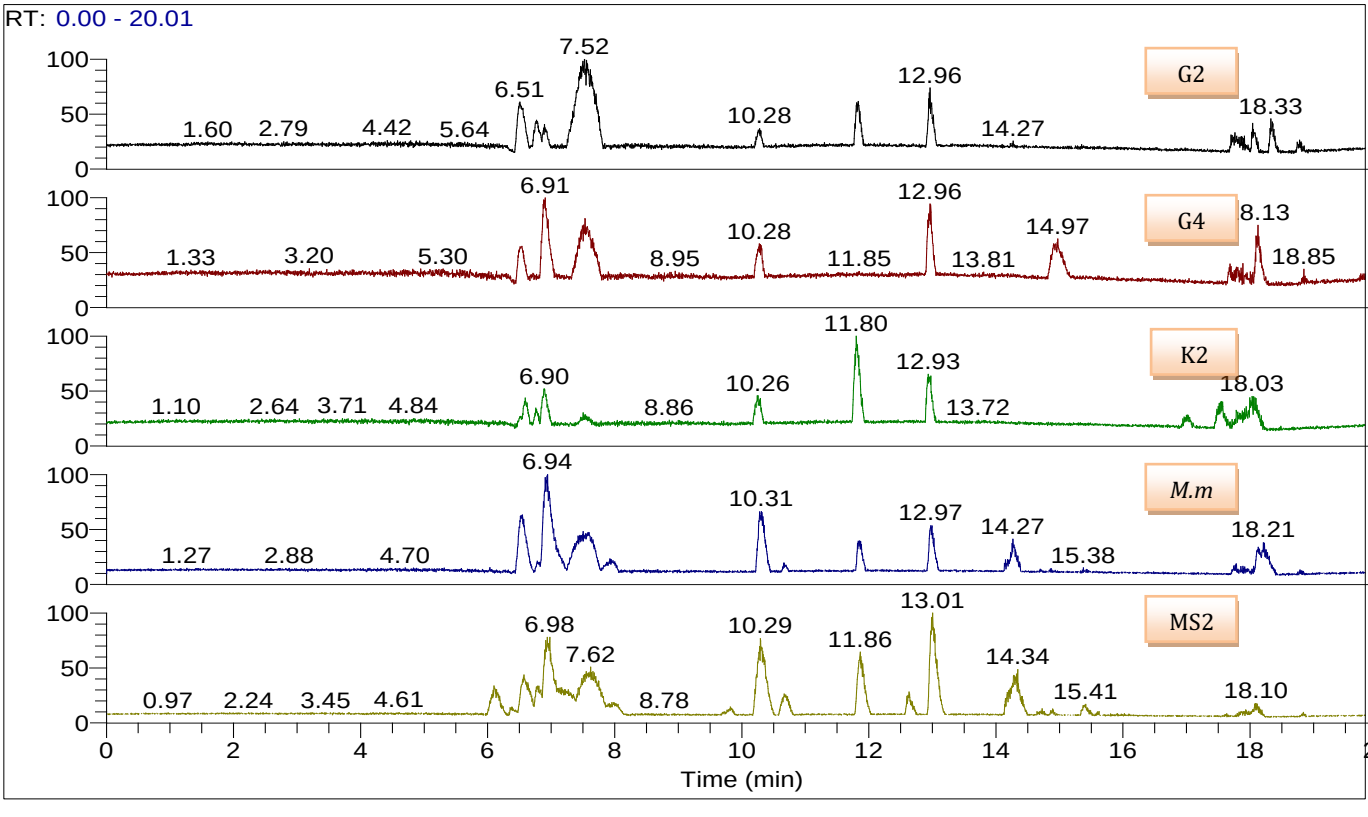


Fig. 5.11: LC-MS Chromatograms of mulberry leaf (G2, G4, K2, *M. multicaulis* and MS2) methanolic extract

Pilot study: Standardization of hydroponics method for multiplication of mulberry (Sept. 2021 to Feb. 2022)

Divya Singh, Ravindra, Dhaneshwar Padhan

- To standardize nutrient solution and hydroponic system for effective rooting
- To evaluate survivability of rooted mulberry cuttings in soil

Two types of hydroponic systems (dip type nutrient supply system and sprinkler type nutrient supply system) were tested. The nutrient solution with rooting hormone was continuously supplied to the cuttings. In dip type nutrient supply system, cuttings were dipped in the nutrient solution + IBA (rooting hormorn) whereas the nutrient solution + IBA were sprinkled over the cuttings in sprinkler type nutrient supply system. IBA was supplied in both hydroponic systems at different concentrations (1, 3 and 5 mg/L). However, water without nutrient solution and IBA was treated as control in both hydroponic systems. The root length, number of roots and period of rooting were recorded at regular intervals up to proper rooting (45 days). The survivability of plantlets was evaluated in the soil at regular intervals. The results showed that rooting percentage, number of roots and root length was high in dip type nutrient supply system in comparison to sprinkler type nutrient supply system. No roots were observed in control and IBA @ 1 mg/L in both types of hydroponic systems. However the survivability of rooted cuttings in the soil was comparatively high in sprinkler type nutrient supply system. The continuous soaking of mulberry cuttings increased the root development.

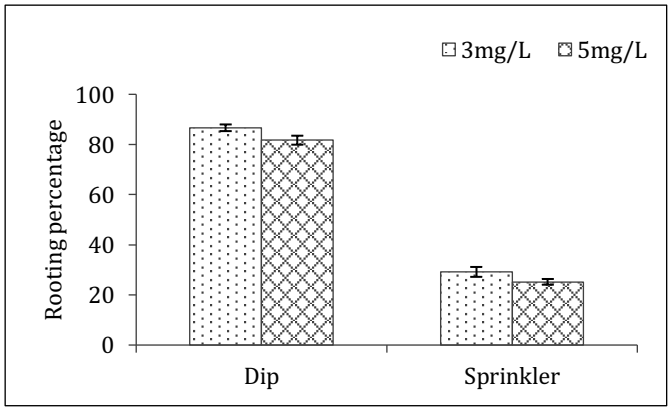


Fig. 5.12: Rooting percentage in dip and sprinkler type nutrient supply system

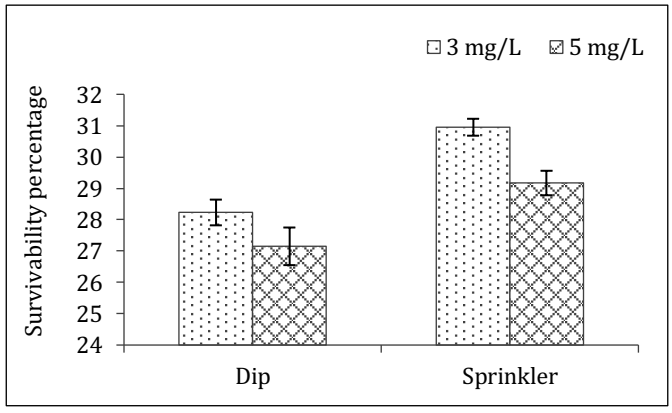


Fig. 5.13: Survivability percentage in dip and sprinkler type nutrient supply system

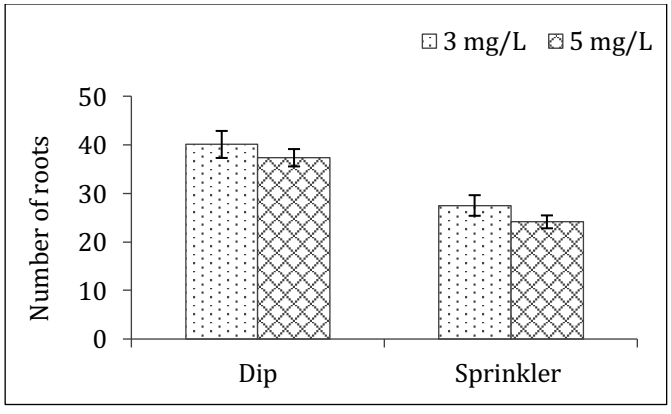


Fig. 5.14: Number of roots after 45 days in dip and sprinkler type nutrient supply system

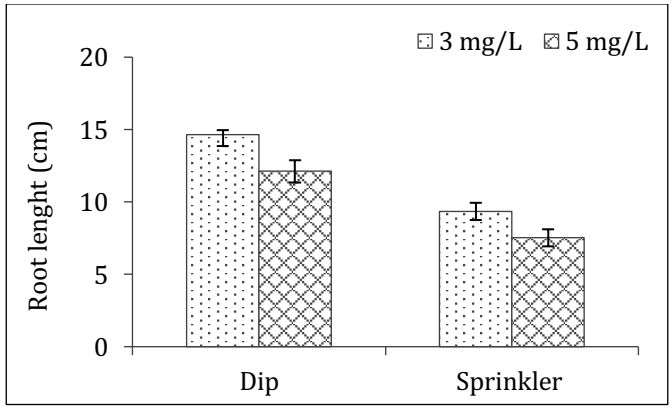


Fig. 5.15: Root length after 45 days in dip and sprinkler type nutrient supply system

6. MULBERRY PATHOLOGY

Ongoing Research Project

PRP-01015 SI: Identification, evaluation and inclusion of potential antagonistic microbes in Integrated Root Rot Disease Management in Mulberry (Nov. 2020 - Oct. 2023)

G. S. Arunakumar, L. Satish, N. Dhahira Beevi, and Vinod Kumar Yadav

Objectives

- Collection, isolation, identification and characterization of potential biocontrol agents available at rhizosphere of mulberry.
- *In vitro* evaluation of potential bio-control agents available at rhizosphere of mulberry against root rot causing pathogens.
- To study compatibility of potential bio-control agents for development of antagonistic microbial consortia and *in-vivo* evaluation against root rot pathogens.
- *In-vivo* evaluation of compatible potential bio-control agent's integration with existing best management practices for formulation of integrated root rot disease management packages.

A total of 106 soil samples were collected from mulberry gardens of south India (Karnataka, Tamil Nadu, Telangana and Andhra Pradesh). The soil samples were collected randomly from rhizosphere of healthy mulberry plants in sterile polythene bags. Isolation and characterization of beneficial bacterial/fungal isolates were done. Twenty seven bacterial isolates were studied for colony colour, shape, size, margin, elevation, opacity and surface characters. Gram's staining and biochemical tests were done. Based on these characteristics, 10 isolates were identified as *Pseudomonas aerogenosa,* one each identified as *Aeromonas caviae, Pseudomonas putida, Lysinibacillus macaroids* and *Bacilus subtilis.*

In the antagonistic study, a total of 27 bacterial isolates and four fungal isolates showed antagonistic activity against four root rot causing fungal pathogens *viz*., *Fusarium solani, F. oxysporum, Rhizoctonia oryzae, Lasiodiplodia theobromae*. Per cent mycelial inhibition of four root rot pathogens by isolate of *Trichoderma harzianum* (KAMLS14) and *Pseudomonas aerigenosa* (KASS4 10-2) is given in the Table 6.1. The antagonistic activity of *T. harzianum* is shown in Fig. 6.1.

Table 6.1: Per cent inhibition of root rot causing pathogens by antagonistic microbes

Pathogens/Bio-agents	*Trichoderma harzianum*	*Pseudomonas aerigenosa*
Fusarium solani	80.46 *(63.76)	87.63 *(69.40)
F. oxysporum	76.09 (60.72)	84.33 (66.68)
Rhizopus oryzae	69.04 (56.19)	83.53 (66.05)
Lasiodiplodia theobromae	51.56 (45.89)	64.61 (53.49)
S. Em ±	1.03	2.05
CD at 1%	4.09	8.19

*Arc sign transformed values

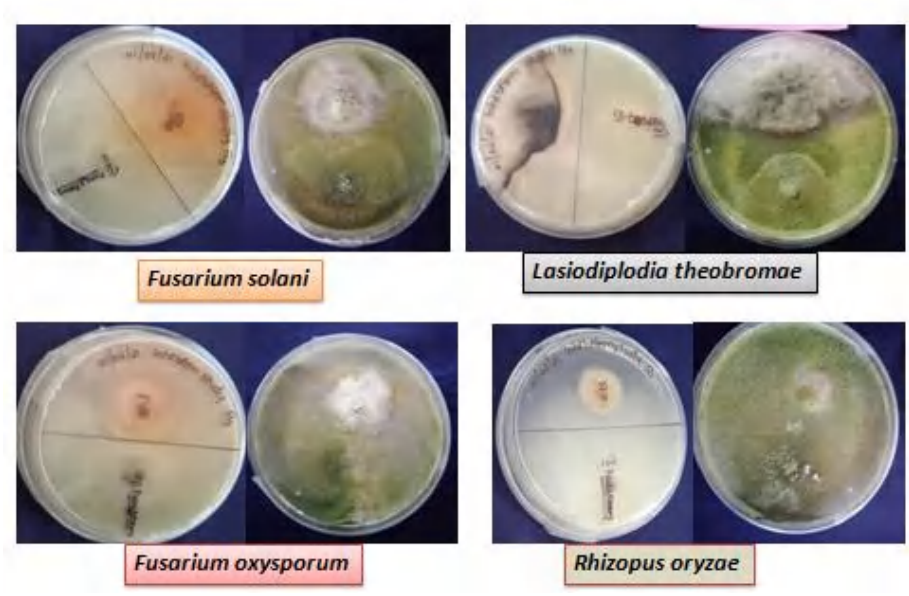


Fig. 6.1: Antagonistic study of *T. harzianum* against four root rot causing fungal pathogens

Among 29 bacterial isolates, 18 isolates were found to be compatible with Carbendazim 12% + Mancozeb 63% WP at 0.1% concentration. Among 19 isolates, 18 were found compatible with Carbendazim 50% WP, nine were found compatible with Hexaconazole 5% SC, and none of the isolates were compatible with copper oxy chloride (COC) and Mancozeb at 0.2% concentration. Among 19 isolates, 12 were found compatible with Tebuconazole 250 EC, 13 isolates with Captan 70% + Hexaconazole 5% WP and 14 isolates with Propiconazole 25% EC. *Trichoderma harzianum* was found compatible with copper oxy chloride (COC) at 0.1, 0.2 & 0.3% concentrations and also with mancozeb at 0.1% concentrations. Whereas, not compatible with other fungicides studied.

Other activities

- Maintenance of different pathogens and beneficial cultures in the section.
- *In vitro* evaluation of products (*Navinya* and *Rot fix*) received from manufacturers against root rot causing fungal pathogens to issue quality analysis report.
- Resolved field problems of sericulture farmers by suggesting suitable management practices.

7. FARM MANAGEMENT

Y. N. Sanath Kumar

Continuous/Routine activities

- Maintained 19 acres of mulberry garden, 2 acres *chawki* garden and 3 acres tree plantation for production of quality mulberry leaf with recommended package of practices.
- Maintained the farm machineries *ie*, tractors, power tillers, irrigation pump sets, pruning machines and other equipments for effective management of mulberry garden.
- Supplied 34785 kg mulberry leaf and 16300 kg mulberry shoot to different sections of the institute for rearing of 3425 dfls under different projects/experiment/race maintenance programmes.

- Supplied 14420 kg mulberry *chawki* leaf to Commercial *Chawki* Rearing Centre of the Institute for *chawki* rearing of 47100 dfls.
- Maintained 5 acre V1 mulberry garden for seed multiplication.
- Supplied 28.576 MT of V1 mulberry seed cuttings to 61 farmers for expansion of about 114 acres.
- An amount of Rs.1,50,345/- generated through sale of mulberry seed cuttings, grass auctioning, *etc*.

8. BIVOLTINE BREEDING LABORATORY

Concluded Research Project

PIC 01008 SI: Isolation and characterization of chitin/chitosan from silkworm pupal exuviae/spent pupae and its commercial exploitation (Feb. 2020-Jan. 2022)

K.N. Madhusudhan

Objectives

- Extraction and purification of chitosan from pupal exuviae /spent pupae/moth scales.
- Characterization of chitosan
- Standardization of protocols for commercial production/exploitation

Modified chemical extraction Technology/protocol for pupae was standardized. The microbial extraction protocol for pupae, exuviae and scales were standardized. 16S rRNA gene sequences (14) of bacterial isolates from rhizosphere and midgut were deposited to NCBI database. Comparative characterization of silkworm and shrimp chitin and chitosan was carried out. Silkworm chitin and chitosan showed more purity (HPLC) and crystallinity (XRD) in comparison with that of shrimp. Shrimp chitin and chitosan were more amorphous in nature. Results revealed differences in crystallinity of chitin and chitosan in different stages of silkworm.

Quantification of chitin from exuviae of different bivoltine breeds using chemical method

Among the different bivoltine breeds used for extraction of chitin from pupal exuviae, more recovery was recorded in GEN1 followed by N6, S8 and CSR2.

Table. 8.1: Comparative quantification of chitin from exuviae of different bivoltine breeds

Breeds	Male Exuviae	Female Exuviae	Mean
S8	79.335	62.388	70.861
CSR50	57.378	51.515	54.446
CSR52	56.388	36.588	46.488
CSR13	55.41	36.31	45.86
CSR2	75.875	56.495	66.185
CSR17	60.743	41.02	50.881
5HT	49.165	24.66	36.913
Gen1	82.313	79.15	80.731
SK6	42.138	33.395	37.766
N5	68.118	47.208	57.663
N6	73.49	65.078	69.284

Analysis of variance table

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated	Sig
Factor A	1	5,043.25	5,043.25	72,634.51	0
Factor B	10	16,272.68	1,627.27	23,436.46	0
Interaction A x B	10	1,032.61	103.26	1,487.19	0
Error	66	4.583	0.069		
Total	87	22,353.12			

Microbial Extraction

Different deproteinizing (DP), demineralizing (DM) bacteria were used for extraction of chitin from silkworm pupae, exuviae and moth scales. Further, the obtained chitin was converted to chitosan using deacetylating (DA) bacteria.

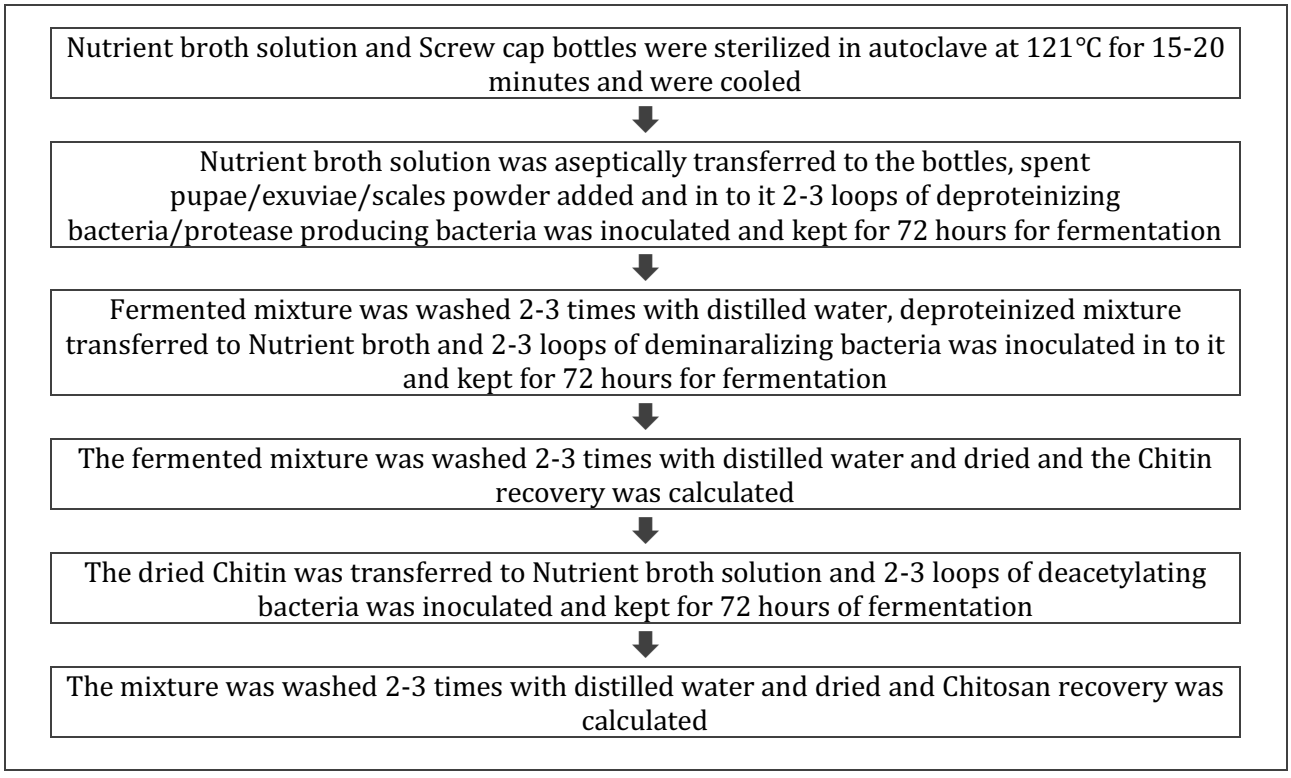


Fig. 8.1: Flow chart for isolation of chitin and chitosan through microbial fermentation methods

Table 8.2: Comparison of extraction of chitin using different microbes from pupal exuviae

	DM 1	DM 2	DM 3	DM 4
DP 1	60.283	52.453	50.678	4.31
DP 2	66.363	55.365	51.17	53.118
DP 3	51.315	54.315	54.66	58.535
DP 4	26.385	50.238	16.115	49.345
DP 5	50.195	52.14	58.348	52.42
DP 6	51.178	51.63	50.598	51.198

*DP= Deproteinizing Bacteria; DM=Demineralizing Bacteria

Analysis of variance

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated	Sig
Factor A	5	5,492.84	1,098.57	28,657.82	0
Factor B	3	938.279	312.76	8,158.82	0
Intraction A x B	15	11,099.94	739.996	19,303.92	0
Error	72	2.76	0.038		
Total	95	17,533.82			

The maximum recovery of chitin from exuviae was recorded in DP 2 and DM 1 combination followed by DP 1 and DM 1 combination.

Table 8.3: Comparison of extraction of chitin using different microbes from spent pupae

	DM 1	DM 2	DM 3	DM 4
DP 1	20.325	20.838	10.43	23.25
DP 2	20.253	22.273	14.328	22.55
DP 3	11.398	1.365	3.035	15.548
DP 4	14.4	15.235	14.3	15.34
DP 5	10.155	13.66	10.638	15.363
DP 6	14.473	6.32	18.56	14.088

*DP= Deproteinizing Bacteria DM=Demineralizing Bacteria

Analysis of variance

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated	Significance
Factor A	5	1,541.64	308.327	2,714.84	0
Factor B	3	454.999	151.666	1,335.43	0
Interaction A X B	15	1,044.82	69.655	613.314	0
Error	72	8.177	0.114		
Total	95	3,049.63			

The maximum recovery of chitin from spent pupae was recorded in DP 1 and DM 4 combination followed by DP 2 and DM 4 and DP 1 and DM 1 combinations.

Table 8.4: Comparison of extraction of chitin using different microbes from Moth scales

	DM 1	DM 2	DM 3	DM 4
DP 1	55.33	74.368	68.218	56.578
DP 2	55.445	5.175	10.555	0.98
DP 3	5.46	7.2	6.36	28.468
DP 4	16.408	10.13	25.45	13.4
DP 5	20.32	34.233	27.388	38.498
DP 6	36.288	15.49	45.805	15.138

*DP= Deproteinizing Bacteria DM=Demineralizing Bacteria

Analysis of variance

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated	Sig
Factor A	5	28,297.93	5,659.59	135,242.47	0
Factor B	3	921.086	307.029	7,336.81	0
Interaction A X B	15	13,333.84	888.923	21,241.86	0
Error	72	3.013	0.042		
Total	95	42,555.87			

The maximum recovery of chitin from moth scales was recorded in DP 1 and DM 2 combination followed by DP 1 and DM 3 and DP 1 and DM 4 combinations.

Table 8.5: Conversion of chitin into chitosan using deacetylating bacteria

Source	Deacetylating bacteria 1	Deacetylating bacteria 2
Shrimp	32.31	22.625
Exuviae	51.24	33.985
Pupae	34.21	24.165
Scale	42.39	23.4

Analysis of variance

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated	Sig
Factor A	3	1,100.70	366.901	5,193.17	0
Factor B	1	1,565.91	1,565.91	22,164.07	0
Interaction A X B	3	139.528	46.509	658.299	0
Error	24	1.696	0.071		
Total	31	2,807.84			

Deacetylating bacteria 01 showed more conversion of chitin into chitosan.

Table 8.6: Microbial genes deposited to NCBI

Sl. No	Microbes	Accession Number	Title of the submission
1	*Pseudomonas fluorescens* SWBL14	OL831228	Microbial isolation of chitin/chitosan from silkworm exuviae and spent pupae
2	*Agrobacterium fabrum* SWBL12	OL831222	
3	*Bacillus proteolyticus* SWBL11	OL831194	
4	*Acinetobacterbaumannii* SWBL10	OL831191	
5	*Enterobacter sp.* SWBL9	OL831188	
6	*Alcaligenesendophyticus* SWBL8	OL831171	
7	*Brevibacillusagri* SWBL 7	OL677393	
8	*Pseudomonas aeruginosa* SWBL6	OL677063	
9	*Pseudomonas sp.* SMBL5	OL614776	
10	*Pseudomonas plecoglossicida* SMBL4	OL614766	
11	*Pseudomonas aeruginosa* SMBL3	OL589644	
12	*Bacillus subtilis* SMBL2	OL589609	
13	*Pseudomonas putida* SMBL1	OL374169	
14	*Ligilactobacillusagilis* SWMBL0	MW082828	

Ongoing Research Projects

AIB 01 009 MI: Evaluation of new bivoltine silkworm double hybrid TT21 x TT56 at farmers level for authorization and commercial exploitation (Mar. 2020-Feb. 2023)

S. Manthira Moorthy (up to Jun. 2021), K. N. Madhusudhan (from Jun. 2021), L. Kusuma, M. S. Ranjini,

M. N. Chandrashekar, N. Dhahira Beevi, K. P. Kiran Kumar, S. B. Kulkarni, Sivasubramaniam, K. Praveen Kumar, K. Sashindaran Nair, K. P. Radha, K. P. Sivakumar, N. Chandrakanth, R. P. Singh, Rita Singh

Objective

- To evaluate the performance of bivoltine hybrid, TT21 x TT56 in field for productivity and silk quality

A total of 2, 36,000 hybrid dfls were prepared by NSSO and 2,01,850 dfls were supplied to different agroclimatic regions of India and 35,000 dfls were kept in 3 months hibernation schedule. The test hybrid TT21xTT56 performed better than the ruling hybrids in all trials.

Table 8.7: Details of the dfls supplied to different states

State	Dfls
Karnataka	75,900
Tamil Nadu	57,550
Andhra Pradesh	21,400
West Bengal	19,500
Uttarakhand	8,500
Jammu & Kashmir	5,500
Maharasthra	5,500
Telangana	3,550
Tripura	4,500
Total	2,01,850

AIB 01024 MI: Development of productive, autosexing silkworm breeds/ hybrids of *Bombyx mori* L. in egg stage and separation of male silkworm population by optical sorting method for commercial exploitation (Jan. 2022-Mar. 2024)

L. Kusuma, S. Manthira Moorthy, M. S. Ranjini and S. M. Hukkeri

Objective

- Development of viable bivoltine sex-limited strains at egg stage
- To develop appropriate automated technology to sort male silkworm eggs by optical sorting method
- Development of productive sex limited bivoltine hybrid and evaluation of male population for important commercial traits.

Parental resource materials were screened and selected, crosses were set up and new hybrid combinations were made. Seven Donor parent was crossed with 24 elite breeds. Only few breeds expressed sex limited character. Number of male population varied between breeds. Few selected oval and dumbbell breeds were crossed with donor parents. Study on the inheritance of sex limited characters in progeny and performance is under progress. Further, breeds having more male preferences based on egg colour were screened. Rearing of 19 breeds including seven parental races and derived lines, 24 hybrid combinations and nine back cross dfls were conducted.

AIE 01026: Evaluation of new bivoltine double hybrid, BFC1 x BFC10 at farmers' level for authorization for commercial exploitation (Feb. 2022-Jan. 2025)

K. B. Chandrashekar, S. Manthira Moorthy, L. Kusuma, M. S. Ranjini, Anand Kumar, N. Chandrakanth (CSRTI-Berhampore), V. Lakshmanan, T. Sivasubramonian, M. Venkatachalapathy, V. K. Harlapur (NSSO-Bengaluru), Shanbougue (SSPC-Mysuru), Radha (SSPC-Ramanagara), H. Pramod (SSPC-Malavalli), Y. Srinivasulu and A. Umesha.

Objective

- To evaluate the performance of bivoltine double hybrid, BFC1xBFC10 in field for high silk content and silk quality

Rearing of parental breeds (BMV1, BMO10A, BMD3, BMFD) was initiated for maintenance, along with preparation of FCs (BFC1:BMV1XBMO10A, BFC10:BMD3XBMFD) and preparation of double hybrids (BFC1XBFC10).

MOE 01021SI: Evaluation and Popularization of improved technologies developed in the field of mulberry sector for South India

Component-2: Popularization of G11x G19 double hybrid in kolar region of Karnataka (Apr. 2021 to Mar.2023)

K. N. Madhusudhan, L. Satish, Pramod Sasivihalli, J. B. Narendra Kumar and Kariyappa

Objective

- To popularize new double hybrid G11 x G19 in rainy seasons in Kolar region of Karnataka

Maintained the parental breeds *viz*., GEN1, 2C, 4S, 4D and cocoons conforming to the original traits were selected and the foundation cross were prepared. A total of 12,500 dfls were distributed to farmers of Kolar region and recorded an average yield of 70kgs/100 dfls.

Component-3: Evaluation of productive double hybrid, DHP5 at farmers' level (Apr. 2021 to Mar. 2023)

R. Meenal, K. N. Madhusudhan, M. S. Ranjini, P. Samuthiravelu, Y. Srinivasulu, Y. Humayun Sharief and Kariyappa

Objective

- To evaluate the newly developed bivoltine silkworm double hybrid, DHP5 at farmers' field through On Farm Trials

Seed cocoons of the identified parental breeds *viz*., S8, D2, CSR16 & CSR51 were prepared. Cocoons conforming to the original traits were selected and the required foundation cross dfls *viz*., S8xD2 and CSR16 x CSR51 were prepared. A total of 6000 dfls of DHP5 dfls were prepared and kept in hibernation schedule for the supply.

Component-7: Evaluation of robust bivoltine silkworm hybrid suitable for different regions of high temperature and high humidity conditions (Apr. 2021 to Mar.2023)

R. Meenal, S. Purushotham, M. S. Ranjini, S. Kamaraju, TVSS Rao and M. N. Chandrashekar

The identified parental breeds *viz*., S8, D2, CSR4 and SK6 were reared at bivoltine breeding lab and seed cocoons were generated. Cocoons conforming to the original traits were selected and the required foundation cross dfls *viz*., S8xD2 and CSR4xSK6 were prepared and kept in hibernation.

Pilot Study

Identification of candidate gene markers for the development of silkworm hybrids with longevity associated stress tolerance and productive trait [No. CSB/CSRTI/PMCE/Pilot studies/2020-21/217, dated 31.12.2020]

M. S. Ranjini, L. Kusuma, S. Manthira Moorthy (Upto May 2021)

Objectives

- Assessment of lifespan and screening for stress tolerance in selected silkworm breeds.
- Identification and characterization of candidate genes.
- To develop bivoltine silkworm breeds/hybrids with better longevity associated with stress tolerance and productive trait.

Twelve Bivoltine silkworm breeds *viz*., CSR2, CSR4, CSR6, CSR16, CSR17, CSR26, CSR27, CSR50, CSR51, CSR52, CSR53 and S8 maintained at Silkworm Bivoltine Breeding Laboratory, CSRTI-Mysuru were utilized for the assessment of life-history trait, longevity and stress induction experiments (Starvation and Paraquat (PQ)-Oxidative stress). Lifespan assessment in the above breeds have revealed differences in the average lifespan ranging from 204±5.64 to 318±18.74, 177.6±8.77 to 260.4±11.18, 193.2±8.95 to 270±14.34 and 162±11.13 to 234±9.51 hours in virgin females, unmated males, mated females and mated males respectively with *P-value*<0.001. Breeds with shortest adult lifespan CSR17, longest adult lifespan CSR51, S8 along with CSR2 as check breed was exposed to starvation stress and Paraquat (PQ)-Oxidative stress. Significant difference was observed among the selected breeds with *P-value*<0.05 in starvation stress. Exposure of selected breeds to varying concentrations of PQ stress revealed relatively higher resistance in CSR51 and S8 than CSR17 as evident by the lower incidence of mortality. Plasticity was observed in the selected breeds for PQ Oxidative stress. In the short-lived and long-lived breeds polymorphism was observed in short-listed genes in *Thioredoxinperoxidase*gene (Table 8.8) with specific SNPs (both synonymous and non-synonymous). Major deletion ~188bp was observed in CSR17 selected for shortest lifespan associated with susceptibility for oxidative stress than other breeds. Specific SNPs was found in CSR51 and S8 with longest lifespan and higher resistance to PQ Oxidative stress. The 47thRAC suggested to carry out the functional gene analysis through cDNA for targeting the part of gene.Gene sequences pertaining to *Thioredoxin peroxidase* of selected breeds were submitted to NCBI GENBANK.

Table 8.8: Important motifs of *Thioredoxin peroxidase*

Pfam results	Position	Description
Ahpc-TSA	36-167	Ahpc/TSA family
Redoxin	36-176	Redoxin
1-cysprx_c	188-224	C-terminal domain of 1-Cys peroxiredoxin

AIT-08005MI: Development and evaluation of Bi-densovirus resistant silkworm hybrids developed from marker assisted breeding lines Phase II. Collaborative Research Project (Mar. 2020-Feb. 2023)

K. S. Tulsi Naik, A. Ramesha, M. S. Ranjini, M. N. Chandrashekar, K. Rahul and Mihir Rabha

Objectives

- Identification of productive Multivoltine/Bivoltine parents carrying BmBDV resistance
- Development of cross breeds and bivoltine hybrids resistant to BmBDV with productive traits.

The larval samples of silkworm bivoltine breeds viz., CSR16, CSR26 and CSR51 were collected for genomic DNA isolation. PCR amplification of *nsd-2* resistant marker for Bi-densovirus was initiated. Cocoon assessment and grainage operations of silkworm bivoltine breeds *viz*., CSR16, CSR26 and CSR51 were completed. Recorded homozygosity in two pairs of CSR51 male and female moths and the line will be

confirmed again for the BmBDV resistance. Resistant lines for BmBDV developed at SBRL *viz*., CSR2R, CSR27R, CSR6R and CSR26R were challenged with virus during the rearing.

Continuous/Other activities

Maintenance of Bivoltine Genetic Resources

K. B. Chandrashekar, S. Manthira Moorthy (Upto May 2021), R. Meenal, K. N.Madhusudan, M. S. Ranjini and L. Kusuma

Productive bivoltine breeds, robust bivoltine breeds, thin denier bivoltine breeds, sex limited breeds, amylase marker assisted selection breeds, NPV tolerant breeds and morphological mutants were maintained for conservation and evaluation. The values obtained for the traits were in conformity with the original breed characteristics.

Table 8.9: Breed characteristics of Bivoltine genetic resources

Breed Category	Breeds		Fecundity (Nos)	Pupation Rate (%)	Cocoon wt. (g)	Shell (%)	Fil. Length (m)	Raw Silk (%)	Denier
Productive	CSR2 CSR4 CSR5 CSR6	CSR16 CSR17 CSR26 CSR27	>500	>85	>1.70-1.80	>22-24	>900	>17.0	2.7-3.0
Robust	CSR18 CSR19 CSR46 CSR47 CSR50 CSR51	CSR52 CSR53 S8 D2 RD1	>500	>90	>1.60-1.80	>22-23	>900	>15.0	2.7-3.0
Thin Denier	CSR48 JPN7		>500	>85	>1.60-1.80	>22-23	>1200	>15.0	2.2-2.4
Sex-Limited	CSR2 (SL) CSR4 (SL) CSR8 (SL)	CSR12 (SL) CSR27 (SL) CSR202 (SL)	>400	>85	>1.50-1.70	>20-21	>700	>13.0	2.6-2.9
Amylase Marker assited selection	GEN1 GEN2 GEN3 2C 2S 3C 3D	4D 4S 4C 6P 6C	>450	>85	>1.50-1.70	>20-21	>800	>14.0	2.7-3.0
NPV Tolerant	S8N 52N	16N 26N	>500	>85	>1.40-1.60	>20-21	>700	>13.0	2.6-2.9
Morphological mutants	TMS 18 TMS 40	TMS 52 TMS 59 TMS KNOB	>300	>80	>0.90-1.30	>13-16	>350	>10.0	2.1-2.5

9. MULTIVOLTINE BREEDING LABORATORY

Concluded Research Project

MOE 01021 SI: Evaluation of improved Technologies of Mulberry Sericulture in South India

Component-6: Evaluation of Improved Pure Mysore-PM-4 (Apr. 2021-Mar. 2022)

K. B. Chandrashekar

Objective

- To evaluate the improved Pure Mysore lines - PM 4 at P3 farm, DOS Bilidevalaya, Kunigal and its crossbreed at farmers' level.

In co-ordination with DOS Karnataka 5 rearings of PM-4 were undertaken with 50 dfls of improved Pure Mysore (PM-4) at P3 GSF Bilidevalaya Kunigal and 2000 crossbreed dfls (PM-4 x CSR2) were prepared. 50 dfls were distributed to 40 farmers. The performance of improved PM-4 at farm and cross breeds at farmers level was evaluated for both pre and post cocoon parameters. The improved Pure Mysore was found to be superior to the control.

Table 9.1: Performance of Improved Pure Mysore at P3 Bilidevalaya Kunigal

Breed Source	Fec. (Nos)	ERR		SCW (g)	SSW (g)	Shell %
		Nos.	Wt. (kg)			
PM-4	515.40 (10.22)	9176.26 (208.59)	13.11 (0.47)	1.42 (0.08)	0.21 (0.02)	14.88 (0.84)
PM	490.80 (7.25)	9098.27 (105.58)	12.48 (0.46)	1.31 (0.09)	0.19 (0.01)	14.26 (0.60)
% Imp.	5%	1%	5%	8%	12%	4%
t-test (p value)	0.000	0.417	0.006	0.006	0.007	0.113

Note: Values in parentheses indicates SD; p<0.05 indicates significant at 5%

Table 9.2: Rearing performance of PM4 × CSR2 at farmer's level

Breed Source	Fec. (Nos)	Hatch. %	ERR		SCW (g)	SSW (g)	Shell %	Yield / 100 dfls (kg)	Pupation (%)
			Nos.	Wt (kg)					
PM-4x CSR2	505.65 (12.61)	92.51 (1.07)	9022.43 (118.37)	15.36 (0.47)	1.80 (0.06)	0.35 (0.02)	19.58 (0.59)	71.49 (1.32)	90.22 (1.18)
PM x CSR2	493.35 (12.64)	92.94 (1.12)	8930.94 (158.11)	14.83 (0.52)	1.73 (0.05)	0.33 (0.02)	19.06 (0.89)	67.27 (1.55)	89.31 (1.58)
% Imp.	2%	0%	1%	4%	4%	7%	3%	6%	1%
t-test (p value)	0.000	0.087	0.004	0.000	0.000	0.000	0.003	0.000	0.004

Note: Values in parentheses indicates SD; p<0.05 indicates significant at 5%

Table 9.3: Coccon parameters of improved Pure Mysore cross in comparison with crossbreed sources

Parameters	PM-4	Kunigal PM source	% Improvement	t-stat (p value)
Single Cocoon Weight (g)	1.78 (0.08)	1.73 (0.10)	3%	0.44
Single Shell Weight (g)	0.33 (0.01)	0.32 (0.02)	1%	0.74
Shell %	18.36 (0.04)	18.53 (0.14)	-1%	0.06
Defective Cocoon	9.05 (0.64)	16.95 (2.37)	-47%	0.00
AFL (m)	803.50 (36.37)	789.00 (30.02)	2%	0.56
NBFL (m)	731.00 (48.50)	698.50 (64.09)	5%	0.45
Single Cocoon Filament Denier	2.88 (0.08)	2.84 (0.05)	1%	0.46
Reelability (%)	89.50 (0.58)	87.00 (2.31)	3%	0.08
Renditta (On Green Cocoon Wt.)	7.15 (0.29)	7.80 (0.92)	-8%	0.23
Raw Silk Recovery (%)	14.00 (0.69)	12.95 (1.56)	8%	0.26
Raw silk (%) (on green cocoons)	76.25 (3.64)	69.95 (8.83)	9%	0.24
Silk Waste % on Silk Wt.	19.55 (1.21)	20.70 (1.73)	-6%	0.32
Average Size Denier (d)	21.52 (0.89)	22.18 (0.76)	-3%	0.30

Note: Values in parentheses indicates SD; p<0.05 indicates significant at 5%

Ongoing Research Pojects

MOE 01021 SI: Evaluation of improved Technologies of Mulberry Sericulture in South India

Component-5: Evaluation of Cauvery Gold (MV1 × S8), an improved crossbreed for cocoon productivity and silk quality (Apr. 2021-Mar. 2022)

K. B. Chandrashekar, R. Bhagya, S. M. Hukkeri, Dayananda, J. B. Narendrakumar, S. B. Kulkarni, Vinod Harlapur and M. B. Radha

Objective

- To evaluate the field performance of newly evolved improved crossbreed Cauvery Gold for productivity and silk quality

Seed cocoons generated at TVDC section and RSRS Kodathi.

A total of 30,000 dfls were distributed to the farmers, 21,500 dfls in Kolar area of Karnataka through REC Madivala and 8,500 dfls in Tripura (North East) through REC Agarthala. The crossbreed performed well in Kolar area, fetched highest price ((Rs 565/-) at Kolar Govt cocoon market.

Table 9.4: Performance of Cauvery Gold in comparison with PM x CSR2

Breeds	Yield / 100 dfls (kg)	SCW (g)	SSW (g)	Shell %
MV1 x S8	70.1 (8.7)	1.89 (0.14)	0.38 (0.03)	20.08 (0.63)
PM x CSR2 (Control)	64.7 (6.5)	1.52 (0.15)	0.28 (0.03)	18.57 (0.90)
% Imp.	8	24	35	8
t-test (p-value)	0.000	0.000	0.000	0.000

Note: Values in parentheses indicates SD; p<0.05 indicates significant at 5%

Table 9.5: Reeling parameters of MV1 x S8 and PM x CSR2

Parameters	MV1 × S8	PM × CSR2	% Imp.
Single cocoon weight (g)	2.18	1.743	20.05
Single shell weight (g)	0.45	0.30	33.11
Shell %	20.66	17.26	16.46
Defective cocoon	8.8	4.8	45.45
Av. filament length (m)	974	718	26.28
Non broken filament length (m)	805	643	20.12
Single cocoon filament denier	3.16	2.94	6.96
Reelability (%)	82.7	89.9	-8.71
Renditta (on green cocoon wt.)	6.6	8.0	-21.21
Raw silk recovery (%)	72.9	72.8	0.14
Raw silk (%) (on green cocoons)	15.1	12.6	16.56
Silk waste % on silk wt.	18.7	15	19.79
Average size denier (d)	24.97	23.78	4.77
Overall Grade	2A	A	-

AIB 01004 MI: Development of multivoltine breeds with improved silk quality utilizing indigenous and exotic bivoltine breeds (Sep. 2018-Aug. 2022)

K. B. Chandrashekar, K. M. Ponnuvelu, S. M. Hukkeri and L. Kusuma, S. M. Moorthy (upto May 2021)

Objectives

- To develop multivoltine breeds with improved silk quality (3A grade) with bivoltine breeds through marker assisted selection.
- To develop multivoltine hybrids with improved silk quality and productivity

Four parents and their derived lines/hybrid combinations were analysed through RT-PCR for all 20 genes which are responsible for the diapause and non-diapause character. These genes include: diapause – *Trehalose transporter, Sorbitol dehydrogenase, Cytochrome b5, Methyltransferase, DnaJ (Hsp40) homolog 5, Paralytic peptide binding protein, Hsp 70, Spatzle, Serotonin receptor, Dopamine receptor* for diapause and *Pseudouridine synthase, Chitinase A precursor, Polyubiquitin 4 UBQ4, Acyl-coenzyme A dehydrogenase, Profilin protein, 40S ribosomal protein S5, Nuclosome assembly protein, Kruppel, Bm period, Bm relish* for Non-diapause. Among 20 genes, 3 genes were associated with parental breeds *viz.,* Diapause gene - *Methyl transferase,* Non-diapause genes - *Acyl coenzyme A dehydrogenase* and *Nucleosome assembly protein*. Stabilized lines were analysed through RT-PCR for relative gene expression using these three associated genes against control (parental breeds). Crossbreed dfls with 3 bivoltine breeds - CSR2, S8, BM2E were utilised to prepare 18 different combinations of hybids.

Based on the RT-PCR results six stabilized lines were maintained viz., MAS1, MAS2, MAS3, MAS4, MAS5 and MAS6. Among the 6 lines, better performing lines were taken forward for further trials. From the selected three lines - hybrids were prepared using the bivoltine parents BM2 (Exotic), S8 (Indigenous) and CSR2. Based on the phenotypic characters of cocoons, fecundity, hibernation character and post cocoon characters, short listing of the lines was carried out and OST was taken up. MAS1, MAS3 and MAS6 performed better among the combinations and yielded improved silk quality with 2A to 3A grade.

Table 9.6: The laboratory rearing performance of the stabilized lines with 3 bivoltine silkworm breeds

#	Lines	Fec.	ERR		SCW (g)	SSW (g)	Shell %	AEI
			Nos.	Wt.				
1	MAS1 × S8	511 (51.12)	8310 (44.93)	15.59 (62.86)	2.666 (63.38)	0.534 (63.38)	20.44 (65.62)	57.32
2	MAS1×BM2E	516 (53.21)	8590 (52.18)	15.28 (60.62)	2.641 (62.44)	0.549 (62.44)	20.79 (68.60)	59.52
3	MAS1 × CSR2	518 (53.84)	8900 (60.21)	15.98 (65.62)	2.513 (57.66)	0.507 (57.66)	20.43 (60.20)	58.91
4	MAS2 × S8	496 (44.82)	7830 (32.50)	14.01 (51.60)	2.712 (65.11)	0.519 (65.11)	19.50 (62.66)	50.34
5	MAS2 × BM2E	484 (39.58)	8590 (52.18)	14.01 (51.58)	2.539 (58.64)	0.500 (58.64)	19.97 (58.73)	51.90
6	MAS2 × CSR2	459 (29.09)	8730 (55.81)	15.51 (62.26)	2.571 (59.84)	0.491 (59.84)	19.20 (57.03)	51.00
7	MAS3 × S8	522 (55.73)	9280 (70.05)	14.11 (52.31)	2.106 (42.46)	0.439 (42.46)	20.83 (46.65)	54.61
8	MAS3 × BM2E	538 (62.44)	8620 (52.96)	12.76 (42.67)	2.059 (40.70)	0.421 (40.70)	20.37 (43.10)	49.52
9	MAS3 × CSR2	529 (58.46)	8400 (47.26)	13.03 (44.58)	2.109 (42.57)	0.435 (42.57)	20.63 (45.75)	49.46
10	MAS4 × S8	537 (61.81)	8320 (45.19)	11.95 (36.93)	1.967 (37.25)	0.381 (37.25)	19.36 (35.01)	43.33
11	MAS4 × BM2	512 (51.32)	7760 (30.69)	11.27 (32.04)	1.990 (38.13)	0.381 (38.13)	19.16 (34.99)	38.13
12	MAS4 × CSR2	510 (50.70)	8760 (56.59)	12.35 (39.78)	2.027 (39.51)	0.425 (39.51)	20.94 (43.82)	48.69
13	MAS5 × S8	494 (43.98)	8120 (40.01)	13.54 (48.21)	2.531 (58.33)	0.465 (58.33)	18.76 (51.75)	46.55
14	MAS5 × BM2	482 (38.74)	8120 (40.01)	14.17 (52.72)	2.603 (61.03)	0.477 (61.03)	18.36 (54.18)	46.53
15	MAS5 × CSR2	467 (32.66)	8780 (57.10)	16.17 (66.95)	2.332 (50.91)	0.452 (50.91)	19.56 (49.26)	50.50
16	MAS6 × S8	505 (48.39)	8680 (54.51)	13.28 (46.36)	2.094 (41.99)	0.425 (41.99)	20.33 (43.86)	48.32
17	MAS6 × BM2	551 (67.69)	8740 (56.07)	13.55 (48.30)	2.129 (43.30)	0.432 (43.30)	20.42 (45.27)	52.74
18	MAS6 × CSR2	515 (52.79)	8200 (42.08)	12.52 (40.98)	2.080 (41.49)	0.437 (41.49)	21.00 (46.17)	47.65
	Average	508	8506	13.79	2.308	0.456	19.91	
	SD	23.837	386.14	1.403	0.268	0.050	0.882	

Note: Values in parentheses indicates SD; p<0.05 indicates significant at 5%

Based on the results of the RT-PCR analysis, Ct values and variations in copy number were recorded with *β-actin* as an internal standard. The experiment was performed in triplicates and results were standardized to the expression level of the constitutive *β*-actin gene. A Non-template control (NTC) sample

was also run to detect contamination if any. Accordingly, genes related to non-diapause were identified utilizing Marker Assisted Selection (MAS) and correlated among the developed hybrid lines in comparison to parental lines (Fig. 9.1).

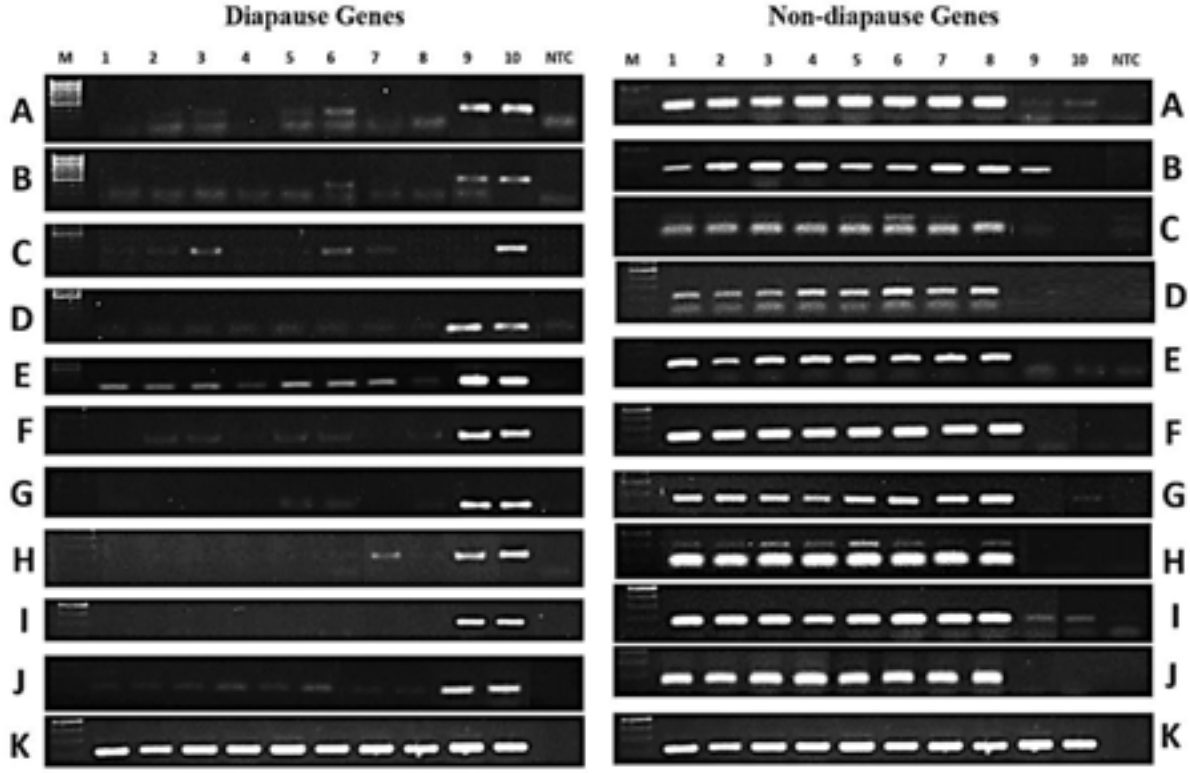


Fig. 9.1: Gene expression patterns in stabilized lines and parental breed eggs of Silkworm *Bombyx mori* L. with respect to diapause and non-diapause character (1:MV1, 2:MV1×BM2, 3:MV1×BMV1, 4:MV1×S8, 5:HB4, 6:HB4×BM2, 7:HB4×BMV1, 8:HB4×S8, 9:S8, 10:BM2, 11:NTC)

	Diapause Genes	**Non-diapause Genes**	
A	Trehalose transporter	Pseudouridine synthase	A
B	Sorbitol dehydrogenase	Chitinase A precursor	B
C	Cytochrome b5	Polyubiquitin 4 UBQ4	C
D	Methyl transferase	Acyl-coenzyme A dehydrogenase	D
E	DnaJ (Hsp40) homolog 5	Profilin protein	E
F	Paralytic peptide binding protein	40S ribosomal proteinS5	F
G	Hsp 70	Nuclosome assembly protein	G
H	Spatzle	Kruppel	H
I	Serotonin receptor	Bm period	I
J	Dopamine receptor	Bm relish	J
K	β – actin	β – actin	K

The detailed data of pre and post cocoon parameter of the parental breeds and stabilized lines is presented in Table 9.7.

Table 9.7: Rearing and reeling performance of the MAS stabilized lines

Stabilized Lines	SCW (g)	SSW (g)	SR %	Reel-ability (%)	AFL (m)	NBFL (m)	Denier	Rendita	Raw Silk (%)	RSR (%)
MV1	1.333	0.253	18.98	74.83	695.98	604.84	2.82	8.10	13.77	64.30
MAS1 (MV1S6AB × BM2E)	1.273	0.221	17.36	72.55	626.64	587.39	2.84	7.99	12.66	62.89
MAS2 (MV1B×BMV1)	1.251	0.219	17.50	66.41	589.92	553.49	2.82	8.64	12.61	60.19
MAS3 (MV1 × S8)	1.270	0.219	17.24	73.22	683.80	625.39	2.79	7.97	13.44	64.39
HB4	1.243	0.217	17.45	76.31	736.96	589.76	2.72	8.06	13.87	63.68
MAS4 (HB4×BM2E)	1.277	0.221	17.07	69.63	600.39	553.38	2.87	8.71	12.93	61.65
MAS5 (HB4×BMV1)	1.240	0.222	17.96	72.15	648.76	581.74	2.84	8.29	13.52	61.61
MAS6 (HB4×S8)	1.224	0.201	16.83	73.48	661.34	573.16	2.80	8.14	13.16	61.00
PM (Control)	1.189	0.189	15.87	64.15	408.10	348.30	2.31	10.27	12.24	49.25

The OST trial was under taken at RSRS, Chamarajanagar and two trials data was statistically analyzed using Tukey's Multiple mean comparison test.

Table 9.8: Rearing and reeling performance of the OST batches reared at RSRS Chamarajanagar

Hybrids	SCW (g)	SSW (g)	SR %	Reel-ability (%)	AFL (m)	NBFL (m)	Denier	Rendita	Raw Silk (%)	RSR (%)
MAS1 × S8	1.358	0.278	20.3	76.4	654.5	536.6	2.77	8.18	13.77	65.4
MAS1 × BM2	1.393	0.292	21.0	74.6	587.6	450.7	3.35	8.49	12.62	57.1
MAS1×CSR2	1.488	0.300	20.1	77.0	693.7	562.9	2.87	8.02	12.72	62.7
MAS3 × S8	1.660	0.367	22.2	76.9	645.4	557.2	3.15	7.89	12.70	61.7
MAS3×BM2	1.386	0.258	18.6	75.2	547.5	443.4	3.35	7.98	14.50	63.9
MAS3×CSR2	1.521	0.318	20.6	77.4	671.4	565.5	2.82	8.11	14.76	61.3
MAS5 × S8	1.520	0.322	21.1	76.4	604.6	497.4	3.00	7.88	12.66	59.1
MAS5xBM2E	1.448	0.284	19.6	76.3	591.6	495.6	3.17	8.00	14.67	64.6
MAS5×CSR2	1.552	0.354	22.1	73.5	663.3	569.8	2.98	8.41	12.16	58.6
PM ×CSR2	1.111	0.198	17.8	74.2	591.0	553.5	2.86	7.75	12.79	52.7
MV1 ×S8	1.575	0.339	21.2	75.6	668.2	566.1	2.79	8.34	13.30	63.0
p-value	-	-	-	-	-	*	*	-	-	-
CV	17.6	22.4	10.0	3.3	8.5	9.6	8.1	4.2	16.5	15.7

Based on the results of this study, stabilized crossbreed lines with non-diapause character in the egg were identified along with identification of better performing crossbreed producing gradable silk.

AIB 01011 SI: Development of multivoltine foundation crosses for productivity and high silk percentage (Apr. 2020-Mar. 2023)

P. V. Soudaminy (Upto March 2021), K. B. Chandrashekar, R. Meenal and M. N. Chandrashekar

Objective

- Development of Multivoltine foundation crosses for production of multi × bivoltine double hybrids for high silk percentage and improved productivity.

Based on the rearing performance and the economical parameters, 20 combinations of multivoltine foundation crosses (MFCs) have been shortlisted from the initial 108 combinations. Further, in the double hybrid phenotypic characters (colour variation) have been taken into consideration along with the rearing performance and 27 double hybrids were short listed from the initial 90 combinations.

Table 9.9: The rearing performance of the short listed multivoltine foundation crosses (MFCs)

MFCs	ERR		SCW(g)	SSW(g)	SR%	Avergae Evaluation Index
	By Nos	By Wt.(kg)				
PM × MO6	8400 (53.85)	11.252 (55.21)	1.172 (50.94)	0.196 (52.08)	16.69 (53.51)	53.12
PM × ND10	9000 (60.13)	12.324 (60.04)	1.203 (54.58)	0.201 (55.29)	16.72 (54.08)	56.82
BL67 × ND7	7920 (48.82)	10.732 (52.86)	1.189 (52.94)	0.199 (53.74)	16.69 (53.58)	52.39
BL67 × NDV6	7200 (41.28)	10.132 (50.16)	1.293 (65.05)	0.213 (61.78)	16.44 (49.36)	53.53
BL67 × MO6	7400 (43.38)	9.428 (46.99)	1.174 (51.17)	0.190 (49.10)	16.22 (45.66)	47.26
HB4 × PM	9250 (62.75)	13.516 (65.40)	1.231 (57.82)	0.215 (62.93)	17.43 (65.82)	62.94
HB4 × MO6	9360 (63.90)	12.912 (62.68)	1.210 (55.35)	0.196 (52.14)	16.18 (44.99)	55.81
MO6 × ND7	6600 (35.00)	7.764 (39.49)	1.181 (51.94)	0.207 (58.57)	17.52 (67.44)	50.49
MO6 × PM	6400 (32.90)	7.288 (37.35)	1.139 (47.03)	0.185 (45.82)	16.22 (45.71)	41.76
MO6 × BL67	7560 (45.05)	7.940 (40.29)	1.050 (36.67)	0.166 (34.98)	15.79 (38.49)	39.10
MO6 × HB4	8200 (51.75)	8.868 (44.47)	1.081 (40.33)	0.185 (46.11)	17.12 (60.80)	48.69
ND7 × PM	7200 (41.28)	7.824 (39.76)	1.072 (39.19)	0.163 (33.08)	15.16 (28.07)	36.28
ND7 × BL67	8440 (54.27)	10.316 (50.99)	1.222 (56.81)	0.199 (53.92)	16.26 (46.46)	52.49
ND7 × MO6	7400 (43.38)	7.344 (37.60)	0.999 (30.62)	0.162 (32.80)	16.22 (45.76)	38.03
ND10 × PM	9200 (62.23)	12.540 (61.01)	1.169 (50.53)	0.191 (49.56)	16.36 (48.07)	54.28
NDV6 × BL67	8160 (51.34)	8.652 (43.49)	1.137 (46.79)	0.199 (54.09)	17.52 (67.31)	52.60
NDV6 × PM	9200 (62.23)	13.416 (64.95)	1.328 (69.20)	0.218 (65.17)	16.44 (49.46)	62.20

NDV6 × MO6	6680 (35.83)	8.960 (44.88)	1.213 (55.69)	0.197 (52.83)	16.24 (45.99)	47.04
ND10 × ND7	9080 (60.97)	13.012 (63.13)	1.203 (54.58)	0.200 (54.43)	16.60 (52.00)	57.02
PM × ND7	8000 (49.66)	7.704 (39.22)	1.017 (32.77)	0.160 (31.59)	15.72 (37.45)	38.14
Mean	8032.5	10.096	1.164	0.192	16.48	-
SD	954.74	2.22	0.0854	0.017	0.60	-

Figures in paranthesis indicate the individual evaluation index

Table 9.10: Rearing performance of the multi × bivoltine double hybrids

MFC× BFC (Double Hybrid)	ERR		SCW (g)	SSW (g)	SR %	Avergae Evaluation Index
	Nos	Wt (kg)				
(PM × ND10) × FC2	8960 (54.09)	14.400 (55.87)	1.601 (60.56)	0.310 (60.50)	19.38 (54.93)	57.19
(PM × MO6) × FC2	9560 (60.19)	14.208 (55.02)	1.257 (32.88)	0.220 (31.58)	17.51 (37.18)	43.37
(BL67 × NDV6) × FC2	6760 (31.74)	10.480 (38.51)	1.492 (51.80)	0.310 (60.34)	20.76 (68.05)	50.09
(BL67 × MO6) × FC2	5800 (21.98)	9.324 (33.39)	1.263 (33.40)	0.224 (32.70)	17.70 (38.95)	32.09
(BL67 × MO6) × G11	8000 (44.34)	9.760 (35.32)	1.372 (42.14)	0.254 (42.45)	18.51 (46.69)	42.19
(HB4 × PM) × FC1	9320 (57.75)	14.792 (57.60)	1.567 (57.78)	0.250 (41.20)	15.96 (22.47)	47.36
(HB4 × PM) × FC2	7520 (39.46)	13.672 (52.64)	1.579 (58.79)	0.325 (65.34)	20.61 (66.58)	56.56
(HB4 × PM) × G11	9760 (62.22)	16.576 (65.50)	1.473 (50.23)	0.292 (54.50)	19.80 (58.93)	58.28
(HB4 × PM) × G19	8960 (54.09)	15.904 (62.53)	1.636 (63.39)	0.326 (65.56)	19.93 (60.15)	61.14
(HB4 × MO6) × FC2	9080 (55.31)	15.200 (59.41)	1.678 (66.70)	0.322 (64.25)	19.19 (53.17)	59.77
(MO6 × ND7) × FC2	9640 (61.00)	14.584 (56.68)	1.313 (37.36)	0.243 (38.95)	18.52 (46.77)	48.15
(MO6 × ND7) × G11	8520 (49.62)	13.200 (50.55)	1.630 (62.89)	0.302 (57.80)	18.52 (46.76)	53.52
(MO6 × ND7) × G19	9240 (56.94)	15.452 (60.52)	1.617 (61.85)	0.300 (57.20)	18.55 (47.04)	56.71
(MO6 × BL67) × G11	8840 (52.88)	13.012 (49.72)	1.503 (52.65)	0.277 (49.66)	18.40 (45.61)	50.10
(MO6 × BL67) × G19	8760 (52.06)	14.520 (56.40)	1.607 (61.00)	0.309 (59.98)	19.21 (53.35)	56.56
(MO6 × HB4) × FC2	9080 (55.31)	15.384 (60.22)	1.593 (59.88)	0.290 (53.89)	18.19 (43.61)	54.58
(ND7 × PM) × FC2	9480 (59.38)	13.144 (50.30)	1.430 (46.77)	0.258 (43.60)	18.02 (41.99)	48.41
(ND7 × PM) × G11	8560 (20.03)	12.328 (46.69)	1.420 (45.97)	0.261 (44.66)	18.38 (45.41)	46.55
(ND7 × MO6) × FC2	8160 (45.97)	11.836 (44.51)	1.523 (54.24)	0.302 (57.87)	19.84 (59.32)	52.38

(ND7 × MO6) × G11	9000 (54.50)	11.972 (45.11)	1.474 (50.35)	0.280 (50.62)	18.96 (50.94)	50.31
(NDV6 × BL67) × FC2	7360 (37.84)	9.888 (35.59)	1.313 (37.39)	0.240 (37.96)	18.28 (44.47)	38.71
(NDV6 × BL67) × G11	6880 (32.96)	7.172 (23.86)	1.312 (37.31)	0.255 (42.70)	19.42 (55.32)	38.43
(NDV6 × PM) × G11	9640 (61.00)	14.608 (56.79)	1.427 (46.57)	0.256 (42.96)	17.91 (40.96)	49.66
(NDV6 × MO6) × G19	9040 (54.91)	14.320 (55.51)	1.472 (50.15)	0.301 (57.58)	20.46 (65.25)	56.68
(ND10 × ND7) × FC2	8480 (49.22)	13.004 (49.68)	1.399 (44.28)	0.266 (46.23)	19.00 (51.36)	48.15
(ND10 × ND7) × G11	7920 (43.53)	11.712 (43.96)	1.413 (45.39)	0.279 (50.30)	19.72 (58.14)	48.26
(ND10 × PM) × FC2	8720 (51.66)	12.580 (47.81)	1.325 (38.33)	0.245 (39.60)	18.50 (46.60)	44.80
Mean	8557	13.08	1.46989	0.27756	18.9	
SD	984	2.258	0.12439	0.03119	1.05	

Figures in paranthesis indicate individual evaluation index

Based on rearing performance and post cocoon evaluation further shortlisting of the better performing hybrids will be cariied out and on station trials will be undertaken.

Collabrative Research Project

AIB 02006 MI: Improvement of Nistari lines for survival and silk productivity (Jun. 2020-May 2024)

Thangjam Ranjita Devi*, Anil Kumar Verma*, Gautam Mitra*, K. Rahul, Mihir Rhaba*, Pooja Makwana* and K. B. Chandrashekar

*CSRTI-Berhampore

Objective

- To develop Nistari lines for improved survival and silk productivity
- To Evaluate improved Nistari crossbreeds for productivity traits

During the year under report four rearings were conducted and the lines provided are maintained. Data was provided to CSRTI, Berhampore.

Continuous/other activities

Maintenance of polyvoltine silkworm breeds

K. B. Chandrashekar and M. N. Chandrashekar

Objective

- To maintain the polyvoltines breeds conforming to their original characters.

Thirty two (32) polyvoltines breeds maintained for conforming to their original breed character were reared and evaluated.

Table 9.11: Rearing performance of the 32 polyvoltines breeds

Races	Fec. (Nos)	Hatching %	ERR By Nos	ERR By Wt. (kg)	SCW (g)	SSW (g)	SR %
AGL-35	436	97.71	9440	13.49	1.433	0.245	17.10
APDR 15	425	95.29	8960	10.60	1.213	0.218	17.97
BL 24	441	95.01	9160	13.29	1.46	0.239	16.37
BL-65	434	96.54	8600	11.25	1.321	0.229	17.34
BL-67	426	94.13	9440	13.98	1.498	0.239	15.95
BL-68	419	95.47	9000	12.02	1.372	0.219	15.96
BM-005	439	95.44	9120	11.02	1.221	0.176	14.41
BM-078	426	92.72	9040	10.61	1.21	0.211	17.44
FVB1	432	96.30	8840	10.41	1.341	0.219	16.33
HB4	460	96.09	8600	12.86	1.529	0.264	17.27
HB6	469	93.60	8560	13.00	1.533	0.275	17.94
L1	475	94.32	8760	13.82	1.612	0.274	17.00
L3	472	93.01	9000	13.85	1.549	0.265	17.11
L14	482	95.23	9160	13.44	1.489	0.261	17.53
L15	490	96.12	9240	13.02	1.429	0.241	16.86
MH1	457	92.34	8840	12.85	1.479	0.239	16.16
MV1	475	95.79	9080	13.20	1.463	0.235	16.06
MO6	485	95.88	9160	14.48	1.591	0.255	16.03
ND2	457	96.72	8960	11.87	1.341	0.221	16.48
ND5	441	94.78	9080	13.24	1.465	0.261	17.82
ND7	448	94.20	9320	11.82	1.296	0.224	17.28
ND10	468	94.66	9360	13.62	1.467	0.239	16.29
NDV6	465	94.41	9560	13.98	1.491	0.264	17.71
Nistari	465	93.55	9240	10.25	1.121	0.156	13.92
NP1	458	94.76	9040	13.50	1.501	0.269	17.92
NP4	446	96.64	8960	12.02	1.352	0.236	17.46
PV1	451	94.24	9160	13.65	1.498	0.256	17.09
2000H	459	96.30	9440	13.25	1.422	0.249	17.51

10. SATELLITE SILKWORM BREEDING STATION-COONOOR

V. Vijay

Maintenance of Bivoltine Silkworm Germplasm Stocks

During the reporting year one conservation rearing for 26 breeders' stock *viz*., CNR3, CNR4, CNR5, SLD1, SLD8, SLD9, SSBS2, SSB3, SSBS4, SSBS5, SSBS6, SSBS7, SSBS9, SSBS10, SSBS11, SSBS12, SSBS16, SSBS17, D1, D11, D13, D15, D17, MASN4, MASN6, MASN7 were taken up during April-May 2021. A total of 2389 dfls were produced and preserved in three schedules.

Table 10.1: Rearing performance of SSBS germplasms

Race	Larval Marking	Cocoon Shape	Hatching %	Av. SR Female (n=10)	Av.SR Male (n=10)	Av SCWT (n=10)	Av SSWT (n=10)	Av SR (n=10)	ERR No.
CNR3	Marked	Dumbell	97.1	18.6	22.2	1.63	0.33	20.2	9409
CNR4	Plain	Oval	95.1	17.9	24.4	1.61	0.33	20.8	7795
CNR5	Plain	Oval	91.9	18.5	23.1	1.62	0.33	20.5	7977
SLD1	Plain	Oval	88.7	18.6	23.0	1.79	0.37	20.6	8523
SLD8	Marked	Dumbell	96.0	19.2	22.3	1.65	0.34	20.5	8864
SLD9	Marked	Dumbell	95.1	18.6	21.1	1.72	0.34	19.7	5886
SSBS2	Plain	Oval	94.8	18.8	22.9	1.90	0.39	20.6	7545
SSBS3	Plain	Oval	96.7	19.4	23.0	1.63	0.34	21.0	8091
SSBS4	Plain	Oval	97.2	19.0	22.8	1.85	0.38	20.7	7136
SSBS5	Plain	Oval	87.9	19.4	23.2	1.72	0.36	21.1	7659
SSBS6	Marked	Dumbell	92.8	18.8	22.4	1.57	0.32	20.4	8977
SSBS7	Plain	Dumbell	92.5	19.9	23.3	1.72	0.37	21.4	5955
SSBS9	Plain	Oval	92.7	18.4	22.4	1.83	0.37	20.1	5250
SSBS10	Plain	Oval	95.7	18.9	22.4	1.84	0.38	20.5	7455
SSBS11	Plain	Oval	92.7	20.1	23.4	1.89	0.41	21.5	7750
SSBS12	Plain	Oval	92.3	19.7	23.1	1.85	0.39	21.2	7386
SSBS16	Plain	Oval	91.0	18.6	23.5	1.76	0.36	20.8	6977
SSBS17	Plain	Oval	93.0	19.8	23.3	1.79	0.38	21.4	7909
D1	Plain	Oval	94.1	19.9	24.2	1.71	0.37	21.8	5523
D11	Marked	Dumbell	87.4	17.9	22.0	1.70	0.34	19.7	9795
D13	Marked	Dumbell	90.4	18.4	22.5	1.80	0.36	20.3	9773
D15	Plain	Dumbell	88.0	20.3	25.5	1.73	0.39	22.6	8803
D17	Marked	Dumbell	90.7	20.5	24.1	1.72	0.38	22.1	9795
MASN4	Plain	Oval	95.1	17.5	21.4	1.84	0.36	19.2	9477
MASN6	Plain	Oval	96.3	18.5	22.6	1.76	0.36	20.3	9750
MASN7	Plain	Oval	96.0	18.1	22.1	1.76	0.35	19.8	9477

Production and supply of dfls to Bivoltine Breeding Laboratory, CSRTI-Mysuru

Reared 17 dfls of 9 Elite breeds for rejuvenation, supplied 300 dfls to BBL, CSRTI, Mysore.

Revenue Generation

During the reporting period Rs. 3,18,474 revenue was generated.

Table 10.2: Revenue generated under various heads

Particular/Head	Amount
House Rent + Licence fee + Water Charges	2,93,024
Guest House Charges	20,450
Auction amount	3,000
Internship fee	2,000
Total	3,18,474

11. P4 BASIC SEED FARM, HASSAN

Dayananda

Bivoltine silkworm breeds maintenance and multiplication

Objectives

- Maintenance of mulberry garden for the production and supply of quality mulberry leaf for breed maintenance
- Maintenance of eight authorised/popular bivoltine breeds as per the breed maintenance procedure
- Production, preservation and supply of quality P3 stock for P3 downstream multiplication

Maintained 0.93 Acres of mulberry under block plantation as per the recommended package of practices set for Basic Seed Farms. Another 1.66 acres of tree mulberry has been maintained as per general package of practices. Eight authorized bivoltine breeds including four oval breeds (CSR2, CSR17, CSR27 and S8) and four dumbbell breeds (CSR4, CSR6, CSR16 and CSR26) were maintained true to the original breed characteristics in four rearing cycles in a year (May-June 2021, Aug-Sep 2021, Nov-Dec 2021 and Feb-Mar 2022). Meticulous testing at every stage is carried out to keep the crop free from disease in general and Pebrine in particular.

Table 11.1: Performance of bivoltine breeds (Mean of 4 rearing cycles)

Breed	ERR by No.	ERR by wt. (kg)	SCW (g)	SSW (g)	Shell Ratio %
CSR2	9573±208	17.130±1.788	1.839±0.184	0.419±0.057	22.79±1.18
CSR17	9468±653	17.591±2.016	1.879±0.200	0.416±0.064	22.18±1.71
CSR27	9634±155	17.910±2.023	1.872±0.167	0.418±0.056	22.33±1.30
S8	9707±187	17.533±1.365	1.849±0.148	0.420±0.044	22.71±1.06
Mean of ovals	9596±301	17.491±1.798	1.860±0.175	0.418±0.056	22.47±1.31
CSR4	9471±432	16.406±1.628	1.746±0.108	0.381±0.031	21.81±1.22
CSR6	9606±158	16.327±1.437	1.733±0.159	0.368±0.037	21.23±0.63
CSR16	9597±206	16.345±1.424	1.700±0.160	0.368±0.046	21.60±1.06
CSR26	9527±260	16.150±1.705	1.708±0.177	0.365±0.041	21.37±0.82
Mean of dumbbells	9550±264	16.307±1.549	1.722±0.151	0.371±0.039	21.54±0.93
Overall Mean	9573±282	16.899±1.673	1.791±0.163	0.395±0.047	22.05±1.12

A total quantity of 263.339 kg P3 cocoons was generated.

Table 11.2: Production, utilization and disposal of cocoons during 2021-22

Crop No	Cocoon production (kg)	Cocoons utilized/disposal (Kgs)				
		Assessment/ Sample	Grainage	Others	Marketed	Revenue (Rs.)
1	66.555	3.750	6.000	0.600*	56.205	23122.00
2	59.765	3.500	6.500	1.000*	48.765	34700.00
3	66.889	3.500	6.989	0.500*	55.90	52576.00
4	70.130	4.500	5.250	-	60.380	62120.00
Total	263.339	15.250	24.739	2.100	221.250	1,72,518.00

* MV1 x S8 - an improved crossbreed for productivity and silk quality multiplied for field evaluation

A total of 24.739 kg of seed cocoons (14,360 by no.) were processed as per the set procedure and produced 5411 P4/P3/P1 dfls with 37.68% egg recovery. The dfls produced were preserved under 4 and 6 months hibernation schedule.

Table 11.3: Dfls production at P4 Hassan during 2021-22

Month	Qty. of Seed Cocoon utilized (kg/nos.)	Qty. of Seed produced (nos.)	Egg recovery (%)	Pebrine Incidence (%)
June 2021	6.000/3150	1274	40.44	0.08
September 2021	6.500/3740	1459	39.01	0.21
December 2021	6.989/3950	1176	29.77	0.17
March 2022	5.250/3520	1502	42.67	0.20
Total	24.739/14360	5411	37.68	0.17

1030 P3 dfls were supplied in 29 splits to P3 multiplication centers of DoS, Karnataka and NSSO for further multiplication. In addition, a total quantity of 1028 S8 P1 dfls was supplied to CSRTI-Mysuru.

Revenue generation

Table 11.4: Revenue generated

Particulars	Amount (Rs.)
Through sale of excess cocoons	172518.00
Through sale of P3 Dfls	46295.00
Total	218813.00

12. SILKWORM PHYSIOLOGY LABORATORY

Concluded Research Project

AlP01006Sl: Identification of probiotic consortium to improve the productivity in mulberry *silkworm, Bombyx mori* (Nov. 2019-Oct. 2021)

Y. Thirupathaiah, J. Harishkumar and E. Bhuvaneswari

Probiotic consortium identified includes combinations of *Bacillus* spp. and *Lactobacillus* spp. Treatment1 (T1) formulated with different combinations of both *Bacillus* spp. and *Lactobacillus* spp. whereas Treatment2 (T2) prepared with combinations of different *Lactobacillus* spp. The data on silkworm larval weight of 5th instar double hybrid (FC1 x FC2) of probiotic supplemented batch and control batch indicated higher larval weight in probiotic consortium treated batch (T1) followed by probiotic consortium treated batch (T2). Similarly, T1 recorded the highest single cocoon weight, shell weight and shell ratio followed by T2 and control group. Whereas, ERR percent is lower in T1 than T2 and control. There is not much difference between T1 and T2 with respect to yield/100 dfls (Table 12.1). The reeling parameters *viz*., reelability (%), average filament length (m), NBFL (m), denier, raw silk (%), raw silk recovery (%) of probiotic consortium treatments were significantly higher in T1 followed by T2 and control. Similarly, the rendita is significantly lower in T1 than in T2 and control.

Table 12.1: Effect of probiotic consortium supplementation on FC1 x FC2 hybrid rearing performance

Treatment	Single larval wt. (g)	SCW (g)	SSW (g)	SR (%)	ERR (%)	Yield/100 dfls (kg)
T 1	5.33±0.21	2.04±0.01	0.47±0.01	23.04±0.34	71.5±6.36	69.83±17.79
T2	4.75±0.06	2.02±0.03	0.45±0.01	22.35±0.62	75.0±13.11	70.7 ± 14.64
Control	5.02±0.17	1.99±0.05	0.45±0.01	22.65±0.07	73.0±5.19	65.883±4.04
CD @ 0.05	NS	NS	*	*	*	*

Table 12.2: Reeling performance of probiotic consortium

Treatment	T1	T2	Control
Single Cocoon wt (g)	2.04±0.01	2.02±0.03	1.99±0.05
Single Shell wt (g)	0.47±0.01	0.45±0.01	0.45±0.01
Shell Ratio	23.04±0.34	22.35±0.62	22.65±0.07
Reelability %	92.99±0.16**	90.56±0.44	90.93±0.62
Avg.filament length (m)	917.02±19.68	885.89±28.25	870.41±12.10
NBFL (m)	763.27±41.14	750.85±21.53	720.32±10.70
Denier	2.98±0.06	2.91±0.06	2.90±0.09
Renditta	6.84±0.16*	7.12±0.06	7.11±0.03
Rawsilk %	17.37±0.47**	16.60±0.12*	15.73±0.16
RawSilk Recovery %	78.02±1.34*	74.59±1.20	75.22±1.21

** significance @p<0.01, * significance @p<0.05

Ongoing Collaborative Project

BPS 01013 CN: Utilization and diversification of silkworm pupae products for human & animal consumption and composting (Oct. 2022-Mar. 2023)

Y. Thirupathaih, J. Harishkumar, Ravindra, Y. N. Sanath Kumar and S. M. Hukkeri

CFTRI-Mysuru: N. M. Sachindra, B. Sathyndra Rao, S. Shinde Vijay, Sridevi A Singh and K. Rathinaraj

CIFRI-Barrakpore: B. K. Das, D. K. Meena and M. A. Hassan

CSTRI-Bangalore: M. R. Itigi, Kiran B. Malali and Y. N. Radhalakshmi

CTRTI-Ranchi: K. Jena, Susmita Das and Jitendra Singh

CMERTI-Lohdaigarh: D. S. Mahesh and T. James Keisa

CSRTI, Mysuru

Sugars, phenolics, flavonoids and volatile compound profiling were carried out in mulberry silkworm pupae. Sugar profiling revealed the presence of 15 different sugar molecules, with sorbitol as the main component known to promote digestion and oral health. Total of 18 different phenolic acid compounds were found in pupae including of ferulic and cinnamic acids and all these compounds are known to same beneficial effects. Moreover, 15 different flavonoids molecules have detected in pupae, of which luteolin, quercetin, myrcetin, catechin and epicatechin are having anti-cancer, anti-ageing and anti-diabetic properties. The volatile compounds detected in silkworm pupae were Styrene, β-Terpinene, γ-Terpinene, α-phelladrene, p-menthone and Levomenthol, have industrial, cosmetic and medical importance. Comprehensive nutritional and bioactive molecule analysis of silkworm pupae revealed the presence of high- value nutrients and bioactive compounds and these compounds can be potentially used in pharmaceuticals, nutraceuticals, functional foods and feed additives.

Microbial analysis by metagenomics approach in spent silkworm pupae was carried out and compared the diversity of bacterial communities immediately after reeling and sundried spent pupae. The predominance of genus *Bacillus sp*. followed by *Streptococcus sp*. and *Staphylococcus sp*. was observed in spent pupae before drying, whereas, *Enterococcus sp*, *Acinetobacte*r sp. followed by *Prevotella sp*, *Streptococcus* sp. and *Enterobacteria* were commonly present in sundried spent pupa samples. Metagenomics analysis of silkworm pupae indicates that bacterial population was highly diverse in sundried samples. Hence collecting the spent pupae immediately after reeling and drying by oven or storing under refrigerated conditions could retain all the nutritional characteristics and prevent the spoilage due to microbial growth.

Table 12.3: Profiling of Sugars, Phenolics and Flavonoids compounds in silkworm pupae

Sugars		Phenolics		Flavonoids	
Name Sugars	mg/g	Name of Phenolics	mg/g	Name of flavonoids	mg/g
Sorbitol	3.75	Ferulic acid	0.63	Luteolin	0.12
Galactose	2.95	p-Coumaric acid	0.05	Epicatechin	0.02
Trehalose	1.06	t-Cinnamic acid	0.04	Naringenin	0.01
Maltose	0.71	Gentisic acid	0.04	Catechin	0.01
Mannose	0.30	Benzoic acid	0.01	Myricetin	0.01
Glucose	0.24	Caffeic acid	0.007	Quercetin	0.008

Table 12.4: Microbial enumeration in spent mulberry silkworm pupae

Microbial category	Spent pupae (Before drying) (CFU/g)	Spent pupae (Sun dried) (CFU/g)
Total bacterial count on	2.0×10^4	2.1×10^6
Gram negative coliforms/enterobacteria	5.0×10^3	3.0×10^5
Salmonella	-	1.3×10^2
Lactobacillus	3.5×10^4	2.0×10^5
Total fungi/yeast	2.4×10^2	1.0×10^3
Bacterial endo toxin	Negative	Positive

CFTRI, Mysuru

Preparation of food products from silkworm pupae

For the preparation of food products from fresh mulberry silkworm pupae, pulp was taken from boiled pupae and was subjected to freeze drying, drum drying or tray drying to obtain pupae powder. The freeze dried and drum dried powder was incorporated into beverage mix, cookies, mayonnaise and pasta at 5%, 10%, 15% and 20% level and the samples were analyzed for quality parameters. Sensory evaluation of these food products were conducted at both traditional and non-traditional areas. Roasted spiced eri silkworm pupae was prepared and sensory evaluation was conducted.

Fig. 12.1: Pasta with 10% silkworm pupae powder

Fig 12.2: Roasted and spiced Eri pupae

Evaluation of spent silkworm pupae (SWP) as an ingredient in poultry feed

Formulations for layer feed and broiler feed has been finalized and the raw materials (silkworm pupae, defatted silkworm pupae, cutical removed defatted silkworm pupae and defatted cuticle removed silkworm pupae meal) were prepared as per the quantity required to make different feed formulations and conducted broiler and layer feeding experiment.

CIFRI, Barrakpore

Fish feed trials with tasar pupae feed formulation were completed and trials with mulberry pupae are under progress. The experiment at wet-lab of ICAR-CIFRI, Barrackpore, India to study the extent up to which fish meal can be replaced by vanya silkworm (*Antheraea mylitta*) pupae meal for fry of *Pangasionodon hypophthalmus*. Five experimental diets were formulated using various oil cakes with sequential replacement of fish meal with pupae meal. Three hundred *Pangasionodon hypophthalmus* fish (2.51 ± 0.01 g) were arbitrarily dispensed into five dietary groups *viz*., D0, D25, D50, D75 and D100 in duplicate by keeping 30 fish per 330 liter fibre-reinforced plastic circular experimental tanks with round the clock aeration. Each fish group was fed with respective experimental diets on satiation basis thrice daily at 08:00, 12:00, and 16:00 h in the morning. The experimental tanks were cleaned manually. After 56 days of trial, based on the growth, nutrient utilization, flesh quality, and survivability of fish, it was observed that 75% of fish meal protein can be replaced by *Antheraea mylitta* pupae meal (AMPM) in the diet of *Pangasionodon hypophthalmus* without any detrimental effect compared to the control diet with 40% fish meal protein.

The experiment was conducted at wet-lab of ICAR-CIFRI, Barrackpore, to study the extent upto which fish meal can be replaced by vanya silkworm (*Antheraea mylitta*) pupae meal in practical fish feed for fry of *Oreochromis niloticus.* Four experimental diets were formulated using various oil cakes with sequential replacement of fish meal with pupae meal. Two hundred *Oreochromis niloticus* fish (0.72 ± 0.02 g) were arbitrarily dispensed into four dietary groups' viz. D0, D33.33, D66.66, and D100 in duplicate by keeping 25 fish per 250 litre fibre-reinforced plastic circular experimental tank with round the clock aeration. Each fish group was fed with respective experimental diets on satiation basis thrice daily at 08:00, 12:00, and 16:00 hrs. After 56 days of trial, based on the growth, nutrient utilization, flesh quality, and survivability of fish, it was observed that fish meal protein can be replaced completely (100%) by the *Antheraea mylitta* pupae meal (AMPM) in the diet of *Oreochromis niloticus* without any deleterious effect compared to the control diet with 40% fish meal protein.

Fig. 12.3: Fish feed formulation by using Tasar pupae

CSTRI, Bangalore

Tasar silkworm pupae based vermi compost (Tasar black gold) was applied to mulberry field to assess the leaf yield. The experiment is under progress.

CTRTI, Ranchi

Profiling of phenolic and flavonoids in both fresh and spent tasar pupae was carried out. The microbial count of *Bacillus cereus*, *Candida albicans* in both fresh and spent pupae were below 10 CFU/g. Standardization and isolation of chitin and chitosan from spent pupae was carried out. DPPH and hydrogen peroxide scavenging potential, FTIR, TGA-DTA, FESEM, CHNS and Colour study of Chitin and chitosan (tasar pupae) were performed.

CMERTI, Lahdaigarh

Bacterial species were identified from spent muga silkworm pupae and the nucleotide sequences were submitted to NCBI GenBank and obtained accession numbers. Protein quantification of eri pre-pupa, matured pupae and muga pupae were carried out and profiling of these proteins was done using SDS gel electrophoresis. The proteome characterization for both eri and muga pupae was also carried out.

Collaborative ongoing project progress

BPC 07015 CN: Development of mulberry sericin powder for nutraceutical applications (Jul. 2020-Jun. 2022). (Coordinating institute: CSTRI, Bangalore)

CSRTI-Mysuru: Y. Thirupathaih

CSTRI-Bengaluru: Abhilasha and Y. N. Radhalakshmi

CFTRI-Mysuru: N. M. Sachindra and Sridevi A. Singh

Silkworm rearing was conducetd using organic mulberry leaf and without using bed disinfectants. The cocoon shells were supplied to collaborators at CSTRI, Bangalore and CFTRI, Mysuru for extraction and characterization of mulberry sericin for nutraceutical purposes.

MOE 01021 SI: Evaluation and popularization of improved technologies developed in the field of mulberry sector for South India (April 2021-March 2023)

Evaluation of Chawki Feed Supplement Formulation in Commercial chawki rearing centers

M. Muthulakshmi, E. Bhuvaneswari, Y. Thirupathaiah, J. B. Narendrakumar, M. Venkatachalapathi and Jessy Daniel

Objective

- To popularize chawki feed supplement formulation at commercial chawki rearing centers of Andhra Pradesh, Karnataka and Tamil Nadu

On farm trials were conducted for the evaluation of chawki feed supplement formulation (CFSF) in the commercial chawki rearing centers of Andhra Pradesh, Karnataka and Tamil Nadu during rainy, winter and summer season using FC1xFC2 silkworms. The treated batch was supplemented during I instar for first three days @ 10 ml for 100 dfls one feed per day. The CFSF was sprinkled on mulberry leaves and left for 15mins for absorption before feeding. Chawki parameters such as larval weight (100 nos), percentage of missing and unequal larvae and disease incidence were recorded (Table 12.5).

During the rainy season (June to September 2021), the CFSF were evaluated for 1500 dfls of CFSF in comparison with same quantity of similar hybrid as control. There was no significant differene in the average larval weight in control and treated batch. Significant difference was observed between the control and treated batches with respect to misssing larval percentage (3.742 % and 0.990 %), average undersized larval percentage (3.706 % and 1.508%). The larvae were supplied to the progressive farmers and significant difference was noted in the control and CFSF treated group in respect of pupation rate (89.607% and 91.011%) and yield/100 dfls (78.717 kg and 83.360 kg) respectively.

During winter season (October 2021 to January 2022), a total of 1500 dfls of CFSF in comparison with control was evaluated. There was no significant differene in the average larval weight in control and treated batch. Significant difference was observed between the control and treated batches with respect to misssing larval percentage (3.397% and 1.179%), average undersized larval percentage (3.789% and 1.231%). The second moult larvae were supplied to the progressive farmers and significant difference was noted in the control and CFSF treated group in pupation rate (89.365% and 92.298%) and yield/100 dfls (78.065 kg and 83.7 kg) respectively.

During summer season (January to March 2022), 2500 dfls were evaluated for CFSF supplementation in Tamil Nadu and there was significant difference in missing larvae percentage in control and treated (2.550% and 1.033%), under sized larvae percentage (2.210% and 1.129%). From the evaluation it is observed that CFSF improved the overall cocoon productivity by 5.7 % with an average yield of 69.03 kg /100 dfls in control and 72.965 kg/100 dfls in CFSF treated.

Table 12.5: Evaluation of CFSF in commercial CRCs of Andhra Pradesh, Karnataka and Tamilnadu

Para-meter	Chawki performance			Late age and cocoon parameters						
	Larval growth (g/100 L)	Missing Larvae %	Under sized larvae %	Weight of 10 larvae (g)	SCW (g)	SSW (g)	SR (%)	Pupn. rate (%)	Yield (kg/ 100 dfls)	Cocoon rate in Rs./kg
Rainy season										
Control	3.267 (±0.11)	3.742 (±1.16)	3.706 (±0.37)	43.630 (±3.349)	1.885 (±0.04)	0.388 (±0.005)	20.400 (±0.19)	89.607 (±0.87)	78.717 (±3.080)	413.453 (±3.16)
CFSF treated	3.418 (±0.28) NS	0.990 (±0.49) **	1.508 (±0.15) **	45.136 (±4.07) NS	1.931 (±0.02) NS	0.4015 (±0.008) NS	20.908 (±0.39) **	91.011 (±0.40) **	83.360 (±2.76) **	432.933 (±3.843) **
Winter season										
Control	3.264 (±0.19)	3.397 (±1.69)	3.789 (±1.19)	46.906 (±4.540)	1.900 (±0.03)	0.391 (±0.05)	20.597 (±0.08)	89.365 (±1.87)	78.065 (±2.528)	750.800 (±14.60)
CFSF treated	3.491 (±0.348) NS	1.179 (±1.00) **	1.231 (±0.38) **	48.078 (±4.886) NS	1.982 (±0.05) **	0.412 (±0.003) NS	20.841 (±0.51) NS	92.298 (±1.72) **	83.700 (±2.07) **	795.889 (±12.83) **

Summer season										
Control	3.005 (±0.091)	2.550 (±0.24)	2.210 (±0.07)	41.532 (±0.59)	1.808 (±0.05)	0.387 (±0.02)	21.461 (±0.34)	86.996 (±3.86)	69.03 (±0.60)	657.00 (±17.78)
CFSF treated	3.048 (±0.065) NS	1.033 (±0.36) **	1.129 (±0.20) **	42.200 (±0.590) NS	1.912 (±0.04) NS	0.418 (±0.010) NS	21.864 (±0.16) NS	89.239 (±2.03) **	72.965 (±6.00) **	658.00 (±15.89) NS

Each value is the mean ±SD of five separate observations; **Significant at 0.05% level (P value <0.05); NS: Non Significant

13. TECHNOLOGY VALIDATION AND DEMONSTRATION CENTRE

R. Bhagya

MOE 01021 SI: Evaluation of improved technologies of mulberry sericulture in Sourth India

Component 5: Evaluation of Cauvery Gold (MV1 x S8): An improved cross breed for cocoon productivity and silk quality (Apr. 2021 - Mar. 2022)

Objective

- To evaluate the field performance of newly evolved improved crossbreed Cauvery Gold for productivity and Silk Quality.

Under the large scale multiplication programme, a total of 145 dfls of MV1 and 80 dfls of S8 breeds were reared and generated 94.2 kg (69,771 Nos) of cocoons. The rearing performance was evaluated and the data revealed that they are in confirmation for its original breed characters.

Table 13.1: Rearing performance of silkworm breeds at TVDC during 2021-22

Race	No of Dfls	Fec.	Actual yield		ERR/ 10,000 larvae		SCW (g)	SSW (g)	SR%	Coc/ kg	Yield/ 100 dfls (kg)
			No.	Wt. (kg)	No.	Wt. (kg)					
S8	50	392	19188	26.8	9779	13.6	1.6	0.337	21.0	716	53.6
MV1	75	377	19958	32.4	7054	11.45	1.5	0.30	19.5	616	43.2
S8	30	396	6058	6.5	5099	5.471	1.15	0.259	22.5	932	21.66
MV1	70	374	24567	28.5	9383	10.88	1.25	0.265	21.1	862	40.71

Source: MBL; MV1 B/on 7.11.21, 17.2.22; S8 B/on 3.11.21, 14.2.22

Table 13.2: Cocoon supplied during 2021-22

Race	Place	Cocoons		Total Revenue generated (Rs.)
		By No.	By wt (kg)	
S8	Ramanagar	25246	33.3	48,515.00
MV1	Ramanagar	35043	49.9	

14. PEST MANAGEMENT LABORATORY

Concluded Research Project

PRE 01010SI: Development of Integrated Pest Management (IPM) module for leaf roller *Diaphania pulverulentalis* (Lepidoptera: Pyralidae) in mulberry (Mar. 2020 - Feb. 2020)

S. Mahiba Helen and A. V. Mary Josepha (Shery)

Objectives

- Evaluation of egg, larval and pupal parasitoids for the management leaf roller in mulberry
- Screening of efficacy of selected botanicals and chemical insecticides against leaf roller and their bio-safety to silkworms

Standardized laboratory mass production of leaf roller on mulberry leaves. Continuous leaf roller culture has been maintained in the laboratory. One egg-larval parasitoid *Phanerotoma* sp. and one larval parasitoid *Dolichogenidea* sp. of *D. pulverulentalis* have been collected from the field. Parasitization efficiency of *Tetrastichus howardi* Olliff (Hymenoptera: Eulophidae) on leaf roller pupae in different depth (1-7 cm) soil was studied. The results indicated that *T. howardi* is able to parasitise leaf roller pupae up to 7 cm depth of soil.

Standardized mass production of leaf roller egg larval parasitoid *Phanerotoma sp*. larval parasitoid *Dolichogenidea* sp. and pupal parasitoid *Tetrastichus howardii* (Hymenoptera: Eulophidae) on leaf roller egg, larva and pupa. Safety testing of 13 chemical insecticides and five botanicals against silkworm larvae were completed. The results indicated that Chlorfenapyr 10% SC (Intrepid), Imidacloprid 17.80% SL (Confidor), Dinotefuran 20% SG (Dominant), is safe after 15 days after spray; Fenobucarb 50% EC (Sipvin) safe after 20 days; Indoxacarb 14.5% SC (Kemdoxa) safe after 25 days and three botanical formulations namely *Vidigreenpath*, *VidiKossipil*, Azadirachtin (10000 PPM) Neem super T safe after 5 days after spray. Field evaluation of natural enemies has been completed in leaf roller infested mulberry plot of CSRTI-Mysuru. Data was collected before and after release of parasitoid.

The leaf roller incidence reduced from 74% to 16% in one week after post release of parasitoids. In control plot the leaf roller incidence of 33% increased to 63% after one week.

Fig. 14.1: Laboratory mass production of *D. pulverulentalis* on mulberry leaves

Fig. 14.2: Mass production of Egg-larval parasitoid: *Phanerotoma* sp. (Cheloninae) (Hymenoptera: Braconidae)

Fig. 14.3: Phanerotoma sp. life cycle on D. pulverulentalis

Fig. 14.4: Parasitization efficiency of Tetrastichushowardi (Hymenoptera: Eulophidae) on leaf roller pupae in different depths of soil

Fig. 14.5: Release of egg-larval, larval and pupal parasitoid against Leaf roller in mulberry garden

Table 14.1: Comparison of *D. Pulveruletalis* incidence in mulberry garden before and after release of egg larval, larval and pupal parasitoids

Group	Incidence Percentages before and after release of parasitoids			Test statistic (P-value) for comparison of before and after release of parasitoids		
	Pre release	One week after post release (Post 1)	14 days after post release (Post 2)	Pre vs Post 1	Pre vs Post 2	Post 1 vs post 2
Exp	74.0	16.0	28.0	52.40** (<0.001)	31.641** (<0.001)	3.559^{ns} (0.059)
Control	33.0	63.0	91.0	16.17** (<0.001)	54.15** (<0.001)	26.04** (<0.001)
t-value	6.376**	7.753**	11.832**			

*** Significant at 0.01 level; ns non-significant*

Comparison of incidence between control and experimental groups was done by using t test for comparison of independent proportions. Comparison was done at the time of pre-release, one week after post release and 14 days after post release was done separately.

- One week after post release and 14 days after post release control group have more incidences compared to experimental group.
- Results show that in the experimental group, incidence percentage significantly reduced to 16 percent one week after post release from prelease incidence (74.0%).
- Even though there is a slight increase in incidence percentage (28%) 14 days after post release it shows no significant difference with the incidence one week after post release. But it is significantly lower than pre-release incidence.
- In the case of control group, incidence increased significantly from initial day (33.0%) to one week after (63%) and then 14 days after initial day (91%).

Table 14.2: Comparison of intensity (%) of leaf roller before and after release of parasitoids

Period	Mean±SE		t-value (P-value)
	Experimental	Control	
Pre release	27.78±4.98[a]	17.42 ±2.87[b]	1.804[ns] (0.081)
One week after	3.39±1.81[c]	16.29± 3.40[b]	3.352** (0.002)
14 days after	12.81±2.02[b]	37.49±3.95[a]	3.551** (<0.001)
F-value (P-value)	12.792** (0.001)	12.835** (<0.001)	

** Significant at 0.01 level; ns non-significant; Means having different letter as superscript differ significantly within a row

- Results shows that in the experimental group, intensity (%) of leaf roller was 27.78 on the initial day and it significantly decreased to 3.39 one week after post release and then it significantly increased to 12.81%, 14 days after post release.
- In the case of control group, incidence increased significantly from initial day (33.0%) to one week after (63%) and then 14 days after initial day (91%).

Continuous/Other Activities

Maintenance of mother cultures for mass production and supply to stake holders of recommended bio-control agents of sericultural pests in CSRTI campus.

S. Mahiba Helen

Objective

- To maintain mother cultures of bio-control agents for mass production, release and supply to stake-holders.

Nucleus cultures of two pupal parasitoids of uzi fly *viz., Nesolynx thymus*, and *Tetrastichus howardii* and two predators of mealy bug (*Cryptolaemous montrouzieri* & *Scymnus coccivora*) besides host culture of housefly and pink mealy bug were maintained throughout the year.

Mass produced *Corcyra cephalonica* host for the production of egg parasitoid (*Trichogramma chilonis*) and larval parasitoid (*Bracon brevicornis*) for the management of leaf roller in mulberry. Supplied 45 units of *T. chilonis* and 39 units of *B. brevicornis* (one unit = 250 adults/pupae) to farmers of Karnataka, Tamil Nadu and Andhra Pradesh.

Mass produced predators, *Chrysoperla zastrowi sillemi* and *Blaptostethus pallescens* for the management of thrips in mulberry. Supplied 31 units (1 unit = 1000 nymphs/adults) of *B. pallescens* to Karnataka and Tamil Nadu farmers. Following the introduction of the predator the thrips incidence reduced from 40 per cent to below 8 per cent. The release of bio-control agents along with other components of IPM was effective in keeping the major mulberry pests and silkworm pest incidence below ETL in the field.

Table 14.3: Details of production of bio-control agents at CSRTI Mysuru (2021-22)

Biological control agents	Quantity Produced	Quantity sold	Total Revenue (Rs)
Nesolynx thymus (No. of pouches; 1 pouch=50 ml or 10,000 parasitoids)	1900	1791	89550/-
Trichogramma chilonis (1 unit= 1 cc/1 card)	71	45	2250/-
Bracon brevicornis (1 unit= 250 Nos.)	55	39	1950/-
Blaptostethus pallescens (I unit= 1000 grubs/adults)	51	31	4650/-
Total			98,400/-

15. SILKWORM PATHOLOGY LABORATORY

Concluded Research Project

ARP 01012 SI: Development of a knowledge base on the silkworm diseases and pests and their management (Mar. 2020-Feb. 2022)

A.V. Mary Josepha (Shery), G. Mallikarjuna, Amit Saha (uptoNov.2021), Guneshwar Kumar Churendra (upto Aug 2021), S. Mahiba Helen, J. Justin Kumar

Objectives

- To develop a knowledge base on silkworm diseases and pests
- A web based silkworm disease and pest diagnosis system and calendar for the silkworm disease and pest occurrence in south India will be developed.
- To develop a virtual interaction platform for the sericulturists and scientists on the silkworm diseases and pests and management of silkworm diseases and pests.

Designed the Web page for the disease and pest management. Collected publication from different publishers such as Wiley, Springer, Taylor and Francis and Elsevier related to diseases of silkworm and its management and silkworm pest and their management. The links of the papers embedded were uploaded. The PDFs of the papers from Indian Journal of Sericulture and Sericologia were uploaded with the permission of the competent authority. The outcome of the concluded research projects on silkworm diseases and pest management conducted at CSRTI-Mysuru, other CSB institutes, KSSRDI, APSSRDI and universities were collected and uploaded. The calendar for the silkworm diseases and pests were prepared and uploaded. Worked out the economics of sericulture and included in the web page.

Conclusion

Developed a data base related to silkworm diseases and symptoms, silkworm pests and their mode of attack, prophylactic measures, *etc*., and the works published on the topics.

MOE 01021 SI: Evalution and popularization of improved technologies developed in the field of mulberry sector for South India

Compopnent: Validation of the M-LAMP technology in Mulberry and *Vanya* sector (Apr. 2020-Mar. 2022)

G. Mallikarjuna and A. V. Mary Josepha (Shery)

500 Eri silkmoth samples were tested at ESSPC, Hosur. 230 Mulberry silkmoth sampes at P4 BSF, Hassan and 110 Mulberry silkmoth samples at P3 BSF Mysuru and 300 Mulberry samples received from CSRTI, Pampore were tested by both M-LAMP as well as microscopic method. 500 Muga silkmoth samples were tested at CMERTI, Lahdoigarh.

Table 15.1: Testing report of different samples by M-LAMP assay and microscopical methods

Name of the Institute/Centre	Target	No. of Samples	No. of +ve samples		+ve samples in both methods
			M-LAMP assay	Microscopy	
P4 BSF, Hassan	230	230	01+ve	-	-
P3 BSF, Mysuru	110	110	-	-	-
CSR&TI, Pampore	220	300	-	-	-
ESSPC, Hosur	500	500	-	-	-
CMERTI, Lahdoigarh	500	500	91+ve	90+ve	90+ve
Total	1560	1640	92+ve	90+ve	90+ve

Conclusion

The technology M-LAMP assay can be used for testing the microsporidial infection in both mulberry and *vanya* silkworms. The validation of the technology has been done in Mulberry, Muga, Tasar and Eri and the sensitivity of the test is 96.82% in mulberry, 97.41% in Tasar and 100% in Muga and Eri silkworms.

Ongoing Research Project

AIT 01019 SI: Screening of drugs/Inhibitors to inhibit the PI3K-Akt pathway in *Bombyx mori* for controlling Nuclear Polyhedrosis Virus infection (Nov. 2020-Oct. 2023)

G. Mallikarjuna and K.N. Madhusudhan

Objectives

- To screen different commercial drugs and their analogues against BmNPV infection targeting PI3K-Akt pathway.
- To study the impact of potential drugs on differential expression of genes involved in PI3K-Akt pathway by real-time qPCR.
- To identify the transcripts in control as well as drug treated samples. To evaluate the effect of PI3K inhibitors in BmN cell lines.To develop an effective drug for controlling the viral infection.

The bioassay was conducted using the drugs iodentified in the *in silico* work. Retinovir, Daclatasvir, Indinavir, PIK-249, GSK-1059615, PTP inhibitor, and Tipronavir drugs are the selected drugs for the study. The bioassays of the identified drugs were done on silkworms. Declatasvir is not having any toxicity to silkworms. BmNPV inoculated silkworms (20000 polyhedra/worms) were treated with different concentrations of Declatasvir (10 mg, 5 mg, 2.5 mg and 1.25 mg) and both healthy and BmNPV inoculated silkworms were kept as control. Genomic DNA was isolated from the control, BmNPV inoculated, drug treated and drug treated BmNPV inoculated silkworms. Identification of genes which are involving in the

viral multiplication process is under progress. Real Time-qPCR primers of different genes involved in PI3K-Akt pathway were designed.

MOE 01021 SI: Evaluation and popularization of improved technologies developed in the field of mulberry sector for South India

Component 4: Evaluation of newly developed multiviral diseases tolerant bivoltine hybrid RDIN1 (Apr. 2021-Mar. 2023)

L. Satish, L. Kusuma, K. N. Madhusudan, H. R. Raveendranath, A.V. Mary Josepha Shery

Objective

- To evaluate the newly identified multi-viral disease tolerant (DNV1, IFV & NPV) hybrid (RDIN1) at farmer's level

RDIN1, developed through marker-assisted selection showed >72% survival compared to FC1 x FC2 under inoculated condition. The parents of RDIN1 hybrid HBM10 and PAM117 were inoculated and based on the marker selected resistant ones, whereas, CSR52 and CSR27 were selected without inoculation directly. The Foundation cross HBM10 x PAM117 multi-viral tolerant FC were inoculated and selected using SSR markers and CSR52 x CSR27 productive FC was uninoculated and directionally selected. The field evaluation of RDIN1 was performed by rearing 9000 dfls at different location and season. The pupation of RDIN1 was 94.8% and FC1 x FC2 was 91.4%. Other parameters such as cocoon yield, cocoon weight, shell weight, shell percentage, reelability, filament length, raw silk %, denier, and neatness had no significant difference in RDIN1 and FC1 x FC2. RDIN1 had significantly better pupation compared to FC1 x FC2 in all the seasons. The RDIN1 is expected to reduce cocoon crop losses due to viral infection and inturn will increase the profit of sericulture farmers.

AIC 01023 SI: Development of Spectroscopic Tests for insecticide resistant biomarkers in silkworm, *Bombyx mori* (Jan.2022-Dec. 2023)

L. Satish, S. Mahiba Helen

Objectives

- Screening and evaluation of insecticide resistant biomarkers in silkworm
- Development of spectroscopic tests for insecticide resistant biomarkers

A rapid visual screening paper-strip method for the detection of pesticide contamination in sericultural field was standardised. The visual screening is based on blue colour appearance during the hydrolysis of indoxyl acetate catalysed by acetylcholinesterase and remains colourless when acetylcholinesterase is inhibited by pesticides. Different paper strips (Whatman filter paper 1, HybondN, HybondP, millipore) were tested of which Whatman filter paper 1 was found to be more reliable and economically affordable. The indoxyl acetate was dissolved in methanol and diluted to 10 mM by Tris buffer solution (pH 7.4) which is a colourless solution and different concentrations of pesticides were dissolved in Tris buffer . The optimal colour development from colourless to blue-green colour during acetylcholinesterase and indoxyl acetate catalysis was standardised.

BPC07022 MI: Regeneration of silk filaments from silk waste material (Mar.2021-Feb. 2022) (In collaboration with CSTRI, Bangalore)

K. Jahanathan, K.M.A. Kadhar, L. Satish, H. R. Raveendranath

Objectives

- Development of protocol to dissolve silk waste/cocoons and regeneration of silk
- Characterization of the silk filament
- Development of products from regenerated silk

35,000 MT of silk was produced in the year 2019-20 from which around 18 % (5500 MT) of silk wastes was generated. Silk waste is basically used for spun silk production only. In view of this an attempt was made to regenerate silk filaments from the silk waste materials which could be of utilized in biomedical and biomaterial applications. Thirteen different bivoltine silkworm breeds were reared and cocoons were produced. These cocoon shells were degummed with 0.5% Calcium carbonate, 0.5% Sodium Carbonate, 0.3% Sodium Bicarbonate, 0.25% SDS individually and in combination of 0.3% Sodium Bicarbonate with 0.3% SDS. Mixture of 0.3% anhydrous Sodium bicarbonate and SDS was found to be more effective in degumming the cocoons with 70% fiber recovery. Different chaotropic chemicals namely Lithium bromide (9M), Calcium nitrate (5M), Calcium nitrate (10M), Calcium chloride(10M), Magnesium chloride (10M), Zinc Chloride (8M), Urea(8M), Formic Acid, mixture of Formic acid + Calcium chloride (10:1), were used for the dissolution of silk filaments. Among these chemicals, 5M Calcium nitrate was found to be effective in complete dissolution of 2gm fibroin (10% fibroin) at 90°C for 5hr. Fibroin silk dope was dialysed against water for 72 hrs and precipitated the dissolved fibroin using n-Butanol, Ethanol, Methanol and mixture of Ethanol and Methanol (1:1).

Continuous/other activities

Silkworm Disease Monitoring in South Indian States

Objectives

- To estimate the prevalence of silkworm diseases at selected Basic Seed Farms and Commercial crop rearings (CPP Clusters) in the South Indian States
- To suggest remedial measures on the spot to the farms/farmers to manage the silkworm diseases and prevent disease outbreak.

Results

In the BSFs of Karnataka the average grasserie incidence was 2.43%, flacherie incidence was 0.37% and muscardine incidence was 0.43%. In Madhya Pradesh from Hoshangabad 0.094 % grasserie was reported and from Aurangabad, Maharashtra 0.24% flacherie was reported. In Tamil Nadu data collected from Thenkasi and Dindigul shows 1.2 and 0.27% grasserie, 6.3 and 0.14% flacherie respectively.

Maintenance of the silkworm Pathogens

Maintained the BmNPV, BmIFV and BmDNV virus stocks, pathogenic bacteria *viz*., *Staphylococcus aureus, Streptococcus faecalis, Bacillus thuringiensis* and *Serratia marcescens* and fungal pathogens *Beauveria bassiana* and different microsporidian strains. Sub-culturing of all bacterial and fungal pathogens and reinoculation of the viral pathogens and microsporidia were done periodically. Virulence of all the pathogens tested periodically as per the standard procedure.

Field problems resolved

Resolved 21 field problems related to silkworm diseases and gave guidance to the farmers for proper disease management. Follow up action also done by contacting the farmers.

Sensitization of stakeholders

Pebrine monitoring

The scientists conducted Pebrine monitoring at Bivoltine and multivoltine breeding laboratories, P4 BSF Hassan, P3 BSF Mysuru and P2 BSF Ambuga (DoS).

Quality analysis

Issued 41 quality analysis reports for different room and bed disinfectants developed by the silkworm pathology section.

Seed officer and seed analysts

- G. Mallikarjuna is working as Seed Officeer of Channapatna, Kasaba 02
- A.V. Mary Josepha (Shery) is working as the Seed Analyst of Mysuru, H.D. Kote, Nanjungud and T. Narasipura area.

16. POST COCOON EVALUATION

Shivakumar M. Hukkeri and M. N. Chandrashekar

As per the guidelines of Ministry of Textiles "National Handloom Week" was conducted at three different hand loom weaving societies *viz*. H.D.Kote, Nanjanagud and Chamarajanagar from 07.08.2021 to 13.08.2021.

Conducted test reeling of 310 cocoon lots received from different centers and sections of the institute and mono cocoon test reeling of 50 cocoon lots of experimental rearings of the institute.

17. SERICULTURE ENGINEERING DIVISION

Concluded Research Project

MFM 01020 CN: Development of artificial intelligence empowered multisensory approach for gender classification and separation of silkworm cocoons (Dec. 2020-Nov. 2021)

Shivakumar M. Hukkeri, K. N. Madhusudhan, K. S. Nitin KS (NIE College-Mysuru)

Objectives

- To develop an appropriate tool for gender identification in pupa stage.
- To develop an appropriate tool for non-destructive gender classification in cocoon stage.

Brief work done

- Developed a working prototype of the identified novel tool for sex identification of silk pupae.
- The validation trials of the machine done at SSPC Mysuru.

Fig. 17.1: Demonstration of the non-destructive gender classification machine at SSPC, Mysuru on 26.01.2022

Other works

Addressed issues pertaining to sericulture and developed equipments for

- Maintaining Temperature & Humidity inside the Rearing House
- Developed hand operated Dusting equipments
- Developed a protocol for shoot cutting, bundling & transporting to the rearing house
- Small and handy Leaf cutting machine for chawki rearing
- Conveyer type tray washing machine
- An easy method for removal of the waste from rearing bed
- Collapsible rearing racks

Pilot Studies

Design & Development of 3-D fabric based mountages suitable for silk worm rearing (Nov. 2021 to Jan. 2022) [CSB/CSRTI/PMCE/Pilot studies/20-21 dated 16.10.201]

Shivakumar M. Hukkeri, K. N. Madhusudhan, M. N. Chandrashekhar

Objectives

- Development of low cost fabric based mountage for production of cocoons with reduced defective %.
- To analyze the impact of such fabric based mountages on silkworm spinning, cocoon quality and ease of maintenance during and post spinning activities.

Specific outcome

- One model mountage developed and trials conducted.
- The developed mountages are easy to keep by spreading and hanging over the rearing bed and the worms can easily crawl into the pockets and start spinning.
- Fabric material can offer better comfort and breathability to the worms. The protruding fibers of the warp and weft will give a good hold to worms during spinning.
- The inter section of the highly twisted warp and weft are going to create small holes which will allow the urine to flow down and dry easily.

- Harvesting is very easy by just lifting the mountages after spinning, reversing and stretching from all four corners will make the cocoons to fall down.

Fig. 17.2: Fabric based 3D mountage developed under the study

Other activites

1. Developed new room Heaters (with Twin Coils fitted with fan and Thermostat) – Can throw heat in two directions so that more area is covered	
2. Developed new low cost humidifier (Wall mounting with remote and speed adjustment)	

18. CAPACITY BUILDING AND TRAINING

S. Purushotham, Anuradha H. Jingade, G. S. Geetha

A total of 2618 persons were trained under various training programmes including CBT and NBT for the year 2021-22 against the target of 2010 (% of achievement 130). The trainees were from various backgrounds such as officers/officials from DOS, sericulture practicing farmers from different states, young entrepreneurs from sericulture practicing states, sericulture start up trainees, researchers, employment seekers on compassionate ground and students perceiving project (long term/short term) and internship as a part of masters' degree.

Table 18.1: Details of Capacity Building and Training (CBT) programmes conducted at CSRTI Mysuru and its nested units

#	Particulars	Target		Achievement	
		Physical (Nos.)	Beneficia-ries (No.)	Physical (Nos.)	Beneficia-ries (No.)
1	Structured Training Course*				
1.1	Intensive Bivoltine Training	2	40	1	10
1.2	Farmers Skill Training	55	1100	60	1237
1.3	MDP under STEP	2	30	2	30
1.4	Sericulture Resource Centres (SRCs)	25	500	23	508
1.5	Other Need Based Training	-	-	3	76
2	Non-CBT #	-	340	29	702
2.1	Training on Seed Act	-	-	16	55
	Total	84	2010	134	2618

Training programme funded by agencies other than CSB

During the year, the CSRTI, Mysuru had trained 116 officers/officials under CBT in six batches and 702 farmers/entrepreneurs/students which includes online training of 552 persons through webinars in 19 batches under Need Based Training (NBT) programme. Similarly 14 private entrepreneurs were trained for the establishment of Commercial Chawki Rearing Centre (CRC) and 41 CRC entrepreneurs under Refresher Training programme for the renewal of CRC licence (Table 18.2). The nested units - RSRSs/RECs of the CSRTI, Mysuru trained 1237 farmers under Farmers Training Programme (FST). The four Sericulture Resource Centres (SRC) operating in the states of Tamil Nadu and Karnataka trained 508 sericulture farmers on different sericulture technologies.

Table 18.2: Details of training programmes conducted at CSRTI Mysuru

#	Name of training	Area of training	No of days	No of batches	Date		Total no of trainees
					From	To	
1	CBT	Trainers Training - KVK Scientists	5	6	13.09.2021	17.09.2021	116
2		STEP	2		21.10.2021	22.10.2021	
3		STEP	2		16.11.2021	17.11.2021	
4		IBT-CBT	35		17.02.2022	23.03.2022	
5		FA refresher	3		02.03.2022	04.03.2022	
6		Scientist training	36		07.03.2022	08.03.2022	
7	NBT	Awareness programme for Farmers	10	15	26.10.2021	04.11.2021	135
8			5		15.11.2021	19.11.2021	
9			10		15.11.2021	24.11.2021	
10			5		22.11.2021	26.11.2021	
11			5		2.12.2021	06.12.2021	
12			10		10.12.2021	19.12.2021	
13			5		13.12.2021	17.12.2021	
14			10		16.12.2021	25.12.2021	
15			5		20.12.2021	24.12.2021	
16			5		20.12.2021	24.12.2021	
17			3		01.02.2022	03.02.2022	
18			3		02.02.2022	04.02.2022	

19			5		07.02.2022	11.02.2022	
20			10		08.03.2022	17.03.2022	
21			5		15.03.2022	19.03.2022	
22	NBT	ITBS	90	2	27.07.2021	23.10.2021	9
23					11.01.2022	11.04.2022	
24	NBT	IBT	35	2	15.11.2021	20.12.2021	6
25					14.01.2022	18.02.2022	
26	Online	Webinars on sericulture technologies			April 2021	July 2021	552
27	NBT	Refresher	7	13	05.04.2021	11.04.2021	41
28			3		19.07.2021	25.07.2021	
29			7		09.08.2021	15.08.2021	
30			7		30.08.2021	05.09.2021	
31			5		23.09.2021	29.09.2021	
32			7		16.10.2021	22.10.2021	
33			7		05.11.2021	11.11.2021	
34			7		15.11.2021	21.11.2021	
35			7		25.11.2021	01.12.2021	
36			7		16.12.2021	22.12.2021	
37			7		07.02.2022	13.02.2022	
38			7		26.02.2022	04.03.2022	
39			7		18.03.2022	24.03.2022	
40	NBT	CCRC	90	3	30.08.2021	27.11.2021	14
41			90		09.02.2022	08.05.2022	
42			90		27.01.2022	26.04.2022	
Total							873

Table 18.3: Unit wise details of Farmers Skill Training (FST) and SRC Training

#	Name of unit	Annual Target				Achievement			
		FST		SRC		FST		SRC	
		Physical (nos)	Benef. (nos)	Physical (nos)	Benef. (nos)	Physical (nos)	Benef. (nos)	Physical (nos)	Benef. (nos)
1	RSRS Salem	12	250	3	250	15	286	13	250
2	RSRS Kodathi	07	150	2	250	09	139	10	258
3	RSRS Ananthapur	13	300	-	-	10	200	-	-
4	RSRS Ch'nagar	02	40	-	-	03	77	-	-
5	RSRS Mulugu	06	150	-	-	06	226	-	-
7	REC Parbhani	02	30	-	-	03	75	-	-
8	REC Baramathi	02	30	-	-	04	70	-	-
9	REC Aurangabad	03	75	-	-	04	51	-	-
10	REC Amaravathi	02	30	-	-	04	63	-	-
11	REC Hoshangabad	01	15	-	-	02	50	-	-
Grand Total		50	1100	5	500	60	1237	23	508

Table 18.4: State wise details of CBT and NBT Trainings

#	State	CBT (Nos)	Non-CBT (Nos)
1	Tamil Nadu	550	110
2	Karnataka	547	515
3	Telangana	227	
4	Andhra pradesh	208	1
5	Maharashtra	276	9
6	Madhya Pradesh	51	0
7	Uttarapradesh	-	86
8	Haryana	-	35
8	Kerala	2	1
Total		1861	757

Trainers Training programme on convergence in Sericulture Extension for KVK Scientists and Subject Matter Specialists

As per the MoU entered between ICAR with CSB, the CSRTI, Mysuru had organised five days training on 'Convergence in Sericulture Extension Training with ICAR/KVKs'. The scientists and Subject-matter Specialists (16 nos) attended training from Karnataka, Tamil Nadu, Andhra Pradesh, Telangana and Maharashtra. The training was focused mainly on Soil Management and Mulberry Nursery Raising, Mulberry Plantation, Disinfection and Hygiene, Mulberry Silkworm Rearing both *chawki* and late instars, Mulberry and silkworm diseases and their management, Integrated farming, By-product Utilization, Waste Management and Entrepreneurship Opportunities in Sericulture.

Refresher Training on Technological Advancement for CSB Extension Unit field functionaries

To enrich and empower the knowledge of CSB extension unit field functionaries, the institute provided training on "Refresher training on Technological advancement in Sericulture and Extension Approaches" for three days from 2nd to 4th March 2022. A total of 24 Field Assistants/Technical Assistants/Senior Technical Assistants attended the training and enriched their knowledge in new technologies in Bivoltine Rearing and Extension Management.

Hands on training on Application of Statistical Tools for CSRTI, Scientists

Two days "Hands-on-Training on Application of Statistical Tools in Sericulture Research" was organised on 7-8th March 2022 to 35 scientists working at different laboratories. Two faculties from Central Office, Bangalore trained scientists in both conventional statistics tools and advanced statistical techniques and programmes *viz.,* big data analysis, machine learning, python, R programming, *etc*.

Dissertations Submitted

In addition to the regular training programmes the institute had also facilitated 96 students from different universities/colleges to do their project as a part of their Masters Degree under the guide ship of CSRTI-Mysuru Scientists at different laboratories.

Table 18.5: List of Dissertations submitted during 2021-22

#	Name of the student	Title	University/Institution to which submitted	Name of the guide/co-guide
1	Jhanavi Narayan	Molecular characterization of mapping population developed from mulberry root rot resistant and susceptible parents	Yuvaraja's College, Mysore	Arunakumar G. S.
2	K. Swetha	Isolation, identification and characterization of beneficial bacteria from soil and compatibility study with fungicides	Maharani's Science College for Women, Mysuru	
3	S. Arpitha	Characterization of bacterial biocontrol agents associated with mulberry rhizosphere	JSS Academy of Higher Education & Research, Mysuru	
4	N. Asha	Studies on fungal biocontrol agents for management of root rot disease in mulberry		
5	R. Anagha	A detailed study on mulberry stem discoloration		
6	R. Prajwal	Molecular fingerprinting of mulberry mapping population and assessment of genetic purity using microsatellite markers	National College, Tiruchirapalli	Gnanesh B. N.
7	I. Muralidhara	Standardization and screening of new set of SSR markers derived from *Morus alba*	Yuvaraja's College, Mysuru	
8	Eepsithamarathe			
9	E. V. Jayashre			
10	K. G. Harshith			
11	T. S. Jayarajshekara			
12	M. R. Aishwarya	Proteomic analysis of digestive tract in silkworm *Bombyx mori* during the *staphylococcus aureus* infection	Maharani's Science Collage for Women, Mysuru	Mallikarjuna G.
13	S. Anusha	Molecular characterization of silkworm *Bombyx mori* L. fat body after bacterial infection		
14	N. Gambhirya	Impact of Nuclear Polyhedrosis virus on malpighian tubules of silkworm *Bombyx mori* L."		
15	M. P. Hitha	Molecular characterization of silkworm *Bombyx mori* l. digestive tract after Nuclear Polyhedrosis Virus infection.		
16	R. Manasa	Molecular analysis of silkworm *Bombyx mori* silk glands after Nuclearpolyhedrosis Virus infection		
17	Sreeraksha Yogesh	Differential expression of fat body proteins in silk worm *Bombyx mori* with effect of Nuclear Polyhedrosis Virus infection.		
18	R. K. Spoorthi	Differential expression of proteins in fat body of silkworm, *Bombyx mori* by microsporidia infection.		

19	B. S. Vathsala	Molecular characterization of silk gland in silkworm, *Bombyx mori* by microsporidia infection.		
20	R. Malavika	Identification and Biochemical characterization of Bivoltine silkworm cocoon total protein shows antibacterial activity.		
21	Aishwarya	Identification and Biochemical characterisation of Multivoltin silkworm cocoon total protein shows antibacterial activity.		
22	N. Kavitha	Molecular characterization of silkworm intracellular pathogenic microsporidia.	University of Mysore, Manasagangothri, Mysore	
23	K. A. Brunda	Changes in the activity of digestive enzymes in response to Samrudhi (Juvenile hormone analogue) application in Silkworm *Bombyx mori*	Maharanis college, Mysuru	Bhuvaneswari E.
24	Indraja			
25	H. R. Chandana	Extraction and characterization of Chlorophyll and its associative bioactive compounds from the excrement of silkworm *Bombyx mori*		
26	U. G. Chaithra			
27	M. R. Kavyashree	Studies on the effect of *Mucuna pruriens* fortification and Sampoorna on the antioxidant activity of silkworm, *Bombyx mori*		
28	M. B. Varshini			
29	M. Chandana	Extraction and characterization of pectin from sericulture residues	JSS AHER, Mysuru	
30	K. M. Pooja	Studies on the effect of spirulina fortification on the digestive protease and carbohydrases of silkworm *Bombyx mori*		
31	R. Poojitha	Comparative analysis of few secondary metabolites in silkworm *Bombyx mori's* digestive content with response to feeding V1 and G4 mulberry leaves		
32	R. K. Prathiksha	Comparative study of few biochemical and economical traits of silkworm, *Bombyx mori* treated with spirulina		
33	K. Yashaswi	Anti-Oxidant Activity of Ascorbic acid and *Moringa Olifera* Supplementation in the 5th instar larvae of Silkworm *Bombxy mori*		
34	D. S. Inchara	Evaluation and Supplementation of Cobalamin Producing Probiotic Bacteria to Silkworm, *Bombyx mori*	Maharani's Science College, Mysuru	Y. Thirupathaiah
35	R. Jyothi	Microbial enumeration of silkworm, *Bombyx mori* spent pupae	Maharani's Science College, Mysuru	
36	B. V. Shreelakshmi	Biochemical characterization of *Cordyceps militari*	Maharani's Science College, Mysuru	

37	M. Ranjitha	Bioethanol production from mulberry shoot and silkworm excreata	Maharani's Science College, Mysuru	
38	A. R. Chaithanya	*Invivo* probiotic characteristics of bacteria isolated from silkworm, *Bombyx mori* midgut	Maharani's Science College, Mysuru	
39	P. Bindushree	Production of proteases by bacteria using Silkworm, *Bombyx mori* pupae powder	Maharani's Science College, Mysuru	
40	K. P. Pooja	Physio-biochemical evaluation of few mulberry genotypes for primary metabolites and physiological efficiency	Pooja Bhagavat Memorial Mahajana Education Centre, Mysuru	Gayathri T.
41	Sandhya Hegde	Comparative studies of five mulberry genotypes for micronutrients, vitamins and physiological parameters	Pooja Bhagavat Memorial Mahajana Education Centre, Mysuru	
42	Sheebu Samaran	Antagonistic endophytic bacteria and fungi from healthy mulberry leaf	JSS College of Arts, Commerce and Science, Mysuru	Satish L.
43	D. G. Rakshitha	Evaluation of Biological activities from the methanolic extracts of Morus alba leaves	JSS College of Arts, Commerce and Science, Mysuru	
44	N. Vidhyashree	Isolation and Characterization of Mulberry endophytic bacteria and fungi	Maharani's Science college for women, Mysuru	
45	V. Vani Reddy	Isolation and Identification of endophytes from mulberry with antagonistic activity	Maharani's Science college for women, Mysuru	
46	H. R.Raveendranath	Isolation and Identification of endophytes of mulberry and antagonistic study against foliar disease	Pooja Bhagavath Memorial Mahajana PG Center, Mysuru	Kusuma L.
47	S. Keerthana Varshini	Isolation and identification of endophytes of mulberry and antagonistic activity	Pooja Bhagavath Memorial Mahajana PG Center, Mysuru	
48	Spoorthi N. Raj	Biochemical studies in selected diploid and triploid mulberry genotypes	Maharani's Science College For Women, Mysuru	Tanmoy Sarkar
49	G.V. Sumitra	Biochemical studies in selected diploid and triploid mulberry genotypes	Maharani's Science College For Women, Mysuru	

50	S. Swathi	Isolation of protease producing bacteria from soil: extraction and characterization of protease	Maharani's Science College for Women, Mysuru	Ravindra
51	P. M. Sushma	Isolation of amylase producing bacteria from soil: Extraction and characterization of amylase	Maharani's Science College for Women, Mysuru	
52	P. Sneha	Green synthesis of silvernanoparticles by multivoltine cocoon and mulberry bark extract: its antifungal activity	JSS College of Arts & Science, Mysore	
53	M. S. Akshatha	Green synthesis of silvernanoparticles by bivoltine cocoon and mulberry stem extracts: its antifungal activity	JSS College of Arts & Science, Mysuru	
54	K. Sahana	Studies on removal of heavy metals from solution using mulberry and rice husk biomaterial	Maharani's Science College for Women, Mysuru	
55	L. V. Nithyashree	Studies on removal of heavy metals from solution using mulberry and rice husk biomaterial	Maharani's Science College, for Women, Mysuru	
56	M. Monika	Studies on removal of heavy metals from solution using mulberry and cocopeat biomaterial	Maharani's Science College for Women, Mysuru	
57	H. N. Kavya	Studies on removal of heavy metals from solution using mulberry and cocopeat biomaterial	Maharani's Science College, for Women, Mysuru	
58	B. V. Monica	Soil respiration, microbial biomass carbon and related enzyme activities in rhizosphere soils of mulberry	MS College for Women, Mysuru	Dhaneshwar Padhan
59	C. Sinchana	Soil respiration, microbial biomass sulphur and related enzyme activities in rhizosphere soils of mulberry	MS College for Women, Mysuru	
60	Jyoti Madar	Study on the biochemical properties of mulberry leaf (V1 & G4) under varied cultivation practices	PBMM PG Centre, Mysusru	
61	A. Architha	Study on the biochemical properties of mulberry leaf (AGB8 & MSG2) under varied cultivation practices	PBMM PG Centre, Mysusru	
62	K. N. Thejaswini	Dynamics of carbon in soils of different aged mulberry plantation	JSS Science & Technology University, Mysuru	
63	S. Chaithanya	Manganese fractions in soils of different aged mulberry plantation		
64	P. Swarna	Dynamics of potassium in soils of different aged mulberry plantation		
65	M. Meghana	Sulphur fractions in soils of different aged mulberry plantation		
66	S. K. Gagan Kumar	Zinc fractions in soils of different aged mulberry plantation		

67	S. D. Nithya	Study on obligatory and facultative feeding in few bivoltine silkworm breeds	Pooja Bhaghwat memorial Mahajans PG Centre, Mysuru	Ranjini M. S.
68	K. Gowtham	Comparative study on induced stresses in few bivoltine silkworm breeds		
69	M. N. Nishchitha	Synthesis and characterization of zinc nanoparticles from different plant sources/extracts and its antimicrobial activity	JSS College, Ooty Road, Mysuru	Madhusudhan K.N.
70	Pooja N. Babu			
71	M. Devika	Isolation and characterization of protease Producing bacteria.	M.Sc. (Biotechnology), JSS College, Ooty Road, Mysuru	
72	M. Lavanya			
73	J. A. Pooja	Isolation and charecterization of protease from Leguminous seeds and its evaluation for its Proteolytic activity	Pooja Bhagavat Memorial Mahajana Education Centre, Mysuru	
74	G. S. Ashvini	Chemical and biological method of extraction of chitin and chitosan from silk moth scales and their characterization		
75	S. Shalini	Microbial extraction of chitin/chitosan from spent pupae		
76	B. M. Naga Mouna	Synthesis and characterization of zinc nanoparticles from different bacteria and its antimicrobial activity		
77	Likitha Umesh Kanagal	Techniques of Molecular Biology (Internship Report)	Yuvaraja collge, Mysuru	
78	K. Trupti			
79	J. Vasudha Varma			
80	M. B. Yashaswini			

Commercial Chawki Rearing activity

During the year 47,950 dfls were chawki reared and distributed to 377 farmers and generated revenue of Rs. 4,79,500/- as the *Chawki* charges. Average cocoon yield of 74.52 kgs/100 dfls was recorded for the farmers.

Table 18.6: Brushing details of CRC

Month	No. of dfls	No. of farmers	Cocoon yield/100 dfls
Apr. 2021	5350	42	65.89
May	1450	10	70.12
Jun.	3600	27	62.27
Jul.	3550	26	78.87
Aug.	5200	43	72.49
Sep.	5500	34	68.34
Oct.	5050	44	73.58
Nov.	6150	50	74.39
Dec.	3700	31	76.82
Jan. 2022	2300	21	83.97
Feb.	3200	29	87.19
Mar.	2900	20	80.42
Total	47950	377	74.52

Feedback evaluation

Feedback evaluation was conducted for few Training programmes at the end through a questionnaire. The course-wise feedback of the same is shown below.

Table 18.7: Feed back analysis 2021-22

Course	Training Utility Index	Training Efficiency Index	Training Facilities Index	Course Coverage Index	Training Mngt. Index	Variance
STEP Batch-1	79.28	78.27	77.37	76.36	77.94	12.94
STEP Batch-2	81.79	78.27	73.05	88.95	82.61	17.61
IBT	92.10	93.37	82.92	89.20	90.56	25.56
NBT	82.14	82.90	75.78	74.29	78.78	13.78

The overall training Management Index for the training program (TMI) ranged from 77.94 to 90.56% against 65% required indicating 12.94 to 25.56% above the ISO standard. The trainees appreciated the knowledge level of faculty, study tour, co-ordination & co-operation and efforts of faculty and staff of Training Division.

Table 18.8: Revenue generated during the year 2021-22

Particulars	Amount (Rs.)
Sale of chawki worms	479500
Course Fee (trainees)	416500
Registration Fee (students)	690000
Sale of cocoons	35114
Hostel Rent	311250
Total	19,32,364

19. SERICULTURAL EXTENSION, ECONOMICS AND MANAGEMENT

N. G. Selvaraju, M. Muthulakshmi, Ravindra M. Mattigatti and Amit Saha

On-going Research Project

PPF 01017 SI: Economics of Mulberry Sericulture in South India (Nov. 2020-Oct. 2022)

Amit Saha (Upto 24.11.2021), Raveendra M. Mattigatti and M. Muthulakshmi

Objectives

- Scientific estimation of state-wise cost of mulberry cultivation and cocoon production in silkworm rearing and cost of cultivation of major crops
- Development and updating of optimum and financially feasible farm models for sericulture
- To study the resource use efficiency in sericulture

Data collected from 560 sericulture and non sericulture farmers from Karnataka, Maharashtra, Andhra Pradesh and Tamilnadu.

Table 19.1: Progress Achieved

State	Target	Achievement		Total
		Sericulture	Non Sericulture	
Karnataka	440	140	140	280
Tamilnadu	240	0	0	0
Andhrapradesh	200	60	60	120
Telangana	120	20	20	40
Madhya Pradesh	40	20	20	40
Maharashtra	200	40	40	80
Total	1240	280	280	560

Table 19.2: Progress Achieved in Clusters

State	Clusters	Achievement	
		Sericulture	Non Sericulture
Karnataka	Chitradurga, Bidar, Maddur, Koppal, Kolar, Bijapur, Haveri	140	140
Andhra Pradesh	Palamaneru, Ananthapur, Hindupur	60	60
Telangana	Siddipet	20	20
Madhya Pradesh	Hoshangabad	20	20
Maharashtra	Parbhani, Osmanabad	40	40
Total		280	280

Cluster Promotion Programme (CPP)

Central Silk Board in collaboration with the Departments of Sericulture (DoS) implemented the Cluster Promotion Programme under (CPP)-XII plan (2012-2017) in southern states, which was extended and continued in 2021-22. The CPP clusters in the southern zone were monitored by CSRTI-Mysuru. The southern zone includes 26 Mega clusters (Karnataka - 11, Andhra Pradesh - 5, Telangana - 2, Tamil Nadu - 6 and Maharashtra - 2 and five clusters under non-captive area).

The Director, CSRTI-Mysuru is the south zone Coordinator; the heads of SEEM and RSRSs are the Nodal Officers for effective implementation of CPP. Each Cluster is directly monitored by two Cluster Development Facilitators (CDFs), each nominated by Central Silk Board and State Department of Sericulture. Targets of the clusters for 2021-22 were fixed based on the farmers profile and potentiality. The name and designation of the CDFs are provided below:

Table 19.3: CDFs of Cluster Promotion Programme in the Captive area for 2021-22

Clusters	**CSB**	**DoS**
ANDRA PRADESH		
1. Atmakuru (MC)		
1. Atmakuru	P. Sudhakar, Sci-D, RSRS-Anantapur	K. Raju SO, DoS, Atmakuru
2. Pattikonda		K. Shoba Rani SO, DoS, Pattikonda
3. Giddaluru	A. Venugopal, Sci-D, REC-Rayachoti	A. Balasubramanyam SO, DoS, G'luru
2. Chebrole (MC)		
1. Bhimadole	T. V. S. Srinivasa Rao, Sci-D, REC-Eluru	K. Ranga Rao, ASO, TSC, Bhimadole
2. Chebrole		K. Appa Rao, SO, TSC, Chebrolu
3. Vijayawada		L. K. V. D. Prasada Rao, ASO, Challapalle

3. Hindupur (MC)		
1. Hindupur	P. Sudhakar, Sci-D, RSRS-Anantapur	M. Suresh, ADS, DoS, Hindupur
2. Madakasira		A. Ratnam, ADS, DoS Penukonda
4. Kalyandurg (MC)		
1. Kalyandurg	K. P. Kiran Kumar, Sci-D, RSRS-Anantapur	K. Nagesh, DSO, Anantapur
2. Penukonda		A. Ratnam, ADS, Penukonda
5. Palamaner (MC)		
1. Chittoor	M. Venkatachalapathy, Sci-D, REC-Palamaner	G.Babu, ADS, Gangasagaram
2. Palamaner		K. Kishore Naik, ADS, Palamaner
3. Venkatagiri Kota		H.Hanumantha Naik, ADS, Kuppam
KARNATAKA		
1. Bangalore rural (MC)		
1. Andarlahalli	S.B. Kulakarni, Sci-D, RSRS-Kodathi	Akmal pasha, ADS, Chikballapura
2. Channarayapatna		Bojanna, ADS, Beerasandra
3. Gowribidanur		Muralidhar, ADS, Gowribidanur
4. Harohalli (B)		Prabhakar, DD/ M. Ramakrishna Reddy, ADS, Hosakote
5. Tubugere		Udaya Kumar, ADS, Doddaballapura
2. Bidar (MC)		
1. Aurad	V. Nishita Naik, Sci-D, REC SU-Bidar	B. G. Shelke, Sericulture Inspector, Aurad
2. Gulbarga		S. Prakash Babu, ADS, Gulbarga
3. Humnabad		Jaganath Palapure, ADS, Humnabad
3. Chitradurga (MC)		
1. Challakere	Y. Srinivasulu, Sci-D, REC-Chitradurga	K. Kenchojirao, ADS, Challakere
2. HB hally		Bheemappa, ADS, Kudligi
3. Hiryur		C. D. Usha, ADS, Chitradurga
4. Kudiligi		Bheemappa, ADS, Kudligi
4. Haveri (MC)		
1. Davanagere	G. Papaiah, STA, REC-Chitradurga	A. Sreeharsha, ADS, Davanagere
2. Haveri		M. S. Patil, ADS, Haveri
3. Rannebennur		Pujar, SEO, Ranebennur
5. Jamakhandi (MC)		
1. Bijapur	A. P. Raghavendra, FA, REC-Koppal	B.Y. Biradar, ADS, DoS, Bijapur
2. Jamakhandi		S.M. Dheshpande, ADS, Jamakhandi
3. Belagavi	A. Umesha, Sci-C, REC-Koppal	G. B. Mallannavara, ADS, Belagavi
6. Kolar (MC)		
1. Ithandahalli	J.B. Narendra Kumar, Sci-D, REC-Madivala	Dinesh, ADS, Bangarpet
2. Kurudumalai		M. Venketesh, ADS, Mulabagal
3. Shapur (Kolar)		Anjaneya gowda, DDS, Kolar
4. Sidlaghatta		Byrappa, DDS, Chikballapura/ H. Ramakrishnappa, ADS, Sidlaghatta
5. Tekal		Ravichandra, ADS, Malur
6. Yeldur		Krishnappa, ADS, Srinivasapura
7. Koppal (MC)		
1. Yelburga	A. Umesha, Sci-C, REC-Koppal	C. Anjanamurthy, DDS, Kushtagi
2. Shirahatti		C. H. Mudagal, ADS, Gadag
3. Lingasugur	J. Justin Kumar, STA, REC-Koppal	S. Rajendra Kumar, ADS, Lingasugur
8. Maddur (MC)		
1. Bevuru	D. Guruswamy, Sci-D, REC SU-Maddur	G. Manjunath, ADS, Channapattana
2. Bidarakote		Madesh, SEO, TSC, Koppal
3. D Halasahalli		Surendra Murthy, SEO, TSC, D Halasahalli
4. Gajanuru		M. P. Umesh, ADS, Malavally

5. Toresettahalli		Madesh, SEO, I/c, TSC, Toresettahalli
9. Mysuru (MC)		
1. B R Koppalu	K. N. Madhusudhan, Sci-D, CSRTI-Mysuru	S. Siddaraju, ADS (in charge), K R Nagar
2. H D Kote		N. Mahesh Kumar Vage, ADS, S R Patna
3. K R Nagar		C. R. Krishna, ADS, T Narasipura
4. T Narsipura		C. Umesh, SEO, H D Kote
10. Ramanagara (MC)		
1. Banniguppe	P. Saraswathi, Sci-D, RSRS, Kodathi	Kumarasubramanya, ADS, Ramanagara
2. Kanakapura		Muthuraj, ADS, DOS, Kanakapura
3. Harohalli (KKP)		
4. Doddalahalli		
11. Tumakur (MC)		
1. Tumakur	H. K. Hanumantharayappa, Sci-D, RSRS-Kodathi	Narsimha swamy, ADS, Tumkur
2. Sira		Rajgopal, ADS, Sira
3. Y.N. Hosakote		Nagaraj, ADS, Pavagada
MAHARASHTRA		
1. Aurangabad (MC)		
1. Beed	Ramprakash Sci-D, REC-Aurangabad	Vinit Pawar, SDO, Beed
2. Jalna		Ajay P. Mohite, SDO, Jalna
2. Satara (MC)		
1. Satara	Y. Humayun Sharief, Sci-D, REC-Baramati	Bapurao Kulkarni, SDO Sangli/ Rajesh Kamble, SDO, Wai
TAMIL NADU		
1. Alangeyam (MC)		
1. Alangeyam	S.Kamaraj, Sci-C, RSRS-Salem	A. Meenakshi Sundari, AIS, Alangeyam
2. Dindigul (MC)		
1. Keeranur	A. Mahima Santhi, Sci-D. REC-S'nallur	S. Vinu Kumar, AIS, TSC-Palani
2. Palani		
3. Oddanchatiram		R. Jayapraba, AIS, TSC-Oddanchatiram
4. Sanarpatty		A. Sivamani, AIS, TSC-Sanarpatty
3. Gobichettipalayam (MC)		
1. Gobi	E. Rajalakshmi, Sci-D, REC-G'palayam	M. Sangavi, IS, TSC-North Gobi
2. Pitchandampalayam		Sivananjappa, AIS, TSC-South Gobi
3. Bhavani		Usha, JIS, TSC-Bhavani
4. Anthiyur		Sathya, AIS, TSC-Bhavani
5. Annur		Chandran, AIS, TSC-Annur
6. Dharapuram		S. Muneeswaran, AIS, TSC-Dharapuram
7. Manurpalayam		Mythili, AIS, TSC-Dharapuram
4. Krishnagiri (MC)		
1. Bagalur	K. Jhansilakshmi, Sci-D, REC-Krishnagairi	S. Hemanandini, AIS, TSC, Bagalur
2. Kodiyalam		
3. Berigai		
4. Krishnagiri		R. Ashok, TA, ADS, Krishnagiri
5. Dharmapuri		R. Elangovan, AIS, Dharmapuri
5. Tenkasi (MC)		
1. Srivilliputtur	A. Mahima Santhi, Sci-D. REC-S'nallur	V. Jeyalakashmi, AIS, TSC-Srivilliputtur
2. Adaikalapattinam		Palavesammal, AIS,TSC-Adai'alapattinam
6. Udumalpet (MC)		
1. Udumalpet	P. Samuthiravelu, Sci-D, REC-Udumalpet	S. Sundar, AIS, TSC-Udumalpet
2. Gudimangalam		P. Geethapriya, AIS, TSC-Gudimangalam
3. Pollachi		R. Shobana, AIS, TSC-Pollachi
4. Pongalur		R.Ramesh, AIS, TSC-Pongalur

TELANGANA		
1. Karimnagar (MC)		
1. Karimnagar	D. V. K. Yadav, Sci-C, RSRS-Mulugu G. Chalapathi, STA, RSRS-Mulugu K. Praveen Kumar, Sci-D, RSRS-Mulugu	Muralidhar Reddy, DDS-Warangal Yethinder, ADS Anasuya, DDS-Khammam
2. Siddipet (MC)		
1. Siddipet	K. Praveen Kumar, Sci-D, RSRS-Mulugu	Indrasena Reddy, ADS-Siddipet Venkateswarlu, SO-Janagoan. K. Laxmaiah, ADS-Nalgonda Veera Kumar, ADS-Suryapet

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Table 19.4: Particulars of CPP CDFs of NonCaptive Clusters for the year 2021-22

Clusters	CSB	DoS
	MADHYA PRADESH	
1. Hosahangabad	A. G. K. Daniel, Scit-D, REC-Hoshangabad	Lal Singh Narganwa, Field Officer
		Navneet Gour, Jr Seri. Insp., H'gabad
		Jagdish Vishwakarma, FO, Hoshangabad
	MAHARSAHTRA	
2. Akola	R.V. Kushwaha, Sci-D, REC-Amravati	P.B. Narwade, SDO, Akola
3. Buldana		Narsingh B. Bowge, SDO, Buldana
4. Wardha		Ajay V. Wasnik, SDO, Wardha
5. Nanded	A .J. Karande, Sci-D, REC-Parbhani	A.V.Wakure,SDO, Nanded
6. Osmanabad	Ashok Jadhav Limabaji, Scientist D	Unit closed in May 2021
	TELANGANA	
7. Zaheerabad	S. Rajadurai, Sci-D, REC-Vikarabad	Indrasena reddy, SO, Zaheerabad

Performance of Clusters

During the period, south zone clusters produced 5832.82 MT of bivoltine raw silk against the target of 5777.54 MT.

Table 19.5: Raw Silk Production in south zone clusters (2013 to 2022)

Year	Target (MT)	Production (MT)	Achv. (%)
2013-14	1400.00	1420.90	101.49
2014-15	1944.00	2241.15	115.29
2015-16	2491.50	2772.09	111.26
2016-17	3100.00	3786.27	122.14
2017-18	3800.00	3905.35	102.77
2018-19	4560.00	4781.21	104.85
2019-20	5300.29	5054.50	95.36
2020-21	5819.94	5006.60	86.02
2021-22	5777.54	5832.82	100.96
Total	28415.73	28968.07	101.94

Table 19.6: State wise bivoltine raw silk production for 2021-22

State	Raw Silk		
	Target (MT)	Achievement (MT)	Achievement (%)
1. Andhra Pradesh	1507.69	1590.84	105.52
2. Karnataka	2161.00	1941.64	89.85
3. Maharashtra	233.50	369.92	158.42
4. Tamil Nadu	1607.31	1628.21	101.30
5. Telangana	142.15	159.89	112.48
6. Non-captive	125.88	142.31	113.05
Total/Avg.	5777.54	5832.82	100.96

Crop Performance

A total of 495.04 lakhs dfls were distributed to the farmers against the target of 547.93 lakhs with an achievement of 90.35%. A total of 37656.50 MT bivoltine cocoons were produced with an average cocoon yield of 77.30kg/100 dfls.

Table 19.7: State wise dfls distribution: target vs. achievement

State	Dfls target (lakh)	No. of crops	Dfls brushed (lakh)	Achievement (%)
1. Andhra Pradesh	140.00	54387	134.81	96.29
2. Karnataka	216.10	103346	175.70	81.31
3. Maharashtra	23.35	11487	28.97	124.05
4. Tamil Nadu	139.30	68341	129.23	92.77
5. Telangana	13.20	4778	13.00	98.45
6. Non-captive	15.98	6318	13.34	83.47
Total/Avg.	547.93	248657	495.04	90.35

Table 19.8: Average cocoon yield/100 dfls (kg) in captive and Non-Captive (N-C) clusters

#	State	XI Plan	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22
1	AP	61.56	66.69	66.68	69.93	70.68	73.47	76.38	75.46	74.76	76.70
2	KA	62.73	65.83	65.23	66.74	67.49	67.62	66.05	66.37	68.68	71.83
3	KL	-	76.45	75.88	75.69	81.68	84.05	86.13	-	-	-
4	MP	-	52.93	53.93	47.66	49.12	51.68	46.08	-	-	-
5	MH	60.73	63.26	63.49	62.51	65.47	66.07	66.45	71.08	78.44	83.01
6	TN	71.13	74.46	75.54	77.86	78.33	80.32	79.59	79.78	80.94	81.89
7	TS	-	-	65.08	66.11	70.62	70.89	68.08	67.35	71.65	79.97
8	N-C	-	-	-	-	-	-	-	68.79	66.32	70.42
Average		64.98	68.45	68.27	70.16	71.33	72.15	71.79	72.62	73.83	77.30

Table 19.9: Performance of Mega clusters in Andhra Pradesh for the year 2021-22

Mega cluster	Dfls target (lakhs)	Dfls distri-buted	Dfls. Achv. (%)	Cocoon yield (kg)	Yield/ 100 dfls (kg)	Rate/kg (Rs)	New plantation	
							No. of Farmers	Area (acres)
1. Atmakur	15.60	1398750	91.16	1029342.67	70.44	423.83	224	335.00
2. Chebrolu	13.90	930555	60.14	711916.00	80.05	383.17	166	336.25
3. Hindupur	37.10	3922590	105.73	2884044.17	74.44	473.38	1441	1803.00
4. K'durgam	18.70	1923900	102.88	1534874.27	75.14	460.54	352	587.00
5. Palamaner	54.70	5305152	96.99	4128302.00	80.33	492.77	2005	2965.85
Total/Avg.	140.00	13480947	96.29	10288479.11	76.70	446.74	4188	6027.10

Table 19.10: Performance of Mega clusters in Karnataka for the year 2021-22

Mega cluster	Dfls target (lakhs)	Dfls distri-buted	Dfls. Achv. (%)	Cocoon yield (kg)	Yield/ 100 dfls (kg)	Rate/kg (Rs)	New plantation	
							No. of Farmers	Area (acres)
1. B'lore Rural	12.00	803208	66.54	562319	71.56	517.32	220	272.16
2. Bidar	10.00	595265	59.53	416844	70.90	432.36	237	363.29
3. Ch'durga	35.05	2935230	86.57	2208347	74.58	458.92	782	1383.15
4. Haveri	25.70	2011849	78.28	1500262	76.00	427.39	424	600.90
5. Jamkandi	19.60	1299877	66.32	966704	74.13	489.75	609	865.25
6. Kolar	29.40	2169115	78.40	1270721	65.36	488.34	1062	694.64
7. Koppal	13.25	1046525	78.98	745723	72.59	481.83	368	598.87
8. Maddur	13.35	1504597	112.70	1134453	73.17	495.95	314	346.92
9. Mysuru	18.10	1529652	84.51	1026855	67.29	482.67	95	152.50
10. Ra'nagara	13.05	1607296	122.25	1282835	77.66	483.68	1598	1605.09
11. Tumkur	26.60	2067739	78.57	1425142	67.79	467.47	356	488.00
Total/Avg.	216.10	17570353	81.31	12540205	71.83	475.06	6065	7370.77

Table 19.11: Performance of Mega clusters in Maharashtra for the year 2021-22

Mega cluster	Dfls target (lakhs)	Dfls distri-buted	Dfls. Achv. (%)	Cocoon yield (kg)	Yield/ 100 dfls (kg)	Rate/kg (Rs)	New plantation	
							No. of Farmers	Area (acres)
1. Aurangabad	17.35	2262700	130.41	1718372.00	84.31	520.64	246	246.00
2. Satara	6.00	633820	105.64	497670.55	78.83	450.33	199	209.00
Total/Avg.	23.35	2896520	124.05	2216042.55	83.01	485.48	445	455.00

Table 19.12: Performance of Mega clusters in Tamil Nadu for the year 2021-22

Mega cluster	Dfls target (lakhs)	Dfls distri-buted	Dfls. Achv. (%)	Cocoon yield (kg)	Yield/ 100 dfls (kg)	Rate/kg (Rs)	New plantation	
							No. of Farmers	Area (acres)
1. Alangayam	10.60	1069605	100.91	840307.00	78.18	488.33	209	353.0
2. Dindigul	22.30	2371025	106.32	2011912.00	83.19	487.33	353	777.0
3. Gobi	32.80	3041977	94.98	2507035.00	82.73	496.83	158	313.3
4. Krishnagiri	30.25	2716198	93.76	2234531.50	82.26	481.00	439	780.0
5. Tenkasi	10.35	1028110	99.33	864751.00	81.13	472.25	170	342.5
6. Udumalpet	33.00	2696170	81.70	2211613.00	81.06	488.25	162	259.0
Total/Avg.	139.30	12923085	92.77	10670149.50	81.89	485.67	1491	2824.8

Table 19.13: Performance of Mega clusters in Telangana for the year 2021-22

Mega cluster	Dfls target (lakhs)	Dfls distri-buted	Dfls. Achv. (%)	Cocoon yield (kg)	Yield/ 100 dfls (kg)	Rate/kg (Rs)	New plantation	
							No. of Farmers	Area (acres)
Karimnagar	6.60	646,650	97.98	537562.00	79.65	464.50	77	189.00
Siddipet	6.60	652925	98.93	543130.00	80.29	474.96	169	407.00
Total/Avg.	13.20	1299575	98.45	1080692.00	79.97	469.73	246	596.00

Table 19.14: Performance of Non-captive clusters for the year 2021-22

Cluster	Dfls target (lakhs)	Dfls distri-buted	Dfls. Achv. (%)	Cocoon yield (kg)	Yield/ 100 dfls (kg)	Rate/kg (Rs)	New plantation	
							No. of Farmers	Area (acres)
Hoshangabad[1]	3.70	262000	70.81	96966.00	51.58	272.50	0	0.00
Akola, Buldana, Wardha[2]	5.00	444820	88.96	287060.50	73.88	437.68	324	330.00
Nanded[2]	3.00	182600	60.9	111954.00	69.75	511.78	224	225.00
Osmanabad[2]*	0.27	27750	100.00	54853.62	61.46	309.00	0	0.00
Zaheerabad[3]	4.00	416500	104.13	310080.00	78.27	488.92	86	161.00
Total	15.97	1333670	83.47	860914.12	70.42	294.50	634	716.00

[1]Madhya Pradesh; [2]Maharashtra; [3]Telangana; *unit closed during May 2021

New Plantation in clusters

More emphasis was given on horizontal expansion and 13,069 farmers were motivated to plant improved varieties to an extent of 17,989.62 acres in the mega and non-captive clusters.

Table 19.15: New plantation details in Clusters and non-captive area for the year 2021-22

State	New plantation	
	No. of farmers	Area (acres)
Andhra Pradesh	4188	6027.10
Karnataka	6065	7370.77
Maharashtra	445	455.00
Tamil Nadu	1491	2824.75
Telangana	246	596.00
Non-captive	634	716.00
Total	13069	17989.62

m-K*isan* portal

A total of 56 SMS messages, covering 76,200 farmers over different states *viz*., Karnataka, Andhra Pradesh, Telangana, Tamil Nadu, Maharashtra, Madhya Pradesh and other states were sent during the year through m-Kisan portal.

Continuous/Other Activities

Extension Communication programmes (ECP)

During 2021-22 a total of 280 Extension Communication Programmes were conducted and sensitized 18,064 farmers. The main topics of ECPs covered are: Mites and thrips management, wider spacing/tree mulberry; leaf roller and its control measures; awareness on use of rot fix; soil testing & its importance in mulberry cultivation; INM practices for mulberry; IPM; integrated disease management practices;

disinfection & hygiene in silkworm rearing; popularization of new silkworm hybrids; demonstration of rotary mountages; mounting & spinning care, *etc*.

Table 19.16: Extension Communication Programmes conducted

ECP	Events	Farmers Sensitized
Reshme Krishi Mela cum Exhibition	4	2023
Farmers Field day	42	3434
Awareness programme	113	8757
Technology demonstration / Enlightenment programmes	120	3219
Workshop / Seminars & Conferences	1	196
Other activities	8	435
Total	288	18064

Reshm Krishimela

Reshm Krishimela cum farmers' workshops in coordination with Department of Sericulture covering 2023 farmers was conducted during 2021-22.

Table 19.17: Details of Reshme Krishi Melas conducted

Name of the centre	Venue	Date
CSRTI-Mysuru	CSRTI Mysuru	19.03.2022
RSRS Ananthapur	Penukonda	18.02.2022
RSRS Mulugu	Kondannaguda	11.03.2022
RSRS Salem	Theni	04.01.2022

Organization of virtual workshop

A Virtual Workshop was organized on 5th October, 2021 on Mites and Thrips Management under the chairmanship of Dr. N. K. Krishna Kumar, DDG (Retd.), Horticulture. The scientific personnel of various institutions /departments / Universities, DOS and representatives from farmers participated.

Seed Act Awareness Programme

An Awareness programme on Seed Act Regulations was organized by Regional Sericultural Research Station, Salem in association with National Silkworm Seed Organization, Bengaluru at Salem on 07.12.2021 to enlighten the mulberry sector stake-holders *viz*., Registered Chawkie Rearers (RCRs), Registered Seed cocoon producers (RSCPs) and Registered seed Producers (RSPs) of Tamil Nadu on the importance of Seed Act Regulations. Totally 100 members including 17 RCRs, 52 RSCPs, 3 RSPs besides 28 CSB and DOS officers/officials participated in the programme.

Technical workshop for Registered Chawki Rearers and Farmers

A Technical Workshop on New Technologies in Bivoltine Sericulture for Registered Chawki Rearers RCRs and Farmers was organized by REC Udumalpet in association with National Silkworm Seed Organization; Bengaluru at Pongalur on 07.03.2022 in which 81 farmers, 6 RCRs, 18 CSB and DOS officials participated

Publication of Sericulture Success Stories

A compilation depicting flourishing sericulturists titled "Sericulture Success stories" volume-III was released during Krishimela conducted at CSRTI, Mysuru on 19.03.2022. The book is the collection of 69 (AP-15, KA-28, MP-3, MH-11 and TN-12) progressive farmers narrating their saga of sericulture life and appreciation on taking it as their way of life for sustainable livelihood.

Visitors' Service

A total of 1032 Sericulture related personnel have visited the Institute during 2021-2022. Visitors include Farmers, Students, Entrepreneurs, Departmental staff. Need based services were rendered to Sericulture farmers visiting the Institute. Agriculture farmers were sensitized in all the activities of Sericulture. Students of varied disciplines viz., Agriculture, Life sciences, Textiles, Horticulture, Biotechnology etc., were explained about the activities of Institute. They were also explained with various Entrepreneurship opportunities in Sericulture. Women farmers were encouraged to take up Sericulture for their livelihood by highlighting the importance of Skill in Sericulture activities.

Category	No. of Persons
Farmers	320
Students	669
Others	43
Total	1032

20. REGIONAL SERICULTURAL RESEARCH STATION (RSRS) - ANANTAPUR

In-Charge officer	P. Sudhakar
Scientists	05
Technical staff	11
Administrative & Supporting staff	05

Units	Total area (acres)	Mulberry acreage
RSRS-Anantapur	40.73	3.52
REC-Rayachoti	5.00	2.50
RECSU-Bidar (KA)	11.33	4.50
REC-Vikarabad (TS)	5.50	2.50

Collaborative Research Projects/Programmes

RSRS Ananthapur and its nested units are involved in the following collaborative projects with the main institute.

Project/Programme	Unit
PIB 3632: Evaluation of superior triploid genotypes for yield and adaptability under varied agro-climatic conditions (Apr. 2018-Feb. 2024)	RSRS Ananathpur
PIE 13001 MI (AICEM Phase-IV): All India Coordinated Experimental Trial in Mulberry Phase-IV (Apr.-Mar. 2025)	RSRS Ananathpur & REC Rayachoti

Continuous /other activities

Cluster Promotion Programme (CPP)

Bivoltine sericulture technologies were disseminated in 13 clusters in Andhra Pradesh State. 134.81 lakhs dfls of bivoltine hybrids were reared with an achievement of 96.29% against the target of 140.00 lakhs dfls and recorded the cocoon yield of 74.01 kg/100 dfls. The raw silk production achievement was 1582.84 MT against the target of 1507.69 MT with achievement percent of 104.98%.

Development of new mulberry plantation at Clusters

Unit	Acres	Farmers
Pathikonda	76	48
Bhimadole	55	30
Chebrolu	155	85
Vijayawada	126	51
Hindupur	763	577
Madakasira	1040	864

Extension communication programmes (ECPs)

Workshops, Group discussions, Awareness Programmes, Field Days, Farmers Days and Exposure visits were conducted by RSRS, Anantapur and its nested units for transfer of technologies developed by main institute and are fine tuned.

Table 20.1: Extension communication programmes conducted by RSRS Ananthapur and nested units

Centre	Technology Demonstrtion		Awareness Programmes		Field Day		Resham Krishi Mela	
	Prog (No)	Far (No)	Prog (No)	Far (No)	Prog (No)	Far (No)	Prog (No)	Farmers (No)
RSRS-Anantapur	6	156	8	693	6	619	1	503
REC-V.Kota	4	102	7	608	-	-	-	-
REC-Eluru	4	80	2	164	-	-	-	-
REC-Rayachoty	4	107	4	236	-	-	-	-
REC-SU Bidar	4	157	4	296	-	-	-	-
Total	22	602	25	2012	6	619	1	503

Resham Krishimela/Farmers' workshop

Resham Krishimela was conducted at Palamaneru on 18.02.2022. 503 participants including farmers, DOS staff, CSB officials, Sri Mallarapu Naveen, Sub- Collector, Penukonda, Smt. C. Aruna Kumari, Additional Director of Sericulture, Govt. of AP, Dr. S. Purusotham, Scientist-D, Dr. N.G. Salvaraju, Scientist-D, CSRTI, Mysore and Smt. C. Padmamma, Joint Director of Sericulture, Anantapur participated in the workshop.

Table 20.2: Training Programmes under Capacity Building and Training [Farmers Skill Training (FST)]

Unit	No. of programmes	No. of benificiaries
RSRS-Anantapur	6	150
REC-V.Kota	1	20
REC-Eluru	-	-
REC-Rayachoty	1	20
REC SU-Bidar (KA)	1	10
Total	9	200

AIB 01009 MI: Evaluation of new Bivoltine Silkworm hybrid TT21 X TT56 at farmers level for authorization and commercial exploitation

K.P. Kiran Kumar

Table 20.3: OFT details of RSRS, Anantapur

Hybrid	DFLs	Yield/100 dfls	Rate/1Kg
TT21 x TT56	4000	70.25	725

Radio/ TV programmes

RSRS Ananthpur participated in 04 radio programmes for the benefit of sericulturists as part of technology dissemination.

Revenue generation

Unit	Amount (Rs.)
RSRS-Anantapur	60,675
REC-Rayachoti	

21. REGIONAL SERICULTURAL RESEARCH STATION (RSRS) CHAMARAJANAGARA

In-Charge officer	T. Sivasubramonian
Scientists	02
Technical staff	03
Administrative/Supporting staff	01

Units	Total area (acres)	Mulberry acreage
RSRS- Chamarajanagara	14.02	7.80

Transfer of Technology

Under the ToT programme 3 rearings were conducted with differernt improved breeds and 2 seed crop rearings of S8 and MV1.

Table 21.1: Rearing performance of new hybrids

Season	Race	Dfls	Yield/ 100 dfls (kg)	ERR		SCW (g)	SSW (g)	DR%
				By.No	By. wt (kg)			
Apr. '21	MV1 x S8	15	96.66	9657	18.025	1.865	0.391	20.96
	ICB29 x S8	10	80.00	8385	15.120	1.800	0.376	20.88
	ICB29 x CSR2	10	75.00	9025	14.410	1.596	0.321	20.17
	PM x CSR2	15	83.00	9675	15.720	1.626	0.329	20.23
	Total/Avg.	50	84.12					
Dec. '21	MAS1 x S8	10	60.00	8646	13..10	1.50	0.285	19.00

	MAS5 x S8	10	71.00	9056	14.48	1.60	0.295	18.43
	MAS5 x BM2E	10	75.00	9955	15.53	1.56	0.290	18.58
	MAS1 x BM2E	10	65.00	8448	13.78	1.63	0.340	20.85
	MAS1 x CSR2	10	59.00	8427	12.73	1.51	0.290	19.20
	MAS5 x CSR2	5	64.00	8495	13.08	1.54	0.310	20.12
	PM x CSR2	5	30.00	4095	6.34	1.55	0.285	18.38
	MV1 x S8	10	39.80	4742	7.20	1.52	0.290	19.07
	Total/Avg.	70	59.54					
Feb. '22	MAS1 x CSR2	9	54.44	8002	10.57	1.32	0.23	17.42
	MAS1 x S8	9	58.8	9183	11.39	1.24	0.21	16.93
	MAS1 x BMV1	9	61.11	9175	11.65	1.27	0.21	16.53
	MAS3 x CSR2	9	56.66	9571	12.54	1.31	0.23	17.55
	MAS3 x BMV1	9	46.66	8017	1067	1.33	0.23	17.29
	MAS3 x BM2	9	61.11	9620	12.70	1.32	0.24	18.10
	MV1 x S8	9	46.66	8062	10.24	1.27	0.23	18.11
	PM x CSR2	9	50.00	8193	10.33	1.26	0.20	15.87
	Total/Avg.	72	54.44					

Table 21.2: Rearing performance of S8 and MV1 seed crop

Season	Race	Dfls	Yield (kg)	Yield/ 100 dfls (kg)	ERR		SCW (g)	SSW (g)	SR%
					By.No	By. wt (kg)			
Jun-21	S8	30	85.20	25.56	9144	14.99	1.64	0.330	20.24
	MV1	30	55.00	16.55	7836	11.13	1.42	0.270	19.01
Oct-21	S8	25	61.2	15.3	6847	11.22	1.64	0.34	20.73
	MV1	35	58.6	20.5	8606	12.65	1.47	0.28	19.04

Extension Communication Programme

Two Enlightenment Programmes, 6 Farmers Field Day and 2 Awareness Programmes covering 561 farmers were conducted by RSRS, Chamarajanagar.

Farmers Skill training programme

77 farmers were trained under Farmers Skill Training Programme in three batches.

Farm rearing

312 dfls were reared in the farm in five rearings and recorded an average yield of 64.48 kg/100 dfls.

Revenue generation

Particulars	Amount (Rs)
Mulberry seed cuttings	675.00
Sale of Cocoon	25484.00
Total	26159.00

22. REGIONAL SERICULTURAL RESEARCH STATION (RSRS) – KODATHI

In-Charge officer	S.B. Kulkarni, Scientist-D
Scientists	03
Technical staff	04
Administrative/Supporting staff	01

Units	Total area (aces)	Mulberry acreage
RSRS-Kodathi	66.90	5.00
REC-Chitradurga	7.00	2.41
REC-Madivala	8.00	3.50
REC-Koppal	8.00	1.50

Collaborative Research Projects/Programmes

Project/Programme	Unit
PIB 3632: Evaluation of superior triploid genotypes for yield and adaptability under varied agro-climatic conditions (Apr. 2018-Feb. 2024)	RSRS-Kodathi
PIE 13001 MI (AICEM Phase-IV): All India Coordinated Experimental Trial in Mulberry Phase-IV (Apr. 2019-Mar. 2025)	RSRS-Kodathi & REC-Madivala
AIE 06002MI : Evaluation of selected bivoltine – for tolerance to high temperature and low humidity Collobarative project with CGSRC, Hosur	REC-Chitrdurga

On -Farm Trials (OFTs)

Table 22.1: Popularization of new hybrids

Centre	Hybrid	No. of Dfls	No. of farmers	Yield/ 100 dfls (kg)	Rate/kg (Rs)	Total yield (kg)
REC Chitradurga	TT21 x TT56	27000	108	68.20	-	18410
REC Madivala	G11 x G19	7500	14	75.99	408.00	1687
	MV1 x S8	10500	42	73.90	548.31	7609
	Total/Avg.	45000	164	71.57	478.15	27706

Cluster Promotion Programme

Bivoltine sericulture technologies were disseminated in 11mega clusters across Karnataka. A total of 175.7 lakh dfls were distributed in mega clusters and harvested an average cocoon yield of 71.83 kg / 100 dfls.

Extension communication programmes

A total of 29 technology demonstrations, 05 Field Days and 13 Awareness programmmes were conducted in all clusters covering 3019 farmers. 09 success stories were published.

Capacity Building Farmers Training Programme [FST]

Table 22.2: Capacity Building Farmers Training Programme [FST]

Centre	Benificiaries
RSRS-Kodathi	58
REC-Chitradurga	45
REC-Koppal	39
REC-Madivala	393*
Total	535

* in coordination with KVK & DoS, Kolar

Farmers Training at SRCs

During the year 2021-22, RSRS and its nested units carried out trainings at two Sericulture Resource centers. At B.G Kere & B.S. Doddi, 258 farmers were trained in five batch and under FST 142 farmers were trained.

Revenue generation

Table 22.3: Revenue generation (in Rs.) at RSRS Kodathi

Name of the items	RSRS Kodathi	REC Chitradurga	REC Madivala	REC, Koppal	Total
Sale of Mulberry leaf	13442	-	17840	-	31282
Sale of Saplings cutting	2273	-	-	-	2273
Sale of cocoons	1665	25854	-	-	27519
Sale of Earth worms	800	-	-	-	800
Chawki worms/others	-	-	-	27000	27000
Others	-	-	3540	-	-
Total	18180	25854	21380	27000	88874

Other activities

In the 30 acres of RSRS, different species of forest trees were maintained.

23. REGIONAL SERICULTURAL RESEARCH STATION (RSRS), MULUGU

In-Charge officer	Praveen Kumar K, Scientist-D
Scientists	03
Technical staff	04
Administrative/Supporting staff	04

Units	Total area (acres)	Mulberry acreage
RSRS-Mulugu	-	-
REC-Vikarabad	5.31	2.50

Collaborative Projects

Project/Programme	Unit
PRP 01015 SI: Identification, evaluation and inclusion of potential antagonistic microbes in Integrated Root Rot Disease Management in Mulberry	RSRS-Mulugu
AIB 01009 MI: Evaluation of new bivoltine silkworm hybrid TT21 X TT56 at farmers level for authorization and commercial exploitation	RSRS-Mulugu
PIE 13001 MI (AICEM Phase-IV): All India Coordinated Experimental Trial in Mulberry Phase-IV	REC-Vikarabad

Capacity building Programme

Trained 226 beneficiaries in 7 batches with an expenditure of Rs. 7, 28,715.00

Extension Communication Programmes

Programme	No. of Programmes	No. of farmers	No. of Programmes	No. of farmers
	RSRS-Mulugu		REC-Vikarabad	
Farmers Field Day	6	561	-	-
Awareness Programmes	2	145	4	394
Tech. Demon./Enlightenment	2	46	4	149
Resham Krishimela	1	728	-	-
Total	11	1480	8	543

Cluster Promotion Programme

Maintained two mega clusters and one non-captive cluster in Telengana and bivoltine sericulture technologies were disseminated to the farmers. A total of 15.58 lakh dfls were distributed and recorded an average cocoon yield of 77.6 kg/100 dfls

Revenue generation

Particulars	Amount(Rs)		Total (Rs.)
	RSRS-Mulugu	REC-Vikarabad	
Mulberry seed cuttings	238.00	-	238.00
Sale of Cocoon	-	69790.00	69790.00
Others	-	5500.00	5500.00
Total	238.00	75290.00	75528.00

24. REGIONAL SERICULTURAL RESEARCH STATION (RSRS) - SALEM

In-Charge officer	N. Dhahira Beevi
Scientists	07
Technical staff	09
Administrative & supporting staff	-

Units	Total area (aces)	Mulberry acreage
RSRS-Salem	20.00	3.40
REC-Krishnagiri	2.77	2.50
REC-Samayanallur	2.62	0.60
REC-Gobichettipalayam	-	-
REC-Udumalpet	-	-

On-going Research Projects

PIN 01018 SI: Effect of Potassium Mobilising Bacteria *Frateuria aurentia* on growth and development of mulberry (Nov. 2020-Oct. 2022)

N. Dhahira Beevi and S. Kamaraj

Objective

- To study the influence of potassium mobilizing bacteria with graded levels of potassium on growth and leaf yield of mulberry
- Reduce the cost of cultivation by curtailing the chemical fertilizer application
- Conserving the soil sustainability by applying eco-friendly biological agents

Farmer's field were identified and experiment was laid out in field having V-1 and G-4 mulberry varieties with 7 treatments. Completed six crops and quantitative and qualitative parameters were recorded. Soil samples were collected for estimation of 'K' fractions and microbial colonies.

Table 24.1: Effect of *Frateuria aurentia* on plant growth parameters in V1 mulberry variety

Treatment	Plant height (cm)	Shoot length (cm)	Leaf yield/kg /ha/crop	K-content (%)	Total chlorophyll content (mg/g)
T1	150.13	125.15	7,062	1.685	2.16
T2	165.66	131.14	10,834	2.118	3.52
T3	166.64	137.40	10,566	2.262	3.93
T4	164.95	137.55	10,902	2.293	3.74
T5	157.80	135.91	10,212	2.18	3.24
T6	162.46	132.34	9,297	1.929	3.28
T7	159.71	123.02	8,737	1.746	3.06
CD at 5%	2.11	2.72	247	0.047	0.113
SE(m)	0.68	0.87	79.26	0.015	0.036
SE(d)	0.96	1.24	112.09	0.021	0.051
C.V.	0.73	1.15	1.42	1.293	1.921

Table 24.2: Effect of *Frateuria aurentia* on plant growth parameters in G4 mulberry variety

Treatment	Plant height (cm)	Shoot length (cm)	Leaf yield/kg /ha/crop	K-content (%)	Total chlorophyll content (mg/g)
T1	125.27	82.15	7,384	1.443	1.48
T2	140.343	89.87	10,073	1.789	2.75
T3	139.518	89.21	10,007	1.916	3.23
T4	142.607	92.13	10,027	1.932	3.28
T5	131.235	86.61	9,723	1.772	2.49
T6	134.932	88.09	9,315	1.638	2.52
T7	130.552	81.83	7,986	1.764	2.27
CD at 5%	3.292	1.01	178	0.021	0.109
SE(m)	1.057	0.32	57	0.007	0.035
SE(d)	1.494	0.46	80.88	0.01	0.050
C.V.	1.357	0.64	1.08	0.676	2.358

Collaborative Research Projects/Programmes

Project/programme	Name of the unit
PIE 13001 MI (AICEM Phase-IV): All India Coordinated Experimental Trial in Mulberry Phase-IV (April 2019 – March 2025)	REC Krishnagiti

On-Station Trials

1. Validation of Chawki Feed Supplement Formulation

On-farm trials were conducted for chawki feed supplement formulation (CFSF) evaluation in the commercial chawki rearing centers of Tamil Nadu during the rainy, winter, and summer seasons with FC1xFC2 silkworms. The CFSF was evaluated for chawki parameters such as larval growth (weight of 100 no), percentage of missing and unequal larvae and disease incidence during the second moult. Later, cocoon parameters were compared and the results are given in the Table 24.3.

Rainy season trial was held at Amman CRC and Manupatty Village in October and November 2021 with 500 dfls for the control and 500 dfls for the CFSF treatment. Significant difference was noted in missing larvae % and under sized larvae % (2.418%, 3.921% in control and 0.569%, 1.541% in CFSF treatment respectively) in chawki rearing. Significant difference was noted in shell % (20.33% in control, 21.13% in CFSF treatment) also.

Winter season trial was held at Akaram CRC, Pongalur with @ 500 dfls of CFSF and control during January and February 2022. Significant difference was noted in missing larvae % and under sized larvae % (2.152%, 2.852% in control and 0.113%, 0.808% in CFSF treatment respectively) in chawki worms. Significant difference was noted in single shell weight and yield /100 dfls (0.389 g, 80.495 kg/100dfls in control, 0.415 g, 83.308 kg/100 dfls in CFSF treatment) in late age rearing.

Similarly, the CFSF was assessed during the summer season (March-April 2022) with 500 dfls treated and control at Sankar CRC, Jaliyur and 2000 dfls of treated at Amman CRC. Significant difference was noted in missing larvae % and under sized larvae % (2.550%, 2.210% in control and 1.033%, 1.129% in CFSF treatment respectively) in chawki rearing. Also significant difference was noted in pupation rate and yield /100 dfls (86.996%, 69.03 kg/100 dfls in control, 89.239%, 72.465 kg/100 dfls in CFSF treatment) in late age rearing.

Table 24.3: Evaluation of CFSF in commercial CRCs of Tamil Nadu

Particulars	Chawki performance			Late age and cocoon parameters						
	Weight of 100 larvae (g)	Miss-ing Larvae (%)	Under sized larvae %)	Weight of 10 larvae (g)	SCW (g)	SSW (g)	Shell (%)	Pup. rate (%)	Yield/ 100 dfls (kg)	Cocoon rate (Rs.)
Rainy season (@ 500 dfls each batch)										
Control	3.141 ±0.202	2.418±0 .013	3.921 ±0.065	41.11 ±1.213	1.934 ±0.057	0.394 ±0.015	20.33 ±0.269	90.96 ±0.922	81.39 ±0.935	377.5 ±26.29
CFSF treated	3.123 ±0.086 (0.850) NS	0.569 ±0.023 (0.0001) *	1.541 ±0.062 (0.0001) *	41.325 ±0.725 (0.702) NS	1.95 ±0.046 (0.638) NS	0.412 ±0.012 (0.069) NS	21.126 ±0.461 (0.013) *	91.132 ±0.691 (0.088) N	84.74 ±2.730 (0.030) *	392.20 ±13.198 (0.296) NS
Winter season (@ 500 dfls each batch)										
Control	3.087 (0.036)	2.152 ±0.010	2.852 ±0.076	41.664 ±0.243	1.881 ±0.058	0.389 ±0.016	20.694 ±0.296	91.487 ±1.169	80.495 ±0.935	795 ±64.031
CFSF treated	3.101 ±0.038 NS	0.113 ±0.005 *	0.808 ±0.009 *	42.437 ±0.393 NS	1.985 ±0.089 NS	0.415 ±0.028 *	20.882 ±0.531 NS	91.796 ±1.439 NS	83.308 ±0.662 *	825 ±33.166 *
Summer season (500 dfls control and 2500 dfls CFSF treated)										
Control	3.005 (0.091)	2.550 ±0.242	2.210 ±0.076	41.532 ±0.599	1.808 ±0.050	0.387 ±0.015	21.461 ±0.341	86.996 ±3.861	69.03 ±0.602	657 ±17.785
CFSF treated	3.048 ±0.065	1.033 ±0.368*	1.129 ±0.200 *	42.200 ±0.590 NS	1.912 ±0.042 NS	0.418 ±0.010 NS	21.864 ±0.166 NS	89.239 ±2.036 *	72.465 ±6.00 *	658 ±15.899 NS
Each value is the mean ±SD of five separate observations, *Significant at 0.05% level (P value <0.05) NS- Non Significant										

Continuous/other routine activities

Silkworm disease survey

The survey was conducted under the continuous programme, Silkworm Disease Monitoring of Seed and Commercial Crop Rearing of South Indian States. Disease survey data from 10 selected farmers' rearing (in each CPP cluster) was collected and uploaded in the website seriDM.

Extension Communication Programme (ECPs)

Table 22.4: Extension Communication Programmes

Centre	Farmers day	Awareness programme	Technology demon.	Success stories	Resham krishimela
RSRS-Salem	7 (649)	3 (250)	2 (44)	4	1 (226)
REC-Krishnagiri	-	5 (459)	4 (118)	3	
REC-Samayanallur	3 (243)	11 (728)	4 (104)	4	
REC-Udumalpet	-	4 (402)	4 (84)	3	
REC-Gobi	-	4 (327)	4 (95)	-	
Total	10 (895)	27 (2116)	18 (445)	14	1 (226)

Note: Figures in parenthesis denotes number of beneficiaries

Resham Krishi Mela cum Workshop

Resham Krishi Mela was conducted at Theni on 04-01-2022. Thiru K.V.Muralidharan, I.A.S.,District Collector, Theni, Tmt.K.Santhi,I.A.S., Director of Sericulture, Govt. of Tamil Nadu, Salem, Dr. Babulal, Director CSR&TI, Mysuru , Thiru. B. Sathishkumar, District Development Manager, NABARD, Theni, Thiru. P.Murugan, RDD, Madurai, Thiru. M Ganapathi, ADS, Theni, besides 226 Sericulturists from Theni district, Scientists / Staff of Central Silk Board and Officers / Officials of Department of Sericulture, Tamil Nadu participated in the Mela.

Seed Act Awareness Programme

An Awareness programme on Seed Act Regulations was organized by RSRS, Salem in association with National Silkworm Seed Organization, Bengaluru on 07.12.2021 to enlighten the mulberry sector stakeholder's *viz*., Registered Chawkie Rearers (RCRs), Registered Seed cocoon producers (RSCPs) and Registered seed Producers (RSPs) of Tamil Nadu on the importance of Seed Act Regulations. 100 members including 17 RCRs, 52 RSCPs, 3 RSPs besides 28 CSB and DOS officers/officials participated in the programme.

Technical workshop for Registered Chawki Rearers and Farmers

A Technical Workshop on New Technologies in Bivoltine Sericulture for Registered Chawki Rearers RCRs and Farmers was organized by REC, Udumalpet in association with National Silkworm Seed Organization, Bengaluru at Pongalur on 07.03.2022 in which 81 late age rearers, 6 RCRs, 18 CSB & DOS officials participated.

Transfer of Technology Programme

Table 24.5: Sericulture Technologies undertaken under Transfer of Technology Programme

Centre	Rot Fix (kg)	G2 (ac)	G4 (ac)	RC1 (ac)	V1 (ac)	Serifit
RSRS-Salem	14 (7)	700 (1)	5.5 (4)	255 (2)	670 (6)	-
REC-Gobi	-	-	-	-	-	1625 (812)
REC-Udumalpet	-	-	-	-	-	-
REC-Samayanallur	-	-	-	-	-	-
REC-Krishnagiri	-	-	15204 (3)	-	-	-

Values in parentheses denote number of farmers covered.

Cluster Promotion Programme

Bivoltine sericulture technologies were disseminated in 6 mega clusters and 1 potential cluster across Tamil Nadu. A total of 129.23 lakh Dfls and 3.364 lakh Dfls were distributed in mega and potential clusters and harvested an average cocoon yield of 81.89 and 80.08 kg / 100 dfls respectively.

Capacity Building Farmers Skill Training Programme [FST]

Table 24.6: Capacity Building under Farmers Skill Training Programme [FST]

Name of the Centre	Prog. (No.)	Farmers	Male	Female	SC	ST	OBC	Gen.
RSRS-Salem	4	85	57	28	8	15	19	43
REC-Krishnagiri	4	51	46	5	1	0	19	31

REC-Samayanallur	2	50	48	2	15	-	-	35
REC-Gobi	3	50	23	27	-	-	17	33
REC-Udumalpet	4	50	42	8	3	2	-	45
Total	17	286	216	70	27	17	55	187

Sericulture Resources Centres (SRC)

Sericulture Resource Centres at Manupatty, Udumalpet mega cluster (REC, Udumalpet) & Maangadu, Alangudi potential cluster (REC-Samayanallur), conducted each 5 batches of Sericulture training in co-ordination with the lead farmers and 251 farmers were trained on new sericulture technologies in mulberry cultivation & silkworm rearing.

Table 24.7: Training Programmes conducted by SRCs

Name of the Centre	Name of the SRC Owner/cluster	No. of batches	No.of farmers trained	Male	Female	Expenditure (Rs.)
REC-Udumalpet	Sri Ponnusamy, Manupatty, Udumalpet	5	126	97 (Gen)	29 (Gen)	45000.00
REC-Samayanallur	Sri A. Kalaichezhian, Maangadu, Alangudi	5	125	116 (Gen-110, SC-6,)	9 (Gen-8, SC-1)	45000.00
Total		10	251	213	38	90000.00

Mass multiplication and distribution of Bio-control Agents

Name of the Biocontrol agents	Units supplied	No. of Farmers
Acerophagus papayae (1 unit=250 nos.)	416	104

Centre for Higher Studies in Botany and Sericulture, RSRS, Salem

Periyar University, Salem has recognized RSRS, Salem as a Centre for Higher Studies in Botany and Sericulture for pursuing M.Phil. & Ph.D., and the following students are pursuing Ph.D. programme.

Name of the candidate Sarvashri / Smt.	Name of the Guide	Year of Joining	Topic of Research
G. Punithavathy*	Dr. D. S. Chandrashekar Scientist-D (Rtd)	2008	Studies on evaluation and selection of elite bivoltine hybrids (*Bombyx mori* L.) suitable for non traditional areas of Tamil Nadu.
E. Rajalakshmi*	Dr. N. Sakthivel Scientist-D	2013	Studies on identification of new foundation crosses and double hybrids of bivoltine *Bombyx mori* L under semi-temperate conditions of Nilgiris.
T. S. Manoj	Dr. N. Dhahira Beevi Scientist-D	2019	Studies on supplementation of organic inputs vis-a vis reduction of chemical fertilizers in G-4 mulberry variety (*Morus* spp.).

M. Devamani	Dr. N. Dhahira Beevi Scientist-D	2019	Effect of micronutrient application on growth and yield of mulberry.
A. Abdul faruk	Dr. S. Balasaraswathi Scientist-D	2018	Studies on economic impact of cocoon production by sericulturists through training.

** Thesis submitted and viva-voce awaited*

25. LECTURES, WEBINARS, VIDEO OR RADIO-TALKS DELIVERED

Lecture

Topic	Organized by	Date	Name
Package of practices for mulberry cultivation and disease management	SSPC, Ramanagara	20-07-2021	P Saraswathi
Management of mites & thrips in mulberry	KVK Kolar, at Tamaka, Kolar	18-08-2021	JB Narendra Kumar
Management of mites &thrips in mulberry	KVK Chintamani	31-08-2021	JB Narendra Kumar
Management of Mites &Thrips in Mulberry	KVK Kolar, at Tamaka, Kolar	21-09-2021	JB Narendra Kumar
Management of mites & thrips in mulberry	DoS, Bangarpet, at Silk Farm, Kuppanahalli	07-10-2021	JB Narendra Kumar
Management of mites & thrips in mulberry	TSC, DoS, Vemagal, at Sugatur	11-10-2021	JB Narendra Kumar
Pest management in mulberry	KVK Kolar, at Tamaka	26-10-2021	JB Narendra Kumar
Management of pests in *chawki* mulberry gardens	SSPC, NSSO, at Chintamani	27-10-2021	JB Narendra Kumar
Disinfection and hygienic conditions for bivoltine silkworm rearing & Package of practices for mulberry cultivation	DoS, Ramanagara at Devisiddaiahnadoddi	27-10-2021	P Saraswathi
Management of insect and non-insect pests of mulberry	KVK Kolar, at Tamaka, Kolar	28-10-2021	JB Narendra Kumar
Mulberry cultivation practices and silkworm rearing technology	DoS, Lingasugur, at STC, Kesretti Farm	08-11-2021	J Justin Kumar
Management of insect and non-insect pests of mulberry	DoS, Malur, at Tekal	04-12-2021	JB Narendra Kumar
Mulberry cultivation practices, disinfection & hygine in silkworm rearing	DoS, Lingasugur, at STC, Kesretti Farm	06-12-2021	J Justin Kumar
Management of insect and non-insect pests of mulberry	DoS, Bangarpet, at Kuppanahalli	07-12-2021	JB Narendra Kumar
IPM of insect pests of mulberry	KVK Kolar, at Tamaka	16-12-2021	JB Narendra Kumar
Management of leaf roller, thrips and mites	KVK Kolar, at Muthanur	23-12-2021	JB Narendra Kumar
Mulberry cultivation practices, disinfection and hygine in silkworm rearing	DoS, Lingasugur, at STC, Kesretti Farm	10-01-2022	J Justin Kumar
Mulberry cultivation practices, disinfection and hygine in silkworm rearing	DoS, Lingasugur, at STC, Kesretti Farm	07-02-2022	J Justin Kumar
IPM of insect pests of mulberry	KVK Kolar, at Tamaka	10-02-2022	JB Narendra Kumar

Webinar

Topic	Organized by	Date	Name
IPM of major pests of mulberry	KVK-Kolar	26-05-2021	JB Narendra Kumar
IPM in mulberry	KVK-Ramanagara	02-06-2021	S Mahiba Helen
Mulberry diseases and their management	KVK-Chintamani	04-06-2021	GS Arunakumar
Improved sericulture technology for production	KVK-Mandya	16-06-2021	Dayananda

of quality bivoltine cocoon			
Insect & non-insect pests of mulberry and their management	KVK-Mandya	18-06-2021	JB Narendra Kumar
Mites and Thrips Management in mulberry	CSRTI-Mysuru	05-10-2021	S Mahiba Helen

Radio Talk

Topic	Organized by	Date of broadcast	Name
Bivoltine sericulture & commercially viable by-products, under *Thotamum Thozhilum* – in two parts	All India Radio, Ooty	03.12.2021 & 10.12.2021	V Vijay
Integrated root rot disease management in mulberry	All India Radio, Mysore	16.01.2022	GS Arunakumar
Sericulture practice during the Summer Season	All India Radio	21.04.2021	KP Kiran Kumar
Disease and pest management in Mulberry garden	All India Radio	13.08.2021	KP Kiran Kumar
Disease and pest management in Silkworm rearing	All India Radio	15.11.2021	KP Kiran Kumar
Soil health and Fertilizer application in mulberry gardens	All India Radio	11.03.2022	KP Kiran Kumar

26. CONFERENCES, WEBINARS, WORKSHOPS ATTENDED

Conference/Webinar/Workshop	Organized by	Date	Name
Mulberry cultivation and silkworm rearing management during rainy season	Silk Association of India, Bengaluru	08.05.2021	A Umesha
Entrpreunial opportunities in sericulture	Faculty of Agriculture, Annamalai University, Chidambaram	20.05.2021	N Dhahira Beevi, R Meenal
Integrated root grub management in mulberry	ICAR-KVK, Kandali, Hassan	24.05.2021	A Umesha
Integrated pest management in mulberry	ICAR-KVK, Kolar & DOS, Tumkur	26.05.2021	JB Narendra Kumar, A Umesha
Improved sericulture technology for bivoltine cocoon production to increase farmers' returns	ICAR-KVK, Kolar & DOS, Kolar	27.05.2021	A Umesha
Soil fertility management and improved mulberry cultivation practices	ICAR-KVK, Chintamani, & REC, Madiwala	29.05.2021	A Umesha
Improved mulberry cultivation practices & IPM in mulberry	ICAR-KVK, Ramanagara	02.06.2021	A Umesha
Mulberry diseases and their management	ICAR-KVK, Chintamani, Kolar & REC, Madiwala	04.06.2021	A Umesha, GS Arunakumar
Improved cultivation practices for sustainable mulberry production	ICAR-KVK, Chintamani, DoS, Bangarpet & REC, Madiwala	07.06.2021	A Umesha
Strategies for production of quality cocoon & raw silk	Silk Association of India, Bengaluru	12.06.2021	A Umesha

Improved sericulture technology for production of quality bivoltine cocoon	ICAR-KVK, Chintamani, DoS, Kolar & REC, Madiwala	16.06.2021	Dayanand, A Umesha
IPM in mulberry	ICAR-KVK, Mandya	18.06.2021	JB Narendra Kumar, A Umesha
Silkworm diseases and their management	REC, Madiwala ICAR-KVK, Kolar & DoS, Kolar	25-06-2021	A Umesha
Agri-enterprises for livelihood security & rural development	Sri Padhmavathi Mahila Visva Vidyalayam, Tirupati	05.07.2021 to 10.07.2021	A Umesha
International webinar on slkworm as a model for drug development	Dep. of Studies in Sericultural Science, UoM, Mysuru	15.07.2021	A Umesha
Drip irrigation and fertigation in mulberry	Silk Association of India, Bengaluru	14.08.2021	A Umesha
Sericulture extension management activities	Silk Association of India, Bengaluru	11.09.2021	A Umesha
Mites and thrips management	CSRTI-Mysuru	05.10.2021	196 scientists/Staff of CSB/DoS
Management of muscardine disease in silkworm	Silk Association of India, Bengaluru	16-10-2021, 11-12-2021	A Umesha
A socio economic assessment of sericulture technology	Central Silk Board	20.12.2021 to 23.12.2021	NG Selvaraju M Muthulakshmi R Mattigatti
National workshop soil and water management for climate smart crop production	ANGRAU, Bapatla	04.12.2021 to 08.12.2021	Dhaneshwar Padhan
National webinar on conservation agriculture in India: Myths, realities and way forward	Rajasthan College of Agriculture, Rajasthan	17.02.2022	Dhaneshwar Padhan
Managing agro-chemicals for crop and environmental health	Society for fertilizers and environment	25.02.2022 to 26.02.2022	R Mahesh Dhaneshwar Padhan

27. HUMAN RESOURCE DEVELOPMENT

Training programme	Organized by	Date	Name & Designation
Extension management approaches for promotion of sericulture industry	MANAGE, Hyderabad	15.06.2021 to 18.06.2021	Dhaneshwar Padhan
Molecular data analysis through bio-informatics tools	Acharya N.G. Ranga Agricultural University, S.V. Agricultural College, Tirupati	01.11.2021 to 10.11.2021 (7 days)	Manjappa
Advances in agricultural water management under changing climate	Centre for Water Resources Development and Management, Kozhikode, Kerala	15.11.2021 to 25.11.2021	R Mahesh
Waste management in sericulture	Extension Education Institute	23.09.2021	SM Hukkeri

	Min of Agriculture Govt. of India, Hyderabad		
Hands-on Training on Physical Verification of Training Centres under SAMARTH Scheme	Central Office, CSB, B'lore at CSRTI-Mysuru	03.08.2021	Dayananda K Praveen Kumar TS Sivasubramonian Y Srinivasulu SM Hukkeri KN Madhusudan A Umesha Vinod Kumar Yadav GS Arunakumar L Satish Manjappa
Hands-on-Training on Application of Statistical Tools in Sericulture	CSRTI-Mysuru	07.03.2022 to 08.03.2022	35 scientists of CSRTI-Mysuru
Improved Bivoltine Sericulture Technilogy (STEP Trg)	CSRTI-Mysuru	21.10.2021 to 22.10.2021	G Papaiah Niranjanmurthy BK Narayanaswamy
Improved Bivoltine Sericulture Technilogy (STEP Trg)	CSRTI-Mysuru	16.11.2021 to 17.11.2021	NK Murthy
Technological advancement in sericulture and extension approaches	CSRTI-Mysuru	02.03.2022 to 03.03.2022	AP Raghavendra

28. PATENTS & COMMERCIALISATION

Patent granted

Process for the utilization of spent silkworm moths for producing value added by-products. Patent No.365781 granted on 30.04.2021.

Product	Name of Firm/Party	Date
Commercialisation		
Vijetha Supplement Powder: a silkworm bed disinfectant	1. M/s. Serio Care, Survey No. 118, Kamadenahalli Village, Kasaba Hobali, Kolar Taluk, Kolar-563101	23.10.2021
	2. M/s. Kaveri Agro Products, Plot No.12, Matagally Industrial area, KRS Road, Mysuru-570016	10.11.2021
Poshan: a multi-nutrient formulation for correcting nutrient deficiencies in mulberry	1. M/s. Kaveri Agro Products, Plot No.12, Matagally Industrial area, KRS Road, Mysuru-570016	10.11.2021
License Renewal		
Navinya: a plant based formulation for control of mulberry root rot disease	1. M/s.Nandi Agro Vet, Plot No. 453, Sompura Industrial Area, 2nd Sage KAIDB, Thamagongalu, Nelamangala, Bangaluru - 562132	10.11.2021

29. RESEARCH ADVISORY COMMITTEE & MEETINGS

Chairman

Dr. Mahadev B. Chetti
Vice-Chancellor
University of Agricultural Sciences (UASD)
Yettinagudda Campus
Krishinagar, Dharwad - 580 005

Members

Dr. E. Sreenivasa Rao
Principal Scientist, Division of Vegetable crops
ICAR-Indian Institute of Horticultural Research
Hesaraghatta Lake post
Bengaluru - 560 089

Prof. Janarthanan
Professor and Head
Department of Zoology
University of Madras
Chennai - 600 025

Dr. K. Narayanagowda
Associate Director of Extension
Agricultural Science Museum
University of Agricultural Sciences
GKVK Bengaluru - 560 065

Dr.H.K.Basavaraja
Retd. Director (I/c)
National Silkworm Seed Organization (NSSO)
No.263, 9th Cross, Srirampuara 2nd stage
Mysore -570 023

The Commissioner of Sericulture
Sericulture Development & Director of Sericulture
Govt. of Karnataka, 5th Floor
M. S. Building, Dr. B. R. Ambedkar Veedhi
Bengaluru - 560 001

The Director of Sericulture
Govt. of Tamil Nadu
Nethaji Nagar, Hasthampatti,
Tamil Nadu, Salem - 636 007

The Commissioner of Sericulture
Dept. of Sericulture, Govt. of Andhra Pradesh TTDC building, First floor, Old market yard, Chuttugunta (besides Mini Rythyu Bazaar), Guntur - 522 007, Andhra Pradesh

The Commissioner of Sericulture
Govt. of Telengana
Road no-72, Prashashan Nagar
Adjacent to Water tank, Jubilee hills
Telengana, Hyderabad - 560 033

The Director of Sericulture
Dept. of Sericulture
Govt. of Maharashtra, New Administrative building, No-2, B-wing, Civil lane, lV floor
Maharashtra, Nagpur - 440 010

The Commissioner of Sericulture
Govt. of Madhya Pradesh,
Lower Basement, Satpuda Bhavan,
Bhopal - 462 004, Madhya Pradesh

Sri Y. Shankar Reddy
S/o Narasimha Reddy
Nadimi Kallada Village,
Kolamasinapalli Post, Palamaner Mandal,
Chittoor - 517 432, Andhra Pradesh

Sri Shaik lsmail
Chinnasandra Village and post,
Chintamani Taluk
Chikkaballapura - 503 125

The Director
National Silkworm Seed organization(NSSO)
Central Silk Board, CSB Complex
BTM Layout, Madiwala
Bengaluru - 560 068

The Director (Tech)
Central Silk Board, CSB Complex
BTM Layout, Madiwala
Bengaluru - 560 068

Scientist-D & Head
Resarch Co-ordination Section
Central Silk Board, CSB Complex
BTM Layout, Madiwala
Bengaluru - 560 068

The Director (Member Convener)
Central Sericulturual Research and Training Institute, Central Silk Board, Manadavadi road,Srirampura,Mysore-570 008

Details of Review Meetings at CSRTI-Mysuru

66th Research Council : 29th & 30th July 2021

67th Research Council : 25th November 2021

46th Research Advisory Committee : 20th August 2021

47th Research Advisory Committee : 24th & 25th January 2022

30. PUBLICATIONS

Book/Book Chapter

Akhileshwar Kumar Srivastava, Dhruv Kumar, Divya Singh, Rajesh Kumar Singh (2022) Xenobiotics in Chemical Carcinogenesis, Academic Press, Elsevier Science Publishing Co Inc., San Diego, United States, pp: 314.

Babulal, Selvaraju NG, JustinKumar J and Muthulakshmi M (2022) Sericulture Success stories Vol-3, Central sericultural Research and Training Institute, Central Silk Board, Ministry of textiles, Govt of India, Srirampura, Mysuru, pp:1-148.

Chandrakanth N, Makwana P, Satish L, Rabha M, Sivaprasad V (2021) Molecular approaches for detection of pebrine disease in sericulture. *Methods in Microbiology, Academic Press,* pp: 47-73.

Divya Singh, Sandeep Kumar Singh, Vipin Kumar Singh, Sougata Ghosh, Hariom Verma, Ajay Kumar (2021) Plant growth promoting bacteria as biocontrol agents against diseases of cereal crops. In: Food Security and Plant Disease Management (eds.) Ajay Kumar and Samir Droby, Woodhead Publishing, United Kingdom, pp: 221-239.

Nivedita S, Radhalakshmi YC, Kiran B Malali, Hippargi SA, Moon MA and Babu CM (2021) Advances in silk waste management and recycling. Published by Dr. Subhas V Naik, Director, CSTRI, CSB, Bengaluru, pp: 81-91.

Vijayan K, Arunakumar GS, Gnanesh BN, Prashanth A Sangannavar, Ramesha A and Zhao W (2022) Genomic Designing for Biotic Stress Resistant in Mulberry. In: Genomic Designing for Biotic Stress Resistant Technical Crops. In: Chittaranjan Kole (eds) Genomic Designing for Biotic Stress Resistant Technical Crops. Springer, Cham. https://doi.org/10.1007/978-3-031-09293-0_8.

Research Papers

International Journals

Arunakumar GS, Gnanesh BN, Manojkumar HB, Doss Gandhi S, Mogili T, Sivaprasad V and Pankaj Tewary (2021) Genetic Diversity, Identification and Utilization of Novel Genetic Resources for Resistance to *Meloidogyne incognita* in Mulberry (*Morus* spp.). *Plant Disease,* 105(10): 2919-2928. https://doi.org/10.1094/PDIS-11-20-2515-RE.

Mahesh R, Melissa L, Soumen C, and Sivaprasad V (2021) Balanced fertilization for improved nutrient use efficiency and mulberry productivity. *Int. J. Plant & Soil Science*, 33(20): 205-217. DOI: 10.9734 /ijpss/2021/v33i2030647 NASS rating: 5.07.

Mudasir G, Senger S, Satish L, Saini P, Bali K, Gupta R, Sivaprasad V, Jehle JA, and Wennmann JT (2021) Patterns in Genotype Composition of Indian isolates of the *Bombyx mori* Nucleopolyhedro virus and *Bombyx mori* Bidensovirus, *Viruses,* 13(5): 1-17.

Naleen, Bharath M, Sannappa B, Manjunath KG and Umesha A (2020) Knowledge and Adoption Levels of Farmers on Sericulture Technologies in Srirangapatna Taluk of Mandya District of Karnataka. *Res. J. Agric. Sci.,* 11(4): 959-965.

Narendra Kumar JB and Manjunath D (2021) Comparative performance of *Trichomalopsis uziae*, a pupal parasitoid of the tachinid, *Exorista bombycis*. *Indian J. Entomology,* 83 (2021) Online published, DoI No.: 10.5958/0974-8172.2020.00205.9.

Narendra Kumar JB and Manjunath D (2021). Effect of temperature on *Trichomalopsis uziae*, pupal parasitoid of the silkworm uzi fly, *Exorista bombycis*. *Indian J. Entomology*, 83 (2021) Online published, DoI No.: 10.5958/0974-8172.2021.00016.X.

Poojashree K, Arunakumar GS and Gnanesh BN (2021) *In vitro* evaluation of novel fungicide molecules against *Cerotelium fici* Cast. (Arth.) causing black leaf rust of mulberry. *Sericologia*, 61 (3&4): 74-80.

Rishi Gupta, Archana Mishra, Yeruva Thirupathaiah, Anuj Kumar Chandel (2022) Biochemical conversion of CO^2 in fuels and chemicals: Status, innovations and industrial aspects. *Biomas conversion and Biorefinary*. DOI:10.1007/s13399-022-02552-8.

Sarkar T, Ravindra KN, Doss SG, Pratheesh Kumar PM, Tewary P (2022) *In vitro* regeneration of mulberry plants from seedling explants of *Morus indica* cv. G4 through direct organogenesis (2022). Trees-Structure and Function (Springer): 36:113–125. doi.org/10.1007/s00468-021-02186-9.

Shinde BB, Manojkumar HB, Arunkumar GS, Bhavya MR and Gnanesh BN (2021) Assessment of statistical software to analyze genetic diversity in mulberry germplasm. *Sericologia*, 61(3&4): 105-113.

Sivaprasad V, Satish L, Mallikarjuna G, Chandrakanth N, Mary Josepha AV and Moorthy SM (2021) A Field-Friendly Loop-Mediated Isothermal Amplification (FF-LAMP) method for rapid detection of *Nosema bombycis* in silkworm, *Bombyx mori, Invertebr. Survival J.* 18(1): 66-74.

Thirupathaiah Y, Ananthan R, Manthira Moorthy S, Chandrashekar KB, Chandrasekharaiah M, Sivaprasad V and Pankaj Tewary (2021) Silkworm (*Bombyx mori*) pupae proteins: The source of high value Amino acids: *Sericolgia* 61(1&2): 19-22.

Thirupathaiah Yeruva and Chandel Anuj Kumar (2021) Coronavirus disease 2019: fundamentals, chronology and vaccine evolution. *Reviews in Medical Microbiology,* 32(4): 246-254.

Umesha A, Sannappa B, Rahamathulla G and Manjunath KG (2021) Cost and return structure of mulberry and cocoon production at varied levels of organic manures applied to mulberry. *Aegeum Journal*, 9(4):184-193.

Umesha A, Sannappa B, Rahamathulla G and Manjunath KG (2021) Effect of organic based nutrients on physical, chemical and biological properties in three types of soils of mulberry garden. *Proteus Journal*, 12(4):20-42.

National Journals

Mahimasanthi A and Rajaram S (2021) Farmers' perceptions on drought, technological preferences in drought mitigation and their implications in mulberry sericulture in South India. *Journal of Extension Education,* 32(4): 6604-6612.

Subrata Das, Sneha RG and Shivkumar Hukkeri (2022) Handcrafting of silk cut cocoons. *Asian Textile Journal,* March-April 2022, pp: 25-27.

Sudhakar P, Vijaya Naidu B, Kiran Kumar KP and Babulal (2021) Tree Mulberry: The future of Tropical Sericulture Farming. *Biotica Research Today,* 3(5): 297-302.

Khare TR, Sobhana V and Kalpana GV (2022). Weed management in mulberry (*Morus alba*): A review. *Agricultural reviews*. DOI: 10.18805/ag.R-2350.

Vijay Vrajan, Mahesh R, Sayantan Manna, Arunima Banerjee, Anil Pappachan, Manjunatha GR, Soumen Chattopadhyay and Sivaprasad V (2021) Soil Nutrient Status of Mulberry (*Morus* species) Growing Fields in West Bengal, India. Int. J. Curr. Res., 13(6): 18058-18066. https://doi.org/10.24941/ijcr.41768.06.2021

Popular articles

Arunakumar GS, Bhavya MR, Bharathesh S and Narendra Kumar JB (2021) Termites attack in mulberry and their management. *Reshme Krishi*, May-June, Jul.-Aug. 2021 (In Kannada) pp: 3-6.

Arunakumar GS, Bhavya MR, Bharathesh S and Narendra Kumar JB (2021) Integrated management of root rot disease in mulberry. *Reshme Krishi*, May-June, Jul.-Aug. 2021 (In Kannada) pp: 10-11.

Arunakumar GS, Raghunath MK and Babulal (2021) Management of root rot disease in mulberry. *Indian Silk,* 12[Old 60](2): 4-5.

Dhahira Beevi N (2021) Integrated Rootrot Disease management in mulberry. *Pattumalar* (Tamil monthly magazine), 11(5):14-16.

Dhahira Beevi N and Mahiba Helen S (2021) Management of broad mite in mulberry. *Pattumalar* (Tamil monthly magazine), 11(6):17.

Dhahira Beevi N, Jessy Daniel and Kamaraj S (2021) Management of silkworm diseases during summer season. *Pattumalar* (Tamil monthly magazine), 11(7):14-17.

Kushwaha RV, Selvaraju NG and Pankaj Tewary (2020) Buldana Farmer Adopted Sericulture as Industry and for sustainable income source under CPP Buldana. *Indian Silk,* 11[Old 59](4): 18.

Mahesh R, Chakraborty D and Sivaprasad V (2021) Low cost drip fertigation for mulberry. *Resham Bharati* (Hindi Magazine) published by Central Silk Board, Bengaluru, Aug, 2021, pp: 26-27.

Mahimasanthi A, Rajaram S and Sivaprasad V (2021) Integrated drought management technologies in mulberry sericulture. *Indian silk,* 11(5): 4-7.

Mahimasanthi A (2021) Mulberry valarpil orunginaitha varatchi melanmai. *Pattu Mala*r 11(9):14-17.

Narendra Kumar JB (2021) Adulteration of fertilizers- A bane in Agriculture. *Reshme Krishi (*March-April 2021), pp: 19-20.

Narendra Kumar JB, Thimmaraju and Morrison N (2021) Change over through adoption of bivoltine sericulture. *Indian Silk*, 12[Old 60](2): 6-8.

Sowbhagya P, Bhavya MR and Arunakumar GS (2021) Distinctiveness, Uniformity and Stability (DUS) descriptors – need and implications in protection of mulberry varieties and farmers' rights. *Indian Silk*, 12[Old 60](1): 4-7.

Sobhana V, Sen S, Reddy MM, Sudhakar P, Dahira Beevi N, Vijay Naidu B, Ravindra, Babu CM, Sivaprasad V and Babulal (2022) Digitalized soil health card and soil fertility management in mulberry gardens*. Indian Silk* 12(1): 8-11.

Conference/Webinars

Gnanesh BN, Arunakumar GS, Tejaswi A, Supriya M and Manojkumar HB (2021) Multilocus phylogenetic analysis of the fungal complex associated with root rot of mulberry (*Morus* spp.). NSPPH2021, 27th to 29th Dec. 2021, ICAR-IIHR, Bengaluru. P. 19.

Devamani M and Dhahira Beevi N (2021) Impact of micronutrients application on mulberry growth and yield parameters. International Halich Congress on multi disciplinary scientific Research, August 15-16, 2021 on line presentation.

Mahesh R, Melissa L, Sivaprasad V, Babu CM and Babulal (2022) Balanced fertilization for improved nutrient use efficiency and mulberry productivity. In proceedings of 9th Annual Convention and A Webinar on "Managing Agro-chemicals for Crop and Environmental Health" organized by Society for fertilizers and environment, Kolkata during February 25 & 26, 2022.

Mary Josepha Shery AV, Narendra Kumar JB and Babulal (2021) Avian Fauna of the Central Sericultural Research & Training Institute Campus in Mysore presented in National Level Virtual Conference on Diversity and Distribution of Indian Birds, organized by National Science Association, Dept. of Zoology, St. Joseph's College, Bangalore on 1st May 2021 pp 15.

Padhan D, Sindhu G, Sobhana V, Ravindra, Babu CM and Babulal (2022) Comparison of different chemical extractants for estimation of bioavailable zinc in mulberry garden. National Webinar on Managing Agro-Chemicals for Crop and Environmental Health, organized by Society for fertilizers and environment, Kolkata during February 25 & 26, 2022. Pp.55.

Ravindra, Swathi S, Sushma PM, Thirupathaiah Y, SobhanaV, Dhaneshwar Padhan, Kishorekumar B, Babulal (2022) Isolation of Protease producing bacteria from soil and characterization of protease. In National webinar on Managing agro-chemicals for crop and environmental health organized by Society for fertilizers and environment Kolkata during 25th and 26th February 2022, pp-99.

Gayathri T, Rajashekar K, Doss SG, Sarkar T and Babulal (2022) Physio-biochemical evaluation of mulberry genotypes for alkalinity stress tolerance. International conference on Sustainable utilization of Bioresources at University of Kerala on 10th to 15th Jan. 2022 *Abstracts,* P:150.

Manoj TS and Dhahira Beevi N (2021) Effect of poultry manure with bio fertilizers on leaf quality of G-4 mulberry variety (*Morus indica* L.) assessed through silkworm feeding. Abstract presented in International Halich Congress on multi disciplinary scientific Research, Istanbul, Turkey, August 15-16, 2021.

Sequences submitted to Natioal Centre for Biotechnology Information (NCBI)

1. Microbial sequences submitted

#	Microbes	Accession Number
1	*Pseudomonas fluorescens* SWBL14	OL831228
2	*Agrobacterium fabrum* SWBL12	OL831222
3	*Bacillu sproteolyticus* SWBL11	OL831194
4	*Acinetobacter baumannii* SWBL10	OL831191
5	*Enterobacter sp.* SWBL9	OL831188
6	*Alcaligenes endophyticus* SWBL8	OL831171
7	*Brevibacillus agri* SWBL7	OL677393
8	*Pseudomonas aeruginosa* SWBL6	OL677063
9	*Pseudomonas sp.* SMBL5	OL614776
10	*Pseudomonas plecoglossicida* SMBL4	OL614766
11	*Pseudomonas aeruginosa* SMBL3	OL589644
12	*Bacillus subtilis* SMBL2	OL589609
13	*Pseudomonas putida* SMBL1	OL374169
14	*Ligilactobacillus agilis* SWMBL0	MW082828
15	*Eutypella* sp. isolate SWPATH5	MZ018641.1
16	*Metarhizium anisopliae* isolate SWPATH4	MZ018640.1
17	*Candida tropicalis* isolate SWPATH3	MZ018639
18	*Fusarium sp*. isolate SWPATH2	MZ018638.1
19	*Eutypella sp. isolate SWPATH1*	MZ018637.1
20	*Mucor irregularis* strain G	MT355428.1
21	*Beauveria bassiana* strain C	MT355427.1
22	*Mucor irregularis* isolate 1	MT355426.1
23	*Plectosphaerella sp.* isolate SWPATH20	MZ018656.1
24	*Mucor sp.* isolate SWPATH19	MZ018655.1
25	*Fusarium verticillioides* isolate SWPATH18	MZ018654.1
26	*Allophoma labilis* isolate SWPATH17	MZ018653.1
27	*Mucor irregularis* isolate SWPATH16	MZ018652.1
28	*Aspergillus niger* isolate SWPATH15	MZ018651.1
29	*Cordyceps* sp. isolate SWPATH14	MZ018650.1
30	*Mucor* sp. isolate SWPATH13	MZ018649.1
31	*Aspergillus tamarii* isolate SWPATH12	MZ018648.1
32	*Aspergillus flavus* isolate SWPATH11	MZ018647.1
33	*Aspergillus tamarii* isolate SWPATH10	MZ018646.1
34	*Aspergillus fumigatus* isolate SWPATH9	MZ018645.1
35	*Aspergillus niger* isolate SWPATH8	MZ018644
36	*Aspergillus flavus* isolate SWPATH7	MZ018643.1
37	*Cordyceps javanica* isolate SWPATH6	MZ018642.1
38	*B.mori* strain PAM117 microsatellite S1708	MT749358
39	*B.mori* strain PAM117 microsatellite S1802	MT749357
40	*B.mori* strain PAM117 microsatellite S0803	MN422290
41	*B.mori* strain HBM10 microsatellite S0803	MN422291

The pathogens were isolated from the silkworm samples received from Tamil Nadu, Telangana and Karnataka.

2. Gene sequences pertaining to Thioredoxin peroxidase of selected breeds submitted to NCBI

Pfam results	Position	Description
Ahpc-TSA	36-167	Ahpc/TSA family
Redoxin	36-176	Redoxin
1-cysprx_c	188-224	C-terminal domain of 1-Cys peroxiredoxin

31. ADMINISTRATIVE REPORT

CSRTI-Mysuru & Nested Units

State	RSRS	REC	REC-SU	P4 BSF	SSBS
Andhra Pradesh	Anantapur	Eluru Palamaneru Rayachoti			
Karnataka	Kodathi Ch'rajanagar	Chitradurga Koppal Madivala	Bidar Maddur	Hassan	
Madhya Pradesh		Hoshangabad			
Maharashtra		Amaravati Aurangabad Baramati Parbhani			
Tamil Nadu	Salem	Gobi'palayam Krishnagiri Samayanallur Udumalpet			Coonooor
Telangana	Mulugu	Vikarabad			

Staff list of CSRTI-Mysuru & Nested Units

CSRTI-Mysuru

Babulal (Dr), Director
Mary Shery (Josepha) AV (Dr), Sci-D
Chandra Shekar KB (Dr), Sci-D
Bala Saraswathi S (Dr), Sci-D
Selvaraju NG (Dr), Sci-D
Bhagya R (Dr), Sci-D
Raghunath MK (Dr), Sci-D
Muthulakshmi M (Dr), Sci-D
Babu CM (Dr), Sci-D
Purushotham S (Dr), Sci-D
Anuradha H Jingade, Sci-D
Meenal R (Dr), Sci-D
Raveendra M Mattigatti (Dr), Sci-D
Santha PC (Dr), Sci-D, [Rtd. 31.07.2021]
Mahiba Helen S (Dr), Sci-D
Madhusudhan KN (Dr), Sci-D
Sanath Kumar YN, Sci-D
Shivakumar M Hukkeri, Sci-D (R&S)
Chandra Shekar MN, Sci-D (R&S)
Anand Kumar, Sci-D (R&S) From 03.09.2021
Mohan, Dy. Director (A&A) [Exp. 09.11.2021]
Surendra Kr Upadhyay, DD (OL)
Ganesan V, DD (Comp.)
Om Prakash Narayan Singh, Lib. & IO
Rekha M, Dy. Director (Stat)
Arunakumar GS (Dr), Sci-C
Satish L (Dr), Sci-C
Thirupathaiah Y (Dr), Sci-C
Joycy Rani Dasari, Sci-C
Tanmoy Sarkar (Dr), Sci-C
Bhuvaneswari E (Dr), Sci-C

Ravindra (Dr), Sci-C
Ranjini MS (Dr), Sci-C
Shobhana V (Dr), Sci-C
Kusuma L (Dr), Sci-C
Mahesh R (Dr), Sci-C
Gayathri T (Dr), Sci-C
Mallikarjuna G (Dr), Sci-C
Manjappa (Dr), Sci-C
Munikrishnappa HM, AD, (SM)
Patnaik KL, AD (A&A)
Chandrika P, AD (A&A) [fm 12.07.2021]
Gayathri K, AD (A&A) [fm 11.10.2021]
Dhaneshwar Padhan (Dr), Sci-B
Bhavya MR, Sci-B
Amit Saha, Sci-B [Resigned 26.11.2021]
Divya Singh (Dr), Sci-B
Suresh AN, AD (A&A) fm 28.06.2021
Guneshwar Kr Churendra, Comp. Progr. [Trans. 31.08.2021]
Sachi K, Sr. Transl. (Hindi)
Geetha GS (Dr), SRA (SS)
Nagarathna RJ, Supdt. (Admn.) [fm 01.11.2021]
Preethi B, Asst. Supdt. (Admn.)
Suresh S, Asst. Supdt. (Admn.) [Rtd. 30.09.2021]
Suresh K, Asst. Supdt. (Admn.) [VRS 01.02.2022]
Raghu YR, Asst. Supdt. (Admn.)
Venkatesh A, Asst. Supdt. (Admn.)
Unnikrishnan N, Asst. Supdt. (Admn.)
Raja Shekar NR, Asst. Supdt. (Admn.)
Sathya Anantha Kr MN, Asst. Supdt. (Admn.) [Trans. 09.09.2021]
Govindaraj K, Asst. Supdt. (Admn.)
B.R. Dhananjaya, Asst. Supdt. (Admn.) [fm 15.11.2021] [VRS 17.03.2022]
S. Vijayalakshmi, Asst. Supdt. (Admn.) fm 18.10.2021
Ramakrishna V, Lib. & IA
Manjula S, Steno Gr-I
Sampath Kumari KS, Steno Gr-I
Venkatesh Rao, STA [Rtd. 30.04.2021]
Jayamma HB, STA [Rtd. 31.05.2021]
Prakasha C, STA [Rtd. 28.02.2022]
Umapathy, STA
Nagaraju, STA
Vaikuntavasa, STA
Chickkamahadeva Naik, STA
Nanjundaswamy N, STA [VRS 01.08.2021]
Narendraswamy MN, STA [Rtd. 28.02.2022]
Mahesha J (Dr), STA
Mruthunjaya Rao K, STA
Neelakanthaiah TM, STA [Rtd. 31.07.2021]
Satish Chandra Babu M, STA
Nirmala B, STA [VRS 04.09.2021]
Muthappa STA
Chandrappa S, STA
Gausia Kauser, STA
Nagashree MN, STA
Kalaiah B, STA
Mahadevamma MN, STA
Hemavathi KR, STA [VRS 02.03.2022]
Shivappa, STA
Mruthyunjaya M. STA
Mahendra Prasad, KS, STA
Pushpavathy N, STA
Rajashekara Murthy KA, STA [Exp. 16.09.2021]
Gopal CN, STA [fm 01.10.2021]
Md. Zafar Iqbal, Jr Engineer
Kiran Kumar PN, Jr Engineer [Trans. 15.09.2021]
Suresh MS, Jr Engineer, From 21.08.2021
Janardan Tiwari, Jr.Transl. (Hindi) [Trans. 17.08.2021]
Chandrakanth HT, SCD Gr-I
Nataraju L, SDC Gr-I
Venkatesh Murthy N, SCD Gr-I
Mahesha J, SCD Gr-I
Venkatesha T, SCD Gr-I
Sadashivaiah B, SCD Gr-I [fm 01.11.2021]
Azad Gull, Sr.Field Asst
Shobha Rani S, UDC [fm 27.10.2021]
Shivanna C, UDC
Vasantha Kumari VC, UDC
Chandramma K, UDC
Shubha BS, UDC
Sunanda M, UDC
Harish BM, Field Assist.
Mahadevaswamy S, Cook
Ramesha, Technician
Sundara Murthy Y, Technician
Arumugam S, Technician
Surendra MG, Technician
Imtiaz Pasha, Assist. Technician
Rajashekara, MTS
Basavaraju, MTS

Kempamma, MTS
Mahadeva, MTS
Lokesh BM, MTS
Premamma KG, MTS
Gayathri D, MTS
Leelavathi, MTS
Nalini S, MTS
Hemavathi N, MTS
Mahadevamma, MTS [Rtd. 30.11.2021]
Manohara, MTS
Mohan D, MTS

REC Sub-Unit-Maddur

Guruswamy D (Dr), Sci-D
Shivakumara HB, STA

P4 Farm-Hassan

Dayananda (Dr), Sci-D
Onkara Murthy HN, STA
Rangaswamy BC, STA
Nagaraju KS, STA
Nagaraja, Assist. Technician

RSRS-Kodathi

Satish B Kulkarni, Sci-D
Saraswathi P, Sci-D
Hanumantharayappa SK, Sci-D
Dhananjaya BR, Asst. Supdt. (Admn.) [Trans. 31.10.21]
Suryanarayana Rao R, STA
Padmamma K, STA
Hemavathi R, STA [Vrs on 02.03.2022]
Ganesh L, STA [Rtd. 31.03.2022]
Suneetha S, STA
Vimala C, UDC
Ashwini KJ, Field Assistant [Trans. 16.10.2021]
Rajakumar G, MTS
Gangadharan D, MTS

REC-Madivala (Kolar)

Narendra Kumar JB, (Dr), Sci-D
Narayanaswamy BK, STA
Venkatarevanappa K, STA
Murthy NK, STA

REC-Chitradurga

Srinivasulu Y (Dr), Sci-D
Papaiah G, STA
Niranjanamurthy GN, STA
Shivanna KB, STA
Vasanthi J, STA
Mufeedulla, SCD (SG)

REC-Koppal

Umesha A (Dr), Sci-C
Justin Kumar J, STA
Raghavendra AP, Field Assist.
Nazeera Begum, MTS

RSRS-Chamarajanagar

Soma Prakash DS, Sci-D [Rtd. 31.05.2021]
Sivasubramonian T, Sci-D
Sibayan Sen (Dr), Sci-D [Rtd. 31.01.2022]
Sudha U, Supdt. (Admn)
Rajashekara Murthy KA, STA [Trans. 07.09.2021]
Chinnaswamy C, STA
Shayana R, STA
Shivamma L, STA
Nagesh S, SCD Gr-I
Shobha Rani S, UDC [Trans.26.10.2021]
Kambe Gowda, MTS [Rtd. 31.07.2021]
Srinivasa C, MTS

REC Sub-Unit, Bidar

Nishitha Naik V (Dr), Sci-D
Rameshkumar S, Sci-C [Rtd. 31.08.2021]
Sambha, STA

Andhra Pradesh

RSRS-Ananthapur

Sudhakar P (Dr), Sci-D
Kiran Kumar KP (Dr), Sci-D
Matra Manohara, Asst. Supdt. (Admn.)
Venkata Reddy C, Asst. Supdt. (Admn.)
Geetha K, Steno. Gr-I
Shivaiah A, STA
Suryaprakash Rao SK, STA [Rtd. 31.07.2021]
Shaik Mohamad Arif, STA
Lakshmidevamma Sugali, STA
Alivelu Mangamma Mannala, STA
Sreenivasulu Anamala, STA [Trans. 30.09.2021]
Krishna Veni N, STA
Ramappa C, SCD Gr-I
Sreenivasulu J, SCD Gr-I
Pedda Narashimhudu T, MTS

Krishnamurthy K, MTS [Rtd. 30.06.2021]

REC-Palmaner

Venkatachalapathy M (Dr), Sci-D
Gopal A, STA [Rtd. 31.08.2021]
Anuradha P, STA
Suresh Babu Gona Sujin, STA
Lomada Haribabu, SCD Gr-I

REC-Rayachoty

Venugopal A (Dr), Sci-D
Suneetha S, STA [fm 10.08.2021]
Harry Andrus A, STA [fm 13.09.2021]
Alekhya Byreddi, Field Assist. [Trans. 30.09.2021]
Devangam Aparna, Field Assist. [Trans. 30.09.2021]
Rownak S, MTS

REC-Eluru

Srinivasa Rao TVS (Dr), Sci-D [Rtd. 31.07.2021]
Uma Maheswara Rao G, STA [Rtd. 31.01.2022]
Kota Nirmala Kumari, STA

SSBS-Coonoor

Vijay V (Dr), Sci-C
Gunavathy R, STA
Sarada TT, STA
Lalitha KK, STA [Rtd. 30.09.2021]
Rubasundari A, STA
Marudhammal B, MTS

RSRS-Salem

Dhahira Beevi N (Dr), Sci-D
Jessy Daniel, Sci-D
Kamaraj S, Sci-C
Manivannan TK, Asst. Supdt. (Admn.) [Trans. 30.10.2021]
Balu S, Asst. Supdt. (Admn.) [VRS 01.02.2022]
Chendur Kumar S, STA [Rtd. 31.07.2021]
Matheswaran T, STA [Retd. 31.01.2022]
Vijayakumari S, STA
Muthusami N, STA [Rtd. 31.07.2021]
Paramashivam A, FA [fm 04.10.2021]
Sheik Sadhik Ali R, SCD Gr-I
Narayanan A, SCD Gr-I
Sellamuttu V, Asst. Tch [Rtd. 31.05.2021]
Shivalingam V, MTS

REC-Krishnagiri

Kolli Jhansi Lakshmi (Dr), Sci-D
Sulochana S, STA [Rtd. 30.04.2021]
Ranganayaki R, STA

REC-Samayanallur

Rajaram S (Dr.), Sci-D [Rtd. 31.05.2021]
Mahima Santhi A (Dr), Sci-D
Bhaskaran KVT, STA
Krishna Moorthy R, STA
Vijayalakshmi G, STA
Chellaiah M, STA
Alagarsamy P, MTS

REC-Gobichettipalayam

Rajalakshmi E, Sci-D
Aparna G, Field Assist. [Trans. 06.09.2021]

REC-Udumalpet

Samuthiravelu P (Dr), Sci-D
Ramesha S, STA [fm 20.09.2021]
Gnanaprakash B, Field Assist.
Palaniswamy S, Assist. Technician

RSRS-Mulugu

Praveen Kumar Kalla (Dr), Sci-D
Vinod Kumar Yadav (Dr), Sci-C
Gnaneswar R, Asst. Supdt. (Admn.)
Gandla Chalapathi, STA [Trans. 31.05.2022]
Tuyamani NK, STA
Rauf MA, Assist. Technician

REC-Vikarabad

Rajadurai S (Dr.), Sci-D
Bhagya Lakshmi Gudise, STA
Shoba Rani U, UDC [Trans. 31.03.2022]
Munirathnam Reddy C, Field Assist.
Buchaiah Papagari, Assist. Technician

REC-Amravati

Ram Vilas Kushwaha, Sci-D
Sunanda G Kasampure, STA
Dinesh Chandra, STA
Bheru Lal Kumawat, STA
Ratnadeep Arjun Zine, MTS

REC-Parbhani

Adhikrao Jayasing Karande, Sci-D [Rtd. 31.07.2021]
Jadhav Ashok Limbaji, Sci-C
Sidhartha Pandurang Ingle, STA

Rakeshkumar Nilkanthrai Vyas, STASabale
Shubhangi Vitthalrao, Field Assist.
Dineshkumar Babubhai Patel, MTS
Abdul Salam Sheikh Ibrahim, MTS [Rtd. 28.02.2022]

REC-Baramati

Humayun Sharief Y, Sci-D
Neethaben Meghdut Dang, STA
Vilas Bhujangrao Nagre, MTS
Patel Aratsinh Bhalabhai, MTS

REC-Aurangabad

Ram Prakash (Dr.), Sci-D
Anjali Prakash Nage, STA
Pushpa Bhaulal Ganbas (Hire), STA
Nirmala Suresh Popalghat, STA
Anwarkhan Mustafakhan Pathan, SCD Gr-II
Kantilal Chunilal Surti, MTS

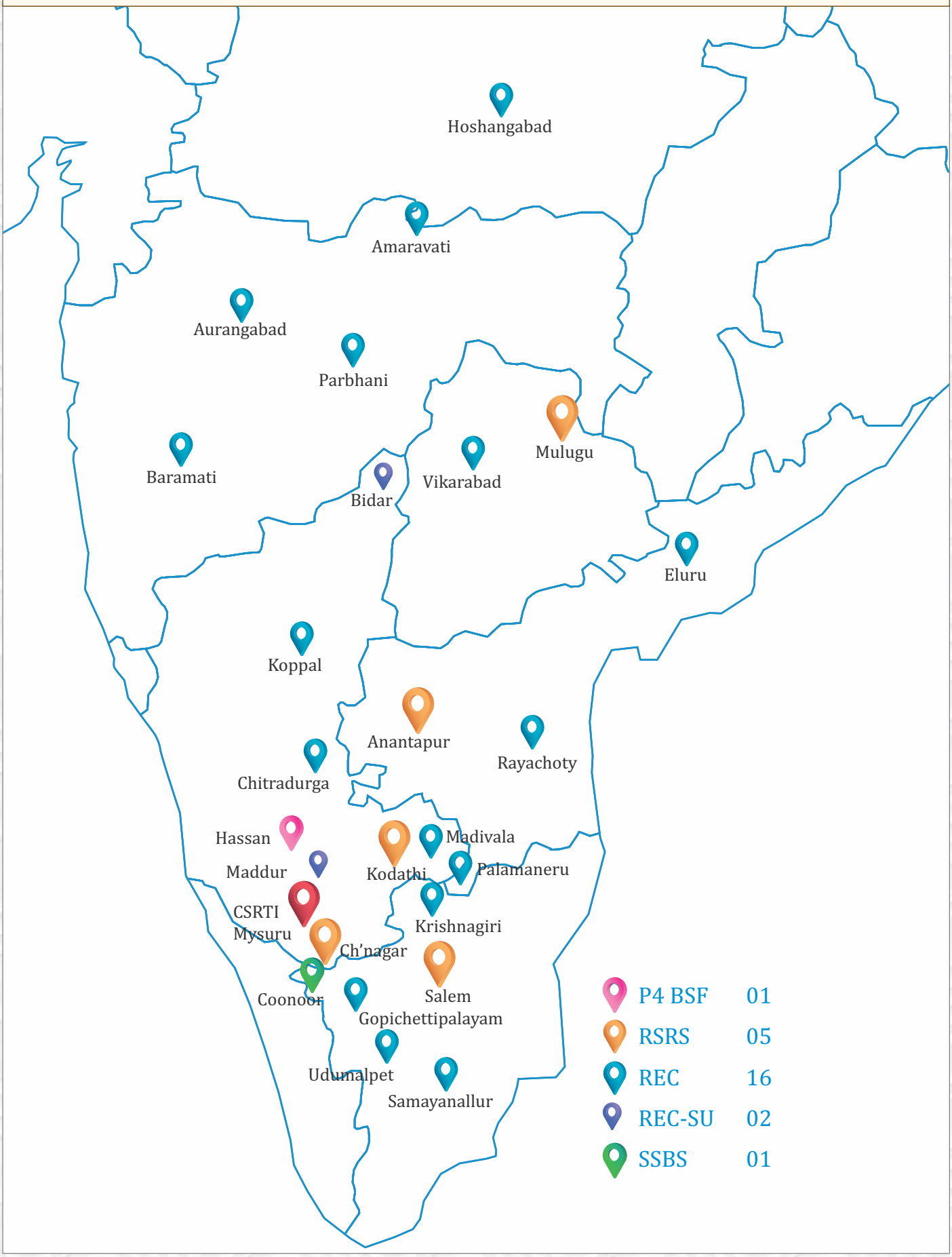
REC-Hoshangabad

Gnana Kumar Daniel A, Sci-D
Gamer Singh Kitawat, STA
Arjun Singh Kitawat, STA
Kanhaiya Lal Jeengar, STA
Tilak Ram Chowhan, FA, [Trans. 06.09.2021]

BUDGET (Rs. in lakhs)

Budget Head	Grants Received	Grants Surrendered	Expenditure Incurred
1. Plan: Salaries-36	3423.73	-	3423.73
2. Plan: SC Salaries-36	1177.55	-	1177.55
3. Plan: ST Salaries-36	443.03	-	443.03
4. Plan: Gen-31	981.06	-	981.06
5. Plan: Cap-35	108.08	-	108.08
Total	6133.47	-	6133.47

CSRTI-Mysuru & Nested Units



RESHAM KRISHIMELA 2021-22


CSRTI-Mysuru on 19.03.2022


Organised by RSRS Ananthapur at Penukonda on 18.02.2022

Organised by RSRS Mulugu at Kondannaguda on 11.03.2022

Organised by RSRS Salem at Theni on 04.01.2022