वार्षिक प्रतिवेदन
Annual Report
2019-20

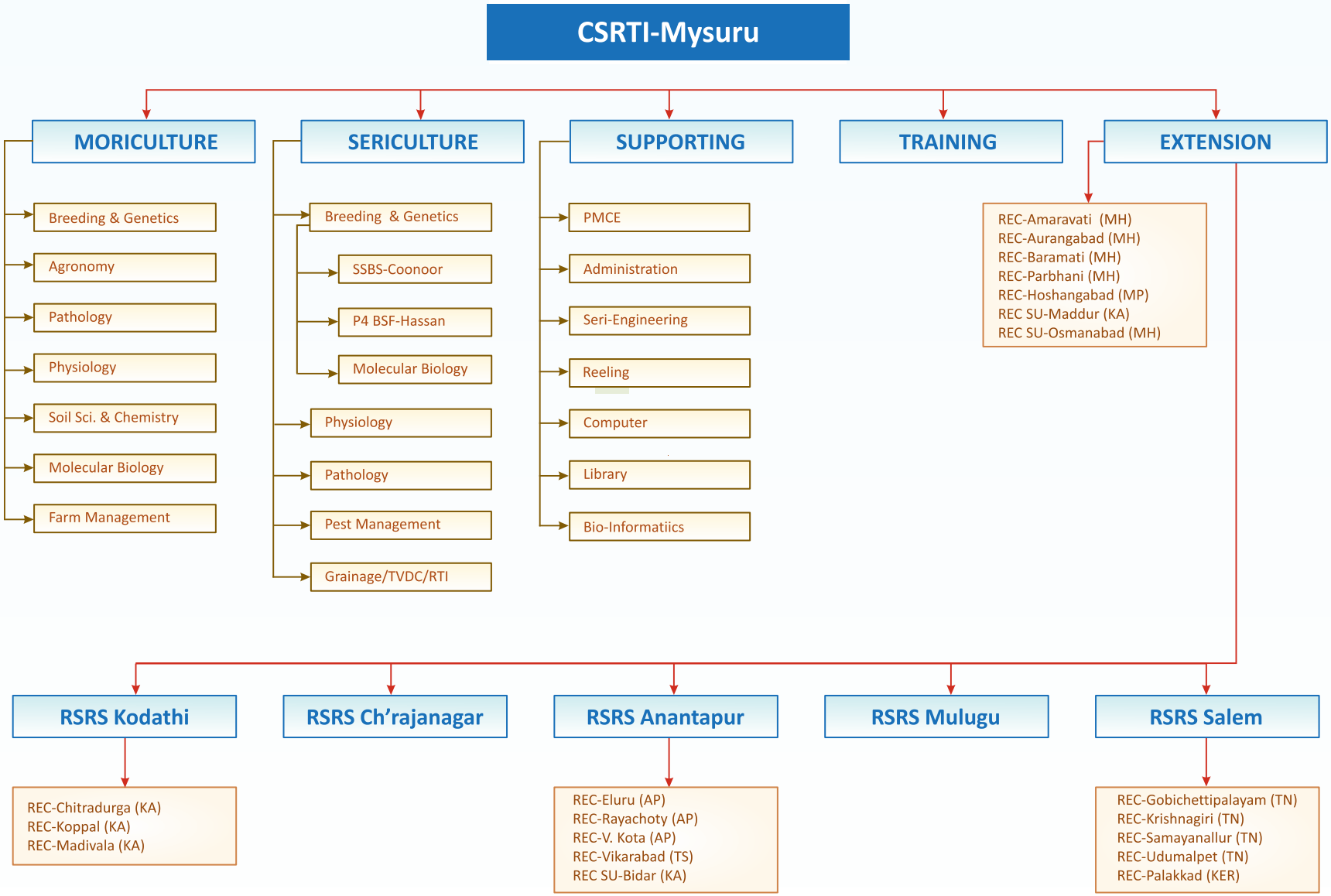
केंद्रीय रेशम उत्पादन अनुसंधान एवं प्रशिक्षण संस्थान

केंद्रीय रेशम बोर्ड, वस्त्र मंत्रालय, भारत सरकार, मैसूरु-570 008

Central Sericultural Research & Training Institute (CSRTI)

Central Silk Board, Ministry of Textiles, Govt. of India, Mysuru-570008

CSRTI-Mysuru Organizational set-up



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प्रस्तावना

दक्षिण भारत स्थित केंद्रीय रेशम उत्पादन अनुसंधान एवं प्रशिक्षण संस्थान, मैसूरु रेशम उत्पादन अनुसंधान एवं प्रशिक्षण के क्षेत्र में अग्रणी संस्थान है । उत्तम और नवीनतम प्रौद्योगिकियों के माध्यम से रेशम उत्पादों की उत्पादकता एवं गुणवत्ता बढाने हेतु संस्थान के द्वारा कर्नाटक, आंध्रप्रदेश, तेलंगाना, तमिलनाडु, केरल जैसे दक्षिण राज्यों के रेशम उत्पादन कृषकों की अपेक्षाओं को पूरा करने हेतु निरंतर प्रयास ज़ारी रखे गए ।

अधिक जल एवं पोषण - उपयोग क्षमता वाले जलवायु – सहिष्णु 8 (आठ) शहतूत प्रभेदों यथा एम.आई-0437, एम.आई-0310, एम.आई-0683, एम.ई-0173, एम.आई-0246, एम.आई- 0685, एम.आई-0762 और एम.ई-0256 की पहचान जलवायु – सहिष्णु शहतूत उपजाति के रूप में की गयी है । मेलोइडोगाइन इनकोग्निटा द्वारा उत्पन्न मूल गांठ रोग के विरुद्ध 415 विविध शहतूत जननद्रव्यों से आठ रोग प्रतिरोधी जननद्रव्य प्रतिरोधी प्रभेदों (बी.आर. 8, करंजटोली – 1 होसूर - सी 8 - 0364 (पी.2) नागलूर एस्टेट, टिप्पु, कलेब्रेसा, थाई-पेच व एस.आर.डी.सी. 3) की पहचान की गयी । क्षारीयता (पीएच>9) सहिष्णुता वाले चार जीनप्ररूपो यथा सहना(एम.आई.0524), भेरिया, डंगी-(एम.आई.0822),टी-36,(एम.आई.0226) और कांतल्लूर-2(एम.आई.0449) की पहचान की गई जिसका भविष्य के प्रजनन कार्यक्रम के लिए उपयोग किया जाएगा । शहतूत में आर्द्रता और क्षारीयता प्रतिबल सहनशीलता के लिए रेखीय समंकन विधि द्वारा योज्य (एडिटिव) सी.एस.आई. (ए.डी.डी.सी.एस.आई.) के आधार पर फसल चयन सूचिका विकसित की गई ।

डीयूएस परियोजना के अंतर्गत शहतूत उपजाति जी-4 के पंजीकरण के लिए आवेदन किया गया और पीपीवी एवं एफआरए से स्वीकृति प्राप्त की गई । उत्तर एवं पूर्वोत्तर अंचल के डीयूएस परीक्षण के लिए प्रमुख सह-परीक्षण केन्द्र के रूप में संस्थापना हेतु संस्थान ने केंरेअप्रसं, बहरमपुर, पश्चिम बंगाल को सहायता प्रदान की । विभिन्न राज्यों से 30,000 मृदा-नमूनों का विश्लेषण किया गया और रेशम उत्पादन कृषकों को स्थान - विशेष के लिए उर्वरकों की अनुशंसा की गई और मृदा उर्वरता स्थिति सहित कृषकों का विवरण प्रलेखित करके रखा गया जिनका विशेषज्ञों द्वारा भविष्य के अनुसंधान मैपिंग / योजना के लिए उपयोग किया जाएगा । रेशम उत्पादन विभाग से, कृषकों तथा विभिन्न संगठनों / एककों से प्राप्त 344 प्रतिदर्शों / उत्पादों के गुणवत्ता का विश्लेषण करके रिपोर्ट भेजी गई । शहतूत के मूल – विगलन रोग को नियंत्रित करने हेतु विकसित रॉट – फिक्स को दक्षिणी राज्यों के रेशम – उत्पादन कृषकों के बीच लोकप्रिय बनाया गया ।

बुल्गेरिया और भारत के रेशमकीट आनुवंशिक संसाधनों का उपयोग करते हुए एक नया द्विप्रज द्विसंकर बी.एफ.सी. 25 x बी.एफ.सी. ११ विकसित किया गया है जिसका कवच प्रतिशत 23.8, तंतु लंबाई 1095 मीटर और रेडिट्टा 5.8 है । प्राधिकरण परीक्षण के अंतर्गत द्विप्रज एकल संकर एस. 8 x सीएसआर १६ का मूल्यांकन(2,84,550 रोमुच) करने पर औसतन कोसा उपज 69 कि.ग्रा. / 100 रोमुच, कोसा कवच वजन - 1.782 ग्रा और कोसा कवच अनुपात 22% दर्ज किया गया । प्राधिकरण परीक्षण के अंतर्गत उन्नत कोसा नस्ल एम.वी. 1 x एस. 8 (कावेरी गोल्ड) का वर्ष में क्षेत्र मूल्यांकन करने पर औसतन कोसा उपज 60-65 कि.ग्रा. / 100 रोमुबीच चकत्ते, रेंडिट्टा 6-6.5, कोसा कवच प्रतिशत 21.65% कच्चा रेशम प्राप्ति 15.41% और तंतु गुणवत्ता 2 ए –3 ए श्रेणी पाई गई । उन्नत शुद्ध – वंश - एम.वी. संकर आई.सी.बी. 29 को द्विप्रज एस 8 से संकरण करने पर यह संकर २ए कोटि का रेशम उत्पादित करता है और यह एम.वी.1 x एस.8 के समतुल्य है और पी.एम.x सी.एस.आर.2 से श्रेष्ठ है । नई शुद्ध मैसूरु प्रजाति (पी.एम. 4) का भी विकास किया गया और पी.एम. 4 x सी.एस.आर. 2 के संकर को सभी प्रमुख आर्थिक विशेषकों में वर्तमान पी.एम. x सी.एस.आर. 2 से बेहतर पाया गया ।

दक्षिण भारतीय राज्यों में 13 मूल बीज फार्मों, 26 मेगा क्लस्टरों, तथा स्वतंत्र (नॉन कैप्टिव) क्लस्टरों को सम्मिलित कर रेशमकीट रोग अनुवीक्षण जारी रखा गया । आईसेरिया जावानिका और ब्यूवेरिया बास्सियाना का अनुक्रम एन.सी.बी.आई. को सूचित किया गया जिसकी प्रभेद की संख्या एम.एच. 712278.1 और एम.टी. 355427 प्राप्त हुई । शहतूत और गैर - शहतूत रेशमकीट के 529 नमूनों का एम. लैम्प आमापन का उपयोग करते हुए विभिन्न बीज प्रगुणन स्तर यथा उ.रे.प्र.कें. कूनूर, पी.4 मूबीफा, हासन, पी३, मूबीफा, मैसूरु, के.त.अ.प्र.सं., राँची, मू.बी.प्र.प.कें., बिलासपुर और मूबीप्रपकें, पाली में परीक्षण किया गया । रेशमकीट रोगों से संबंधित 36 क्षेत्र समस्याओं

को सुलझाया गया और उचित रोग प्रबंधन सुझाए गए ।

कर्नाटक और तमिलनाडु के 250 कृषकों के बीच रेशमकीट ऊजी मक्खी के विरुद्ध फेरोमोन ट्रैप का प्रदर्शन और प्रचार - प्रसार किया गया । कोलार, कर्नाटक और कृष्णगिरी, तमिलनाडु में दो जागरूकता कार्यक्रम संचालित किए गए । रेशमकीट ऊजीमखी के प्रबंधन हेतु 6261 नेसोलिंक्स थाइमस पाउच की आपूर्ति की गई ।शहतूत पर पिंक मिलि - बग प्रकोप नियंत्रित करने हेतु 47 बोक्ससीम्नस कोकिबोरा भृंगकों (11750 वयस्क) की आपूर्ति की गई । पत्ती रोलर एवं थ्रिप्स का प्रबंधन करने हेतु कर्नाटक, तमिलनाडु और आंध्र प्रदेश के शहतूत कृषकों को 216 यूनिट अंड परजीव्याभ (पैरासिटॉइड) (ट्राइकोग्रामा किलोनिम और 209 यूनिट लार्वीय परजीव्याभ (ब्राकोन ब्रेविकोर्निस) की आपूर्ति की गई ।

वर्ष के दौरान दो एकस्व: पोषण तथा बोम्बिक्स मोरी से शुद्ध सेरिसिन निष्कर्षण की प्रक्रिया प्राप्त किए गए ।दो यंत्र यथा प्लास्टिक चंद्रिका के लिए कोसा प्राप्ति यंत्र और शहतूत पत्ती कर्तन यंत्र राअविनि (एन.आर.डी.सी.) के माध्यम से सर्वश्री श्रीकृपा एन्टरप्राइज़ेज प्राइवेट लिमिटेड, कोल्हापुर, महाराष्ट्र को वाणिज्यीकरण के लिए अधिकृत किया गया ।

क्षमता निर्माण एवं अन्य प्रशिक्षण कार्यक्रम के अंतर्गत प्रौद्योगिकी अभिमुखीकरण एवं कृषक कौशल प्रशिक्षण के माध्यम से 1020 लाभार्थियों को प्रशिक्षित किया गया । केंरेअप्रसं, मैसूरु और इसके संबद्ध एककों के कुल 33 विस्तार कर्मचारियों को स्टेप कार्यक्रम एवं 440 लाभार्थियों (कृषकों, उद्यमियों पदधारियों और छात्रों) को आवश्यकता आधारित प्रशिक्षण कार्यक्रम के अंतर्गत प्रशिक्षित किया गया । विदेश मंत्रालय, भारत सरकार द्वारा प्रायोजित आईटीईसी कार्यक्रम के अंतर्गत 19 विदेशी प्रतिभागियों को केंरेअप्रसं, मैसूरु में एक महीने का प्रशिक्षण दिया गया । उनतीस स्नातकोत्तर और नौ स्नातक छात्रों ने अल्पकालिक पाठ्यक्रम के रूप में 3-6 महीने का शोध कार्य पूरा किया । प्रतिदर्श चॉकी कीटपालन केंद्र द्वारा 549 कीटपालकों को 80550 रोमुबी चकत्तों के चॉकी कीटों की आपूर्ति की गई जिससे 83.31किग्रा /100रोमुबीचकत्तों की औसत उपज दर्ज की गई ।

26 मेगा क्लस्टरों (106 क्लस्टर) और स्वतंत्र क्षेत्र के रूप में द्विप्रज क्लस्टर विकास कार्यक्रम के माध्यम से 452.88 लाख रोमुबी चकत्तों से 72.62 कि.ग्रा / 100 रोमुबीच के औसत रिकार्ड से 5054.50 मी.ट. द्विप्रज रेशम उत्पादित किया गया । 1220 विस्तार संचार कार्यक्रमों के माध्यम से 73755 रेशम उत्पादक कृषकों को द्विप्रज कीटपालन, शहतूत एवं रेशम कीट रोग प्रबंधन एवं गुणवत्तापूर्ण कोसा उत्पादन के बारे में जानकारी दी गई । मडकशिरा (आंध्रप्रदेश), सेन्जेरिपुतूर, तमिलनाडु और सिद्दिपेट (तेलंगाना) में रेशम उत्पादक कार्यशाला आयोजित की गई और 4950 कृषकों को उन्नत शहतूत रेशम उत्पादन प्रौद्योगिकियों से अवगत कराया गया । एम - किसान पोर्टल के अंतर्गत हर पखवाड़े में कर्नाटक,आंध्रप्रदेश, तमिलनाडु, तेलंगाना, महाराष्ट्र और मध्य प्रदेश के 75314 पंजीकृत एम. किसानों को कन्नड़, तेलुगू, तमिल और हिंदी में 96 संदेश भेजे गए । कुल 5332 आगंतुकों ने संस्थान का दौरा किया जिसमें कृषक, छात्र और विदेशी लोग शामिल थे । मद्दूर मेगा क्लस्टर, कर्नाटक में रेशम उत्पादन कृषक संगठन गठित किया गया । केंरेअप्रसं, मैसूरु में "कृषक उत्पाद संगठन" गठित करने के संबंध में प्रशिक्षण संचालित किया गया जिसमें केंरेबो और पूरे दक्षिण भारत के राज्यों के मेगा क्लस्टरों के 80 प्रतिनिधि एवं केंरेअप्रसं, मैसूरु के वैज्ञानिकों ने कार्यक्रम में भाग लिया । दिनांक 30 अगस्त 2019 को केंरेअप्रसं, मैसूरु के द्वारा सेरिकल्चर सक्सेस स्टोरिज़ पुस्तक का प्रकाशन किया गया । इस पुस्तक में 52 प्रगतिशील कृषकों की रेशम उत्पादन जीवन-गाथा का जिक्र किया गया है तथा स्थिर आजीविका के रूप में इसे अपनाने पर उनकी सराहना की गई है । आकाशवाणी, मैसूरु से स्थानीय भाषा (कन्नड़) में रेशम उत्पादक प्रौद्योगिकियों पर छ: धारावाहिक प्रसारित किए गए ।

रेशम उत्पादन अनुसंधान एवं विकास पर उत्कृष्ट योगदान हेतु केंद्रीय रेशम उत्पादन अनुसंधान एवं प्रशिक्षण संस्थान, मैसूरु रेशम उत्पादकों की समस्याओं/कठिनाइयों को समय पर हल करने के प्रतिबद्धता स्वरूप वर्ष-पर्यन्त प्रयासरत रहा और भविष्य में भी इस प्रकार के प्रयास ज़ारी रखे जाएंगे ताकि शहतूत रेशम कोसों की उत्पादकता को बढाते हुए रेशम उत्पादक कृषकों की निरंतर सहायता की जा सके । उक्त कार्य संस्थान के विभिन्न अनुभागों तथा संबद्ध एककों यथा क्षेरेअकें और अविकें के वैज्ञानिकों के गहन प्रयास से निष्पादित किया जा सका जिनका संस्थान द्वारा विकसित प्रौद्योगिकियों के स्थानांतरण में विशेष योगदान है एवं इसका अभीष्ट उद्देश्य द्विप्रज रेशम उत्पादन में वृद्धि लाकर आत्मनिर्भरता प्राप्त करना तथा रेशम उत्पादकों के जीवन स्तर में सुधार लाना था ।

FOREWORD

CSRTI-Mysuru is the pioneer research and development Institute of Sericulture in Southern parts of India. The Institute continued to cater to the needs of sericulture farmers of the southern zone comprising Karnataka, Andhra Pradesh, Telangana, Tamil Nadu, Kerala, Maharashtra and Madhya Pradesh by enriching them with the best and latest in technologies for improving the productivity and quality of sericulture products.

To address to the climate change, eight climate resilient mulberry accessions were identified viz., MI-0437, MI-0310, MI-0683, ME-0173, MI-0246, MI-0685, MI-0762 and ME-0256 with high water and nutrient use efficiency. Eight resistant germplasm accessions (BR-8, Karanjtoli-1, MI-0437×MI-0364 (P-2), Nagalur Estate, Tippu, Calabresa, Thai Pech & SRDC-3) were identified against root knot disease caused by *Meloidogyne incognita* from 415 diverse mulberry germplasm. Identified four genotypes highly tolerant to alkalinity stress (pH>9) viz., Sahana (MI 0524), Bheria dangi-1 (MI 0822), T-36 (MI 0226) and Kanthaloor-2 (MI 0449) which could be utilized for future breeding programmes. Crop selection indices for moisture and alkalinity stress tolerance in mulberry were developed based on additive CSI (ADD CSI) by linear scoring method.

Registration of mulberry variety G-4 has been filed and accepted by PPV&FRA under DUS project. We have also extended help in establishing CSRTI, Berhampore as a co-nodal DUS test centre for North and North-Eastern zone. 30000 soil samples from different states were analysed and provided the site specific fertilizer recommendations to the sericulture farmers. The soil fertility status with farmer's details is documented and maintained for future research / mapping / planning by the experts. Quality analysis of 344 samples / products received from DOS, farmers, different organizations/units was got done. Rot-fix, a product developed for control of root rot disease of mulberry has been popularized among the sericultural farmers of southern states.

A new bivoltine double hybrid BFC25 x BFC11 was developed utilizing Bulgarian and Indian silkworm genetic resources and has showed shell percentage of 23.8, filament length of 1,095 metre and renditta of 5.8. We have evaluated S8 x CSR16 a bivoltine single hybrid with 2,84,550 dfls under authorization trial and recorded an average cocoon yield of 69 Kg/100 dfls and shell ratio of 22%. The ICB MV1 × S8 (Cauvery Gold) was evaluated under authorization trails in the field with an average cocoon yield of 60 - 65 kg /100 dfls and fibre quality of 2A-3A grade. ICB 29 an improved pure line MV breed as crossbreed, with S8 produces 2A grade silk which is at par with MV1 × S8 and it is superior over PM × CSR2. We have also evolved new Pure Mysore line (PM 4), and the crossbreed of PM4 × CSR2 is found superior over existing PM × CSR2 on all important economic traits.

Silkworm disease monitoring in South Indian states was continued covering 13 BSFs, 26 mega clusters and non captive clusters. Sequences of *Isaria javanica, Beauveria bassiana* were submitted to NCBI and got accession numbers MH712278.1 and MT355427. Tested 529 samples of mulberry and non-mulberry silkworm were tested using M-LAMP assay at different seed multiplication level. SSBS-Coonoor, P4 BSF- Hassan, P3 BSF-Mysuru, CTRTI-Ranchi, BSMTCs-Bilaspur and Pali. 36 field problems related to silkworm diseases were resolved and addressed for proper disease management.

Demonstration and popularization of pheromone trap against silkworm uzi fly have been conducted with 250

farmers and two awareness programmes were also conducted at Kolar, Karnataka and Krishnagiri, Tamil Nadu. 6,261 pouches of *Nesolynx thymus* supplied for management of silkworm uzi fly. 47 boxes of *Scymnus coccivora* beetles (11,750 adults) supplied to manage pink mealy bug on mulberry. 216 units of egg parasitoid (*Trichogramma chilonis*), 209 units of larval parasitoid (*Bracon brevicornis*) and 19 units of predator *Blaptostethus pallescens* were supplied to manage the leaf roller and thrips to farmers.

Two patents were obtained during the year: Poshan and 'a process for the extraction of virgin sericin of *Bombyx mori'.* Two machineries were also commercialized cocoon harvester machine for plastic collapsible mountages and mulberry leaf chopping machine with M/s. Srikrupa Enterprises Pvt. Ltd, Kolhapur, Maharashtra thorough NRDC.

1020 beneficiaries were trained under Capacity Building and Training programmes through Technology Orientation Programme (TOP) and Farmer Skill Training (FST). Under STEP programme 33 extension staff from CSRTI and its nested units and Need Based Training Programmes 440 beneficiaries (farmers, entrepreneurs, officials and students). 19 overseas participants undergone one month training under ITEC programme sponsored by Ministry of External Affairs, Govt. of India. Three JOCVs were also trained under overseas training for a month. Twenty nine post graduate and nine graduate students completed dissertation work from 3-6 months as a part of partial course fulfillment. The model Chawki Rearing Centre reared and supplied chawki worms of 80550 dfls to 549 rearers and recorded an average yield of 83.31 kg/100 dfls.

5054.50 MT bivoltine raw silk was produced through Bivoltine-CPP in 26 mega clusters (106 clusters) and non captive areas from 452.88 lakh dfls rearing with an average cocoon yield of 72.62 kg/100 dfls. 73755 sericulturists were sensitized with new technologies through 1220 extension communication programmes. Three Sericulture Farmers' Workshops were organized at Madakasira (AP), Senjeriputhur (TN), Siddipet (TG) and 4950 farmers were enlightened. Under MKisan portal 96 messages were sent to 75314 registered farmers fortnightly in Kannada, Telugu, Tamil and Hindi. A total of 5332 visitors including farmers, students and foreign nationals visited the institute. One Farmer Producer Organization (FPO) awareness programme at Maddur mega cluster and a training on “Formation of FPO” was organized at CSRTI, Mysuru in which 80 CSB and DOS counterparts of mega clusters participated. Sericulture success stories book was published and released on 30th August 2019 with a collection of 52 progressive farmers narrating their saga of sericulture and appreciation on taking it as their way of life. A series of six sericulture technologies were broadcasted through AIR (Akashvani) Mysuru in local language (Kannada).

In pursuit of R & D excellence in sericulture, CSRTI-Mysuru continued to fulfill its commitment in resolving problems/difficulties encountered by the sericulturists in time during the whole year and shall continue to do so in future also in serving the sericulture fraternity to maximize the productivity of mulberry and silkworm cocoons with the concerted efforts of scientists of different divisions of the institute and nested units like RSRSs and RECs who are force behind transferring the technologies developed by the Institute to the field in achieving its vision of growth and development of bivoltine sericulture in order to attain self sufficiency in bivoltine raw silk production and to increase standard of living of our sericulturists.

कें रे अ प्र सं, मैसूरु के बारे में

केंद्रीय रेशम उत्पादन अनुसंधान एवं प्रशिक्षण संस्थान, मैसूरु केंद्रीय रेशम बोर्ड, वस्त्र मंत्रालय, भारत सरकार के नियंत्रणाधीन संस्थापित हुआ। पूर्व मैसूर राज्य में स्थापित रेशम उत्पादन अनुसंधान संस्थान के कार्यों को लेकर वर्ष 1961 में संस्थान ने चन्नपट्टणा में कार्य प्रारंभ किया 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 (कैंरेअप्रसं) के रूप में पुनर्नामकरण किया गया। यह संस्थान देश में रेशम उद्योग के विकास के लिए पिछले करीब 60 से अधिक सालों से प्रतिबद्धता के साथ कार्यरत है। संस्थान आई एस ओ 9001:2008 प्रमाणित (2013) है जो रेशम उत्पादन उद्योग के विकास हेतु गुणवत्ता प्रबंधन अनुसंधान व विकास प्रशिक्षण एवं अनुषंगी सेवाओं में उत्कृष्टता का प्रमाण है।

आज यह संस्थान अनुभवी वैज्ञानिकों, समस्त आधुनिक सुविधाओं एवं अवसंरचनायुक्त रेशम उत्पादन अनुसंधान के एक उत्कृष्ट संस्थान के रूप में विख्यात है। इस संस्थान ने देश तथा विदेश में उष्णकटिबंधीय रेशम उत्पादन में अग्रणी अनुसंधान व विकास संस्थान के रूप में ख्याति प्राप्त की है और यह उच्च अध्ययन एवं उन्नत प्रशिक्षण केंद्र के रूप में सुविख्यात है। यह संस्थान कर्नाटक, आंध्रप्रदेश, तमिलनाडु, तेलांगाना, केरल(अगस्त 2020 तक), महाराष्ट्र एवं मध्यप्रदेश में शहतूत रेशम उद्योग संबंधी आवश्यकताओं की पूर्ति करने हेतु रेशम उत्पादन अनुसंधान व विकास संबंधी समस्त कार्यकलापों में संलग्न है। अभी तक इस संस्थान ने रेशम उत्पादन प्रौद्योगिकी के विभिन्न पहलुओं में 830 विदेशियों सहित करीब 51,976 व्यक्तियों को प्रशिक्षित किया है। यह संस्थान अनुसंधान, प्रशिक्षण एवं विस्तार कार्य संचालित करने के अलावा राष्ट्रीय एवं अंतर्राष्ट्रीय अभिकरणों को परामर्श एवं सलाहकारी सेवाएँ भी प्रदान करता है।

दृष्टि	द्विप्रज रेशम उत्पादन में उत्कृष्ट अंतर्रराष्ट्रीय रेशम उत्पादन संस्थान के रूप में प्रतिस्थापित होना
लक्ष्य भारतीय रेशम उत्पादन उद्योग को आजीविका स्तर के उत्पादन से प्रतिस्पर्धी वाणिज्यिक उत्पादन आधार संरचना में परिणित करने हेतु अनुप्रयोग आधारित अनुसंधान में श्रेष्ठता हासिल करना	उद्देश्य • भारत में रेशम उत्पादन, उत्पादकता एवं गुणवत्ता बढ़ाने हेतु अनुसंधान शहतूत एवं रेशम कीटपालन के लिए पैकेज (समग्र पद्धति) विकसित करना • उत्पादों और प्रौद्योगिकियों का वाणिज्यीकरण • प्रौद्योगिकी स्थानांतरण • प्रौद्योगिकी स्थानांतरण के माध्यम से आयातित रेशम के आनुपातिक रेशम उत्पादन बढाना • प्रशिक्षण • अनुसंधान कार्यक्रमों को बल देने हेतु संस्थान के ढाँचे को मज़बूत बनाना • प्रजनक स्टॉक का अनुरक्षण • रोग पूर्वानुमान एवं पूर्वसूचना

संगठनात्मक संरचना

केंद्रीय रेशम उत्पादन अनुसंधान एवं प्रशिक्षण संस्थान, मैसूरु, देश में रेशम उत्पादन अनुसंधान विकास कार्य में संलग्न सबसे बड़ा और सर्वाधिक वैविध्यपूर्ण संस्थान है जिससे कृषि इंजीनियरों, समाजशास्त्रियों एवं अर्थशास्त्रियों सहित करीब 80 वैज्ञानिक जुडे हैं। ये कार्मिक कर्नाटक, तमिलनाडु, आंध्रप्रदेश, तेलंगाना, केरल, (अगस्त 2020 तक) महाराष्ट्र और मध्यप्रदेश राज्यों के मुख्य संस्थानों और संबद्ध एककों के माध्यम से समुचित प्रौद्यौगिकियों के विकास और उनके स्थानांतरण हेतु समन्वय कार्य कर रहे हैं। अनुसंधान व विकास कार्यकलाप और प्रौद्योगिकी विकास कार्य चार प्रमुख प्रभागों यथा पर-पोषी पादप, रेशमकीट, विस्तार एवं प्रशिक्षण संभाग 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 सेवाओं का भी उपयोग करता है। योजना, अनुवीक्षण, समन्वयन एवं मूल्यांकन कक्ष की सहायता से निदेशक, संस्थान और इसकी संबद्ध इकाइयों के अनुसंधान व विकास कार्यकलापों की प्रगति का अनुवीक्षण करते हैं। संस्थान के दो संबद्ध एकक-पी-4, मूल बीज फार्म, हासन और उ.रे.प्र.कें, कूनूर भी हैं जो पी-4 प्रजनक स्टॉक अनुरक्षण एवं द्विप्रज प्रजनन कार्यक्रम में सहायता करते हैं । पीपीवी व एफएफआर,

नई दिल्ली ने संस्थान को शहतूत उपजातियों के मुख्य केंद्र के रूप में मान्यता दी है । राष्ट्रीय एवं अंतर्राष्ट्रीय पत्रिकाओं में प्रकाशित तकनीकी एवं अनुसंधान शोध-पत्रों के अलावा संस्थान के द्वारा 71 पुस्तकें भी प्रकाशित की गई है। संस्थान को अंतर्राष्ट्रीय ख्याति की द्विवार्षिक पत्रिका इंडियन जर्नल ऑफ सेरिकल्चर और रेशम उत्पादन विज्ञान पर दस्तावेज़ी सहित्य सेरिडॉक प्रकाशित करने की प्रतिष्ठा भी प्राप्त है।

विस्तार कार्य-तंत्र (नेटवर्क)

प्रयोगशाला की उपलब्धियों के मान्यकरण एवं उन्हें क्षेत्र में प्रभावी ढंग से स्थानांतरित करने की प्रक्रिया को सुगम बनाने हेतु इस संस्थान के तीन स्तरीय विस्तार कार्य-तंत्र हैं - क्षेत्रीय रेशम उत्पादन अनुसंधान केंद्र (क्षे रे अ कें), अनुसंधान विस्तारण केंद्र (अ वि कें) और उपएकक। दक्षिणी राज्यों के मुख्य रेशम उत्पादन अंचलों में स्थित क्षेत्रीय रेशम उत्पादन अनुसंधान केंद्र क्षेत्र विशेष के अनुकूल एवं प्रायोगिक अनुसंधान संचालित करते हैं। विस्तार कार्य में संलग्न कर्मचारियों एवं कृषकों को प्रशिक्षित करने के अतिरिक्त क्षेत्रीय आवश्यकताओं के अनुसार उपर्युक्त प्रौद्योगिकियों की सिफारिश करने हेतु प्रौद्योगिकी परीक्षण किया जाता है। लाभार्थियों को प्रौद्योगिकी का स्थानांतरण करना और उनकी सहायता के लिए सभी प्रौद्योगिकी निवेश / तकनीकी जानकारी देने का उत्तरदायित्व अनुसंधान विस्तारण केंद्र एवं उप-एककों का है। महाराष्ट्र एवं मध्यप्रदेश के अलावा दक्षिण राज्यों में भी द्विप्रज रेशम उत्पादन को बढ़ावा देने हेतु कें रे अ प्र सं, मैसूरु, 106 समूहों (समूह संवर्धन कार्यक्रम) और ग्यारह सं.ग्रा.सं.का. (आई.वी.एल.पी.) केंद्रों का समन्वयन करता है। राज्य रेशम विभागों के तकनीकी कार्मिकों के समन्वयन से प्रौद्योगिकियों का प्रभावी स्थानांतरण किया गया है।

प्रशिक्षण केंद्र

इस संस्थान को उष्णकटिबंधीय रेशम - उत्पादन के क्षेत्र में प्रशिक्षित मानव संसाधन विकसित करने हेतु उत्कुष्ट केंद्र के रूप में मान्यता प्राप्त है जिसमें राष्ट्रीय एवं अंतर्राष्ट्रीय स्तर पर उष्णकटिबंधीय रेशम उत्पादन में प्रशिक्षण प्रदान किया जाता 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। इसे संस्थान के द्वारा ग्रामीण गरीब लोगों, कमज़ोर वर्गों और महिला रेशम - उत्पादकों के सामाजिक-आर्थिक विकास एवं प्रौद्योगिकी सशक्तिकरण हेतु जैव प्रौद्योगिकी विभाग एवं विज्ञान व प्रौद्योगिकी विभाग, भारत सरकार द्वारा प्रायोजित विभिन्न प्रशिक्षण कार्यक्रम संचालित किए जाते हैं। यह संस्थान राज्य रेशम उत्पादन विभागों की मानव संसाधन विकास आवश्यकताओं को पूरा करने के अलावा जापान अंतर्राष्ट्रीय सहकारिता अभिकरण एवं विदेश मंत्रालय, भारत सरकार (आईटीईसी) जैसे विभिन्न संगठनों द्वारा अंतर्राष्ट्रीय छात्रों/कार्मिकों को रेशम उत्पादन प्रशिक्षण कार्यक्रम भी संचालित करता है। प्रशिक्षण स्कंध में दृश्य-श्रव्य शिक्षण उपस्करों से सुसज्जित कक्षाएँ हैं और योग्य संकाय सदस्यों द्वारा कार्यक्रम संचालित किए जाते हैं। करीब 125 व्यक्तियों के ठहरने हेतु छात्रावास सुविधाएँ भी 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 के अभिकल्प एवं विकास तथा संरचना को समर्थित करने हेतु सभी सुविधाओं से युक्त रेशम उत्पादन अभियांत्रिकी प्रभाग।
- संबद्ध एककों, रेशम उत्पादन विभागों और अन्य संगठनों के साथ प्रभावी पारस्परिक संपर्क के लिए कें रे अ प्र सं, मैसूरु में संस्थापित विडियो सम्मेलन स्टुडियो प्रौद्योगिकी का तेजी से संप्रेषण एवं प्रभावी स्थानांतरण किया जाना सुनिश्चित करता है।
- कंप्यूटर सेन्टर द्वारा लैन के माध्यम से प्रिंट / फाइल शेयर / समर्थन सहित सभी को इन्टरनेट ज़कनेक्शन दिया गया है।
- जैव सूचना विज्ञान केंद्र आंकडें संचयन की पुन: प्राप्ति सेवा प्रदान करता है।
- पुस्तकालय सेवाएँ (11230 पुस्तकें, 8088 वैज्ञानिक पत्रिकाओं का बंध खंड, 51 जर्नल, शोध पत्र 310, प्रबंध-54 तकनीकी रिपोर्ट एवं सीडी रॉम डेटा बेस-एग्रिस।

ABOUT CSRTI-MYSURU

The Central Sericultural Research & Training Institute (CSRTI), Mysore 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 Mysore province and later shifted to Mysore in the year 1963. With the inclusion of training component, the Institute was renamed as 'Central Sericultural Research & Training Institute (CSRTI), Mysore' in the year 1965. The Institute has completed more than 60 years of dedicated service for the development of sericultural industry in the country.

The Institute has the distinction of being premier institution for sericulture research par excellence with all modern facilities and infrastructure including experienced scientific personnel. CSRTI has made mark as a leading R & D institution for quality research and services on tropical sericulture in the country and abroad and is well recognized as center for higher learning and advanced training. CSRTI caters to the need of on-farm sector of mulberry sericulture in Karnataka, Andhra Pradesh, Tamil Nadu, Telangana, Kerala, Maharashtra and Madhya Pradesh. To date CSRTI trained about 51,976 persons including 830 foreign nationals in various aspects of sericulture technology. The institute besides conducting research, training and extension activities, also offers consultancy and advisory services to national and international agencies.

Vision

To become an International Sericulture Institute par-excellence in Bivoltine Sericulture

Mission	***Objectives***
To achieve excellence in application oriented research to transform Indian Sericulture industry from the subsistence level of production to a vibrant competitive commercial production base	• Research to enhance production, productivity and quality of Indian silk • Development of package of practices for mulberry and silkworm rearing • Commercialization of products and technologies • Transfer of technology • Enhance production of import substitute silk through transfer of tech-nology • Training • Strengthening institutional framework to support research programmes • Maintenance of breeders stock • Disease forecasting and forewarning • Publication of R&D innovations and package of practices • Collaborative research with other R&D organizations in India and abroad

Organization Setup

CSRTI-Mysuru is the largest and most diversified institution engaged in sericulture R&D in the country, supported by about 80 scientists of various disciplines apart from agricultural engineers, sociologists and economists. These personnel working in close coordination for the development of appropriate technologies and their transfer through the main institute and its nested units spread in the states of Karnataka, Tamil Nadu, Andhra Pradesh, Telangana, Kerala (upto August 2020), Maharashtra and Madhya Pradesh. R & D activities and technology development are carried out in four major divisions: Host Plant Production & Protection, Silkworm Production & Protection, Sericulture Extension and Training. CSRTI-Mysore also utilizes the services of several able technical and administrative staff in undertaking 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 Institute is also having two nested units in P4 BSF, Hassan and SSBS, Coonoor supporting the P4 breeder's seed stock maintenance and bivoltine breeding programmes. The Institute is recognised as a nodal centre by PPV & FRA, New Delhi for mulberry varieties. CSRTI-Mysore regularly publishes books, bulletins, leaflets and technical pamphlets.

Over 71 books have been brought out so far in addition to large number of technical and research papers published in leading national and international journals. The institute has the distinction of publishing Indian Journal of Sericulture, a biannual journal of international repute and Seridoc documenting literature on sericultural sciences.

Extension Network

CSRTI-Mysuru has a three-tier system of extension network: Regional Sericultural Research Stations (RSRS), Research Extension Centres (REC) and Sub-Units (REC-SU) to facilitate validation and translation of laboratory findings effectively to the field. RSRSs are located in major sericultural zones of southern states carryout region-specific adaptive and applied research. Technology trials are also conducted to suit the regional requirements besides providing training to farmers and grassroot level extension staff. RECs and sub-units share the major responsibility of technology transfer to the beneficiaries and also provide technological inputs and support services. CSRTI-Mysuru coordinates 106 clusters (Cluster Promotion Programme) and eleven IVLP centers for the promotion of bivoltine sericulture in Southern States along with Maharashtra and Madhya Pradesh. Effective transfer of technologies is undertaken in close coordination with technical personnel of State Departments of Sericulture.

Training Centre

CSRTI-Mysuru is recognized as flagship centre for generation of trained human resource in tropical sericulture at international and national level. CSRTI-Mysuru also conducts training programmes sponsored by DBT, DST and Ministry of Textiles: Govt. of India for socio-economic and technological empowerment of the rural poor, weaker sections and women 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 students/personnel through various organizations such as JICA and Ministry of External Affairs: Govt. of India (ITEC). The training hub houses well-equipped classrooms and the programmes are managed by qualified faculty. The attached hostels can accommodate about 125 persons.

Infrastructure Facilities

- Well-equipped laboratories, 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 promote the concept of CRC
- Engineering Division with excellent facilities to support designing, development and fabrication of machines /equipments
- Video Conference Studio to ensure faster communication and efficient transfer of technology for effective interactions with nested units, DOSs and other organizations
- Computer center provides internet connectivity to all through LAN with print/file share support
- Bioinformatics Center (NBN Sub-DIC: DBT) provides database retrieval services
- Library Services (11230 books; 8088 bound volumes of scientific journals; 51 journals; dissertations-310; theses-54; technical reports and CD-ROM database-AGRIS).

अनुसंधान व विकास, विस्तार एवं प्रशिक्षण प्रभाग के मुख्यांश

मुख्य उपलब्धियाँ

1. अनुसंधान व विकास

पोषी पादप:फसल सुधार, उत्पादन एवं संरक्षण

- अधिक जल एवं पोषण - उपयोग क्षमता वाले जलवायु – सहिष्णु 8 (आठ) शहतूत प्रभेदों यथा एम.आई-0437, एम.आई-0310, एम.आई-0683, एम.ई-0173, एम.आई-0246, एम.आई- 0685, एम.आई-0762 और एम.ई-0256 की पहचान जलवायु – सहिष्णु शहतूत उपजातियाँ विकसित करने हेतु की गयी है ।
- जी – 4 शहतूत कल्टिवर के बीज पत्र एवं बीज पत्राधर कर्त्तातकों का उपयोग करते हुए प्रकाश संश्लेषी क्षमतायुक्त ट्रैन्सजेनिक शहतूत विकसित करने हेतु संपूर्ण पादप पुनर्जनन प्रोटोकॉल को अनुकूलतम बनाया गया ।
- पी.ई.पी.सी. + पी.ई.पी.सी.के. जीन और सी.ए. जीन युक्त प्यूटेटिव परिवर्तित और जड़युक्त शहतूत पौध विकसित किए गए जिसकी प्रकाश संश्लेषण क्षमता बेहतर है ।
- इष्टतम और उप - इष्टतम सिंचित स्थितियों में मूलन क्षमता एवं पत्ती उपज क्षमता से संबद्ध प्रकाश संश्लेषी विशेषकों के वंशागति पैटर्न का मूल्यांकन करने हेतु एस.एस.आर. चिह्नक के सहारे 21 संकरों की संकरण प्रकृति का विश्लेषण किया गया ।
- जी – 4 शहतूत कर्तोतकों में एटीडीआरईबी 2ए + एटीएसएचएन – 1 जीन संरचना का उपयोग करते हुए एग्रोबैक्टीरियम – माध्यम से आनुवंशिक परिवर्तन करने का प्रोटोकॉल विकसित किया गया ।
- शहतूत के मूल – विगलन रोग को नियंत्रित करने हेतु विकसित रॉट – फिक्स को दक्षिण राज्यों के रेशम – उत्पादन कृषकों में लोकप्रिय बनाया गया । इस प्रौद्योगिकी को वाणिज्यिक उत्पादन हेतु रा.अ.वि.कें. (एन.आर.डी.सी.) के माध्यम से दो फर्मों को स्थानांतरित किया गया ।
- मेलोइडोगाइन इनकोग्निटा द्वारा उत्पन्न मूल गांठ रोग के विरुद्ध 415 विविध शहतूत जननद्रव्य का मूल्यांकन किया गया । आठ रोग प्रतिरोधी जननद्रव्य प्रतिरोधी प्रभेदों (बी.आर. 8, करंजटोली – 1, एम.आई. x होसूर - सी 8), नागलूर एस्टेट, टिप्पु, कलेब्रेसा, थाई-पेक व एस.आर.डी.सी. 3) की पहचान की गयी ।
- उच्च उत्पादक शहतूत उपजाति जी – 4 की सुस्पष्टता, एकरूपता और स्थायित्व (डी.यू.एस) परीक्षण हेतु पंजीकरण के लिए आवेदन किया गया है ।
- उत्तर एवं पूर्वोत्तर अंचल में विकसित शहतूत उपजातियों का परीक्षण करने हेतु केंरेअप्रसं, बहरमपुर, पश्चिम बंगाल में सुस्पष्टता, एकरूपता एवं स्थायित्व के लिए प्रमुख सह परीक्षण केन्द्र की संस्थापना की जा रही है।
- शहतूत में क्षारीयता के प्रति सहनशीलता को नियंत्रित करने वाले क्यू.टी.एल. को पहचानने के लिए जीव संख्या मानचित्रण (मैपिंग पोपुलेशन) विकसित करने हेतु क्षारीयता सहनशील दो जीनप्ररूप यथा एम.आर. 2 एवं सहना का चयन करके इन जीनप्ररूपों का संवेदनशील जीन प्ररूप.वी - 1 (एस.आर.-2 बी.1 x सहना बी.1) से संकरण कर नया संकर बनाया गया ।
- 96 चयनित विविध जननद्रव्य में 46 एसएसआर चिह्नकों का प्रोफाइल तैयार किया गया । इनमें से 16 चिह्नकों को शहतूत में विविधता विश्लेषण एवं क्यू.टी.एल. पहचान हेतु उपयुक्त पाया गया जो आवर्ती पोलिमोर्फिक बैन्ड दर्शाते हैं ।
- मार्कर आधारित प्रजनन (एम.ए.बी.) के ज़रिए उपज की आनुवंशिक क्षमता का पता लगाकर संस्थान में ए.आर.बी.डी. डिजाइन के अंतर्गत 5 प्रतिकृतियों सहित 231 (183 देशी और 48 विदेशी) विविध जननद्रव्य की संस्थापना की गई ।
- विभिन्न राज्यों से 30,000 मृदा नमूनों का विश्लेषण किया गया और रेशम उत्पादन कृषकों के लिए स्थान - विशेष उर्वरकों की अनुशंसा की गई । उपर्युक्त मृदा उर्वरता स्थिति सहित कृषकों का विवरण प्रलेखित करके रखा गया है जिनका विशेषज्ञों द्वारा भविष्य के अनुसंधान मैपिंग / योजना के लिए उपयोग किया जा सकता है ।
- रेशम उत्पादन विभाग से, कृषकों तथा विभिन्न संगठनों / एककों से प्राप्त 344 प्रतिदर्शों / उत्पादों के गुणवत्ता का विश्लेषण करके रिपोर्ट भेजी गई ।
- शहतूत में आर्द्रता और क्षारीयता प्रतिबल सहनशीलता के लिए रेखीय समंकन विधि द्वारा योज्य (एडिटिव) सी.एस.आई. (ए.डी.डी.सी.एस.आई.) के आधार पर फसल चयन सूचिका विकसित की गई । इन सूचिकाओं का प्रतिबल तीव्रता एवं जीवेतर प्रतिबल

प्रतिक्रिया के परिमाणन में व्यापक तौर पर उपयोग किया जाता है एवं इससे उपजाति की सहनशीलता स्तर पर जानकारी भी मिलती है।

- क्षारीयता प्रतिबल के प्रति अधिक सहनशील (पी एच > 9) 4 जीवप्ररूपों यथा सहना (एम.आई-0524) भेरिया डंगी - 1 (एम.आई-0822), टी - 36 (एम.आई-0226) और कांतल्लूर - 2 (एम.आई-0449) की पहचान की गई । इन जीनप्ररूपों का भविष्य के प्रजनन कार्यक्रमों के लिए उपयोग किया जा सकता है ।

रेशमकीट : फसल सुधार, उत्पादन एवं संरक्षण

- बुल्गेरिया और भारत के रेशमकीट आनुवंशिक संसाधनों का उपयोग करते हुए एक नया द्विप्रज द्विसंकर बी.एफ.सी. 25 x बी.एफ.सी. 11 विकसित किया गया है जिसका कवच प्रतिशत 23.8, तंतु लंबाई 1095 मीटर और रेडिट्टा 5.8 है ।
- रेशमकीट में रेशम गुणवत्ता हेतु किए गए ट्रैस्क्रिप्टोमिक्स विश्लेषण से मन्नोसिडेज और यूबीआई 1 को रेशम फाइब्रोइन विश्लेषण में प्रभावशाली नियामक के तौर पर पाया गया जो फाइब्रोइन विश्लेषण मार्ग एवं रेशम गुणवत्ता को प्रभावित करता है । इन जीनों से संबंद्ध एस.एन.पी. को 3 प्रमुख एसएनपी सहित विशुद्ध मैसूर प्रजाति में 4 मल्टी - एलेलिक साइट की पहचान की गई जबकि पीएम x सीएसआर 2 में (15 एसएनपी सहित) 17 मल्टी - एलेलिक साइट में पहचान की गई जिसका अधिकतम मान 2.22 टीएस/टीएस पाया गया ।
- 100 रेशमकीट जीनप्ररूपों का 20 एस.एस.आर. चिह्नकों से संबंद्ध करके गुणात्मक और 9 परिमाणात्मक विशेषकों के लिए मूल्यांकन किया गया । 20 एस एस आर मार्करों ने बहुरूपिता दर्शाई जिसकी औसत एलीली सं. 4.3, पोलिमोर्फिक सूचना सार (पी.आई.सी.) 0.47, जीन विविधता 0.51 रही । संरचना विश्लेषण करने पर अधिकांश प्रभेदों को पाँच उप-जीवसंख्या में पाया गया जिसमें 16.5% मिश्रित पाए गए । संयोजित जननद्रव्य आनुवंशिक तौर पर विविधता दर्शाते हैं जिसमें प्यूपीय दर, ताप सहनशीलता, कोसा वजन, कोसा कवच वजन, कोसा कवच प्रतिशतता और मुख्य उपज संघटकों में अधिक विविधता है । भारत की उष्णकटिबंधीय स्थितियों के लिए उपयुक्त उत्तम जीनप्ररूपों को विकसित करने हेतु इसका उपयोग किया जा सकता है ।
- आइसो-साइट्रेट डिहाइड्रोजनेज, ग्लूकोस डिहाइड्रोजनेज, लिपेस, प्रोटीन टाइरोसिन फोस्फेटस, एटासिन, एंकिरिन एल्कलाइन, टाइरोसिन किनेस, डिपेप्टिडाइल पेप्टिडेस को रोग प्रतिरोध (बी.एम.डी.एन.वी.1, बी.एम.आई.एफ.वी., बी.एम.एन.पी.वी. से संबंद्ध (एस.एस.आर.) मार्कर के रूप में पहचाना गया । इनमें से आइसोसाइट्रेट डिहाइड्रोजनेज (एस0803-आर) रोग प्रतिरोधी प्रजातियों का चयन करने हेतु सक्षम मार्कर के रूप में पहचान की गयी । एस.एस.आर. मार्कर का क्रोमोसोम स्थान, रेखा पथ (लोकस) और एम्प्लिकॉन – आकार के लिए गुण लक्षण निर्धारित किया गया ।
- प्राधिकरण परीक्षण के अंतर्गत द्विप्रज एकल संकर एस. 8 x सीएसआर 16 का मूल्यांकन (2,84,550 रोमुच) करने पर औसतन कोसा उपज 69 कि.ग्रा. / 100 रोमुच, कोसा कवच वजन - 1.782 ग्रा., एकल कोसा कवच वजन - 0.395 ग्रा. और कोसा कवच अनुपात 22% दर्ज किया गया ।
- उन्नत शुद्ध – वंश - एम.वी. संकर आई.सी.बी. 29 जिसका एकल कोसा वजन 1.431 ग्रा, एकल कोसा कवच वजन - 0.274 ग्रा कोसा कवच प्रतिशत 19.18% और धागाकरण क्षमता 67.87%, तंतु लंबाई 558 मी, रेशम प्रतिशतता 9.72 और स्वच्छता 85.80 है, को द्विप्रज एस 8 और सी.एस.आर. 2 से संकरण किए जाने पर शीतनिष्क्रियता लक्षण प्रकट नहीं करता है । आई.सी.बी. 29 और एस . 8 का संकर नस्ल 2ए कोटि का रेशम उत्पादित करता है जो एम.बी.1 x एस.8 के समतुल्य है और वर्तमान संकर नस्ल पी.एम. x सी.एस.आर.2 से श्रेष्ठ है ।
- विकसित शुद्ध मैसूरु प्रजाति पी.एम. 4 का उपयोग करते हुए पी.एम. 4 x सी.एस.आर. 2 के निष्पादन का मूल्यांकन किया गया और सभी प्रमुख आर्थिक विशेषकों यथा एकल कोसा कवच 1.63 ग्रा. (1.470) एकल कोसा कवच वजन 0.31 ग्रा. (0.270), कोसा कवच अनुपात 19.24% (18.61), धागाकरण क्षमता 86.00% (84.00), तंतु लंबाई 681 मी. (548)] स्वच्छता 85 (80) में वर्तमान पी.एम. x सी.एस.आर. 2 से बेहतर पाया गया ।
- प्राधिकरण परीक्षण के अंतर्गत उन्नत कोसा नस्ल एम.वी. 1 x एस. 8 (कावेरी गोल्ड) का वर्ष में क्षेत्र मूल्यांकन करने पर औसतन कोसा उपज 60-65 कि.ग्रा. / 100 रोमुबीच चकत्ते, रैंडिट्टा 6-6.5, कोसा कवच प्रतिशत 21.65% कच्चा रेशम प्राप्ति 15.41% और तंतु गुणवत्ता 2 ए – 3 ए श्रेणी पाई गई ।
- एम.वी. 1 और एच.बी. 4 को मादा जनक तथा एस. 8 और बी.एम. 2 को नर जनक के रूप में उपयोग करते हुए आठ संयोजन तैयार

किए गए और उपरति और गैर-उपरति जीनों की अभिव्यक्ति की जाँच करने हेतु आर.एन.ए. विश्लेषण किया गया । तीन नमूनों ट्रिहालोस ट्रान्स्पोर्टर जीन की अभिव्यक्ति और 5 नमूनों में पैरालिटिक पेप्टाइड बाइन्डिंग प्रोटीन जीन और 2 नमूनों में सार्बिटॉल डीहाइड्रोजनेस जीन की अभिव्यक्ति दर्शाई गई । प्रजाति की स्थिरता पर कार्य जारी है ।

- कर्नाटक, तमिलनाडु और आंध्र प्रदेश के 13 मूल बीज फार्मों तथा कर्नाटक, आंध्र प्रदेश, तमिलनाडु, तेलंगाना, महाराष्ट्र के 26 मेगा क्लस्टरों और महाराष्ट्र, मध्य प्रदेश और केरल के स्वतंत्र (नॉन कैप्टिव) क्लस्टरों को सम्मिलित कराकर दक्षिण भारतीय राज्यों में रेशमकीट अनुवीक्षण जारी रखा गया ।ग्रैसरी का प्रकोप 0.40%, फलैचरी का 1.37% एवं मस्कर्डाइन का 0.27% पाया गया ।
- रेशमकीट में ग्रे मस्कार्डिन उत्पन्न करने वाले आइसेरिया जवानिका की रोगजनकता पर अध्ययन करने हेतु कर्नाटक के रेशमकीटों से उन्हें पृथक किया गया । पृथक किए गए प्रभेद के एल.डी. 50 की गणना 3×10^5 कोनीडिया / मि.ली. के रूप में की गयी । फफूँद का आण्विकी लक्षण निर्धारण किया गया और एन.सी.बी.आई. में अनुक्रम प्रस्तुत किया गया । प्रभेद की संख्या एम.एच. 712278.1 है । यह भारत में रेशमकीट से पृथक किए गए आईसेरिया जवानिका की पहली रिपोर्ट है ।
- रेशमकीट बोम्बिक्स मोरि एल. से पृथक किए गए ब्यूवेरिया बास्सियाना का अनुक्रम एन.सी.बी.आई. को सूचित किया गया और प्रभेद सं. एम.टी. 355427 प्राप्त हुई ।
- बी.एस.एम.टी.सी. बिलासपुर और बी.एस.एम.टी.सी. पाली में तसर रेशमकीटों के लिए एम लैम्प आमापन का मान्यकरण किया गया । परिणाम सूक्ष्माणु परीक्षण के अनुरूप साबित हुई, तसर शलभ एन्थीरिया माइलिट्टा को शोधित करके उसमें से डी.एन.ए. को पृथक किया गया एम लैम्प आमापन में उपयोग किए गए एफ 3 एवं बी3 प्राइमरों का पीसीआर प्रतिक्रिया में प्रवर्धन हेतु उपयोग किया गया ।प्राप्त अनुक्रम नोसेमा स्पीसिज से 93.43% समानता दर्शाता है । दो अनुक्रमों को एन.सी.बी.आई. में प्रस्तुत किया गया और प्रभेद सं. एम.एन. 416241 और एम.एन. 416240 प्राप्त हुए ।
- शहतूत और गैर - शहतूत रेशमकीट के अंड कवच और शलभ सहित ए 29 नमूना में एम. लैम्प आमापन का उपयोग करते हुए विभिन्न बीज प्रगुणन स्तर यथा उ.रे.प्र.कें. कूनूर, पी.4 मूबीफा हासन ; पी3 मूबीफा मैसूरु ; के.त.अ.प्र.सं राँची ; मू.बी.प्र.प.कें बिलासपुर और मूबीप्रपकें पाली में परीक्षण किया गया ।
- रेशमकीट रोगों से संबंधित 36 क्षेत्र समस्याओं को सुलझाया गया और उचित रोग प्रबंधन सुझाए गए ।
- विभिन्न विसंक्रामकों एवं शय्या-विसंक्रामकों से संबंधित 27 गुणवत्ता विश्लेषण रिपोर्ट जारी की गई ।
- कर्नाटक और तमिलनाडु के 250 कृषकों के बीच रेशमकीट ऊजी मक्खी के विरुद्ध फेरोमोन ट्रैप का प्रदर्शन और प्रचार - प्रसार किया गया । कोलार, कर्नाटक और कृष्णगिरी, तमिलनाडु में दो जागरूकता कार्यक्रम संचालित किए गए ।
- 3.13 लाख रो.मु.बी.चकतों के कीटपालन के लिए पर्याप्त 6261 नेसोलिंक्स थाइमस पाउच की आपूर्ति की गई । शहतूत पर पिंक मिलि - बग प्रकोप नियंत्रित करने हेतु सीम्नस कोकिबोरा भृंगकों (11750 वयस्क) की आपूर्ति 23 एकड़ शहतूत बागान के प्रबंधन के लिए की गई ।
- पत्ती रोलर (डायाफेनिया पल्वेरुन्टालिस) का प्रबंधन करने हेतु कर्नाटक, तमिलनाडु और आंध्र प्रदेश के शहतूत कृषकों को 216 यूनिट अंड परजीव्याभ (पैरासिटॉइड) (ट्राइकोग्रामा किलोनिम और 209 यूनिट लार्वीय परजीव्याभ (ब्राकोन ब्रेविकोर्निस) की आपूर्ति की गई । कर्नाटक और तमिलनाडु के कृषकों के द्वारा परभक्षी ब्लाप्टोस्टेयस पैलेसिन्स की 19 यूनिट (1 यूनिट = 10.00 ग्राम/ब्लाक परभक्षी) का उपयोग करने के परिणाम स्वरूप थ्रिप्स का प्रकोप 34 प्रतिशत से घटकर 8 से भी तक कम हो गया ।

एकस्व एवं प्रौद्योगिकियों का वाणिज्यीकरण

- दो एकस्व प्राप्त हुए: पोषण:एक बहु-पोषक सूत्र और उसे तैयार करने की प्रक्रिया तथा सेरिसिन निष्कर्षण प्रक्रिया:बोम्बिक्स मोरी से शुद्ध सेरिसिन निष्कर्षण की प्रक्रिया।
- दो यंत्र यथा प्लास्टिक की सिमटनेवाली चंद्रिका से कोसा प्राप्ति यंत्र और शहतूत पत्ती कर्तन यंत्र के उत्पादन एवं वितरण हेतु राअविनि (एन.आर.डी.सी.) के माध्यम से सर्वश्री श्रीकृपा एन्टरप्राइज़ेज प्राइवेट लिमिटेड, कोल्हापुर, महाराष्ट्र को उत्पादन एवं आपूर्ति हेतु वाणिज्यीकृत किया गया ।

क्षमता निर्माण/प्रशिक्षण

- क्षमता निर्माण एवं अन्य प्रशिक्षण कार्यक्रम के अंतर्गत प्रौद्योगिकी अभिमुखीकरण एवं कृषक कौशल प्रशिक्षण के माध्यम से 1020

लाभार्थियों को प्रशिक्षित किया गया ।

- केंरेअप्रसं, मैसूरु और इसके संबद्ध एककों के कुल 33 विस्तार कर्मचारियों को स्टेप कार्यक्रम के अंतर्गत प्रशिक्षित किया गया ।
- गहन द्विप्रज प्रौद्योगिकी, चॉकी कीटपालन, जागरूकता कार्यक्रम और जैव नियंत्रण कारक उत्पादन में 440 लाभार्थियों (कृषकों, उद्यमियों पदधारियों और छात्रों) के लिए आवश्यकता आधारित प्रशिक्षण संचालित किया गया ।
- विदेश मंत्रालय, भारत सरकार द्वारा प्रायोजित आईटीईसी कार्यक्रम के अंतर्गत 19 विदेशी प्रतिभागियों को केंरेअप्रसं, मैसूरु में एक महीने का प्रशिक्षण दिया गया ।
- तीन जेओसीवी को विदेशी प्रशिक्षण कार्यक्रम के अंतर्गत केंरेअप्रसं, मैसूरु में एक महीने का प्रशिक्षण देकर विभिन्न राज्यों में तैनात किया गया ।
- उनतीस स्नातकोत्तर और नौ स्नातक छात्रों ने आंशिक पाठ्यक्रम के रूप में शोध कार्य पूरा किया ।
- प्रतिदर्श चॉकी कीटपालन केंद्र द्वारा 549 कीटपालकों को 80550 रोमुबी चकत्तों के चॉकी कीटों की आपूर्ति की गई जिससे 83.31किग्रा /100 रोमुबीचकत्तों की औसत उपज प्राप्त हुई ।

II रेविअप्र

- आंध्रप्रदेश, कर्नाटक, तमिलनाडु, तेलंगाना और महाराष्ट्र और स्वतंत्र क्षेत्र से 26 मेगा क्लस्टरों (106 क्लस्टर) में कार्यान्वित द्विप्रज क्लस्टर विकास कार्यक्रम के माध्यम से 452.88 लाख रोमुबी चकत्तों से 72.62 कि.ग्रा / 100 रोमुबीच के औसत रिकार्ड से 5054.50 मी.ट. द्विप्रज रेशम उत्पादित किया गया ।
- 1220 विस्तार संचार कार्यक्रमों के माध्यम से 73755 रेशम उत्पादक कृषकों को द्विप्रज कीटपालन, शहतूत एवं रेशम कीट रोग प्रबंधन एवं गुणवत्तापूर्ण कोसा उत्पादन के बारे में जानकारी दी गई ।
- मडकशिरा (आंध्रप्रदेश), सेन्जेरिपुत्तूर तमिलनाडु और सिद्दिपेट (तेलंगाना) में रेशम उत्पादक कार्यशाला आयोजित की गई और 4950 कृषकों को उन्नत शहतूत रेशम उत्पादन प्रौद्योगिकियों से अवगत कराया गया ।
- तीन जेओसीवी को विदेशी प्रशिक्षण कार्यक्रम के अंतर्गत केंरेअप्रसं, मैसूरु में एक महीने का प्रशिक्षण देकर हिंदुपुर (आंध्रप्रदेश), हल्द्वानी (उत्तराख़ंड), में तैनात किया गया ।
- एम - किसान पोर्टल के अंतर्गत हर पखवाडे में कर्नाटक,आंध्रप्रदेश, तमिलनाडु, तेलंगाना, महाराष्ट्र और मध्य प्रदेश के 75 एम. किसानों को कन्नड, तेलुगु, तमिल और हिंदी में 96 संदेश भेजे गए ।
- कुल 5332 आगंतुकों ने संस्थान का दौरा किया जिसमें कृषक, छात्र और विदेशी लोग शामिल थे ।
- मद्दूर मेगा क्लस्टर, कर्नाटक में रेशम उत्पादन कृषक संगठन गठित किया गया ।
- केंरेअप्रसं, मैसूरु में 2 व 3 जुलाई 2019 को "कृषक उत्पाद संगठन" गठित करने के संबंध में प्रशिक्षण संचालित किया गया । केंरेबो और पूरे दक्षिण भारत के राज्यों के मेगा क्लस्टरों के 80 प्रतिनिधि एवं केंरेअप्रसं, मैसूरु के वैज्ञानिकों ने कार्यक्रम में भाग लिया ।
- दि 30 अगस्त 2019 को केंरेअप्रसं, मैसूरु में सेरिकल्चर सक्सेस स्टोरिज़ पुस्तक का प्रकाशन किया गया । इस पुस्तक में 52 प्रगतिशील कृषकों की रेशम उत्पादन जीवन-गाथा का जिक्र किया गया है तथा स्थिर आजीविका के रूप में उसे अपनाने पर उनकी सराहना की गई है । उक्त पुस्तक केंरेबो के देश भर के संस्थानों तथा दक्षिण भारत के राज्य रेशम विभाग के अधिकारियों के बीच वितरित की गई ।
- आकाशवाणी, मैसूरु से 9 जनवरी से 13 फरवरी 2020 तक स्थानीय भाषा (कन्नड़) में रेशम उत्पादक प्रौद्योगिकियों पर छः धारावाहिक प्रसारित किए गए ।

HIGHLIGHTS OF RESEARCH & DEVELOPMENT, EXTENSION AND TRAINING DIVISION

The R&D programmes undertaken in mulberry and silkworm breeding, crop production and protection; transfer of technology; extension and training activities resulted in developing technologies suitable for the needs of mulberry sericulture farmers in the states of Andhra Pradesh, Karnataka, Kerala, Tamil Nadu, Telangana, Maharashtra and Madhya Pradesh. The salient achievements of CSRTI-Mysuru are as follows:

I. RESEARCH & DEVELOPMENT

Host plant: Crop Improvement, Production and Protection

- Eight mulberry climate resilient mulberry accessions viz., MI-0437, MI-0310, MI-0683, ME-0173, MI-0246, MI-0685, MI-0762 and ME-0256 with high water and nutrient use efficiency were identified to develop climate resilint mulberry varieties.
- Optimized whole plant regeneration protocol for photosynthetic efficient transgenic mulberry development using cotyledon and hypocotyl explants of G4 mulberry cultivar.
- Developed putative transformed and rooted mulberry plantlets containing *PEPC+PEPCK* genes and *CA* genes contributing towards higher photosynthetic efficiency
- The hybridity nature of 21 hybrids was analyzed through SSR marker in order to evaluate their inheritance pattern for rooting ability and photosynthetic related traits linked to foliage yield potential under optimal and sub-optimal irrigated conditions.
- The protocol using *Agrobacterium* mediated genetic transformation in cotyledons/ hypocotyl explants of G4 mulberry using At*DREB2A+AtSHN1* gene construct has been developed.
- *Rot-fix* a product developed for control of root rot disease of mulberry has been popularized among the sericultural farmers of southern states. The technology has been transferred to two firms through NRDC for its commercial production.
- About 415 diverse mulberry germplasm were evaluated against root knot disease caused by *Meloidogyne incognita.* Identified eight resistant germplasm accessions (BR-8, Karanjtoli-1, MI-0437×MI-0364 (P-2), Nagalur Estate, Tippu, Calabresa, Thai Pech & SRDC-3).
- Application on registration of Distinctiveness, Uniformity and Stability (DUS) test for a high yielding mulberry variety G-4 has been filed and accepted by PPV&FRA.
- A co-nodal Distinctiveness, Uniformity and Stability test centre is being established at Central Sericultural Research & Training Institute, Berhampore, West Bengal to test mulberry varieties developed at North and North-Eastern zone.
- Two genotypes *viz.* MR2 and Sahana were identified for alkaline tolerance, crosses were made using these genotypes with susceptible genotype V1 (MR2×V1 & Sahana×V1) for development of mapping population to identify QTLs governing alkalinity tolerance in mulberry.
- Out of 46 SSR markers profiling against 96 selected diverse germplasm, 16 markers (37.78%) were found suitable for diversity analysis and QTL identification in mulberry displaying repeatable polymorphic bands.
- Established 231 (183 indigenous and 48 exotics) diverse mulberry germplasm with 5 replication under ARBD design in the institute for exploring the genetic potentiality of yield through Marker Assisted Breeding (MAB).
- 30000 soil samples from different states were analysed and provided the site specific fertilizer recommendations to the sericulture farmers. The soil fertility status of above soil with farmer's details is documented and maintained, which can be used for future research / mapping / planning by the experts.
- Conducted quality analysis of 344 samples / products which are used in sericulture and got received from DOS, farmers, different organizations/units and sent the reports.
- Crop selection indices for moisture and alkalinity stress tolerance in mulberry were developed based on additive CSI (ADD CSI) by linear scoring method. These indices have wide utility in quantifying the stress intensity and abiotic stress responses and it also provides information on tolerance level of the variety.
- Identified four genotypes highly tolerant to alkalinity stress (pH>9) viz., Sahana (MI 0524), Bheria dangi-1 (MI

0822), T-36 (MI 0226) and Kanthaloor-2 (MI 0449) which could be utilized for future breeding programmes.

Silkworm : Crop Improvement, Production and Protection

- A new bivoltine double hybrid BFC25 x BFC11 developed utilizing Bulgarian and Indian silkworm genetic resources and has showed shell percentage of 23.8, filament length of 1,095 metre and renditta of 5.8.
- Transcriptomics analysis for silk quality in silkworm, revealed mannosidase and ubi1 as potential regulators involved in silk fibroin synthesis, which would influence the fibroin synthesis pathway and silk quality. SNPs associated with these genes have been identified with 4 multiallelic site in Pure Mysore with 3 prominent SNPs, whereas 17 multiallelic sites were identified in PM X CSR2 bearing 15 SNPs having highest 2.22 ts/ts values.
- 100 silkworm genotypes were genotyped with 20 SSR markers and concurrently evaluated for nine quantitative and five qualitative traits. Twenty SSR markers were polymorphic with mean allele number of 4.3, polymorphic information content (PIC) of 0.47 and gene diversity of 0.51. Structure analyses placed most of the accessions into the five subpopulations with 16.5 % as admixtures. The assembled germplasm is genetically diverse with high variation in pupation rate, thermo tolerance, cocoon weight, shell weight, cocoon shell percentage, and key yield components which could be exploited in developing superior genotypes for tropical conditions of India.
- Isocitrate dehydrogenase, glucose dehydrogenase, lipase, protein tyrosine phosphatase, attacin, ankyrin, alkaline tyrosine kinase, dipeptidyl peptidase are identified as SSR markers associated with disease tolerance (BmDNV1, BmIFV and BmNPV). Of which Isocitrate dehydrogenase (S0803-R) has been identified as potential marker for selection of disease tolerant lines. The SSR markers are characterized for chromosomal location, locus and amplicon size.
- S8 x CSR16, a bivoltine single hybrid evaluated (2,84,550 dfls) under authorization trial has recorded an average cocoon yield of 69 Kg/100 dfls, with single cocoon wt., 1.782g, single shell wt., 0.395g and shell ratio of 22%.
- ICB 29 an improved pure line MV breed with single cocoon weight 1.431g, single shell weight 0.274g, cocoon shell percentage of 19.18% and reelability 67.87%, filament length 558 m, silk percentage 9.72 and neatness 85.80. No hibernation when crossed with bivoltine S8 and CSR2. The crossbreed of ICB29 with S8 produces 2A grade silk which is at par with MV1 × S8 and it is superior over the existing crossbreed PM × CSR2.
- Using the evolved Pure Mysore line PM 4 evaluated the performance of crossbreed of PM4 × CSR2 and found superior over existing PM × CSR2 on all important economic traits, single cocoon weight 1.63g (1.470), single shell weight 0.31g (0.270), shell ratio 19.24% (18.61), reelability 86.00% (84.00), and filament length 681m (548), neatness 85 (80).
- The ICB MV1 × S8 (Cauvery Gold) was evaluated under authorization trails throughout the year in the field showed an average cocoon yield of 60 - 65 kg /100 dfls, renditta 6 - 6.5, cocoon shell percentage of 21.65 % and raw silk recovery 15.41 % and fibre quality of 2A-3A grade.
- Utilizing MV1 and HB4 as female parents and S8 and BM2 as male parents, eight combinations were prepared and subjected to RNA analysis to check the expression of diapause and non diapause genes. Three samples showed the expression for Trehalose Transporter gene, 5 samples expressed for Paralytic peptide binding protein gene and 2 samples expressed for Sorbitol dehydrogenase gene. Stabilization of the line is under progress.
- Silkworm disease monitoring in South Indian states was continued covering 13 BSFs from Karnataka, Tamil Nadu and Andhra Pradesh; 26 megaclusters from Karnataka, Tamil Nadu, Andhra Pradesh, Telangana, Maharashtra and non captive clusters from Maharashtra, Madhya Pradesh and Kerala. The point prevalence of grasserie was 0.40%, Flacherie 1.37% and muscardine 0.27%.
- The pathogenicity of *Isaria javanica* which causes the grey muscardine in silkworm isolated from Karnataka. The LD_{50} of the isolated strain is calculated as $3x10^5$conidia/ml. The molecular characterization of the fungus has been done and the sequence submitted in the NCBI. The accession number is MH712278.1.This is the first report of *Isaria javanica* isolated from silkworm from India.

- Published sequence of *Beauveria bassiana* isolated from silkworm *Bombyx mori* L to NCBI and got accession number Mt355427.
- Validated the M-LAMP assay for tasar silkworms with BSMTC Bilaspur (CG) and BSMTC Pali (CG). The results were confirmative after the microscopic testing. The spores obtained from the tasar moth, *Antheraea mylitta* were purified and the DNA was isolated from it. The primers F3 and B3 used in M-LAMP assay were used for the amplification in the PCR reaction and the sequence obtained shows 93.43% similarity to that of *Nosema sp.* Two sequences were submitted to NCBI and obtained accession numbers MN416241 and MN 416240.
- Tested 529 samples of mulberry and non-mulberry silkworm samples which includes egg shells and moths using M-LAMP assay at different seed multiplication levels, SSBS-Coonoor, P4 BSF- Hassan, P3 BSF-Mysuru, CTR&TI-Ranchi, BSMTC-Bilaspur and BSMTC-Pali.
- Resolved 36 field problems related to silkworm diseases and addressed for proper disease management.
- 27 quality analysis reports for the different disinfectants and bed disinfectants were issued.
- Demonstration and popularization of pheromone trap against silkworm uzi fly have been conducted with 250 farmers from Karnataka and Tamil Nadu. Also two awareness programmes were conducted at Kolar, Karnataka and Krishnagiri, Tamil Nadu.
- 6,261 pouches of *Nesolynx thymus* supplied to cover 3.13 lakh dfls rearing for the management of silkworm uzi fly. 47 boxes of *Scymnus coccivora* beetles (11,750 adults) supplied to cover 23 acres of mulberry plantation to manage pink mealy bug on mulberry.
- 216 units of egg parasitoid (*Trichogramma chilonis*) and 209 units of larval parasitoid (*Bracon brevicornis*) were supplied to mulberry farmers from Karnataka, Tamil Nadu and Andhra Pradesh to manage the leaf roller (*Diaphania pulverulentalis*). For the biological control of mulberry thrips (*Pseudodendrothrips mori*) supplied 19 units (I unit= 1000 grubs/adults) of a predator *Blaptostethus pallescens* to Karnataka and Tamil Nadu farmers. Subsequent to the introduction of the predator, the thrips incidence reduced from 34 per cent to less than 8 per cent.

Patents and Commercialization of Technologies

- Two patents were obtained: Poshan - A multi-nutrient formulation and a process for preparation and Sericin extraction process - A process for the extraction of virgin sericin of *Bombyx mori* .
- Two machineries *viz.,* Cocoon harvester for plastic collapsible mountages machine and mulberry leaf chopping machine were commercialized to M/s.Srikrupa Enterprises Pvt. Ltd, Kolhapur, Maharashtra thorough NRDC for production and supply to sericulture farmers.

CBT/Training

- 1020 beneficiaries were trained under Capacity Building and Training programmes through Technology Orientation Programme (TOP) and Farmer Skill Training (FST).
- A total of 33 extension staff from CSRTI and its nested units were trained under STEP Programme.
- Need Based Training Programmes (NBT) were conducted for 440 beneficiaries (farmers, entrepreneurs, officials and students) in intensive bivoltine technology, chawki rearing, awareness programme, bio-control agent production.
- 19 overseas participants undergone one month training at CSRTI-Mysuru under ITEC programme sponsored by Ministry of External Affairs, Govt. of India.
- Three JOCVs were trained under overseas training for a month at CSRTI, Mysuru and were posted in different states.
- Twenty nine post graduate and nine graduate students completed dissertation work from 3-6 months as a part of partial course fulfillment.
- The model Chawki Rearing Centre reared and supplied chawki worms of 80550 dfls to 549 rearers and recorded an average yield of 83.31 kg/100 dfls.

SEEM

- A record quantity of 5054.50 MT bivoltine raw silk was produced through Bivoltine Cluster Promotion Programme implemented in 26 mega clusters (106 clusters) at Andhra Pradesh, Karnataka, Kerala, Tamil Nadu, Telangana, Maharashtra and non captive areas from 452.88 lakh dfls rearing with an average cocoon yield of 72.62 kg/100 dfls
- 73755 sericulturists were sensitized with new technologies through 1220 extension communication programmes in bivoltine rearing, mulberry and silkworm disease management and quality cocoon production.
- Sericulture Farmers' Workshops were organized at Madakasira (Andhra Pradesh), Senjeriputhur (Tamil Nadu), Siddipet (Telangana) and 4950 farmers were enlightened with improved mulberry sericulture technologies.
- Three JOCVs were trained under overseas training programme for a month at CSRTI, Mysore and posted to Hindupur (Andhra Pradesh), Haldwani (Uttarakhand).
- Under *M-kisan* portal 96 messages were sent to 75314 registered farmers in every fortnight to Karnataka, Andhra Pradesh, Telangana, Tamil Nadu, Maharashtra and MP in Kannada, Telugu, Tamil and Hindi
- A total of 5332 visitors including farmers, students and foreign nationals visited the institute.
- One Farmer Producer Organisation (FPO) was organised under Maddur Mega cluster, Karnataka.
- Training on "Formation of Farmer Producer Organisation" was organized on 2nd and 3rd July 2019 at CSRTI, Mysuru. Eighty CSB and DOS counterparts of mega clusters across southern states and scientists from CSRTI, Mysuru participated in the programme.
- Sericulture Success stories book Vol-I was published and released on 30th August 2019 at CSRTI, Mysuru. The book has the collection of 52 progressive farmers narrating their saga of sericulture life and appreciation on taking it as their way of life for sustainable livelihood. The books were distributed to all CSB institutes across India and DOS offices (Southern zone).
- A series of six sericulture technologies were broadcasted in local language (Kannada) through AIR (Akashavani) Mysuru from January 9th 2020 to 13th February 2020.

राजभाषा कार्यान्वयन संबंधी गतिविधियाँ

केंद्रीय रेशम उत्पदन अनुसंधान एवं प्रशिक्षण संस्थान, मैसूरु में वर्ष 2019-20 के दौरान राजभाषा नीति का सफलतापूर्वक अनुपालन किया गया। राजभाषा के महत्वपूर्ण प्रावधान यथा राजभाषा अधिनियम की धारा 3(3), राजभाषा नियम - 5 आदि का भी शत प्रतिशत अनुपालन सुनिश्चित किया गया । संस्थान में हर तिमाही में राजभाषा कार्यान्वयन समिति की बैठक का आयोजन कर राजभाषा प्रगति के बारे में समीक्षा की गई एवं हिन्दी कार्यशाला का आयोजन नियमित रूप से किया गया । निर्धारित लक्ष्य के अनुसार हिन्दी टिप्पण-आलेखन के अलावा महत्वपूर्ण वैज्ञानिक एवं तकनीकी साहित्य को भी हिन्दी में प्रकाशित करने का कार्य किया गया ।

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, पहचान-पत्र आदि द्विभाषी में तैयार किए गए हैं । इन्हें सुनिश्चित करने हेतु जाँच बिंदु (भंडार अनुभाग, प्रेषण कक्ष और संबंधित अधिकारी के स्तर पर) बनाया गया है ।
3. **हिंदी पत्राचार:** वर्ष के दौरान क, ख तथा ग क्षेत्र स्थित केंद्रीय सरकारी कार्यालयों को क्रमश: 70%, 72% और 77% पत्र हिंदी में भेज कर निर्धारित लक्ष्य प्राप्त किया गया है ।
4. **राजभाषा कार्यान्वयन समिति की बैठकों का आयोजन:** संस्थान में हर तिमाही में राजभाषा कार्यान्वयन समिति की बैठक का आयोजन कर राजभाषा के प्रगामी प्रयोग के बारे में समीक्षा की गई । वर्ष 2019-20 के अंतर्गत दिनांक 09.05.2019, 26.08.2019, 05.11.2019 एवं 31.01.2020 को राजभाषा कार्यान्वयन समिति की बैठक 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 एवं वैज्ञानिकों के लिए इस वर्ष के दौरान दिनांक 10.05.2019, 30.07.2019, 06.11.2019 और 24.01.2020 को अलग-अलग पूर्णकालिक एक दिवसीय हिंदी कार्यशाला का आयोजन कर कुल 33 अधिकारियों व 36 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 – काज निष्पादन को प्रोत्साहित करने के लिए टिप्पण आलेखन प्रोत्साहन योजना कार्यान्वित किया गया है जिसके अंतर्गत निर्धारित शब्द लिखने पर नकद पुरस्कार दिया जाता है । वर्ष 2019-20 के दौरान इस योजना के अंतर्गत संस्थान तथा अधीनस्थ कार्यालयों के 18 पदधारियों को पुरस्कृत किया गया ।
7. **हिंदी प्रकाशन:** वर्ष के दौरान अर्धवार्षिक राजभाषा गृह पत्रिका "रेशम किरण" जून 2019 का प्रकाशन किया गया । इसके अलावा 2 तकनीकी पुस्तिकाओं / पत्रक यथा 1) मृदा स्वास्थ्य एवं उर्वरक प्रबंधन 2) रेशम उत्पादन क्षेत्र अवशिष्टों से वानस्पतिक खाद और कृमि वानस्पतिक खाद का निर्माण का भी हिन्दी में प्रकाशन किया गया ।
8. **राजभाषा नियम 10(4) के अंतर्गत अधीनस्थ कार्यालयों को अधिसूचित किया जाना:** जिन कार्यालयों में हिंदी में कार्यसाधक ज्ञान रखने वाले अधिकारी / कर्मचारी का प्रतिशत 80 या अधिक हो जाता है, उन कार्यालयों को मंत्रालय द्वारा राजभाषा नियम10(4) के अधीन अधिसूचित किया जाता है ।
9. **हिंदी दिवस / पखवाड़ा का आयोजन :** संस्थान में दिनांक 01.09.2019 से 16.09.2019 तक राजभाषा पखवाड़ा मनाया गया । इस दौरान 4 विभिन्न हिंदी प्रतियोगिताओं का आयोजन किया गया । प्रत्येक प्रतियोगिता के विजेताओं को प्रथम, द्वितीय, तृतीय एवं सांत्वना पुरस्कार प्रदान किया गया । हिन्दी दिवस दिनांक 16.09.2019 को पूर्ण उत्साह के साथ मनाया गया ।
10. **कंप्यूटर पर हिंदी में कार्य:** महत्वपूर्ण मद जैसे धारा 3(3) का अनुपालन, फार्म/प्रपत्र,मानक मसौदे, तिमाही रिपोर्ट तथा मूल्यांकन रिपोर्ट, बैठकों की कार्रवाई संबंधी कार्य कंप्यूटर पर सुचारू रूप से किए जा रहे हैं । संस्थान में सभी कंप्यूटरों में यूनिकोड की संस्थापना की गई है जिससे हिंदी,अंग्रेजी तथा अन्य भारतीय भाषाओं में काम करने में सुविधा प्राप्त हो गई है ।
11. **राजभाषा निरीक्षण** : राजभाषा नीति के कार्यान्वयन में हुई प्रगति की समीक्षा करने तथा तदनुसार आवश्यक सुझाव एवं मार्गदर्शन देने हेतु अधीनस्थ कार्यालयों - क्षेरेअकें, अनंतपुर, शादनगर, आविकें, विकाराबाद, अमरावती एवं हासन का निरीक्षण किया गया । संस्थान के अनुभागों के निरीक्षण हेतु 4 सदस्यीय राजभाषा निरीक्षण समिति का गठन किया गया है जो विभिन्न अनुभागों में जाकर राजभाषा कार्यों का निर्धारित रूप से निरीक्षण करती है ।

12. **हिन्दी पुस्तक :** हिन्दी पुस्तकालय हेतु वर्ष के दौरान रु. 7,327/- पुस्तकों की खरीद की गई । इसके अलावा बृहत प्रशासनिक शब्दावली(हिंदी-अंग्रेज़ी) की 50 प्रतियां खरीदकर अधीनस्थ केन्द्रों एवं संस्थान के अनुभागों में वितरित की गई ।
13. **प्रशिक्षण :** दो राज्यों (महाराष्ट्र व उत्तर प्रदेश) से आए कुल 234 प्रशिक्षणार्थियों को रेशम संवर्धन के विविध विषयों पर कुल 17 विभिन्न पाँच - दिवसीय कार्यक्रम में हिन्दी माध्यम से प्रशिक्षण प्रदान किया गया ।
14. **राजभाषा डेस्क प्रशिक्षण :** पत्राचार करने वाले अनुभागों की सुविधा के लिए राजभाषा अनुभाग द्वारा विभिन्न अनुभागों में जाकर राजभाषा डेस्क प्रशिक्षण प्रदान किया गया ।

ACTIVITIES REGARDING OFFICIAL LANGUAGE IMPLEMENTATION

During 2019-20 Official Language policy was implemented succesfully at Central Sericultural Research and Training Institute, Mysuru. Cent-percent compliance of important Official Language Provisions i.e. Section 3(3) of Official Language Act and Official Language Rule - 5 were ensured. The progress in implementation of Hindi was reviewed regularly by conducting quarterly meeting of the Official Language Implementation Committee and the progress regarding the Official Language was reviewed in each quarter. Apart from doing Hindi Noting and Drafting in Hindi as per prescribed target, important Scientific and Technical literature were also published in Hindi.

The detail of the action taken on the different Official Language implementation points during the year under report is as follows.

1. **Compliance of Section 3(3):** All documents specified 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, Signboards, Name plates, Identity Cards etc are made bilingual. Check points (Stores Section, Despatch Section and at the level of concerned officer) have been devised to ensure the same in bilingual.
3. **Hindi Correspondence:** During the year, more than the prescribed targets for correspondence of Hindi were achieved by sending 70%, 72% and 77% 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 from time to time by conducting OLIC meeting in every quarter. During the year 2019-20 Official Language Implementation Committee meetings were organised on 09.05.2019, 26.08.2019, 05.11.2019 and 31.01.2020 and follow up action was taken on the decisions of the meeting.
5. **Organisation of Hindi Workshops:** Hindi workshop was organised in every quarter for the employees of the Institute to provide information related to use of Hindi in the Official work and to extend other relevant information about Official Language Policy. During the year, 23 Scientists / 36 Officers and Staff were trained in one day full time Hindi workshop organised in the institute on 10.05.2019, 30.07.2019, 06.11.2019 and 24.01.2020
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, Noting-Drafting Incentive Scheme was implemented in which cash awards are given for writing prescribed words in Hindi. During the said year 18 officials of the Institute and subordinate offices were awarded.
7. **Publications in Hindi:** Half yearly house magazine – Resham Kiran June 2019 was published. Besides, 2 technical booklets / pamplets 1) Soil Health and fertility management 2) Composting and Vermi composting through recycling of sericultural farm residue were published in Hindi.
8. **Notification of the subordinate offices under 10(4) of the Official Languages Rules:** The Offices in which 80% or more of the staff have attained working knowledge in Hindi are notified under 10(4) of the official languages Rules.

9. **Organisation of Hindi Day / Fortnight:** Official Language Fortnight was organised from 01.09.2019 to 16.09.2019 during in which Hindi competitions were organised. The winners of the competitions were awarded with First, Second, Third and Consolation prizes. Hindi Day was celebrated on 16.09.2019 with full enthusiasm.
10. **Work on Computers in Hindi:** Compliance of Section 3(3), Forms, Standard drafts, quarterly progress report, evaluation report of works related to meetings are carried out smoothly on computers. Unicode system has already been installed in all computers which facilitates employees to do work in Hindi, English and other Indian languages.
11. **Official Language Inspection:** 5 Sub-ordinate offices viz. RSRS, Anantapur, Shadnagar, REC Vikarabad, Hassan and Amaravathi were inspected for reviewing the progress made regarding implementation of Official Language Policy and necessary suggestions & guidance were extended accordingly. Besides, on Official Language Implementation Committee comprising of 4 members has been constituted for inspecting the Official Language works going on in different sections of the Institute.
12. Hindi Books amounting to Rs. 7327/- was purchased for Library of the Institute during the year. Apart from this 50 copies of comprehensive administrative glossary (Hindi- English) were purchased and distributed to all sections and subordinate offices of the institute.
13. **Training:** 234 trainees from 2 states (Maharashtra and Uttar Pradesh) were trained on various topics of sericulture through Hindi medium in 17 different Five Day Training Programmes.
14. **Official Language Desk Training:** Official Language Desk Training was imparted to six correspondence making sections at their work place for their convenience.

PROGRESS OF RESEARCH PROJECTS AND PROGRAMMES
MULBERRY BREEDING AND GENETICS

Concluded Research Project:

PIE-3575: Evaluation of mulberry genetic resources for functional traits associated with resilience to climate change (Aug. 2016 - Jul. 2019; in collaboration with CSGRC- Hosur)

S. Gandhi Doss, T. Gayathri, (upto Mar. 2019), G. S. Arunakumar, Raju Mondal (CSGRC-Hosur) and R. S. Teotia

Objectives

- To estimate variability in different functional traits associated with 'Nitrogen' use efficiency and drought tolerance in mulberry germplasm
- To identify donor parents for specific traits having adaptive significance
- To standardize the assessment method for different functional traits to identify desired mulberry genotypes

The study was conducted at four different locations *viz.,* CSGRC-Hosur; CSRTI-Mysuru; RSRS-Ananthapur and REC-Koppal to evaluate the performance of 37 mulberry germplasm accessions, short-listed for the study, planted in ARBD design in 3 blocks along with 4 check varieties *viz.,* V1, S-13, Vishala and Anantha. After completion of establishment period, the experimental plants were pruned during March 2018 and data on various growth and yield attributing parameters were recorded for consecutive 5 different crop seasons. Besides, photosynthetic gas exchange parameters, water use efficiency and glutamine synthetase activity was also recorded. The average data revealed that four accessions performed better for above ground biomass (AGB) with an increase of 15-37%, six accessions for shoot weight (16-64%) and three accessions for leaf weight (19-22%) over the check variety S13. Similarly 14 accessions performed better for AGB (15-67% increase), 15 accessions for shoot weight (18-103% increase) and Vishala and 11 accessions for leaf weight (16-47% increase) along with check variety S13 for these parameters.

Germplasm accessions evaluated in the study

Accession No.	Variety Name	National Accession	Scientific Name
ME-0007	SHRIM-2	EC493764	*M. alba*
ME-0016	LAZURASO	EC493773	*M. latifolia*
ME-0065	S-1	EC493822	*M. alba*
ME-0107	M. LHOU SERINGE	EC493985	*M. latifolia*
ME-0125	THAILAND LOBED	EC493852	*M. alba*
ME-0137	ZIMBABWE-12	EC493864	*M. alba*
ME-0170	TONKIN	EC493897	*M. latifolia*
ME-0188	CHINA-8	EC493915	*M. latifolia*
ME-0244	MORUS F6	NA	*M.latifolia*
ME-0251	BR-4	NA	*M. alba*
ME-0253	BR-3	NA	*M. latifolia*
MI-0139	GAJAPATHIPUR-3	IC313761	*M.indica*
MI-0214	T-15	IC313864	*M. alba*
MI-0226	T-36	IC313876	*M. alba*
MI-0246	C-1748	IC313896	*M. indica*
MI-0256	UP-23	IC313800	*M. indica*
MI-0286	MOTHER GRAFT	IC313667	*M. indica*

Accession No.	Variety Name	National Accession	Scientific Name
MI-0310	CHEKMAJRA	IC314155	*M. indica*
MI-0314	UP-27	IC313812	*M. alba*
MI-0332	NAGALUR ESTSTE	IC314028	*M. indica*
MI-0376	KUNJAGAO-2	IC314166	*M. indica*
MI-0400	KRISHNASWAMY-2	IC314233	*M. indica*
MI-0437	BARAGARH-2	IC314185	*M. indica*
MI-0439	RSRS, SAHASPUR	IC314187	*M. latifolia*
MI-0458	C-1	IC314239	*M. indica*
MI-0470	K2 X BC	IC313998	*M. indica*
MI-0568	C-1657	NA	*M. alba*
MI-0622	KARANJTOLI-2	IC405770	*M. laevigata*
MI-0657	Dhandore	IC405805	*M. indica*
MI-0670	Madhopur-4	IC405818	*M. indica*
MI-0682	Kota-4	IC405830	*M. indica*
MI-0683	Alsigad	IC405831	*M. indica*
MI-0685	Khakad-2	IC405833	*M. alba*
MI-0686	Mount Abu-1	IC405834	*M. indica*
MI-0762	Chirayinkizh	IC572983	*M. latifolia*
MI-0763	Saranath-2	IC572984	*M. indica*
MI-0768	Mangari	IC572989	*M. indica*
MI-0827	Jalalgarah-3	IC573048	*M. indica*
MI-0835	Hosur-C15	IC573056	*M. indica*

Based on the trait-wise analysis of data, top ten accessions were identified for 5 different growth yield attributes, which could be utilized as potential donor parents for trait specific improvement.

Performance of accessions for growth and yield attributes againts the check variety S-13 and Anantha											
Percent increase over the check (S-13)						Percent increase over the check (Anantha)					
AGB		Shoot weight		Leaf weight		AGB		Shoot weight		Leaf weight	
Acc. No.	% Incr.	Acc. No.	% Incr.	Acc. No.	% Incr.	Acc. No.	% Incr.	Acc. No.	% Incr.	Acc. No.	% Incr.
ME-125	37	ME-125	64	MI-437	22	ME-125	67	MI-125	103	MI-437	47
MI-685	19	MI-763	26	MI-310	19	MI-685	45	MI-763	56	MI-310	43
MI-310	16	MI-768	26	MI-685	19	MI-310	42	MI-768	56	MI-685	43
MI-763	15	MI-685	19			MI-763	41	MI-685	48	MI-683	34
		MI-246	18			MI-683	39	MI-246	47	MI-246	30
		MI-683	16			MI-246	39	MI-683	44	ME-125	25
						MI-768	38	MI-310	42	MI-763	23
						MI-437	28	MI-835	31	ME-173	21
						ME-173	23	MI-226	28	S-13	20
						MI-226	21	ME-173	26	MI-768	16

Trait wise donor parents identified (top ten) for breeding programmes	
Trait	Accession Number
No. of branches	MI-0768, MI-0683, MI-0685, MI-0332, S-13, MI-0762, MI-0763, ME-0065, MI-0226, ME-0125
Plant height (cm)	ME-0125, MI-0835, ME-0065, MI-0226, MI-0376, MI-0768, MI-0763, MI-0256, MI-246, MI-0682
Biomass (g)	ME-0125, MI-0685, MI-0310, MI-0763, MI-0683, MI-246, MI-0768, MI-0437 , ME-0173, S-13
Shoot wt. (g)	ME-0125, MI-0768, MI-0763, MI-0685, MI-246, MI-0683, MI-0310, MI-0835, MI-0226, MI-0332
Leaf wt. (g)	MI-0437 , MI-0310, MI-0685, MI-0683, MI-246, ME-0125, MI-0763, ME-0173, S-13, MI-0768

Correlation analysis revealed a significant positive correlation of AGB, shoot weight and leaf weight with number of branches (p = 0.001). Leaf weight had a significant positive correlation (p = 0.001) with shoot weight.

Plant height also had significant (p = 0.05) positive correlation with number of branches, whereas, AGB, shoot weight and leaf weight also had significant positive correlation (p = 0.05) with plant height. An overall analysis revealed 9 accessions ranking at the top based on the performance of growth and yield attributes.

Correlation analysis of yield attributes among mulberry accessions					
	No. of branches	Plant height (cm)	AGB (g)	Shoot wt. (g)	Leaf wt. (g)
No. of branches	1.00	-	-	-	-
Plant height (cm)	0.58739*	1.00	-	-	-
AGB (g)	0.79753***	0.60884*	1.00	-	-
Shoot wt. (g)	0.78392***	0.65316*	0.97465***	1.00	-
Leaf wt. (g)	0.73789***	0.47858*	0.93806***	0.83676***	1.00
*** & * significant level of p = 0.05 & 0.001, respectively. AGB – aboveground biomass.					

Short listed accessions based on the performance of multiple morphological traits		
Acc. No./ Variety name	No. of traits	Plant height (cm)
MI-0768	5	Biomass, shoot wt., leaf wt., no. of branches, plant height
MI-0763	5	Biomass, shoot wt., leaf wt., no. of branches, plant height
ME-0125	5	Biomass, shoot wt., leaf wt., no. of branches, plant height
MI-246	4	Biomass, shoot wt., leaf wt., no. of branches
MI-0685	4	Biomass, leaf wt., no. of branches, plant height
MI-0683	4	Biomass, leaf wt., no. of branches, plant height
S-13	3	Biomass, leaf wt., plant height
MI-0310	3	Biomass, shoot wt., leaf wt.
MI-0226	3	Biomass, no. of branches, plant height

Conclusion

The promising accessions identified for different yield attributing traits could be utilized in breeding programme for trait specific improvement *vis-a-vis* yield in mulberry. The biochemical traits *viz.,* Glutamate synthase activity correlated to drought tolerance was positively correlated to biomass, shoot weight and leaf weight. Hence, it could be used as screening tool for identifying desired genotypes with functional trait associated with nitrogen use efficiency. Similarly, accessions with high water-use effciency, producing higher biomass with less water inputs, can also contribute to climate resilience. Eight top ranking accessions *viz.,* MI-0437, MI-0310, MI-0683, ME-0173, MI-0246, MI-0685, MI-0762 and ME-0256 were identified with functional traits associated with climate resilience could be utilized in breeding programme targeted to develop climate resilient mulberry varieties. The protocols standardized for estimation of GS activity, photosynthetic and water-use efficiency parameters were optimized and could also be utilized for similar studies in future.

On-going Research Projects:

PIC-3620: Engineering photosynthesis in mulberry for resilience to climate change: A C4 approach (Aug. 2017 - Jul. 2021)

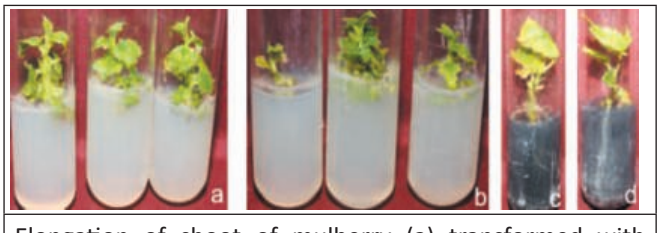
Tanmoy Sarkar, A. S. Raghavendra, (Univ. of Hyderabad), S. Gandhi Doss, Gayathri T., Arunakumar G. S., Ravindra K.N. (JRF), Teotia R. S. (upto Aug. 2019) and Pankaj Tewary (from September, 2019)

Major objective: To develop transgenic mulberry with C4 traits through *Agrobacterium* mediated genetic transformation for climate resilience

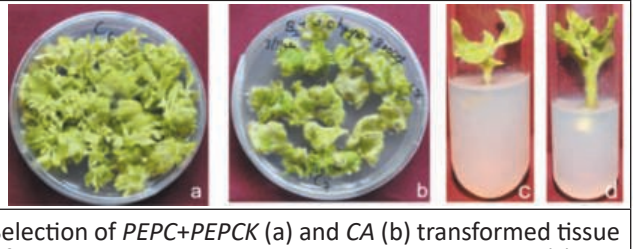
Specific objectives

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

In the study, protocol for *in vitro* regeneration of whole plants from cotyledon and hypocotyl explants of G4 mulberry has been optimized. It was observed that synergistic effects of plant growth regulators, selected macronutrients and tissue culture additives positively influenced *in vitro* regeneration potential of mulberry explants. Dosage of hygromycin (3.5 mg/L) was optimal for selection of transformed mulberry tissues. Protocols for genetic transformation and hygromycin based selection of transformed mulberry and tobacco shoots, containing *PEPC+PEPCK* and *CA* gene constructs, have been optimized. *Agrobacterium* mediated genetic transformation of 1297 cotyledons/hypocotyl explants of G4 mulberry using *PEPC+PEPCK* and *CA* constructs was carried out. Forty nine *PEPC+PEPCK* and *CA* transformed mulberry shoots were selected in hygromycin containing selection medium. Thirty five *PEPC+PEPCK* and *CA* transformed mulberry shoots were elongated in hygromycin containing selection medium and transferred to rooting medium for *in vitro* root induction. Further, selected 112 *PEPC+PEPCK* and *CA* transformed tobacco shoots in hygromycin containing selection medium.



Elongation of shoot of mulberry (a) transformed with *PEPC+PEPCK* genes (b) transformed with *CA* gene, *in vitro* root induction of transformed shootlets with *PEPC+PEPCK* genes (c) and *CA* gene (d) in culture medium.



Selection of *PEPC+PEPCK* (a) and *CA* (b) transformed tissue of tobacco and in *vitro root* induction *PEPC+PEPCK* (c) and *CA* (d) shootlets in culture medium.

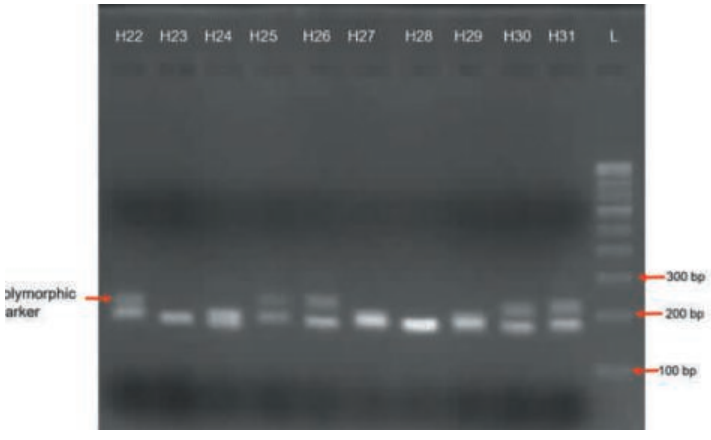
PIB-3631: Primary yield evaluation for identification of superior mulberry hybrids with drought adaptive traits under sub-optimal irrigated conditions (Mar. 2018 - Feb. 2022)

Tanmoy Sarkar, S. Gandhi Doss, G. S. Arunakumar, R. N. Bharath Gowda (JRF), R. S. Teotia (upto Aug. 2019) and Pankaj Tewary (from Sep. 2019)

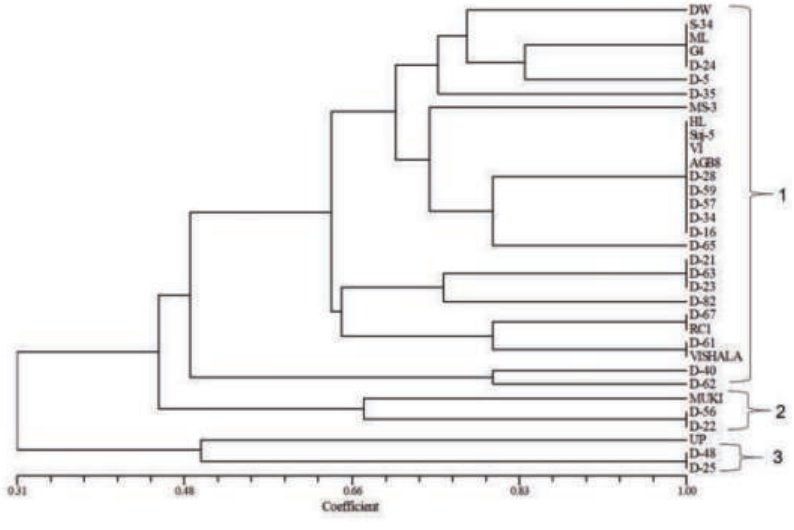
Objectives

- 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-$\Delta^{13}C$

Experimental plots with 21 mulberry genotypes and 5 check varieties were established and maintained in 3 replicates under optimal and suboptimal conditions. Drip irrigation system has been installed in both the experiments. Extraction and quantification of genomic DNA of the 21 mulberry hybrids, 10 parental genotypes, and 5 check varieties were completed. Among the 11 SSR markers, 5 polymorphic SSRs along with biometric-trait have been used for identification and genotyping mulberry hybrids, parental lines and check varieties. Analysis of genetic diversity was carried out for above 34 mulberry genotypes using five polymorphic and/ biometric-trait specific SSR markers. The dendrogram derived from UPGMA cluster analysis indicated 4 groups of the 34 genotypes, branching at a similarity value of 45%.



SSR primers showed polymorphism across the 10 parental lines. Where, H22: Dudhia White; H23:UP105; H24:MS3; H25: Muki; H26:S34; H27: Himachal Local; H28:Sujanpur5; H29:V1; H30: Mysore local; H31:G4



Dendrogram of 34 genotypes constructed from SSR marker based genetic similarity among the mulberry genotypes

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

S. Gandhi Doss, Jalaja S. Kumar (upto Feb. 2020), G. S. Arunakumar, B. Vijaya Naidu, S. Kamaraj, R. S. Teotia (upto Aug. 2019) and Pankaj Tewary (from Sep. 2019)

Objectives

- 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

Six month old mulberry saplings of promising six triploid genotypes, short-listed for the study *viz.,* TRI-1, TRI-5, TRI-6, TRI-8, TRI-9 and TRI-10 were planted in the experimental plot under RBD in 3 replication both in optimal and sub-optimal irrigated experiments in all the test centres *viz.,* CSRTI-Mysuru, RSRS-Kodathi, RSRS-Ananthapur and RSRS-Salem. The plants are maintained with cultural operations for establishment. Drip irrigation system has been installed in both the experiments. Two crops data has been recorded at RSRS-Ananthapur in optimal irrigated experiment. The average data revealed the highest leaf yield in TRI-5 followed by TRI-10, TRI-1 and TRI-9

Performance of triploid mulberry genotypes under optimal input conditions at RSRS-Ananthapur

Genotype	NS	LLS	TSL	AGB	LY	% gain over Vishala	L/S	LMC	LMRC	FWCL	DWCL
TRI-1	3.8	185.8	432.3	1121.1	658.2	18.9	0.59	77.1	98.5	916.0	209.3
TRI-5	5.6	172.3	671.2	1216.5	689.9	24.6	0.57	75.7	97.0	482.6	117.3
TRI-6	6.3	173.4	767.6	1149.4	570.0	2.9	0.51	75.2	97.1	392.0	97.3
TRI-8	4.5	175.6	506.2	1108.5	645.8	16.6	0.58	77.5	97.9	776.0	174.6
TRI-9	5.1	186.0	620.5	1165.1	617.9	11.6	0.53	76.7	97.3	434.6	101.3
TRI-10	7.7	161.8	874.1	1134.5	664.0	19.9	0.59	75.2	97.7	406.6	100.0
G-4 (C)	4.9	177.4	557.7	1122.9	657.0	-	0.59	73.5	97.6	550.6	145.3
Vishala (C)	4.4	165.6	490.8	1083.4	553.6	-	0.52	76.2	97.7	622.6	148.0
CD at 5% level	1.0	10.1	148.2	NS	NS	-	0.02	NS	NS	123.3	35.3
CV %	28.0	8.00	33.2	27.4	25.5	-	5.79	2.2	0.8	12.3	14.7

NS – No. of shoots; LLS – Length of longest shoot (cm); TSL – Total shoot length (cm); AGB – Aboveground biomass (g); LY - leaf yield/ plant/ crop (g); L/S – Leaf/ shoot ratio; LMC – Leaf moisture content (%); LMRC – Leaf moisture retention capacity after 6 h (%); FWCL – Fresh weight of 100 leaves; DWCL – Dry weight of 100 leaves

showing 24.6%, 19.9%, 18.9%, 16.6% and 11.6% improvement over the check Vishala, respectively.

PIC 01003 CN: Genetic enhancement of mulberry by genomics approaches: 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 (Sep. 2018 - Aug. 2021)

Tanmoy Sarkar, N. Nataraja Karaba, (UAS-Bengaluru), S. Gandhi Doss, Lalitha Kumari (PA), R. S. Teotia (upto Aug. 2019) and Pankaj Tewary (from Sep. 2019)

Main 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

Protocol was optimized for genetic transformation and kanamycin based selection of regenerated transformed mulberry shoots containing *AtDREB2A+AtSHN1* gene cassettes. *Agrobacterium* mediated genetic transformation of 825 cotyledons/hypocotyls of G4 mulberry using *AtDREB2A+AtSHN1* genes construct was carried out. Twenty eight *AtDREB2A+AtSHN1* transformed mulberry shoots were selected in kanamycin containing medium. Seventeen *AtDREB2A+AtSHN1* transformed mulberry shoots were elongated in kanamycin containing culture medium and inoculated in rooting medium for *in vitro* root induction.

Genetic transformation of mulberry using AtDREB2A+AtSHN1 genes construct							
No of cotyledons/ hypocotyls used	Days of pre-culturing in MS + 0.1 mg/L TDZ	O.D. of Agrobac-terium culture at 600 nm	Acetos-yrigone (µM)	Co-cultur-ing time (min)	Days of co-cultivation in MS medium+ 1.1 mg/L TDZ+ 200 µM AS	Number of elongated shoots in elongation medium	Number of elongated shoots in elongation medium
825	1 - 2	0.3 - 0.5	200	20	2-3	28	17

All India Co-ordinated Experimental Trial in Mulberry (South Zone) (Phase-IV) (Apr. 2019 - Mar. 2025)

Zonal Coordinator (South Zone): R. S. Teotia (upto Aug. 2019) and Pankaj Tewary (from Sep. 2019)

S. Gandhi Doss, G. S. ArunaKumar, P. M. Pratheesh Kumar, Hanumantharayappa, Jalaja S Kumar (upto Feb. 2020), Noble Morrison, K. Jhansilakshmi, P. Sudhakar, Vijaya Naidu, B. Srinath and A. Venugopal

Objective: To identify and authorize suitable mulberry varieties for commercial use in different agro-climatic mulberry cultivation zones of India

AICEM Phase-IV programme has been initiated to evaluate the mulberry varieties developed by different research Institutes across India at 22 test centres to identify suitable mulberry variety for different sericultural zones in the country. In order to acquaint with the experimental plantation and data recording procedures, a training programme was conducted on 03-05-2019 to all the In-charge Scientists of the 7 different test centres.

Test Centres of AICEM Phase-IV Prog. (South Zone)	
Test Centre	State
CSRTI-Mysuru	Karnataka
RSRS-Kodathi	-do-
REC-Madivala	-do-
RSRS-Ananthapur	Andhra Pradesh
REC-Rayachoty	Andhra Pradesh
REC-Vikarabad	Telangana
REC-Krishnagiri	Tamilnadu

Details on the mulberry varieties tested under AICEM Phase-IV programme (south zone)			
Mulberry Variety	Designated Code	Progenitor Institute	Experiment Code
AGB-8	CMY-01	CSRTI-Mysuru	MV 1
C-1360	CBP-01	CSRTI-Ber-hampore	MV 2
PPR-1	CPP-01	CSRTI-Pampore	MV 3
G4	Check-1	CSRTI-Mysuru	MV 4
V1	Check-2	CSRTI-Mysuru	MV5

The guidelines of AICEM have been circulated to all the test centres and advised to adhere strictly. The progress of all the 7 test centres of south zone were monitored to ensure the availability of water source and land to be utilized for the experiment at all test centres.

The experimental plantation has been completed at 5 test centres of South Zone during Feb. – Mar. 2020, with 3 test varieties (CMY-01; CBP-01 and CPP-01) along with two check varieties (V1 and G4) in RBD under 90 x 90 cm spacing with 6 replications and with 81 plants in each replication.

Continuous /Other activities:

Maintenance of mulberry germplasm, mother culture and demonstration plot

S. Gandhi Doss, Tanmoy Sarkar, R. S. Teotia (upto Aug. 2019) and Pankaj Tewary (from Sep. 2019)

A working germplasm with 28 accessions were maintained for carrying out hybridization programmes. Nineteen elite varieties were also maintained in the demonstration plot for the benefit of sericulturists, students and other stakeholders. Breeders seed cutting stock plots of six mulberry varieties *viz.,* G4 (late age silkworm rearing), G2 (young age silkworm rearing), MSG2 (soil moisture stress environments), AGB8 (sub-optimal irrigated conditions), AR-12 (alkaline resistant) and Sahana (Shade tolerance) were maintained for seed cutting supply. Eleven transgenic lines of K2 OPH (open-pollinated hybrid) with *HVA1* gene and a transgenic line of V1 with *DREB2A* and *SHN1* genes were maintained under net-house containment conditions.

MULBERRY MOLECULAR BIOLOGY LABORATORY

Concluded Research Projects:

PRP-3591: Identification of resistance in mulberry germplasm for root knot nematode disease (Oct. 2016 – Sep. 2019)

G. S Arunakumar and S. Gandhi Doss

Objective: Identification of mulberry genetic resources for root knot nematode resistance

Root-knot nematodes (*Meloidogyne* sp.) cause severe crop loss in mulberry and results in lower leaf productivity which affects economic returns to the farmer due to decreased silkworm brushing capacity. At present cultivated mulberry varieties are highly susceptible to root-knot disease with very limited resources for resistance to root-knot nematode. The present study was undertaken to identify the genetic resources resistance to root-knot nematode from the diverse germplasm and further to initiate breeding programmes to develop RKN resistant mulberry varieties.

1. Screening of mulberry germplasm and identification of contrasting reaction to root-knot nematode populations in the soil:

A total of 415 diverse mulberry germplasm including popular varieties were screened in four batches under artificial inoculation in the glasshouse. Four months old saplings grown in the raised nursery beds were transplanted to 30 cm height earthen pots and arranged in Complete Randomized Design (CRD) with replications under inoculated conditions and controls of each germplasm was maintained without inoculation (Fig.). After 120 days, plants were uprooted and number of root-knots per plant was recorded for each germplasm. The severity of root-knot disease was determined based on gall index (GI) which is considered as the indicator of plant damage (Taylor and Sasser, 1978) using a 0-5 rating scale. Mulberry variety K-2 was used as highly susceptible

Germplasm accessions categorized under different reaction grades against RKN		
Reaction	No. of galls/ plant	No. of germplasm
Immune	Nil	21
Resistance	1-10	48
Moderately Resistance	11-30	46
Susceptible	31-100	143
Highly Susceptible	>100	157
	Total	**415**

(Govindaiah *et al.,* 1996) check for the comparison. The results indicated that 21 germplasm accessions were immune and 48 were resistant. However, 46 accessions showed moderately resistant, 143 germplasm accessions were susceptible and 157 accessions were highly susceptible. Among 415 germplasm accessions 13.64% germplasm were immune /resistant to RKN and 14.77% germplasm were moderately resistant. However, 33.41% and 38.18 % germplasm were susceptible and highly susceptible to RKN, respectively.

A view of the root-knot nematode (RKN) screening experiment at glasshouse

Resistant germplasm: A- Before uprooting of resistant germplasm under glasshouse condition; B - After uprooting roots system without root knots in resistant germplasm

2. Final confirmation of identified resistant germplasm accessions under root-knot nematode hotspots and sick soils: The shortlisted 25 resistant germplasm accessions along with 4 popular varieties, 2 suceptible and 4 highly susceptible checks were evaluated in three hotspots at different mulberry cultivation states of Karnataka (Location ID: 12° 27' 03" N 77°18'58" E), Tamil Nadu (11° 25'59" N 77°33'52" E) and Andhra Pradesh (14°37'05" N 77°36'46" E). Simultaneously, these germplasm accessions were also evaluated under RKN sick soil which is simulated in isolated area at CSRTI-Mysuru by construction of four root structures with dimensions of 25 L × 5 W × 5 D ft filled with 2.5 ft cultivable soil and remaining top layer with RKN sick soil.

Cluster number	No. of Ger-mplasm	Name of the germplasm
Group I	11	BR8, Thaipech, Baragarh3, Vietnam1, Karanjtoli1, Australia, Morus lambong, ACC115, S763, S1708 and Calabresa
Group II	37	Papua New Guinea, Thailand lobed, Thailand male, Gamettee, SRDC3, Himachal local, Mandalaya, *Morus laevigata* (Hybrid), S523, China27, RC2, Beramphore, ERRC103, MR2, Vishala, Kousen, S1635, *Morus cathayana* (Hybrid), AR12, S13Diploid, S13Tetraploid, S34Diploid, TG1, V1Diploid, S34Tetraploid, K2Tetraploid, Semmedu, BU33, V1Tetraploid, MS1, G2, RFS135Tetraploid, S36Diploid, Vishwa DD, S36 Tetraploid, RFS135 Diploid and K2 Diploid
Sub Cluster generated from Group II		
Sub Group A	9	Papua New Guinea, Thailand lobed, Thailand male, Gamettee, SRDC3, Himachal local, Mandalaya, *Morus laevigata* (Hybrid) and S523,
Sub Group B	28	China27, RC2, Beramphore, ERRC103, Vishala, Kousen, S1635, *Morus cathayana* (Hybrid), AR12, S13, S13Tetraploid, S34Diploid, TG1, V1Diploid, S34Tetraploid, K2Tetraploid, Semmedu, BU33, V1Tetraploid, MS1, G2, RFS135Tetraploid, S36, Vishwa(DD), S36Tetraploid, RFS135 and K2

Evaluation in sick soil: Out of 47 shortlisted germplasm evaluated under RKN sick soil, one (*Morus lambong*) was found immune (without any galls/plant) and 13 germplasm were found resistant. Whereas, two germplasm were found moderately resistant and remaining were susceptible or highly susceptible. The significantly highest shoot height and shoot weight was observed in BR-8 over all other germplasm. Whereas, lowest shoot height was found in K2 and lowest shoot weight in RFS 135.

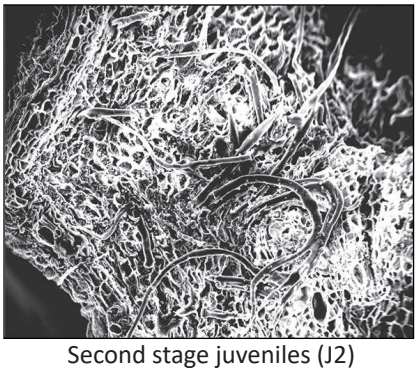
RKN hotspot location 1: Out of 35 shortlisted germplasm evaluated under RKN hotspot location 1 (RSRS-Ananathapur, Andhra Pradesh), eleven germplasm showed resistant and three germplasm were found moderately resistant. Whereas, remaining germplasm were susceptible or highly susceptible. The highest shoot height was observed in S-1531 and highest shoot weight in S-1708 whereas, lowest shoot height and shoot weight in Vietnam-1.

RKN hotspot location 2: Among the 37 shortlisted germplasm evaluated under RKN hotspot location 2 [D. Maarimuthu, Dharmapuri, Bhavani (Tq), Erode (Dt.) Tamil Nadu], 13 germplasm were found resistant and three germplasm were found moderately resistant. Whereas, remaining germplasm were susceptible or highly susceptible. The highest shoot height was observed in Acc. 119 and shoot weight in S-1708 whereas, lowest shoot height and shoot weight in Karanjtoli-1.

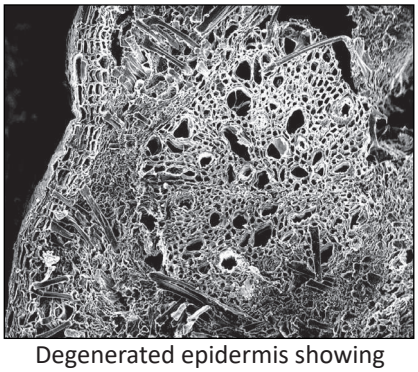
RKN hotspot location 3: Out of 38 shortlisted germplasm evaluated under RKN hotspot location 3 [Mr. Umesh, Sathnoor, Kanakapur (Tq), Ramanagar (Dt.) Karnataka], nine germplasm were found resistant and eight germplasm were found moderately resistant whereas, remaining germplasm were susceptible or highly susceptible. The highest shoot height was recorded in Acc. 119 and highest shoot weight in S-1708 whereas, lowest shoot height and shoot weight was found in Karanjtoli-1.

Pooled data of three hotspot locations showed eight germplasm found commonly resistant across the locations (BR-8, Karanjtoli-1, Hosur-C8, Nagalur Estate, Tippu, Calabresa, Thai Pech & SRDC-3) being Finally, 1.93% germplasm were identified and confirmed their resistance at different locations to root-knot nematode.

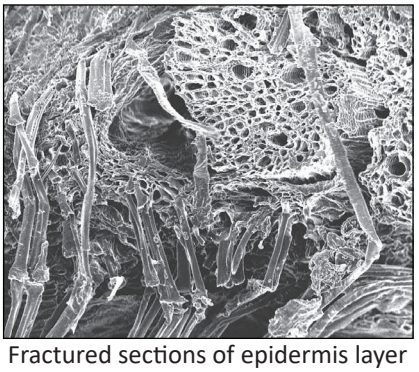
3. Scanning electron microscopy: The root-knot nematode infestation was obsereved based on the formation of galls in root system. However, the developmental stages of the root-knot nematode were identified after penetration into root tissues (Fig.). The SEM examinations indicated the penetration of infective second



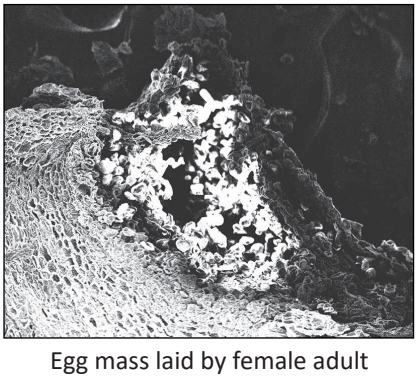
Second stage juveniles (J2) penetrating roots of mulberry (330x)



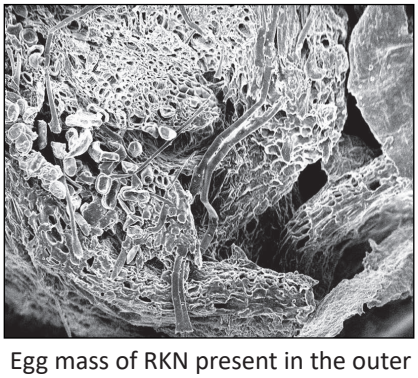
Degenerated epidermis showing differentiated xylem tissue (500x)



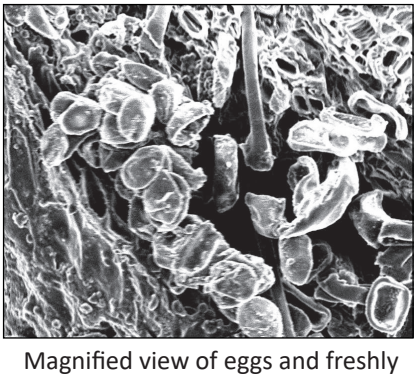
Fractured sections of epidermis layer with finger like projections (500x)



Egg mass laid by female adult nematode in outer periphery of epidermis (330x)



Egg mass of RKN present in the outer layer of epidermis (500x)

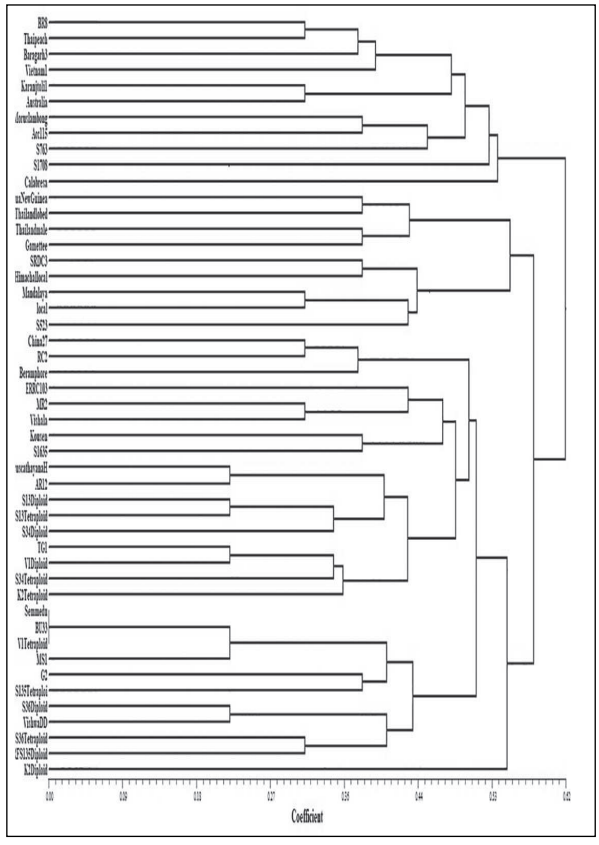


Magnified view of eggs and freshly hatched juveniles (J2) of RKN (330x)

Scanning electron microphotographs of developmental stages of root knot nematode in mulberry

stage juveniles (J2) resulting in degeneration of epidermis. The infestation by RKN in mulberry takes place in two ways, primary infestation by J2 present in soil and secondary infestation by developed J2 within the root tissues. The infected roots exhibit radial swelling due to hypertrophy and hyperplasia which is accompanied by proliferation of root hairs on the surface. The similar observations were made earlier by SEM study on tomato root knot nematode (Wergin and Orion, 1981). The egg mass of root knot nematode was observed in outer periphery of epidermis. Within the eggs, juvenile stage-I was observed and also freshly hatched juveniles (J2) of RKN near the egg mass were found. The growing female remains initially embedded in the tissue, but when matures it induces the development of a distinct cavity around it into which eggs are deposited. The J2 hatched within the cavity migrate to other parts of root through cortex, thus completing the life cycle within the root and the adult females positioned towards root periphery develops cavity which opens outside to release eggs inside a gelatinous matrix.

4. Molecular characterization of selected mulberry germplasm: DNA fingerprinting of selected 48 germplasm using SSR markers have been polymorphic between the mulberry germplasm. The dendrogram generated by statistical analysis demonstrated the formation of two major clusters with the similarity coefficient varied from 0.20 to 0.62. BR-8, Karanjtoli-1, Baragarh-3, Thai peach, Papua New Guinea. Thailand male, Gamettee and Thailand lobed were resistant to root-knot nematode infection and found genetically diverse (Fig.).



Inference / recommendations

1. Identified resistant germplasm accessions can be evaluated further - To find out the yield potentiality in comparison with existing varieties as checks (V1 & G4). If resistant germplasm accessions are found superior over the existing varieties, these can be considered for cultivation under farmer's field.
2. Mode of resistance can be studied using identified resistance sources (Biochemical / Genetics/ Morphological).
3. Selected highly resistant (BR-8) and susceptible (ERRC-103) germplasm accessions are being utilized for transcriptomic studies to characterize host and pathogen interaction and gene expression study (Work under progress).
4. Studies could be undertaken to find out the feasibility of grafting technique by using resistant germplasm accessions as root stock and V1/G4 as scion, which might be effective in severe root-knot nematode conditions.

Conclusion: The glasshouse screening of 415 germplasm indicated that 69 germplasm accessions exhibited immune and resistance reaction. However, 65 accessions showed moderate resistance, 147 germplasm accessions exhibited susceptible and 168 accessions showed highly susceptible reaction to RKN. In the present study, there was a significant decrease in biomass (g) and shoot length (cm) among highly susceptible germplasm under inoculated condition as compare to control (without RKN inoculation). Whereas, there was no significant difference in the RKN inoculated and uninoculated condition of immune to resistance group of germplasm. Further, confirmation of resistance was done by plantation of shortlisted resistance germplasm accessions and

other check varieties at sick soil developed at CSRTI-Mysuru and root-knot nematode hotspots of Karnataka, Tamil Nadu and Andhra Pradesh. For all the four locations, data was compared and it was found that eight germplasm accessions (BR-8, Karanjtoli-1, Hosur - C8, Nagalur Estate, Tippu, Calabresa, Thai Pech and SRDC-3) have resistance to root-knot nematode across the locations. These germplasm could be utilized for further resistance breeding programme.

PIE-3511: Development of Distinctiveness, Uniformity and Stability guidelines for Mulberry (*Morus* spp.) and their validation (Phase II) (Apr. 2017 - Mar. 2020)

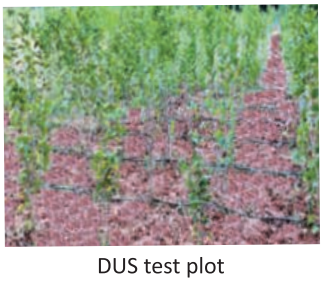
R. S. Teotia (Aug. 2019), Pankaj Tewary (from Sep. 2019), M. R Bhavya and P. Sowbhagya (SRF)

Objectives

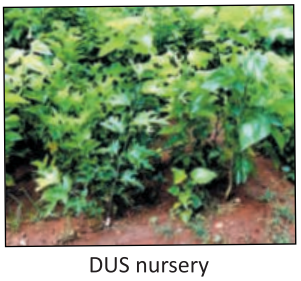
- Development of database for the descriptors of mulberry and add on to IINDUS.
- Establishment of Co-nodal DUS test centre at CSRTI, Berhampore
- Establishment and maintenance of example and reference varieties
- DUS testing of new/ extant varieties and their registration under PPV & FR Act, 2001.

Seventeen example varieties (Kanva-2, Railway Quarter, *M. laevigata* (Hybrid), Phillipines, Punjab Local, Surat, Kajali, Creeping Cp × V-1(P5), Mysore local, Mizusawa, *M. multicaulis*, Acc.106, Moreti (seringe), Bilidevalaya, K2 × BC (P11), Kosen and Karanjtoli-1) had been planted as per DUS guidelines (Anonymous, 2016) during June, 2019. Their further establishment and maintenance are being undertaken. Saplings of other fourteen varieties are in nursery and planting will be taken up in June 2020 (Rainy season). Attempts are under progress for grafting another eleven varieties that possess poor survival and rooting.

DUS test application for registration of extant mulberry varieties *viz.,* V-1 and G-4 has been filed on 14.08.2019 under PPV&FR Act, 2001. Application filed for registration of V-1 mulberry variety was not found eligible as the variety was released before 18 years from the date of filing application. Application filed for registration of G-4 mulberry variety has been accepted for DUS testing and has been acknowledged in the office of the Registrar, PPV&FRA Authority on 12.09.2019. Currently, the application is under preliminary examination. DUS descriptor data of 34 example and 8 reference varieties for 35 characteristics were recorded using DUS guidelines (Anonymous, 2016) during May-July & November-January, 2019. The 41 genotypes and 30 characters were included for analysis. In the present study, all 41 genotypes showed variation with respect to all the characteristics examined. Among the 30 assessed characteristics, 23 were trimorphic and 7 were polymorphic indicating their potential for varietal characterization, establishment of distinctiveness and identification of genotypes/varieties. Morphological profiles obtained for different mulberry genotypes based on 30 characteristics has been shown. Based on plant vigor, 15 varieties were recorded as low in vigour, 16 as medium and 10 having high vigour. For plant growth habit, genotypes were grouped into erect (9), semi-erect (20), spreading (10) and drooping (2). On the basis of inter-nodal distance the genotypes were grouped as short (3), medium (33) and long (5). The genotypes were further classified on the basis of phyllotaxy into distichous (8), tristichous (6), pentastichous (6) and mixed type (21).



DUS test plot



DUS nursery

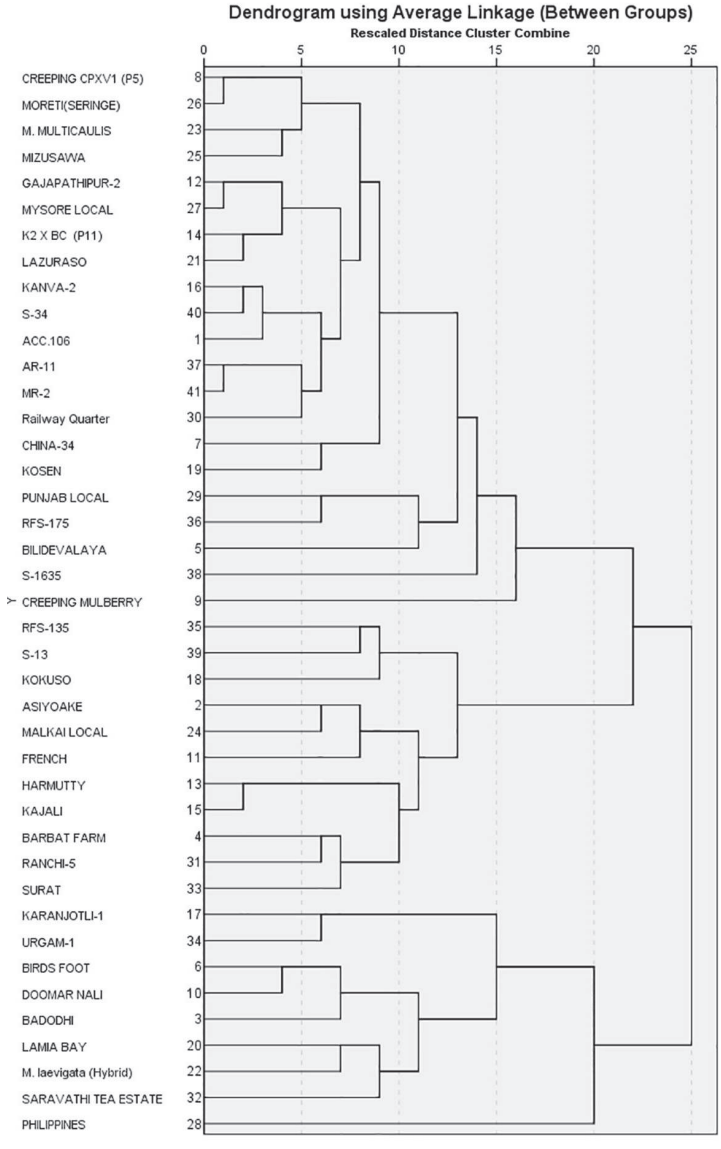
Based on different characters, genotypes were classified i.e, based on Intensity of **leaf colour**: light green (7), green (19) and dark green (15); **Leaf base**: four types *viz*., cordate (15), lobate (9), truncate (16) and acute (4); **leaf lamina length**: short (2), medium (30) and long (9); **leaf lamina width**: three types *viz*., narrow (8), medium (21), broad (12); **leaf size**: small (25), medium (13) and large (3); **leaf apex**:acuminate (31) genotypes - acute (6) and caudate (4) and no genotype having obtuse leaf apex; **leaf margin**: crenate (2), dentate (4), serrate (34) and repand (1); **leaf type**: unlobed (24), lobed (7), mixed type (10);**mature bud shape:** round (2), acute

triangle (21), long triangle (17) and spindle (1); **sex:** gynoecious (18), androecious (11), andromonoecious (4), gynomonoecious (2), androgynomonoecious (3) and no genotype found as bisexual. Number inside parathensis indicate the number of genotypes belonging to that particular expression.

The genotypes were further categorized according to mature inflorescence length as short (12), medium (21), long (5) and three genotypes bare no flowers (NF) to know sex and mature inflorescence length.

Thirty descriptors were used to cluster 41 genotypes using average-linkage rescaled distance with the aid of SPSS software package. The dendrogram generated grouped the genotypes into five main clusters at a rescaled distance of over 15. Cluster 1 consisted 20 genotypes, the genotype creeping mulberry in cluster 2, cluster 3 had 11 genotypes whereas, 8 genotypes in cluster 4 and mulberry genotype Philippines in cluster 5. The distribution of genotypes into different clusters indicates the presence of diversity and distinctiveness among forty-one genotypes. Further, various information regarding mulberry varieties *viz.,* AR-12, Sahana, G-2, RC-1 and RC-2 etc., has also been collected for filing application under PPV&FR Act, 2001.

Training was imparted to a scientist of CSRTI-Berhampore (10.06.2019 to 15.06.2019) pertaining to DUS for establishing a co-nodal DUS centre at CSRTI-Berhampore, West Bengal for testing northern and north-eastern mulberry varieties.



Sl. No.	Genotypes	Descriptors																													
		a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s	t	u	v	w	x	y	z	aa	ab	ac	ad
1	ACC.106	5	3	5	3	5	3	3	5	9	3	5	5	2	5	3	3	7	3	5	5	5	5	5	1	3	1	3	9	2	5
2	ASIYOAKE	3	5	5	3	3	3	5	5	9	3	5	5	2	5	3	3	5	7	5	7	7	5	7	1	5	1	7	1	1	3
3	BADODHI	7	7	3	3	5	5	3	5	3	3	5	7	2	7	5	5	3	7	5	7	5	7	7	3	3	1	7	1	2	5
4	BARBAT FARM	5	3	3	5	3	3	9	5	9	3	5	5	3	5	3	3	5	5	3	7	5	7	7	2	5	2	5	1	2	7
5	BILIDEVALAYA	3	7	3	5	5	3	9	5	5	3	5	5	2	5	5	3	7	7	3	5	9	5	7	2	5	1	7	9	1	3
6	BIRDS FOOT	5	7	5	3	5	5	5	7	3	3	7	7	3	7	7	5	5	5	5	7	5	5	7	2	7	2	7	1	NF	NF
7	CHINA-34	3	5	7	5	7	3	3	5	9	5	5	5	3	5	5	3	3	5	3	5	9	3	7	1	5	2	7	9	1	5
8	CREEPING CPXV1(P5)	5	5	5	5	5	5	1	5	9	5	7	5	2	5	5	5	5	5	5	5	7	5	7	3	3	1	5	9	1	3
9	CREEPING MULBERRY	3	9	5	5	7	3	5	3	5	5	5	5	2	3	3	3	1	7	3	5	7	3	7	3	3	1	5	9	NF	NF
10	DOOMAR NALI	7	7	7	5	7	5	3	7	3	3	5	7	2	7	7	5	5	5	7	7	5	5	7	1	7	1	9	1	NF	NF
11	FRENCH	3	5	7	3	5	3	7	5	9	3	5	5	2	5	3	3	7	5	7	7	3	3	7	1	3	1	5	1	4	5
12	GAJAPATHIPUR -2	5	5	3	5	3	7	3	5	9	3	5	5	2	5	5	3	5	5	3	3	9	5	7	3	3	1	3	9	4	5
13	HARMUTTY	3	7	3	5	5	3	9	5	7	3	3	3	2	5	3	3	5	5	5	3	9	7	7	2	3	2	7	1	1	3
14	K2 X BC (P11)	5	5	5	5	3	5	7	5	9	3	5	5	2	5	5	3	5	5	3	5	7	5	5	1	3	1	5	9	6	5
15	KAJALI	3	7	3	7	5	3	7	5	9	3	3	3	2	5	5	3	7	7	3	3	9	5	7	2	5	2	7	1	1	3
16	KANVA-2	5	3	3	5	3	3	3	5	9	3	3	5	1	5	5	3	5	3	3	5	5	5	7	1	5	1	5	9	1	3
17	KARANJTOLI -1	7	5	3	3	3	5	1	7	5	3	5	5	3	5	7	5	1	7	7	7	9	5	7	2	5	1	7	1	1	5
18	KOKUSO	3	5	5	3	3	3	1	3	7	3	5	5	2	5	5	3	3	7	3	3	7	5	7	2	3	1	5	1	4	5
19	KOSEN	5	5	5	5	5	3	3	5	7	3	5	5	1	5	5	3	3	3	3	5	9	3	3	1	5	1	5	9	4	5
20	LAMIA BAY	3	3	3	3	5	5	5	7	3	3	7	7	2	7	7	7	5	3	3	3	5	5	9	1	5	2	7	1	2	7
21	LAZURASO	5	5	5	3	3	5	5	5	7	5	5	5	2	5	5	3	5	5	5	5	7	5	7	1	5	1	7	9	5	3
22	*M. laevigata (Hybrid)*	7	7	3	3	5	7	1	7	3	5	7	7	2	7	7	7	5	5	3	3	5	5	7	1	5	1	7	1	1	7
23	*M. multicaulis*	7	5	5	7	5	5	1	5	9	3	7	5	2	5	7	5	5	7	3	3	7	5	7	1	5	2	7	9	1	5
24	MALKAI LOCAL	3	5	7	3	5	3	7	5	9	3	5	5	2	5	5	3	3	5	5	7	9	5	5	3	3	2	5	1	5	3
25	MIZUSAWA	7	7	3	3	3	3	1	5	7	3	7	5	2	5	7	5	5	5	3	5	7	5	7	1	3	1	7	9	1	5
26	MORETI(SERINGE)	7	5	5	5	5	3	1	5	9	5	5	5	2	5	5	5	5	7	5	7	7	5	7	1	3	1	5	9	1	3
27	MYSORE LOCAL	5	3	3	5	3	5	3	5	9	3	5	5	2	5	5	3	5	5	3	5	7	5	7	3	3	1	5	9	6	3
28	PHILIPPINES	5	5	5	5	3	3	7	5	3	7	5	5	2	7	7	5	5	5	5	3	5	3	3	1	3	1	5	1	6	5
29	PUNJAB LOCAL	7	5	3	5	3	5	9	5	9	3	5	5	2	5	5	3	3	7	5	5	7	5	7	3	3	1	5	9	1	5
30	Railway Quarter	5	5	3	3	5	5	3	5	7	3	5	5	2	5	5	3	5	7	3	3	5	5	7	3	5	3	7	9	1	5
31	RANCHI-5	3	5	5	3	5	3	9	3	9	3	3	5	2	3	3	3	3	5	5	5	7	7	7	3	3	1	5	1	1	5
32	SARAVATHI TEA ESTATE	3	9	3	3	5	5	5	5	3	3	5	5	3	5	5	5	5	3	3	5	5	3	7	1	3	2	7	1	1	7
33	SURAT	3	3	3	7	3	5	9	5	9	3	3	3	1	5	3	3	5	5	5	5	5	5	5	1	3	1	5	1	1	3
34	URGAM-1	5	3	3	3	3	5	5	5	3	5	7	7	1	7	7	7	1	7	7	7	9	5	7	3	7	2	7	1	2	5
35	RFS-135	5	5	3	5	3	5	5	5	9	3	7	5	2	7	7	5	3	3	3	5	7	5	7	1	3	1	5	1	2	5
36	RFS-175	7	7	5	5	5	5	9	5	9	3	5	5	2	7	7	5	5	3	3	5	5	5	7	1	5	1	5	9	2	5
37	AR-11	3	3	3	5	3	3	3	5	5	3	5	5	2	5	5	3	5	7	3	5	7	5	7	1	5	3	5	9	2	3
38	S-1635	7	7	3	7	5	5	1	5	5	3	5	5	2	5	7	5	3	7	5	7	7	5	7	1	7	2	7	9	2	7
39	S-13	5	5	3	7	3	5	3	5	9	3	3	5	2	5	5	3	7	7	5	5	5	5	7	1	3	1	5	1	2	5
40	S-34	5	5	5	5	5	5	3	5	9	3	5	5	2	5	5	3	5	5	3	5	5	5	7	1	3	1	5	9	2	5
41	MR-2	3	3	5	7	3	3	3	5	5	3	5	5	2	5	5	3	5	5	3	5	5	5	7	1	3	1	5	9	1	5

a. Plant: vigor, b. Plant: growth habit, c. Sprouting (days), d. Survival % of cuttings (rooting), e. Shoot: type, f. Shoot: thickness (cm), g. Mature shoot: color, h. Inter-nodal distance (cm), i. Phyllotaxy, j. Leaf: angle, k. Petiole: length (cm), l. Petiole: thickness (cm), m. Stipule: nature, n. Leaf lamina: length (cm), o. Leaf lamina: width (cm), p. Leaf: size (sq. cm), q. Leaf: shape, r. Leaf: color, s. Leaf: hairiness, t. Leaf: texture, u. Leaf: base, v. Leaf: apex, w. Leaf: margin, x. Leaf: type, y. Mature bud size, z. Bud attachment, aa. Mature bud shape, ab. Accessory bud, ac. Sex, ad. Mature inflorescence: length (cm)
Plant: vigor (Low-3, Medium-5, High-7); Plant: growth habit (Erect-3, Semi-erect-5, Sreading-7, Drooping-9); Sprouting (Early-3, Medium-5, Late-7); Survival % of cuttings (Low-3, Medium-5, High-7); Shoot: type (Straight-3, Slightly curved-5, Curved-7); Shoot: thickness (Thin-3, Medium-5, Thick-7); Mature shoot: color (Yellow-Green Group 147-1, Greyed-Green Group 195-3, Grey-Brown Group 199-5, Brown Group N200-7, Grey Group 201-9; Inter-nodal distance (Short-3, Medium-5, Long-7); Phyllotaxy (Distichous-3, Tristichous-5, Pentastichous-7, Mixed type-9); Leaf: angle (Acute-3, Horizontal-5, Obtuse-7); Petiole: length (Short-3, Medium-5, Long-7); Petiole: thickness (Thin-3, Medium-5, Thick-7); Stipule: nature (Bud scale-1, Free lateral-2, Foliaceous-3); Leaf lamina: length (Short-3, Medium-5, Long-7); Leaf lamina: width (Narrow-3, Medium-5, Broad-7); Leaf: size (Small-3, Medium-5, Large-7); Leaf: shape (Cordate-1, Wide ovate-3, Ovate-5, Narrow ovate-7, Lanceolate-9); Leaf: color (Light Green -141 D-3, Green-137C-5, Dark Green-137A-7); Leaf: hairiness (Glabrous-3, Sparsely Hairy-5, Hairy (pubescent)-7); Leaf: texture (Membranaceous-3, Charataceous-5, Coriaceous-7); Leaf: base (Acute-3, Truncate-5, Cordate-7, Lobate-9); Leaf: apex (Acute-3, Acuminate-5, Caudate-7, Obtuse-9); Leaf: margin (Crenate-3, Dentate-5, Serrate-7, Repand-9); Leaf: type (Unlobed-1, Lobed-2, Mixed type-3); Mature bud size (Small-3, Medium-5, Large-7); Bud attachment (Adhering to branch-1, Slanting out ward-2, Tilting to one side-3); Mature bud shape (Round-3, Acute triangle-5, Long triangle-7, Spindle-9); Accessory bud (Absent-1, Present-9); Sex (Gynoecious-1, Androecious-2, Bisexual-3, Andromonoecious-4, Gynomonoecious-5, Androgynomonoecious-6); Mature inflorescence: length (Short-3, Medium-5, Long-7); Stigma: nature (Pubescent-3, Papillate-7); Stigma: type (Erect-3, Spreading-5, Divaricate-7, Twisted-9); Mature fruit: length (Short-3, Medium-5, Long-7, Very long-9); Mature fruit: width (Narrow -3, Medium-5, Broad -7); Mature fruit: color (Black Group 203 - Bluish Black C-1, Greyed-Orange Group 172 - Dark Reddish Orange B-2, Purple Group 76 - Very Pale Purple C-3, Yellow-Green Group 145 - Light Yellow Green D-4, White-5, Green-6).

Ongoing 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.

A total of nine different crosses were undertaken using exotics (Thailand Male, Zimbabwe 4 and *Morus multicaulis*), wild (Laevigata hybrid), indigenous (Gajapathipur 2 and S-13) and popular varieties (V1, G4 and G2) during the reporting period. The crossed seeds were extracted and stored with fungicide treatment. The seedlings of three crossed F1 hybrids (*M. multicaulis* × Thailand Male, ERRC-103 × BR-8 and G2 × Thailand Male) were raised in a well prepared nursery beds and transplanted to main field for further establishment and seedling selection. Open pollinated hybrid (OPH) seeds were collected from G4 and English black accessions.

Details of crosses selected
Hosur-C8 x Gajapathipur2
G2 × Thailand Male
Laevigata hybrid × V1
M. multicaulis × V1
Zimbabwe -4× Gajapathipur-2
BR-2 × S13
M. multicaulis × Thailand Male
ERRC-103 × BR-8
Morus lambang × S-523

Seedlings of crossed F_1 hybrids established under glasshouse and field condition

PIC-3615: Mapping QTLs for alkalinity tolerance in Mulberry (*Morus* spp.) (Aug. 2017 - Feb. 2021)

M. R. Bhavya, T. Gayathri, Y. N. Sanath Kumar and S. Bharatesh (JRF)

Objective: To validate the response of accessions contrasting for alkalinity stress and development of mapping population.

Identified MR-2, Sahana (females) and check AR-12 as tolerant genotypes to alkaline stress and V-1 (male) as susceptible genotypes. Further, attempted MR-2 **×** V-1 (cross 1) and Sahana **×** V-1 (cross 2) crosses repeatedly to generate F_1 seeds required for development of mapping population and obtained 158 and 580 crossed F_1 seeds in cross 1 and cross 2 respectively. Further, these seeds would be used to raise the mapping population. DNA was isolated and quantified from the parents to study parental polymorphism.

PIC01003 CN: Genetic Enhancement of Mulberry by Genomics Approaches: A Multi Component project

PIC 01003 CN- NW2a: Validation of a high-density SNP genotyping array for QTL discovery by association mapping and bi-parental analysis in Mulberry (Sep. 2018 – Aug. 2021)

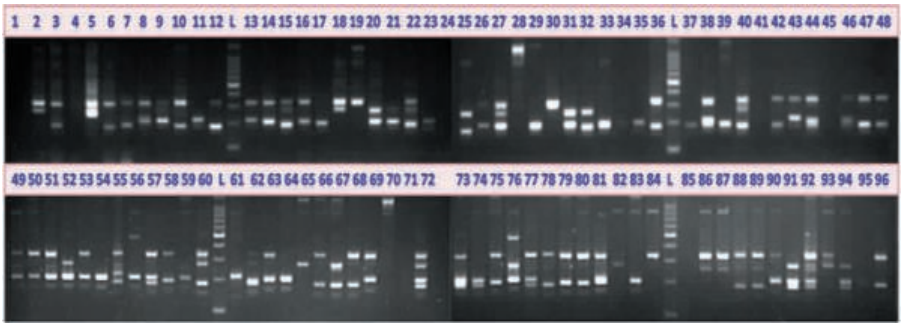
B.N. Gnanesh, G.S. Arunakumar, Tanmoy Sarkar and H.B. Manoj Kumar (RA)

Objectives

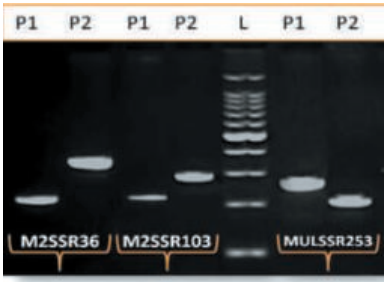
- SNP genotyping of panel of diverse germplasm and mapping population

- Construction of a genetic linkage map using SNP markers
- QTL discovery by marker-trait association and linkage mapping using phenotypic data for different traits

Development of co-dominant marker system is one of the most important requirement, to discover useful QTL regions that govern the variability in complex traits associated with yield potential and stress resilience. DNA was isolated from 311 diverse mulberry germplasm accessions and quantified using Nanodrop. Total of 284 accessions were found with good quality DNA and were stored at -20 ˚C for further use. In first set, a total of 96 accessions were used for genotyping using 106 SSR markers. Among them 80 were successfully amplified and 22 (27.5%) markers revealed polymorphisms with the allelic variation of 2 to 8 across mulberry germplasm. A total of 64 alleles were recorded and the number of alleles per locus ranged from 2 (MULSSR- 253, M2SSR-10, M2SSR-81, MUL3SSR-73, MULSSR-96A and MUL3SSR-124) to 8 (M2SSR82 and Mos0340-2) with an average of 3.38 alleles. These SSR markers categorized the mulberry germplasm effectively; hence these markers could be used for both diversity analysis and breeding applications. The PIC value generated by allelic variation ranged from 0 to 1.0 and PIC value of > 0.5 are considered to be informative markers. The study identified new alleles from different germplasm which could be used for DNA profiling of specific germplasm and to assess the diversity and further to understand the evolutionary pressure acting on these genotypes. The PIC value ranged from 0.38 to 0.82 with an average of 0.58 has been reported and will be useful for selecting the markers for identifying parental polymorphism. Selected SSR markers polymorphic to parents (Punjab Local and *M. cathayana* hybrid) were used for the checking the true hybrid among the developed mapping populations for root rot trait. Three markers M2SSR36, M2SSR10 and MULSSR253 were suitable for confirmation of hybrid in selected parents of F_1 and M2SSR23 and M2SSR83 generated non-specific bands, unlike MULSSR306 marker distinguished the parents as presence and absence of the band but in case of hybrid confirmation this marker will not be useful. The selected three markers will be used for confirmation of true cross.



Agarose gel photograph of 96 Mulberry germplasm using M2SSR82, L : 100 bp ladder



L– 100 bp ladder
Three SSR Markers used in performing parental polymorphism.
P1 – Punjab Local,
P2 - *M. cathayana* (Hybrid)

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

M. R. Bhavya, Tanmoy Sarkar and M. Y. Jagadambha (PA)

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

For the evaluation of genotypes for yield, an experimental plot has been established with 234 mulberry genotypes under (Augmented Randamised Block Design). Experimental plot contains 13 blocks with V-1 border and each block having 18 test samples with 2 checks (V-1 and Kousen). The drip irrigation system was installed to the plot with fertilizer application facility. The plot has been maintained following package of practices and is under 9th month of establishment.

Experimental plot with 234 mulberry genotypes

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

G. S. Arunakumar, B. N. Gnanesh, M. Supriya (JRF) and M. M. Harshitha (PA)

Objectives:

- To develop mapping populations (by crossing of contrasts) for root rot resistance by pseudo-test cross strategy.
- Evaluation of segregating F_1 progeny for disease resistance phenotype.
- QTL analysis for disease resistance by linkage mapping (genotypic data input from the subprogram NW2a)

Root rot is a major disease in mulberry causing leaf yield loss of up to 31.5%. Among various types of root rots, dry root rot caused by *Fusarium solani* (Mart.) Sacc., *F. oxysporum* Schlecht. and black root rot caused by *Botryodiplodia theobromae* Pat. [syn. *Lasiodiplodia theobromae* (Pat.) Griffon & Maubl] have been considered as potential fungal pathogens causing severe damage in mulberry based on our recent study conducted across important south Indian mulberry cultivation states.

Evaluation of F_1 segregating mapping population was undertaken by raising 25 saplings from each F_1 seedlings, after six month of establishment in the main field. Raised saplings were transplanted after four months of establishment in the nursery beds to earthen pots under root rot inoculated and uninoculated condition. All the F_1 segregating mapping population were maintained uniformly with five replication under root rot (*Fusarium solani* and *Lasiodiplodia theobromae*) inoculated condition and one set as uninoculated control. Totally, 200 F_1 segregating mapping population saplings were again raised under nursery beds for repetation of the experiment for second time.

Well established F_1 seedlings at main field and prepared six month old cuttings from each F_1 mapping population and raised F_1 mapping population under nursery bed condition

Transplanted to earthen pots and expression after two months for root rot resistance phenotyping under glass house condition

Continuous/Other Activities:

- Regular maintenance of Panel of Diverse Germplasm (~260)
- Extended 92 new set of Panel of Diverse Germplasm and maintained
- Development and maintenance of mapping resources for Root trait (Dudhia White x UP progeny - 560 Nos; Punjab Local x Thai male progeny - 35 Nos)

Fund Code 9551: (DST-Ramanujan Fellowship): Genomic tools for mulberry improvement (May 2016 – Mar. 2021)

B. N. Gnanesh

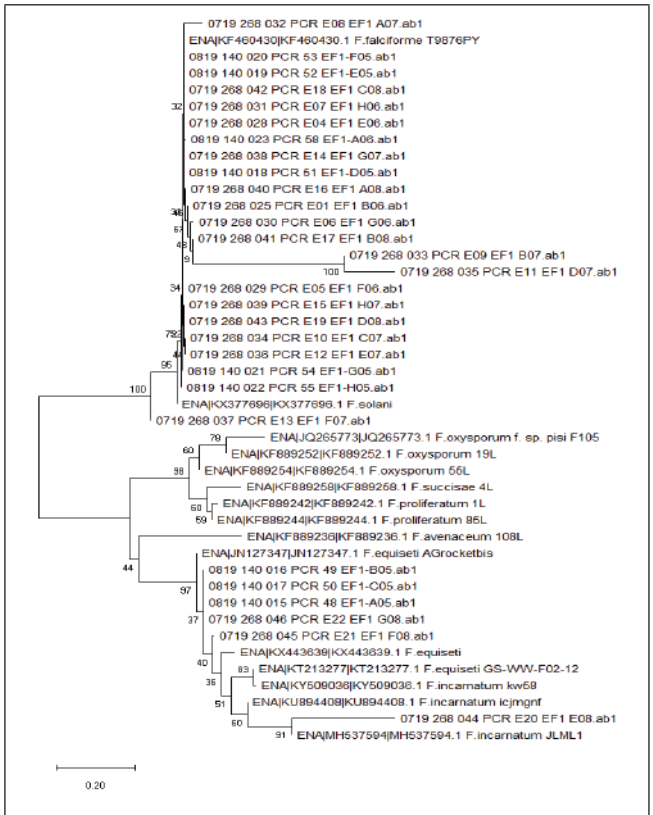
Objectives:

- Flow cytometry determination of genome size and genetic variation using SSR markers in mulberry spp.
- Molecular identification of *Fusarium solani* sp. complex and *Fusarium incarnatum-equiseti* complex associated with root rot of mulberry

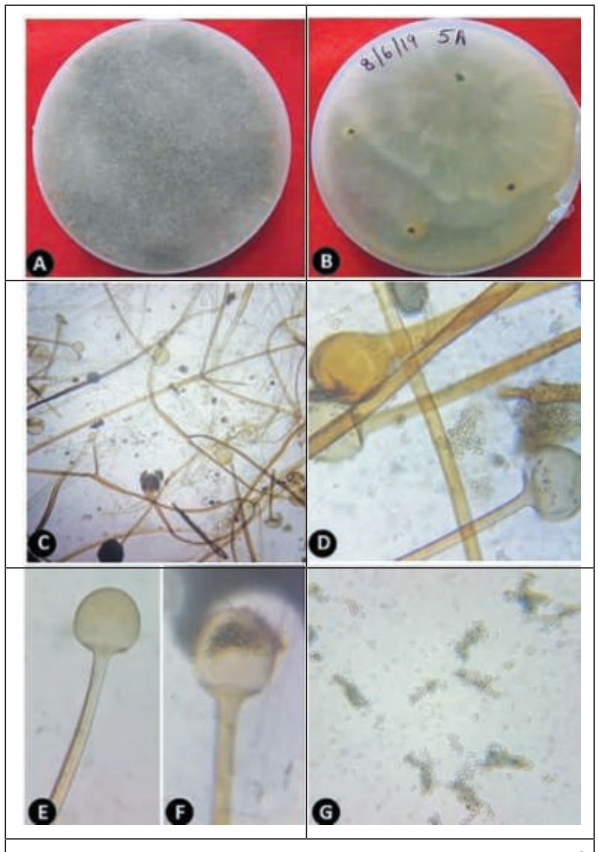
Genome survey and genetic variation using SSR markers in mulberry: Exploring genetic differentiation and genomic content variation is important for utilization of heterosis and dissection of the genetic basis of complex traits. In the present study, we measured the nuclear DNA amounts in 145 indigenous and exotic mulberry germplasm representing eleven different species using Propidium Iodide (PI) method of flow cytometry. The genome size of each accession was estimated by referring to the standard genome size of *Pisum sativum*. Our results predicted four different ploidy levels with genome sizes ranging from 0.5 to 3.3 pg which was smaller than rice plant. A wide range of interspecific 2C DNA values were observed, *M. laevigata*, diploid mulberry plant had an estimated 0.51 pg (2C) which was the smallest genome size detected in this study. In contrast, the hexaploid *M. serrata* exotic wild sp. showed a genome size of 3.32 (2C) representing an approximate 6.5-fold difference. Interspecific variation of nuclear DNA amounts in mulberries varied from 0.51 - 3.32 pg, which was similar to earlier reports. Most of the species showed same ploidy level and few accessions of same species also revealed contrariwise. Results of genome content variation provide helpful information to clarify the taxonomy of *Morus* sp. and simplest reliable indicator of genome variability. Twelve SSR primers produced good and reproducible banding patterns with expected sizes and showed polymorphism in selected 57 genotypes of mulberry. A total of 38 fragments were generated by twelve primers and all accessions were grouped into six different clusters by phylogenetic analysis. Cluster I includes only one accession Chekmajra with genome size of 0.81pg and it is a developed cultivar authorized by mulberry authorization committee for cultivation in India. Cluster II comprised two mulberry germplasm MR-2 (*Morus sinensis*) and BR-8 (*Morus* sp.) with 1.51 and 0.58 pg of genome content respectively, even there is wide variation in genome content but both the germplasm are diploid in nature and reported as same. Cluster III contains Dharatwala and C-15 germplasm had a close genome size of 0.51 and 0.55 respectively. There are 17 germplasm have been grouped in cluster IV, interestingly almost all germplasm from this group are diploid in nature but interspecific ploidy level were found. Popular mulberry triploid known as AR-12 (1.48 pg) and higher genome size mulberry germplasm like Kosen and others are grouped in Cluster V. Cluster VI had a more wide distribution than the other clusters from 0.55 to 2.07 pg. The information on genetic variation will be useful for plant breeders attempting to expand the genetic variation found in this species by crossbreeding using these resources.

***Fusarium solani* species complex and *Fusarium incarnatum-equiseti* complex associated with root rot of mulberry:** Members of *Fusarium* species complex are common pathogens causing root rot of mulberry. Collected 105 *Fusarium* isolates from diseased plants from five different geographic areas of mulberry production in India. The aims of this study were to accurately identify the isolates within the *Fusarium solani* species complex (FSSC) and *Fusarium incarnatum-equiseti* species complex (FIESC) and to determine the genetic diversity and phylogenetic analysis. Based on the sequence data from translation elongation factor (TEF) gene, β-tubulin and

internal transcribed spacer (ITS) regions analysis, all of the 57 selected FSSC and FIESC isolates were divided into two major groups. This is the first report on molecular identification of strains isolated from root rot of mulberry. Also *F. falciforme*, *F. incarnatum, F. equiseti* were reported for the first time in India. We also report for the first time *Rhizopus oryzae* causing root rot of mulberry in India. Several secondary saprophytic invaders associated with root rot of mulberry like *Gongronella butleri, Ovatospora brasiliensis, Amnesia nigricolor, Myrmecridium schulzeri, Pseudallescheria boydii, Aspergillus sp., Talaromyces sp., Graphium euwallacea, Clonostachys rosea* were identified and characterized in this study. The work contributes towards understanding the diversity of fungal species complex in mulberry production areas, which would be useful for developing integrated disease management strategies.



Phylogenetic tree based on the partial sequences of translation elongation factor 1α genes of *Fusarium solani* species complex (FSSC) and *Fusarium incarnatum-equiseti* species complex (FIESC) isolates inferred from Neighbour-Joining method



Macroscopic and microscopic morphology of *Rhizopus oryzae* isolated from roots of mulberry; A & B- Colony characteristics of *R. oryzae* on PDA medium after 7 days of incubation at 30°C; C & D- Sporangium and sporangiophore; E- Columella; F- Sporangiophore bearing a sporangium; G- Sporangiospores

MULBERRY PHYSIOLOGY

Concluded Project:

PIP-3592: Identification of indices for abiotic stress tolerance in mulberry with special reference to moisture and alkalinity stress (Oct. 2016 - Sept. 2019)

T. Gayathri, S. Gandhi Doss, K. Rajashekar (upto Apr. 2019) and Tanmoy Sarkar

Objective:

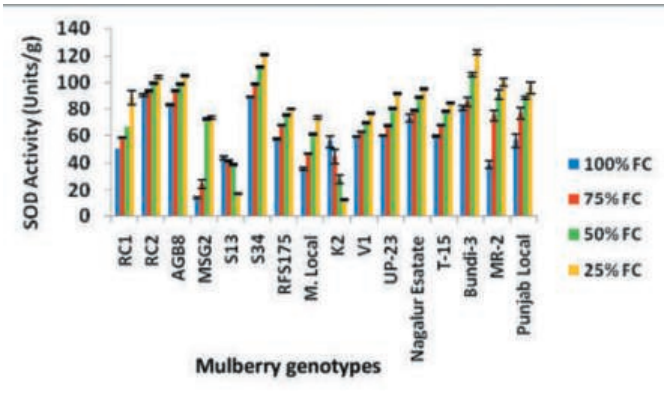
- To identify physio-biochemical indicators (indices) of abiotic stress tolerance in mulberry

Short-listed genotypes were evaluated under moisture and alkalinity stress conditions to identify physio-biochemical indices of stress tolerance in mulberry

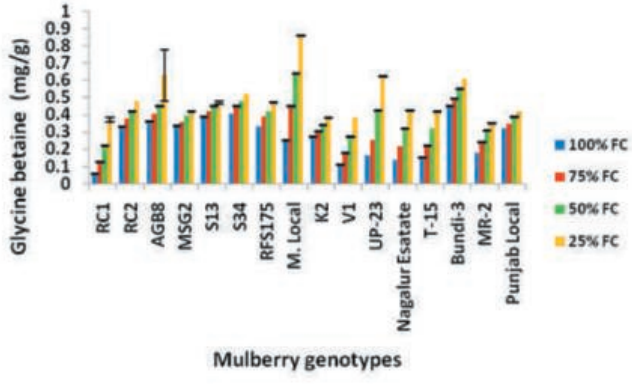
Moisture stress experiments: Moisture stress experiments were conducted in short-listed genotypes *viz.* RC1, RC2, MSG2, AGB8, RFS-175, S13, S34, K2, Mysore Local, V1, MR2 (MI 0025), Punjab Local (MI-0026), T-15 (MI-0214), UP-23 (MI 0256), Bundi-3 (MI-0699), Nagalur Estate (MI-0332). Plants were subjected to four water regimes: in control, pots were maintained at 100% field capacity (FC) and in treatments: low water stress at 75% FC, medium water stress at 50% FC and high water stress at 25% FC. In total, 12 plants were selected for each genotype (control and 3 treatments with 3 replications). Weight loss (transpiration and evaporation loss) was calculated and accordingly water was added to each pot for maintaining the field capacity as per treatment. Moisture stress experiments were continued for one month and fresh leaves were collected from experimental plants for analysis of stress specific biochemical parameters.

Alkalinity stress experiments: Short-listed genotypes: S34, AR12, Sahana, S-1635, RC1, RC2, S13, Mysore Local, K2, RFS-175, V1, Saranath-3 (MI-0764), Bheria dangi-1 (MI-0822), Kanthaloor-2 (MI-0449), T-36 (MI 0226), Pouri-2 (MI-0652), Hosur-C16 (MI-0836), Baragarh -2 (MI-0437), Chirayinkizh (MI 0762), MS-2 (MI 0027) and Madhopur-4 (MI-0670) were evaluated under alkaline soil with pH >9.0 and soil with optimum range of pH (7.0-7.2).

Biochemical parameters: Antioxidants (superoxide dismutase, peroxidase, reduced glutathione, ascorbic acid and phenols) and osmolytes (proline, glycine betaine and soluble sugars) were estimated by standard procedures



Activity of superoxide dismutase (SOD) enzyme during moisture stress



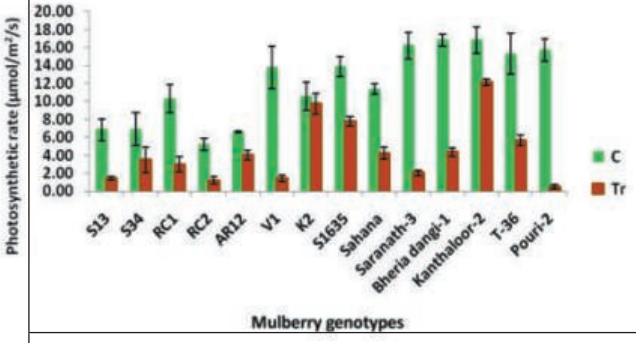
Accumulation of glycine betaine during moisture stress

during moisture and alkalinity stress experiments.

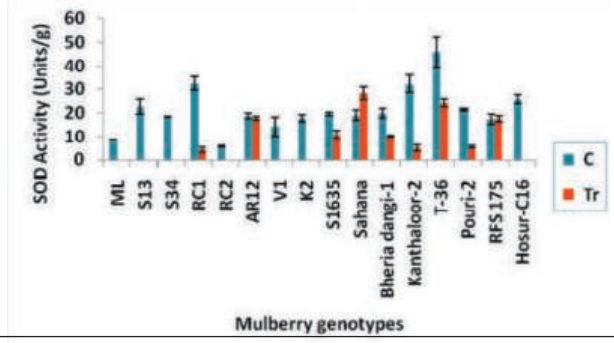
Physiological parameters: Photosynthetic and leaf gas exchange parameters were recorded using a portable photosynthesis system LI-6400 XT (LI-COR Inc., Lincoln, NE, USA).

Results:

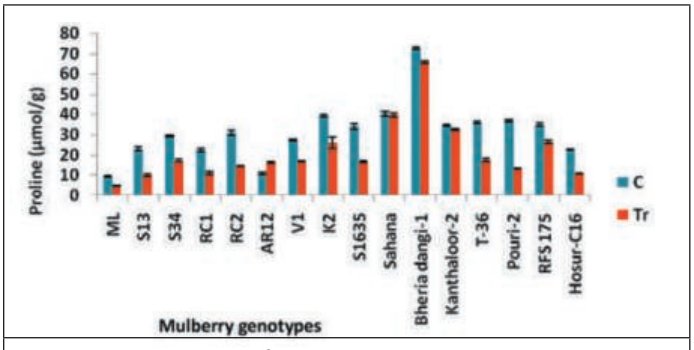
Moisture stress experiments: Photosynthetic rate was maintained even under high stress in tolerant genotypes such as RC1 (8.88 µmol $m^{-2}s^{-1}$), MSG2 (10.15 µmol $m^{-2}s^{-1}$), AGB8 (9.46 µmol $m^{-2}s^{-1}$), MI 0332 (7.45 µmol $m^{-2}s^{-1}$), MI-0026 (8.74 µmol $m^{-2}s^{-1}$); whereas a significant reduction was recorded in K2 (3.50 µmol $m^{-2}s^{-1}$) and Mysore Local (3.46 µmol $m^{-2}s^{-1}$). Progressive higher accumulation of antioxidants (enzymatic: Superoxide dismutase and



Variation of photosynthetic rate during alkalinity stress



Activity of superoxide dismutase (SOD) enzyme during alkalinity stress



Accumulation of proline during alkalinity stress

Peroxidase; non-enzymatic: reduced glutathione and phenol) and osmolytes (proline and glycine betaine) were observed during moisture stress in tolerant genotypes.

Alkalinity stress experiments: Maximum photosynthetic rate was recorded in Kanthaloor-2 (MI 0449) (12.14 µmol $m^{-2}s^{-1}$). Photosynthetic rate was high in all tolerant genotypes; S1635 (7.74 µmol $m^{-2}s^{-1}$), T-36 (MI 0226) (5.65 µmol $m^{-2}s^{-1}$), Bheria dangi-1 (MI 0822) (4.35 µmol $m^{-2}s^{-1}$) and AR12 (3.99 µmol $m^{-2}s^{-1}$). Susceptible genotypes; Pouri-2 (MI 0652), RC2, V1 and S13 exhibited a significant reduction in photosynthetic rate. Superoxide dismutase enzyme activity was maximum in Sahana (28.36 Units/g) and a comparatively higher activity was also recorded

Crop Selection Index for moisture stress tolerance	
Field Capacity (FC) & stress conditions	Crop Selection Index (CSI)*
100% FC (Non stress)	0.170
75% FC (Low stress)	0.231
50% FC (Medium stress)	0277
25% FC (High Stress)	0.322

CSI for alkalinity stress tolerance	
Stress conditions	Crop Selection Index (CSI)*
Optimum pH	0.827
Alkalinity stress	0.172

a) Hosur- C16 (b) S13 (c) RC1

Saplings of susceptible genotypes grown in alkaline soil

(a) Sahana (b) Kanthaloor-2 (c) Bheria dangi-1

Saplings of alkaline tolerant genotypes grown in alkaline soil

in AR12 and T-36 (MI 0226). SOD enzyme activity was not observed in susceptible genotypes (S13, RC1, RC2, Mysore Local, V1). Higher accumulation of proline was observed in all tolerant genotypes: Bheria dangi-1 (MI 0822) (65.7 µmol/g) and Sahana (39.6 µmol/g), recorded the maximum proline content; whereas least content was observed in susceptible genotype Mysore Local (4.88 µmol/g)

Crop Selection Index (CSI): CSI is 0.170 for 100% Field Capacity (FC) (non stress), 0.231 for 75% FC (low stress), 0.277 for 50% FC (medium stress) and 0.322 for 25% FC (high stress) (Table.1). The developed index showed a progressive increase towards the high stress and it indicated an ascending order and hence it is significant for defining the stress tolerance response. CSI is 0.172 for alkalinity stress.

***CSI prepared by considering physio-biochemical indicators**

- Physio-biochemical indices (indicators) identified for moisture and alkalinity stress tolerance in mulberry is useful for selecting tolerant genotypes.
- Identified four genotypes highly tolerant to alkalinity stress (pH>9); Sahana (MI 0524), Bheria dangi-1 (MI 0822), T-36 (MI 0226), and Kanthaloor-2 (MI 0449) and these genotypes could be utilized for future breeding programmes.

Ongoing Projects:

Constructed 3 nos. of root structures (cement structures) and established plantation of diverse germplasm accessions in these structures

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

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

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

Objectives

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

For studying root traits as part of phenotypic characterization of diverse germplasm, 3 nos. of root structures (cement structures) were constructed with irrigation facility in the experimental plot. Saplings of diverse germplasm accessions were raised in nursery and supplied to UAS, Bengaluru for undertaking phenotypic study simultaneously in both locations (CSRTI-Mysuru and UAS, Bengaluru). Plantation of diverse mulberry germplasm accessions were established in root structures (cement structures) in augmented design along with two check varieties (V1 & G4) for recording of phenotypic observations for drought adaptive traits. Experimental plants were maintained in root structures for phenotypic characterization.

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

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

Objective

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

Experimental garden was established in RBD layout with ten mulberry genotypes V1, G2, G4, S13, K2, Mysore Local, S36, MR2, MS-2, *Morus multicaulis* (ME-0168). It is maintained as per the recommended package of mulberry cultivation and the plantation is under establishment. Standardization of procedures for biochemical analysis of primary metabolites with different mulberry genotypes was carried out.

State wise data on number of soil samples analyzed	
State	Number of soil samples analysed (2016-2019)
Karnataka	9593
Tamil Nadu	10431
Andhra Pradesh and Telangana	7139
Maharashtra and Madhya Pradesh	2837
Total	**30000**

SOIL SCIENCE & CHEMISTRY

Concluded Research Project:

PPA-3580: Soil health cards for sericulture farmers in states of Karnataka, Tamil Nadu, Andhra Pradesh, Telangana, Kerala, Maharashtra and Madhya Pradesh (Apr. 2016-Jun. 2019)

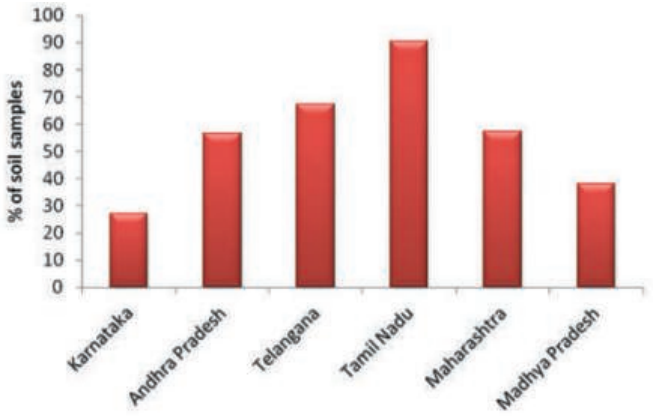
V. Sobhana, S. Sen, M. Munirathnam Reddy, (Retd.), P. Sudhakar[1], , Dahira Beevi[2] and B[3]. Vijay Naidu,

[1]RSRS-Kodathi, [2]RSRS-Salem, [3]RSRS-Anantapur

Objective: To make the farmers aware about the importance of soil fertility on the production of quality mulberry leaves by issuance of soil health cards

A total of 30000 soil samples were collected and analysed from sericulture farmers of Karnataka, Tamil Nadu, Andhra Pradesh Telangana, Maharashtra and Madhya Pradesh in coordination with CSB field units, DOSs and state soil testing laboratories. The state wise data on number of soil samples analysed during the period are shown in table. These soil samples were analyzed for pH, electrical conductivity, organic carbon, major nutrients and micronutrients by following the standard procedures.

Soil pH is an important chemical parameter as it helps in ensuring availability of plant essential nutrients. The results show that in Karnataka the soil pH values, ranged from slightly acidic to moderately alkaline. In the study area of Andhra Pradesh and Telangana the soil pH values ranged from neutral to moderately alkaline whereas in Tamil Nadu the soil pH values ranged from neutral to strongly alkaline. Mulberry grows well in slightly acidic to neutral soil pH. The study shows that 27 % of the soil samples analysed in Karnataka were slightly alkaline to moderately alkaline (7.4-8.4) in reaction whereas it is observed 90 %, 56 %, 67 %, 57 %, 38 % in Tamil Nadu, Andhra Pradesh, Telangana, Maharashtra and Madhya Pradesh respectively. Nearly 60% of soil samples were analysed in Karnataka is neutral in reaction. Maximum soils with alkalinity problems are observed in Tamil Nadu where 20 % of the soil samples analysed comes under strongly alkaline range (>8.5). The state wise percentage of soil samples analysed with alkalinity problems (pH >7.4) were given in below figure. Out of the total soil samples analysed in Karnataka alkaline soils were found in Davangere followed by Koppal, Bagalkot, Chitradurga and Bijapur districts. 98% of the soil samples of Kurnool district of Andhra Pradesh come under slightly alkaline to moderately alkaline range. In Tamil Nadu more than 80 % of the soil samples of Coimbatore, Dharmapuri, Erode and Tiruvannamalai districts comes under moderately alkaline to strongly alkaline range. In Maharashtra, strongly alkaline soils found in Nanded, Akola, Wardha and Beed districts. In Madhya Pradesh more alkaline soils were found in Khandwa district. Majority of the samples analysed in all the states were exhibited normal range with respect to electrical conductivity (EC <1.0 dS/m).



Percentage of soil samples analysed with respect to soil alkalinity in different states

Organic carbon is considered as the soil fertility indicator of mulberry gardens. The organic carbon content in mulberry growing areas ranged from 0.05-1.5 %. The organic carbon content was low in 70 % of the soil samples of Karnataka where as in Tamil Nadu, Andhra Pradesh, Telangana, Maharashtra and Madhya Pradesh the low organic carbon were recorded as 71 %, 85 %, 78 %, 65 %, 55 % soil samples respectively. The analysis of available N showed that most of the soils samples in all the states varied from low to moderate levels. Available nitrogen was noticed low (<280 kg/ha) in 64 % soil samples of Karnataka, 54% soil samples of Tamil Nadu, 70% soil samples of Andhra Pradesh, 68 % soil samples of Telangana, 33% soil samples of Maharashtra and 37% soil samples of Madhya Pradesh.

In the present study, available phosphorus ranges vary from 3 kg/ha to 98 kg/ha. In Karnataka, 27% of soil samples analysed shows low phosphorous content. High proportion of soil samples of Tamil Nadu (35%), Andhra Pradesh (44%), Telangana (47%), Maharashtra (33%) and Madhya Pradesh (48%) are with low available phosphorus status. The extractable potassium content was varied from 89 to 1500 kg/ha. The potassium content in majority of the soil samples analysed was moderate to sufficient range. The results showed that more than 60% of the soil samples analysed in all the states are having sufficient levels of available K and it ranges from moderate to high values.

The available sulphur status shows that most of the soils samples analysed in Karnataka, Andhra Pradesh and Maharashtrta comes under medium to high category, whereas 51% soil samples of Tamilnadu and Madhya Pradesh comes under low category. With respect to Boron the results shows that more than 63% of the soil samples analysed in all the states are deficient in available Boron.

Percentage status of soil samples analysed for available N, P, K, S and B (L=Low; M=Medium; H=High)															
State	Available N			Available P			Available K			Available S			Available B		
	L	M	H	L	M	H	L	M	H	L	M	H	L	M	H
KA	64	26	10	28	21	50	6	27	67	12	38	51	63	29	8
TN	52	36	12	35	28	37	7	33	59	51	44	4	80	16	4
AP	70	25	5	44	22	33	7	30	64	16	42	43	78	18	5
TS	68	24	8	47	9	44	5	24	71	16	28	56	89	9	2
MH	34	48	17	33	28	39	1	7	92	9	41	51	83	15	2
MP	38	45	17	48	35	17	3	35	63	51	37	13	94	4	3

Based on the soil test results, recommendations of fertilizers & manure application were provided to the farmers as per the principle of site specific nutrient management in order to promote balanced and judicious use of plant nutrients thereby over use and under use of fertilizers can be avoided.

Ongoing Research Projects:

PIC 01003 CN: Genetic enhancement of Mulberry through Genomic approaches: A Multi Component Network Project

NW2d: Sub Component: Identification of QTLs for Nutrient Use Efficiency (Sep. 2018- Aug. 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
- To identify QTLs for Nutrient Use Efficiency and associated traits by Linkage Disequlibrium mapping (SNP genotypic data on the panel to be provided by NW2a of the mulberry network programme)

250 diverse mulberry genotypes were shortlisted and collected from CSGRC-Hosur. They were used to raise nursery at CSRTI-Mysuru. After 3 months, the saplings were uprooted and transplanted to the pots. Drip irrigation system was installed to maintain the uniform irrigation. The different fertilizer treatments were imposed with 2 level of fertilizer dosage i.e. recommended dose of fertilizer (350:140:140 kg/ha NPK) and 30% of recommended dose of fertilizer. The experimental pots were maintained as per the schedule.

A view of the experimental site

PIC01007 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, Thirupathaiah Y., Sobhana V., Gayathri T. and Hukkeri S.M.

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

Specific Objective: Purification and characterization of sericin and fibroin from organic cocoon

As a preliminary work, water, soil and leaf samples were collected from existing organic garden maintained at CSRTI, Mysuru and analyzed for heavy metals. Similarly, organically produced cocoons were collected and analysed for heavy metals. It was observed that cocoon contain heavy metals viz., Pb, Cd, As, and Hg within the permissible limits as per the standard guidelines given by different health organizations.

Occurrence of heavy metals in soil, water, leaf and cocoon

Heavy metals	Irrigation Water	Organic			IPCS -Guidelines	USP-Guidelines
		Soil	Leaf	Cocoon	Permissible limit for drugs (mg/kg)/ day Tissue exposure	
	(mg/Kg)	(mg/Kg)	(mg/Kg)	(mg/Kg)	(mg/Kg)	(mg/Kg)
Pb	BDL 0.008	11	3.6	BDL 0.5	0.5	0.5
Cd	BDL 0.002	BDL 5.0	BDL 0.02	BDL 0.1	0.2	0.25
As	BDL 0.005	0.56	BDL 0.05	BDL 0.02	1.5	0.15
Hg	BDL 0.0008	BDL 0.04	BDL 0.01	BDL 0.02	0.3	0.15

BDL: Below Detection Limit; IPCS: International Program for Chemical Safety; USP: United State Pharmacopeia

Nursery with V1 mulberry were raised to take up new organic plantation. After land preparation the soil samples were analysed for its fertility level (Table). The mustard and maize seeds were sown for the effective removal of toxic elements and other minerals available in the soil. Simultaneously mulberry plants were grown through hydroponic and sand culture on trial basis in the laboratory .

Sowing of mustard seeds

Uprooting of mustard crops

Phytoremediation of soil by using mustard and maize crops in organic field

Fertility status of initial soil sample of new organic field

Parameters	Values
pH	7.28
EC	0.19 (dS/m)
OC	0.11 %
N	89.85 (kg/ha)
P	13.4 (kg/ha)
K	179 (kg/ha)

A B C

Production of mulberry leaf through sand culture technique. A) Mulberry saplings are grown in pots with sand B) sprouting of bud C) Saplings with newly sprouted leaves

Different varieties of mulberry saplings grown in cocopeat

Continuous/Other activities:

Quality Testing of Disinfectants, Products and different Farm Inputs used in Sericulture

Objective: To analyse the plant and other samples and assess their suitability for sericulture activities

As mandated under R&D of the Institute, Soil Science & Chemistry Section has conducted quality analysis of various products/ samples (including free of charge) which are used in Sericulture as per the table below by providing technical and services support to all the stake-holders of Sericulture Industry for its promotion.

Products / Samples analysed	Nos.
Soils samples from farmers and various Units/Stations/Projects	280
Irrigation Water	12
Asthra	13
Vijetha	03
Vijetha Supplement	02
Sanitech	02
Amruth	03
Jeevan Amruth	01
Ankush	10
Poshan	07
Vermi-compost	04
Dr. Soil	05
Ankur	01
Serichlor-20	01
Total	344

AGRONOMY

Ongoing 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)

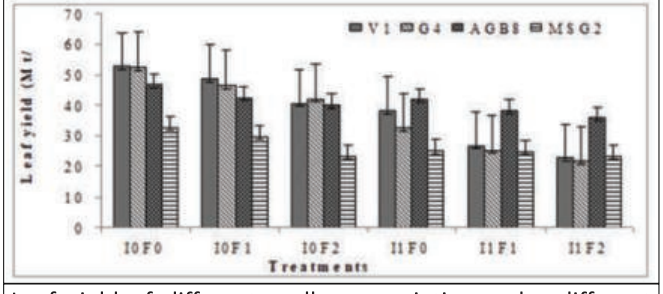
Dhaneshwar Padhan, Sibayan Sen, V Sobhana, E. Bhuvaneshwari and Y. Thirupathaiah

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

An experiment was conducted to evaluate the improved mulberry genotypes for yield potential, nutrient uptake and nitrogen use efficiency under varied cultivation practices.

The experiment comprised of two levels of irrigations (I_0= 100% and I_1= 60%) and three levels of fertilizer dosages (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 was applied uniformly to all the treatments @ 25 MT/ha/yr. Four mulberry genotypes *viz.,* AGB-8, MSG-2, G-4 and V-1 were used for evaluation in split split plot design with three replications.



Leaf yield of different mulberry varieties under different treatments. Values are the pooled yield data of 5 crops and error bars represent standard deviations across replications.

During the period, 5 crops were harvested for the first year and the growth and yield parameters were recorded. Soil samples were analyzed for its physical and chemical properties for different seasons. Pooled data of 5 crops for the first year revealed that under low input conditions ie; in the treatment $I_1F_{2;}$ the AGB8 variety recorded the leaf yield of 36.0 MT/ha/yr followed by MSG2 (23.4 MT/ha/yr) as compared to V1 and G4 which recorded 22.8 and 21.6 MT/ha/yr respectively (Fig.). When the yield was computed across the treatments, AGB8 recorded highest followed by V1, G4 and MSG2. Under 100% irrigation, there was a decline in leaf yield among all the four genotypes to the tune of 9.5 and 21.3% due to the reduction of fertilizer inputs at 80 and 60% respectively. Similarly the reduction of leaf yield for all the genotypes under reduced irrigation showed the magnitude of 15.6 to 23.8%. Soil analysis revealed that there was no significant difference in the physical and chemical properties among the different treatments during the first year.

CSTRI-Bengaluru (Collaborative Project)

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 supplied by the CSTRI-Bengaluru were subjected for composting under 5 different treatment combinations in the compost pots to study the composting feasibility of silk waste. The pots were maintained with standard procedure for a period of 6 months. The nutrient status will be analysed after 6 months.

Continuous/Other activities:

- Maintained two acre seed mulberry garden with G4 variety and also seri-compost and vermicompost units for demonstration.

MULBERRY PATHOLOGY

Concluded Research Project:

PRP-3818: Popularization of *Rot-fix* for management of root rot disease of mulberry among sericulture farmers of southern states (Jul. 2017 – Jun. 2019)

P. M. Pratheesh Kumar, S. Raja Kumar, T. V. Srinivasa Rao, A. Venugopal, and R. S. Teotia (upto Aug. 2019)

Objective: To popularize *Rot-fix* as a broad spectrum formulation for management of root rot disease of mulberry

A formulation *Rot-fix* has been developed by CSRTI-Mysuru recently. The *Rot-fix* is environment friendly and broad spectrum with no any harmful effect. It is having antifungal activity, which inhibits the growth and multiplication of root rot associated fungi effectively in soils; also prevents further development and spread of the pathogens. Effectiveness of the formulation has been proved in various trials conducted in the hotspot areas of Karnataka, Tamil Nadu and Andhra Pradesh with 70-80% control of the disease. Product even showed 100% revival of the infected plants if applied in the initial stages of infection. The *Rot-fix* is also found safer to the silkworm, mulberry and soil microbes as well. The present work has been conducted to popularize the product among the sericulture farmers of Karnataka, Tamil Nadu, Andhra Pradesh and Telangana as an effective eco-friendly product to combat the disease and to avoid economic loss.

Methodology: The project is implemented in four states *viz*. Karnataka, Tamil Nadu, Andhra Pradesh and Telengana through the extension functionaries and Department of Sericulture in these three states. The farmers were selected from these states in four phases based on the reports of the extension functionaries on the incidence of the disease in various areas of these states.

Rot-fix has been prepared and supplied to four states according to the requirements. The method of application is demonstrated to the farmers by the Extension Officers/ officials of Regional Sericulture Research Stations (RSRSs) and Research Extension Centers (RECs) with the help of the officials of Department of Sericulture (DOS) of concerned states. Awareness programmes were conducted in the hotspot areas of these states. Pamphlets on identification of the disease and method of application were prepared and distributed to the farmers in local languages.

After application, the applied plants are earmarked and the data on revival of plants are collected from selected farmers. Also the preliminary details of the farmers such as the variety area under mulberry cultivation, etc. are collected in the prescribed format. The revival percentage is calculated using the following formula and compiled.

$$\text{Wilting}(\%) = \frac{\text{Number of plants revived}}{\text{Total number of plants treated}} \times 100$$

Patenting and Commercialization of *Rot-fix:* Document has been prepared in the prescribed format for patenting of *Rot-fix* and submitted through National Research Development Corporation (NRDC). Also, a technical knowhow of the *Rot-fix* has been prepared and commercialized the product.

Results: A total of 524 farmers were covered in the project in four states. Maximum number of farmers was covered in Tamil Nadu (201) followed by Andhra Pradesh (128), Karnataka (120) and Telangana (75). About 159 demonstrations were conducted to the farmers on identification of the root rot disease and application of the formulation. About 2664 *Rot-fix* was distributed to the farmers of four states. Maximum quantity (1173 kg) was distributed in Tamil Nadu followed by Karnataka (667 kg) and Andhra Pradesh (491 kg).

Rot fix distribution, demonstrations and average disease control				
State	Farmers covered (No.)	Demonstrations (No.)	*Rot-fix* distributed (kg)	Avg. disease Ctrl (%)
Andhra Pradesh	128	31	491	68.91
Tamil Nadu	201	52	1173	72.20
Telangana	75	32	333	64.86
Karnataka	120	44	667	76.63
Total	524	159	2664	70.65

The data on the performance was collected from selected farmers of of various villages. Among various villages of Andhra Pradesh, the highest control of the disease was found 77.5% and lowest 60.66%. The average data of 12 villages showed an average disease control of 68.91% in terms of revival of the plants.

Performance of *Rot-fix* in selected farmers' fields of Andhra Pradesh							
Name of the village	No. of farmers	Area (ac.)	Variety	*Rot-fix* treated plants (No.)	*Rot-fix* supplied (kg)	Plants revived (No.)	Revival (%)
Kurava Pallli	2	2	V1	250	4	173	69.20
V K Pallli	2	2	V1	350	4	243	69.42
Kurava Pallli	1	2	V1	100	2	68	68.00
Odiveedu	12	19	V1	1535	3	1061	69.12
Cherlo Palli	6	6	V1	540	6	384	71.11
Seshapuram	1	2.5	V1	50	0.5	38	76.00
Patharlapalli	1	1	V1	50	0.5	31	62.00
Julukunta	1	2.5	V1	50	0.5	35	70.00
Penukonda	1	1.5	V1	100	1	62	62.00
Pedu.puram	1	2	V1	150	1.5	91	60.66
Nadimipalli	1	1.5	V1	50	0.5	36	72.00
Patharlapalli	1	2	V1	80	1.5	62	77.50
Total/average	30	44		3305	25	2284	68.91

In Tamil Nadu, among 30 farmers of 19 villages, the highest control of disease was observed as 80% and lowest was 62%. The average disease control was found 72.20% in terms of revival of the infected plants after the application of *Rot-fix*. In case of Telangana, data of 24 villages showed the highest control of 78.48% and lowest 60%. The average disease control was 64.86%. Similarly in case of Karnataka, the highest disease control was 94.40% and lowest was 58.52%. The average disease control of the farmers of 17 villages was 76.63%.

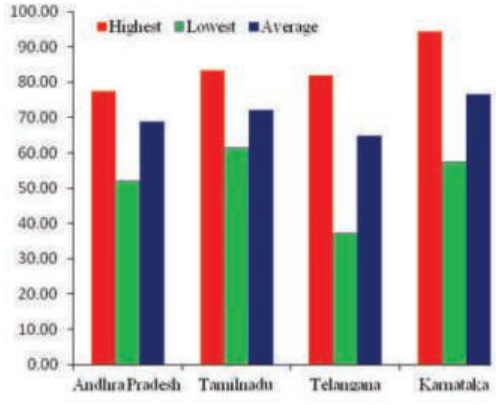
Performance of *Rot-fix* in selected farmers' fields of Tamil Nadu							
Name of the Village	No. of farmers	Area (ac.)	Variety	*Rot-fix* treated plants (No.)	*Rot-fix* supplied (kg)	Plants revived (No.)	Revival (%)
Pethampatty	1	3	MR2	100	0.5	76	76.00
Erugalampalayam	7	13	MR2/ V1	470	13.5	335	71.28
Narasingapuram	1	4.5	V1	100	0.5	71	71.00
Bommanaikanpatti	4	9	MR2/V1	300	5	214	71.33
Thalavaipattinam	2	4	MR2	150	1	111	74.00
Mettupalayam	1	2	V1	70	0.5	50	71.43
Mangalapatty	1	2	MR2	80	0.5	60	75.00
Chinnakampalayam	2		V1	80	0.5	61	76.25
Ayyampalayam	1	2	MR2	50	0.5	31	62.00
Nattukalpalayam	1	4	MR2	80	0.5	56	70.00
Seelanaikanpatti	1	3	V1	60	0.5	41	68.33
Angitholur	1	2	V1	80	0.5	64	80.00
Nainagoundanvalasu	1	1.5	MR2	100	0.5	75	75.00
Nattukalpalayam	1	4	V1	80	0.5	57	71.25
Notchikattuvalasu	1	2.5	V1	70	0.5	55	78.57
Alagugoundanpudur	1	3.5	MR2	80	0.5	51	63.75
C.V.Patti	1	1	V1	60	0.5	40	66.67
Elayamuthur	1	3	V1	80	0.5	60	75.00
Kondampatti	1	2	V1	60	0.5	45	75.00
Total/ average	30	66	-	2150	27.5	1553	72.20

Performance of *Rot-fix* in selected farmers' fields of Telangana							
Name of the Village	No. of farmers	Area (ac.)	Variety	*Rot-fix* treated plants (No.)	*Rot-fix* supplied (kg)	Plants revived (No.)	Revival (%)
Nandyalavarigudem	4	11.5	V1	555	12	378	68.10
Gattikal	2	4.5	V1	190	4	129	67.89
Balemla	1	5	V1	168	2	108	64.28
Vepuru	1	2.5	V1	156	2	102	65.38
Lingala	1	2.5	V1	136	2	88	64.70
Thungathurthy	2	6.5	V1	137	4	86	62.77
Thirumalaipalem	1	4	V1	74	2	48	64.86
Medidhapalli	1	3	V1	96	2	66	68.75

Name of the Village	No. of farmers	Area (ac.)	Variety	*Rot-fix* treated plants (No.)	*Rot-fix* supplied (kg)	Plants revived (No.)	Revival (%)
Duddepudi	3	6	V1	248	6	183	73.86
Ganeswaram	1	2	V1	115	2	72	62.60
Madhapur	1	2	V1	73	2	31	42.46
Narayanapur	1	2	V1	115	2	75	65.21
Sublaid	1	2	V1	123	2	69	56.09
Patharlapadu	1	2.5	V1	79	2	62	78.48
Gadwal	1	5	V1	110	2	69	62.72
Vemula, MBNR	1	3	V1	180	4	116	64.44
Gouraram	1	3	V1	140	2.5	91	65.00
Sankireddypalli	1	3	V1	50	1	35	70.00
Parvathapur	1	5	V1	45	1	30	66.66
Vattipalli	1	6	V1	165	3	102	61.82
Chandur	1	2	V1	185	3	122	65.95
Narshimhapuram	1	5	V1	350	6	210	60.00
Mirzil	1	3	V1	140	3	85	60.71
Total/ Average	30	91	-	3630	71.5	2357	64.86

Performance of *Rot-fix* in selected farmers' fields of Karnataka							
Name of the Village	No. of farmers	Area (ac.)	Variety	*Rot-fix* treated plants (No.)	*Rot-fix* supplied (kg)	Plants revived (No.)	Revival (%)
Kulagere	4	7	V1	540	8	430	79.63
Toresettahalli	2	2.1	V1	26	2	22	84.62
Konasale	2	1.9	V1	600	8	410	68.33
N. N. Halli	2	2	V1	91	2	82	90.11
B. Yarahalli	5	6.75	V1	490	14.5	361	73.67
N. N. Halli	2	3.5	V1	91	2	78	85.71
Hulikere	1	1	V1	30	0.5	18	60.00
Mallanakuppe	1	2.5	V1	250	2	180	72.00
D. Hosahalli	1	2	V1	135	1.5	79	58.52
Hosakere	1	1.5	V1	175	1.5	156	89.14
Pannedoddi	1	2	V1	200	3	161	80.50
Eregowdadoddi	1	2	V1	250	3	236	94.40
Ranganna	1	1	V1	200	2	140	70.00

Name of the Village	No. of farmers	Area (ac.)	Variety	*Rot-fix* treated plants (No.)	*Rot-fix* supplied (kg)	Plants revived (No.)	Revival (%)
Sunkighatta	1	1	V1	350	2	259	74.00
Abbur doddi	1	1	V1	120	2	100	83.33
M. Hosahalli	1	2	V1	200	4	139	69.50
Kadirumanagala	3	6.75	V1	990	12.5	686	69.29
Total/Average	30	46	-	4738	70.5	3537	76.63



Impact of *Rot-fix* on root rot disease in mulberry

Revival of mulberry after application of *Rot-fix*

Commercialization: The *Rot-fix* has been commercialized through National Research Development Corporation (NRDC) to M/s. Kamath Chlorotech, Bengaluru by transferring the technology for commercial production.

Patenting of the technology : Patent application has been filed for getting an Indian patent for the technology through National Research & Development Corporation (No. 201841028088 Dated 02.07.2018) and also application has been submitted to National Biodiversity Authority (NBA) for permission to use bio-resource.

A pamphlet on *Rot-fix* with all details including method of application has been made and published in Kannada, Telugu, Tamil, Hindi and English and distributed among the farmers.

Commercially available *Rot-fix*

Conclusion: Root rot caused by various fungal pathogens is a severe disease of mulberry. The disease reduces leaf yield up to 20%. Further, nematode infection act as portal of entry to root rot pathogens making disease complex. There was no effective management method for control of root rot. The popularization of the *Rot-fix* in four southern states showed the formulation is highly effective with an average 70.65% control of the disease. Therefore, it is to be widely popularized among the sericulture farmers to save the crop from root rot disease and reduce the crop loss.

Recommendations:

- The *Rot-fix* has been found highly effective for control of root rot disease of mulberry and avoid the crop loss. The formulation could be used for control of root rot disease of mulberry.
- The *Rot-fix* is to be further popularized through Extension Communication Programmes by Research Extension Centers and sericulture clusters for effective management of root rot disease

BIVOLTINE SILKWORM BREEDING LABORATORY

Concluded projects

AIT 3593: Transcriptome analysis of silkworm for identification of molecular markers for improvement of silk quality (Sep. 2016 – Aug. 2019)

L. Kusuma, C. M. Kishor Kumar (upto Jun. 2019), S. Manthira Moorthy, M. N. Chandrashekar

Objectives

- To carry out transcriptome analysis of silk gland in mulberry silkworm breeds for identification of markers for silk quality
- To analyze important trait-related gene pathways in silkworm and establish gene-gene and gene-protein interaction pathway

Most of the silk production in India is of mulberry silk and around 75% is from crossbreeds. The silk produced by the crossbreeds (Pure Mysore and Nistari-based) is of inferior quality, but better than multivoltine parental stocks. Bivoltine silkworm breeds are known for their superior productivity and silk quality. Morphological diversity of insects is important for their survival; in essence, it results from the differential expression of genes during development of the insect body (Chen *et al*., 2015). During the last decade, silkworm breeding focused mainly on selecting bivoltine and multivoltine lines with an objective to improve silk quality and productivity besides sustainability. The characteristics of silk that determine the quality need to be incorporated from bivoltines to multivoltines/bivoltines for improvement of overall silk quality. The functional complexity at transcriptome level for silkworm breeds/strains contrasting for silk quality was studied.

Materials and Methodology

Silkworm breeds were reared on fresh mulberry leaves in the bivoltine breeding laboratory, CSRTI, Mysuru, at 25°C and 80% relative humidity under 14 h light and 10 h dark cycles for three generations (inbred). Intact silk glands were dissected out on 3rd day of fifth instar larvae. ASG and PSG were dissected out for Nistrai, CSR27 and Pure Mysore, CSR2, PMxCSR2 (Kolar gold) respectively. Silk glands from five larval samples were pooled and used as one sample in each case. Intact glands were dissected and frozen immediately in RNA stabilization solution and stored in -80°C deep freezer until further use.

Total RNA were isolated using TRIZOL method. The quality of the total RNA was checked on 1% denatured Agarose gel and quantified using Nanodrop8000 Spectrophotometer. The libraries were prepared using 2µg of total RNA *Lexogen SENSE mRNA-Seq Library Prep Kit V2.* The amplified libraries were analyzed in Bioanalyzer 2100 (Agilent Technologies) using High Sensitivity (HS) DNA chip. After obtaining the Qubit concentration for the library and the mean peak size from Bioanalyser profile, library was loaded into Illumina platform for cluster generation and sequencing.

Reference guided transcript assembly was performed for all the 5 samples, first by mapping HQ reads on *Bombyx mori* genome using **HISAT2** and then performed transcript assembly by **StringTie**. A consensus set of transcripts was obtained using **SringTie merge** function which merges together all the gene structures found in any of the samples. Potential novel isoforms that shares at least one splice junction with a reference transcript were identified with **gffcompare** utility. Transcript abundance was estimated using StringTie and differential expression analysis was performed using the fpkm (fragments per kilobase of transcript per million mapped reads) values. Pathway analysis of assembled transcripts were performed using KEGG-KAAS server respectively.

Results

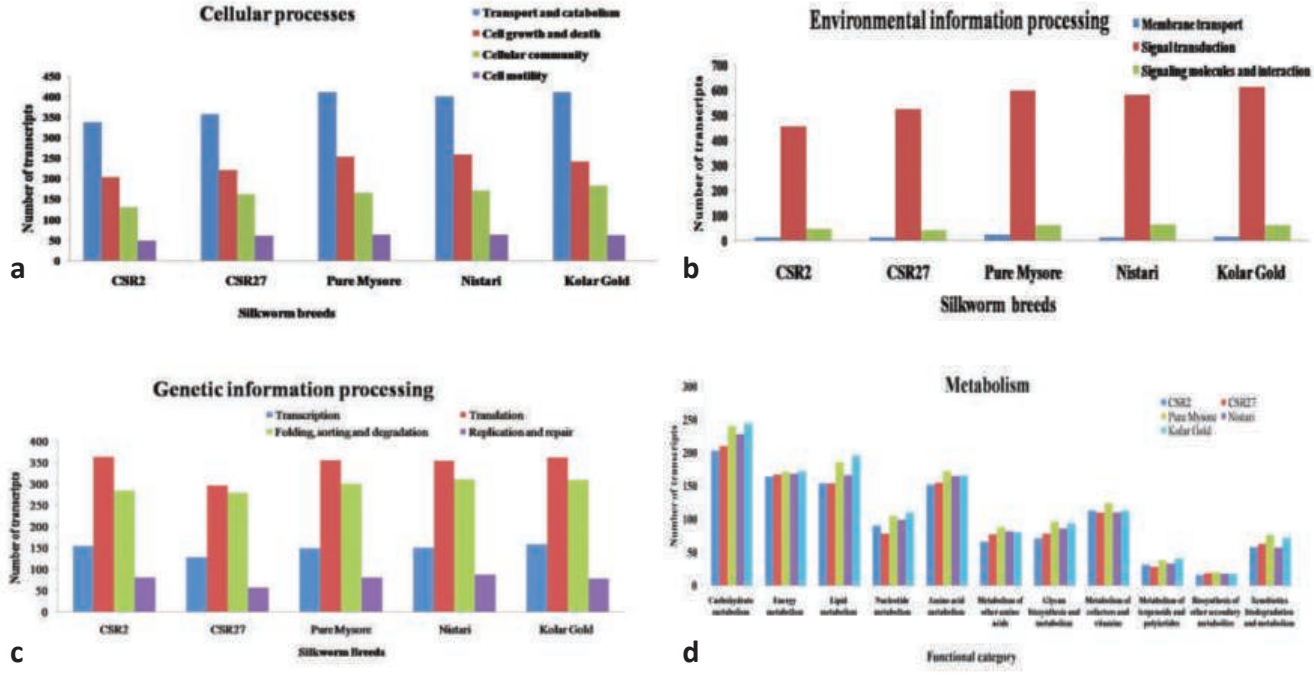
To understand the molecular mechanism controlling the silk quality among the silkworm breeds (Bivoltine: CSR2, CSR27; Multivoltine: PM, Nistari; crossbreed (PMxCSR2)) contrasting for silk quality parameters,the silkgland transcriptomes were compared at the 3rd day fifth instar. 2X150 pair end illumina sequencing (Hiseq500) was carried out from which 96,778,970 raw reads were obtained with a total of 13.77 Gb data (from 5 samples). Among these, the high quality reads were mapped to *B. mori* reference using HiSAT2. The RNA sequences raw data were submitted to NCBI Short Read Archive (SRA, http://www.ncbi.nlm.nih.gov.sra/) under the accession numbers SRR886550, SRR886551, SRR886552, SRR886553 and SRR886554. A total of 85,062,305 reads were mapped with a coverage of 82.96% for CSR2, 87.76% for CSR27, 90.13% for PM, 91.28% for Nistari and 91.28% for Kolar Gold. Transcript assembly was carried out using String Tie which assembles transcripts from RNA reads that have been aligned to the genome, based on which a total of 46,183 merged transcripts were obtained with 14,499 transcripts from CSR2, CSR27 (12,867), PM (21,163), Nistari (17,526) and Kolar gold (22,156). To further, identify the novel transcripts, gff compare utility was employed considering the refrence transcripts obtained and the string tie merged files. A total of 4,732 novel isoforms were identified. All novel isoforms were blastx searched against ncbi database. Differential expression analysis was carried out for 4 different sets – CSR2 vs Kolargold, CSR2 vs PM, CSR27 vs Nistrai and PM vs Kolar gold. Abundances of merged transcripts were estimated using string tie. The log2 transformed fold change values (**log2FC**) were used for deciding upregulated and downregulated genes. Heatmap for highly significant differential expressed genes (i.e up and downregulated genes) were generated using *pheatmap* package from *R* software.

The transcripts that showed differential expression represented interactions in energy metabolism that are vital for silk fibroin production/synthesis, abundance or biogenesis of levels of ribosomal proteins, proteins related to transportation and folding, factors required for development of the posterior silk gland and most importantly repair system. Among these the caspases, Ubiquitin, RNA Pol II, RNA Pol III, Mannosidase and acetylglucosamine accounted for most important regulators that are involved in the silk fibroin synthesis. These caspases, ubiquitins and RNA polymerases play role in silkworm silkgland development and indirectly influence silk fibroin synthesis. Ubiquitin homologs functions as molecular chaperons by activation of proteasome synthesis & autophagy which might influence by promoting degradation of abnormal proteins synthesized in silk gland in the posterior silkgland (PSG). Thus, based on these UbiA prenyl transferase domain containing protein-1 homolog (**BGIBMGA008951) and** Mannosyl-oligosaccharide 1,2-alpha-mannosidase were further identified for validation through RT-PCR. The DEGs were evident with its upregulation 2.84 times higher expression of transcript **BGIBMGA008951** in PSG (CSR2 vs PM) whereas there was no significant expression in anterior silk gland (ASG) (CSR27 vs Nistrai). Further, transcript-UBFD1-like was found to express 3.521 times more in ASG compared to 0.273 times in PSG.

Pathway analysis

Ortholog assignment and mapping of the transcripts to the biological pathways were performed using **K**EGG **a**utomatic **a**nnotation **s**erver (**KAAS**). All the differentially expressed genes were compared against the KEGG database using BLASTX with threshold bit-score value of 60 (default). The mapped transcripts represented metabolic pathways of major biomolecules such as carbohydrates, lipids, nucleotides, amino acids, glycans, cofactors, vitamins, terpenoids, polyketides, etc. The mapped genes also represented the genes involved in metabolism, genetic information processing, environmental information processing and cellular processes. Category wise distribution of these transcripts is represented in figure a-d.

Multiple transcription factors are involved in transcriptional regulation of silk protein genes during the development of silkworm. Transcriptome analysis provide insights into functional genomics by its ability to interpret the functional elements of the genome, biological pathways and molecular mechanism.



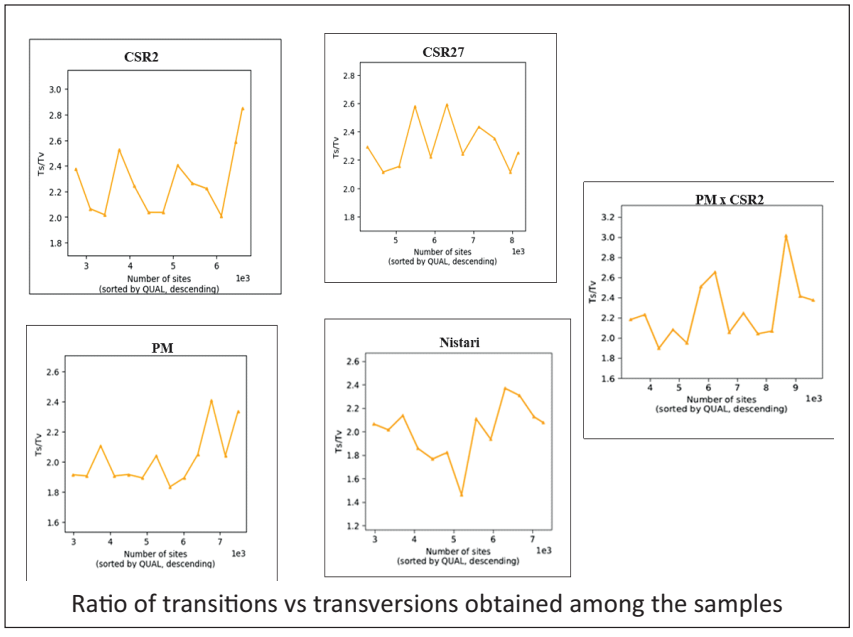
Number of transcripts involved under cellular, environmental information processing, genetic information processing and metabolic pathways

The SNPs/variants were screened for variations using IGV . A total of 40,229 variants were identified among the five samples analyzed with 39,108 SNPs (97.213%) and 1124 indels (2.79%). Highest number of SNPs were recorded in PMxCSR2 (9864) followed by CSR27 harbouring 8314 SNPs, PM recording 7771 SNPs, Nistari with 7493 SNPs and CSR2 having 6787 SNPs. Further analysis identified a total of 192 indels in CSR2, followed by 163, 281, 228 and 260 in CSR27, PM, Nistari and PMxCSR2 respectively among the total of 40,229 variants identified. Highest number of multiple allelic sites was identified in PMxCSR2 with 17 whereas other breeds showed fewer. Transition variants were comparatively higher compared to transversions. Among the SNPs recorded, transitions were found to be overdominating with 68.33% whereas transversion contributed to about 31.72%. The ratio of Ts/Tv ranged between 1.97 to 2.3 with highest reported in CSR27 and lowest in PM (Figure). Interestingly, transitions was found highest in PMxCSR2 (6630) followed by CSR27 (5679), PM (4973), Nistari (4854) and CSR2 (4590). The types of substitutions identified is represented graphically in figure with most common substituion being A>G, follwed by G>A, C>T and T>C. These varinat results indicated that the *Bombyx mori* silk fibroin synthesis is under the influence of complex regulatory machinery since the variants represent high complexity.

Identification of upregulation of mannosidase - Mannosyl-oligosaccharide 1,2-alpha-mannosidase (MAN1) in ASG was correlative to improper folding of protein thereby affecting the silk quality. Further, it is hypothesized that this influences the polyubiquitinization process in PSG which in turn leads to the accumulation of abnormal fibroin thereby activating the caspase activities in the silkgland, thus rendering degeneration of these abnormal

Details of total number of SNP variants identified along with indel distributions							
Sample	Total variants	SNPs	indels	Multiple allelic sites	ts	tv	Ts/tv
CSR2	6787	6595	192	1	4590	2006	2.29
CSR27	8314	8151	163	2	5679	2474	2.3
PM	7771	7491	281	4	4973	2521	1.97
NISTARI	7493	7265	228	5	4854	2414	2.01
PM X CSR2	9864	9606	260	17	6630	2991	2.22

proteins in the silk gland and actual synthesis of quality or normal functional silk fibroin synthesis. Enrichment of caspase dependant pathway is a prerequisite for highly efficient biosynthesis and secretion of silk proteins may be suppressed. Ribosome biogenesis underlies the cells capacity to grow because cell growth or increase in cell mass requires large number of ribosomes, which are the molecular factor that carry out protein synthesis. Increased expression of ribosome proteins reflects rapid biosynthesis in silkglands and is also crucial for transport of primary proteins. The U2small nuclear ribonucleoprotein A and apos, U3 small nucleolar RNA interacting protein 2, small nuclear ribonucleoprotein F were found to be upregulated in PSG whereas these transcripts were down regulated in ASG.

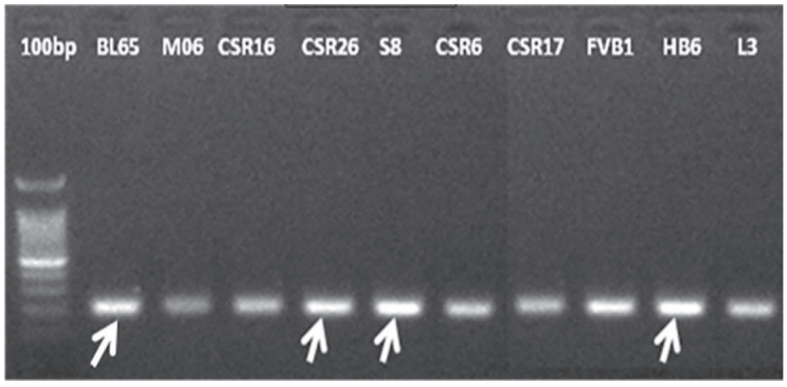


Ratio of transitions vs transversions obtained among the samples

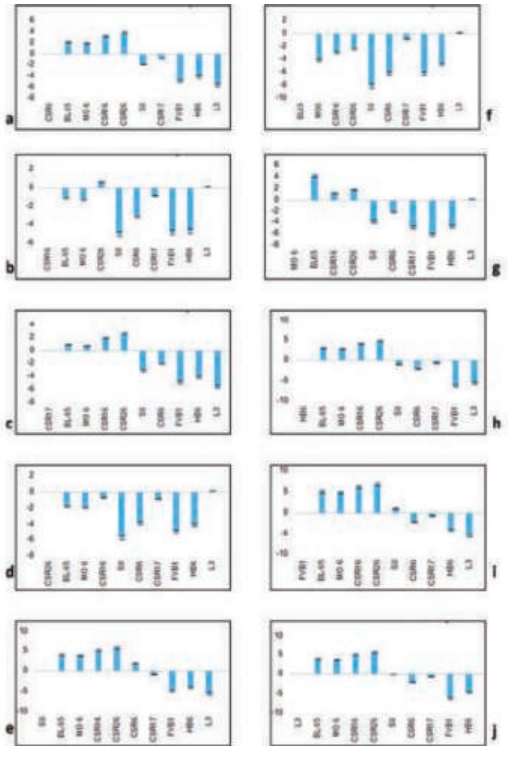
Among the five key regulators identifed as markers involved in silk fibroin syntheis thereby controlling silk qulaity, two genes BGIBMGA008951 - **UbiA prenyltransferase domain containing protein 1 homolog** and Mannosidase were further taken up for validation through RT-PCR. Real Time PCR was carried out for relative quantification of all 10 samples (5 bivoltines:CSR6, CSR16, CSR17, CSR26 and S8 and 5 multivoltines:BL65, MO6, FVB7, HB6 and L3) for target genes Ubi-A and Actin-3 gene as housekeeping gene. The gel profile of UbiA prenyltransferase domain containing protein 1 homolog is shown in figure. The CT values and ΔΔCq (ΔΔCt) values for all samples for Ubi-A genes was obtained and fold change obtained for comparison is represented in figure. The results thus indicate expression of UbiA prenyltransferase domain containing protein 1 homolog was found highest in S8 followed by CSR26; further, two multivoltine breeds (BL65 and HB6) also represented a similar expression. Thus, ubiquitin-proteasome pathway (UPP) represents an important role in the programmed cell death of the silk gland (Cui *et al*., 2018; Li *et al*., 2011). The modification of proteins by ubiquitin is essential for numerous cellular processes (Imai *et al*., 2003). The results of Cui *et al*.,(2018) also suggest that accumulation of abnormal or mutant proteins in the mutant PSG might lead to more activation of proteasomes synthesis as well as autophagy process to promote the rapid degradation of such abnormal proteins and the silk gland cells to activate ubiquitin to mark these abnormal proteins.

Further, Mannosidase 1 was validated through gene-protein interactions analysis as an important regulator of silk fibroin synthesis (Fig.). MAN1 captures or accumulates all the misfolded proteins in silkglands and processes by interacting with the ubiquitin ligase complex for final proteolytic activity as chaperons, which inturn lead to the activation of caspases and elicitation of programmed cell death of unfolded proteins in the cells. This inturn would be hypothesized to represent only the functional protein to be secreted out, thereby leading to synthesis of a better quality of silk protein.

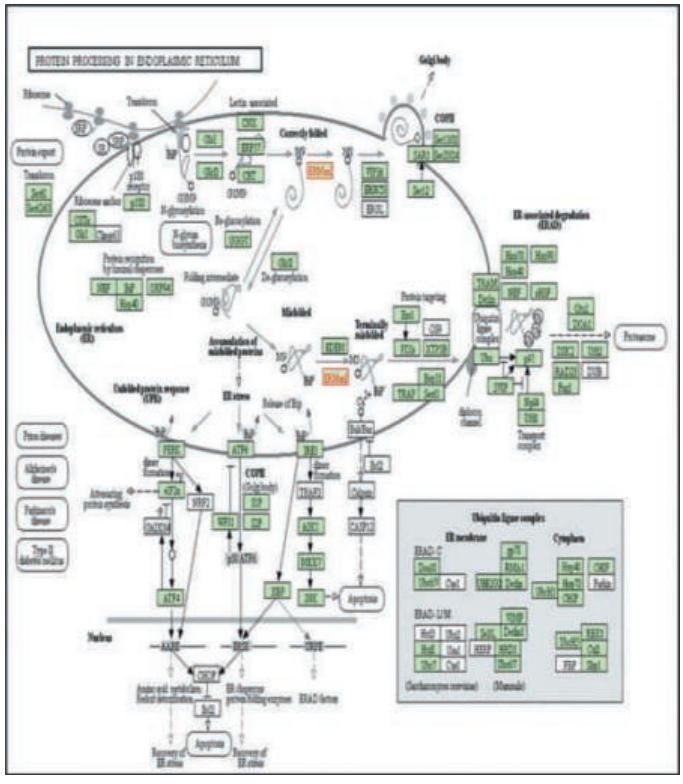
UbiA prenyl A transferase and Mannosidase were identified as potential regulator for silk quality. Along with the five shortlisted transcripts (UbiA, Mannosidase, Caspases, RNA pol. II, Acetyl glucosamine transferase) as potential reguators of silk fibroin synthesis thereby correlating to silk quality. However, these need to be further studied to understand the complexity of silk quality as it is a multifactorial. The identified regulator/marker for silk quality can be utilized for screening breeds that could be useful for development of productive breeds.



Agarose gel profile of RT-PCR products of Ubi-A



Fold change of Ubi-A gene in all samples (a-j)



Representation of Mannosidase 1 in capturing and processing the misfolded protein in silkgland cells thereby preparing it to interact with the ubiquitin ligase complex for final proteolytic activity as chaperons

Ongoing Research Projects International Collaboration

AIB 3537- Improvement of silkworm breeding in India and Bulgaria (Mar. 2015 – Feb. 2020)

S. Manthira Moorthy, Paramesh (JRF), Sivaprasad V. (upto Jan. 2019), R. S. Teotia (upto Aug. 2019), P. Tewary

Objectives:

- To develop silkworm breeds / hybrids with high silk content
- To identify silkworm hybrids suitable to climatic conditions of India and Bulgaria

Five silkworm genotypes (Kom-2, CV-1071-2, ShV, Vr2012 and JH4) and two hybrid [(H1 x KK) x (G2 x V2)] & Super1 x Hessa2 were received from Sericulture & Agriculture Experiment Station (SAES), Vratza, Bulgaria. After quarantine rearing, these breeds were evaluated in Indian Conditions and maintained following appropriate procedures. These genetic resources (GRs) were utilized in two kind of approaches; GRs are directly put in to hybridization programme with Indian genetic resources to develop high silk content double hybrids and also for the development of new silkworm breeds having high silk content & quality silk through conventional breeding programme utilizing Bulgarian and Indian GRs.

GRs of Bulgarian represented true characteristics and rearing performance revealed cocoon weight (g) ranging from 1.54 to 1.71 and shell % from 22.57 to 23.91(Table).

Lines development

Under objective-1, Indian and Bulgarian genotypes were used for development of new oval and dumbbell lines. Seven oval and five dumbbell lines were developed with shell % of 22.50 to 23.63 and 22.14 to 23.13 respectively (Table).

Hybrid development and evaluation

A total of 25 oval breeds (BM2E, BMV1, BMV2, BM10, BMO1, BMO2, BMO3, BMO4, BMO5, BMO6, BMO7, BMO8, BMO9, BMO10, BMO11, CSR2N, CSR17, CSR27, CSR50, CSR52N, A110, S8, SSBS2, SSBS5, CNR5) and 14 dumbbell breeds (BM4, BMFD, BMD1, BMD2, BMD3, BMD4, BMD5, CSR6, CSR26N, CSR16N, CSR51N, CSR53, D15, SSBS6) comprising of Indian and Bulgarian genotypes were used to develop oval and dumbbell foundation crosses (Oval FC-110; Dumbbell FC-60). Further, utilising oval and dumbbell FCs , 488 double hybrids were developed and evaluated in CSRTI- Mysuru and SSBS-Coonoor. Data on fecundity, pupation%, Yield/10000 larvae (wt-kg), SCW (g), SSW (g), Shell%, FL (m), Denier, Reelability%, Renditta, Rawsilk recovery % and neatness were recorded. Data collected were subjected to ANOVA and Mano Evaluation index and ranked. Out of 488 hybrids evaluated, top 50 hybrids are shown in table. It indicated, hybrid (BMV1 x BMO11) x (BMD2 x BMFD) i.e., (BFC25 x BFC11) performed better with shell% of 23.81 and renditta of 5.75 and ranked no.1. Other two hybrids viz., (BMV1 x BMO10) x (BMD3 X BMFD) and (BMV1 x SSBS5) x (BMFD x CSR16N) also showed better performance and both ranked no. 2 with shell (23.41 to 24.06%) and renditta (5.5 to 5.65)

On Station Trial (OST)

The identified hybrids [(BMV1 x BMO11) x (BMD2 x BMFD)-BFC25 x BFC11] and [(BMV1 x BMO10) x (BMD3 x BMFD) -BFC1 x BFC10] were evaluated in RSRS/RECs *viz.,* Kodathi, Ananthapur, Salem, Chamarajnagar and at REC-Royachoty under OST. In test hybrids yield ranged between 65-79kg/ 100 dfls with shell % of 22.6-23.9 and in control (FC1 x FC2) the yield was between 62-70kg with shell% of 22.0-22.6. Further, BFC1 x BFC 10 (250 dfls) and BFC25 x BFC11(400 dfls) were evaluated in field at Kolar area, the yield obtained was 76kg /100 dfls with 23.7% shell and 78kg/100 dfls with 23.9% shell respectively.

Rearing Performance of Bulgarian silkworm genetic resources (Mean of 12 generations)						
Breeds	Fec (No.)	Yield/10000 Larvae (No)	Yield/ 10000 Larvae (Wt)	SCW (g)	SSW (g)	Shell (%)
KOM-2	562	9250	15.489	1.685	0.389	23.08
CV10712	518	9050	14.625	1.625	0.378	23.26
JH4	528	9350	15.871	1.713	0.399	23.29
ShV	545	9000	15.084	1.681	0.402	23.91
Min	506	8600	13.12	1.54	0.35	22.57
Max	562	9350	15.87	1.71	0.40	23.91
Mean	531	9050	14.84	1.65	0.38	23.22
SD	22.12	289	1.06	0.07	0.02	0.48
CV%	4.16	3.20	7.18	4.12	5.69	2.08
Pr > F	NS	NS	NS	NS	NS	NS

Rearing Performance of new Oval lines developed						
Lines	Fec. (No.)	Yield/ 10000 Larvae (No.)	Yield/ 10000 Larvae (Wt.)	SCW (g)	SSW (g)	Shell%
BMO1	562	9250	14.854	1.645	0.385	23.40
BMO2	541	9045	15.052	1.664	0.391	23.50
BMO6	552	9200	14.856	1.626	0.379	23.31
BMO8	536	8600	13.754	1.547	0.348	22.50
BMO9	558	9150	15.062	1.663	0.384	23.09
BMO10	549	9000	14.612	1.624	0.377	23.21
BMO11	565	9240	15.082	1.638	0.387	23.63
Min	536	8600	13.75	1.55	0.35	22.50
Max	565	9250	15.08	1.66	0.39	23.63
Mean	551	9069	14.75	1.63	0.38	23.23
SD	10.73	227.68	0.47	0.04	0.01	0.37
CV%	1.94	2.51	3.19	2.44	3.79	1.60
Pr > F	NS	NS	NS	NS	NS	NS

Rearing Performance of new Dumbbell lines developed						
Lines	Fec. (No.)	Yield/ 10000 Larvae (No.)	Yield/ 10000 Larvae (Wt.)	SCW (g)	SSW (g)	Shell%
BMD1	520	9000	14.321	1.624	0.372	22.91
BMD2	545	9050	14.236	1.587	0.367	23.13
BMD3	526	8950	13.845	1.556	0.354	22.75
BMD4	532	8400	13.054	1.567	0.347	22.14
BMD5	528	9150	13.458	1.524	0.352	23.10
Min	520	8400	13.05	1.52	0.35	22.14
Max	545	9150	14.32	1.62	0.37	23.13
Mean	530	8910	13.78	1.57	0.36	22.80
SD	9.34	294.53	0.53	0.04	0.01	0.40
CV%	1.76	3.31	3.87	2.36	2.96	1.75
Pr > F	NS	NS	NS	NS	NS	NS

Rearing Performance of double hybrids (Top 50 hybrids out of 488 evaluated)														
Hybrid	Fec. (No)	Pup %	Yld/10000 (wt-kg)	SCW (g)	SSW (g)	Shell %	FL (m)	Reel. (%)	Denier	Ren ditta	Rawsilk rec. (%)	Neat ness	EI	Rank
(BMV1 x BMO11) x (BMD2 x BMFD)	631	93.20	18.552	1.991	0.474	23.81	1095	94.00	3.02	5.75	82.00	96	62.34	1
(BMV1 x BMO10)x (BMD3 X BMFD)	634	93.50	17.569	1.879	0.452	24.06	1120	94.00	3.11	5.50	83.21	96	61.25	2
(BMV1 x SSBS5) x (BMFD x CSR16N)	620	98.57	19.325	1.961	0.459	23.41	1020	94.50	3.20	5.65	82.05	96	61.25	2
(BMV1 x CSR52N) x (BMD2 x BMFD)	626	96.30	19.958	1.896	0.448	23.62	1075	93.40	3.26	5.50	82.04	95	60.96	3
(BMO11 x BMO6) x (BMFD x CSR16N)	631	96.96	19.300	1.991	0.462	23.21	1018	93.50	3.24	5.75	80.25	95	60.09	4
(BMV2 x BMO5) x (D15 x BM4)	632	95.50	18.879	1.977	0.459	23.22	1012	93.41	3.42	5.75	81.25	94	58.25	5
(BMO11 x S8N) x (BMFD x CSR16N)	632	96.19	19.911	1.951	0.456	23.37	978	92.10	3.23	5.65	76.84	94	57.46	6
(BMO10 x CSR50) x (D15 x SSBS6)	654	98.46	18.833	1.913	0.436	22.80	990	92.00	3.28	5.85	79.21	94	57.16	7
(BMO11 x BMV1) x (BMD2 x BMFD)	637	92.00	17.425	1.894	0.439	23.18	1032	93.80	3.15	5.50	80.24	95	56.03	8
(BMV2 x BMO6) x (CSR26N x BMFD)	641	94.80	18.035	1.902	0.446	23.43	1010	92.50	3.15	5.75	76.58	94	55.44	9
(BMV2 x BMO2) x (SSBS6 xCSR16N)	610	92.00	17.774	1.932	0.452	23.40	988	92.65	3.22	5.75	79.58	95	52.77	10
(CSR27 x BM2E) x (CSR16N x BMFD)	627	95.24	18.420	1.934	0.441	22.79	989	92.50	3.21	6.00	76.25	94	52.46	12
(BMO10 x CSR52N) x (BMFD x 51N)	642	97.00	16.769	1.815	0.420	23.14	1012	92.10	3.21	5.75	73.62	95	52.36	13
(BMV1 x SSBS5)x (BMD2 x BMFD)	642	95.71	19.207	2.007	0.435	21.69	964	92.00	3.1	6.00	74.25	93	52.19	14
(BMV1 x S8N) x (BMFD x CSR26N)	639	95.38	17.991	1.886	0.437	23.15	975	90.00	3.26	6.10	75.62	95	52.16	15
(BMO3 x 17N) x (BMFD x 51N)	639	97.14	18.802	1.935	0.430	22.22	962	90.25	2.89	6.25	76.52	95	52.15	16

Hybrid	Fec. (No)	Pup %	Yld/10000 (wt-kg)	SCW (g)	SSW (g)	Shell %	FL (m)	Reel. (%)	Denier	Ren ditta	Rawsilk rec. (%)	Neat ness	EI	Rank
(BMO5 x S8) x (BMFD X 51)	642	90.50	17.850	1.972	0.454	23.02	972	92.00	3.24	5.85	77.25	92	51.90	17
(CSR27 x BMO5)x (CSR26N x BMFD)	639	96.36	18.206	1.889	0.430	22.78	963	91.25	3.12	6.00	72.12	95	51.76	18
(S8N x BMV1) x (BM4 x BMD2)	642	94.35	17.939	1.943	0.442	22.77	958	89.25	3.02	6.00	71.25	95	51.28	19
(BMV2 x BMO7) x (BMFD x D15)	638	94.00	16.555	1.795	0.436	24.30	1008	89.50	2.95	6.00	76.58	94	50.81	20
(BMV1 x CSR27) x (CSR16N x BMFD)	616	94.50	17.569	1.859	0.435	23.40	1012	92.15	3.05	6.00	73.65	95	50.56	21
(SSBS5 x BMV1) x (BM4 x CSR26N)	634	95.24	18.357	1.928	0.431	22.38	963	92.00	3.15	6.10	73.54	94	50.52	22
BMV1 x CSR50N) x (CSR26N x BMFD)	627	97.50	17.837	1.829	0.424	23.16	972	92.15	3.08	6.15	73.62	95	50.47	23
BMV1 x CSR52) x (SSBS6 xCSR16N)	634	97.62	17.955	1.839	0.428	23.27	969	91.20	3.12	6.10	75.12	93	50.28	24
(BMV1 x S8N) x (BMFD x 51N)	634	92.38	18.300	1.981	0.440	22.23	937	90.24	3.28	6.25	73.24	95	49.42	25
(BMO3 x CSR52) x (BMFD x CSR26)	622	97.14	18.222	1.876	0.425	22.67	969	90.26	3.021	6.25	73.25	95	49.00	26
(BMO7 x SSBS5) x (51Nx BMFD)	637	92.50	17.440	1.885	0.439	23.27	926	92.00	3.12	6.14	72.26	94	49.00	26
(BMO3N x CSR52) x (SSBS6 x D15)	622	94.00	17.599	1.872	0.432	23.07	963	92.00	3.06	6.00	71.25	94	48.30	27
(BMV1 x S8N) x (CSR26 x BMFD)	642	84.00	16.614	1.978	0.468	23.66	985	91.25	3.25	6.20	70.26	92	47.61	28
(BMV1 x CSR27)x (D15 x BMFD)	629	95.11	18.622	1.958	0.437	22.32	920	88.54	2.98	6.25	68.25	94	47.04	29
(BMV1 x SSBS5) x (BMFD x CSR26N)	618	98.10	18.645	1.901	0.422	22.18	960	90.50	3.12	6.29	70.26	93	46.42	30

Hybrid	Fec. (No)	Pup %	Yld/10000 (wt-kg)	SCW (g)	SSW (g)	Shell %	FL (m)	Reel. (%)	Denier	Ren-ditta	Rawsilk rec. (%)	Neat ness	EI	Rank
(BMV1 x S8N) x (BMFD x CSR16N)	615	95.77	19.076	1.992	0.432	21.68	859	89.50	3.10	6.20	73.54	94	45.98	31
(BMO9 x CSR17) x (BMD2 x BMFD)	645	95.24	18.578	1.951	0.427	21.89	927	90.02	3.15	6.50	67.2	92	45.77	32
(BMV2 x BMO6) x (BMFD x CSR26N)	630	90.00	17.540	1.949	0.441	22.64	930	88.26	3.07	6.25	71.25	94	45.59	33
(BMO10 x CSR17) x (CSR26 x BMFD)	633	94.50	18.059	1.911	0.430	22.51	924	88.26	3.1	6.10	72.61	92	45.77	34
(BMO2 x BMO10) x (SSBS6 xCSR16N)	637	96.33	18.909	1.963	0.424	21.59	923	88.24	3.28	6.45	72.25	92	45.45	35
(BMO10 x CNR5) x (BMFD x 51)	641	95.77	18.294	1.910	0.421	22.04	948	87.25	3.06	6.61	68.12	93	44.94	36
(BM2E x CSR52N) x (BM4 x BMD3)	628	96.67	18.749	1.940	0.420	21.64	924	87.25	2.85	6.50	68.74	94	44.55	37
BMV2 x BMO6) x (BMFD x 51N)	645	97.05	16.152	1.698	0.395	23.27	962	92.15	2.89	6.10	70.21	92	44.53	38
(CSR27 x BM2E) x (BMD2 x BMFD)	637	96.67	18.168	1.879	0.419	22.32	933	87.00	3.07	6.50	69.15	93	44.48	39
(BMV2 x BMO6) x (BMD5 x 51N)	631	92.38	17.513	1.896	0.434	22.92	968	86.87	3.08	6.45	68.15	93	43.97	40
(BMV1 x CSR52N) x (CSR51N x BMFD)	629	90.95	18.481	2.032	0.436	21.45	946	89.14	3.16	6.48	68.25	92	43.62	41
(BMV1 x CSR27) x (BMFD x BM4)	620	92.38	18.046	1.953	0.432	22.12	944	87.69	3.17	6.42	68.25	94	43.51	42
(SSBS5 x BMV1)x (SSBS6 x D15)	633	95.50	16.532	1.731	0.402	23.22	925	88.84	3.1	6.50	72.05	94	42.63	43
(CSR27 x BM2E) x (CSR26N x BMFD)	626	94.67	16.123	1.737	0.408	23.49	968	88.20	3.01	6.37	68.12	92	40.54	44
(SSBS5 x BMV1) x (BM4 x D15)	625	94.50	16.301	1.725	0.398	23.07	939	87.23	3.19	6.62	69.25	93	39.04	45

Hybrid	Fec. (No)	Pup %	Yld/10000 (wt-kg)	SCW (g)	SSW (g)	Shell %	FL (m)	Reel. (%)	Denier	Ren ditta	Rawsilk rec. (%)	Neat ness	EI	Rank
(SSBS5 x BMV1) x (SSBS6 xCSR51N)	621	92.50	16.235	1.755	0.402	22.90	932	87.12	3.23	6.50	71.26	93	38.45	46
(BMO10 x CSR27) x (BMFD x BMD2)	634	93.50	16.254	1.768	0.385	21.78	914	84.25	3.12	6.42	67.15	92	38.40	47
(BMO7 x BMO11) x (BMD3 x BMFD)	642	92.50	16.254	1.781	0.387	21.73	908	82.74	3.09	6.60	65.18	92	37.85	48
(CSR27 x BM2E) x (CSR51N x BMFD)	621	90.50	15.874	1.768	0.381	21.55	912	81.54	3.14	6.75	64.09	92	37.43	49
FC1 x FC2	637	96.14	17.510	1.858	0.434	23.34	985	93.15	3.02	6.18	72.15	94	52.47	11
Min	610	84.00	15.87	1.70	0.38	21.45	859	81.54	2.85	5.50	64.09	92	-	-
Max	654	98.57	19.96	2.03	0.47	24.30	1120	94.50	3.42	6.75	83.21	96	-	-
Mean	632	94.60	17.90	1.89	0.43	22.79	968	90.23	3.13	6.13	73.30	94	-	-
SD	9.03	2.64	1.02	0.08	0.02	0.71	47.71	2.87	0.11	0.32	4.75	1.22	-	-
CV%	1.43	2.79	5.70	4.32	4.74	3.12	4.93	3.18	3.57	5.27	6.48	1.30	-	-
Pr > F	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	-	

Performance of single and double hybrids of Bulgaria												
Hybrid	Fec. (No)	Pup %	Yld/10000 L (wt-kg)	SCW (g)	SSW (g)	Shell %	FL (m)	Reela Bility (%)	Denier	Renditta	Rawsilk recovery %	Neatness
SH1	585	62.50	12.05	1.785	0.398	22.30	825	3.36	78.25	6.5	62.54	92
SH2	604	66.50	12.56	1.681	0.379	22.55	842	3.24	82.54	6.2	68.45	92
TH1	652	82.00	14.87	1.778	0.405	22.78	926	3.34	80.54	6.4	65.54	94
TH2	638	76.50	14.25	1.825	0.424	23.23	941	3.31	89.85	5.85	73.25	95
Min	585	62.50	12.05	1.68	0.38	22.30	825	3.24	78.25	5.85	62.54	92
Max	652.	82.00	14.87	1.83	0.42	23.23	941	3.36	89.85	6.50	73.25	95
Mean	619	71.87	13.43	1.77	0.40	22.71	883	3.31	82.80	6.24	67.45	93
SD	0.71	895	1.34	0.06	0.02	0.40	58.47	0.05	5.02	0.29	4.56	1.50
CV%	4.95	12.46	9.99	3.46	4.63	1.75	6.62	1.59	6.06	4.60	6.76	1.61
Pr > F	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Inter-Institutional Collaborative Project

ARP-3605: Validation of the DNA markers in silkworm breed developed by introgression of DNA maker associated with NPV resistance using marker assisted selection breeding and large scale field trial of the breed (Apr. 2017 – Mar. 2020; Ext. Jul. 2020)

Coordinator: Dr. V. Sivaprasad

Investigators: S. Manthira Moorthy and B. Mohan

Objectives:

To evaluate the evolved bivoltine lines in various agro climatic conditions and select lines for their suitability in that particular environment at RSRS/REC at Bengaluru, Salem, Ananthapur and Chamarajanagar.

To evaluate crossbreed and bivoltine hybrids utilizing MASN lines

Under Objective -1, three MASN lines viz., MASN4, MASN6, MASN7 were procured from SBRL-Bengaluru and reared at SSBS-Coonoor and CSRTI-Mysuru. Selected cocoons from each line were subjected to SSR marker analysis for NPV tolerance. Based on marker presence, progenies were selected for onward generation. Selected lots were maintained at SSBS-Coonoor and CSRTI-Mysuru for further multiplication and conducting On Station Trial (OST).

10 dfls each of MASN4, MASN6, MASN7 were reared at RSRS-Ananthapur, Kodathi, Salem and Chamarajanagar. Two crops (Summer and favourable) at RSRS-Ananthapur, Salem and Chamarajanagar and three crops at RSRS- Kodathi was conducted. Data collected from all RSRSs were pooled and subjected to ANOVA & t-test. No significant difference was observed between lines for all characters (Table) except yield/10000 larvae (wt-kg). To compare the performance of lines, paired t-Test was carried out between groups (MASN4-MASN6, MASN4-MASN7; MASN6-MASN7) and MASN4-MASN 7 showed significant difference for only yield/10000 larvae (wt-kg). Since no significant difference was observed, to select better line, data on the rearing performance was subjected to Evaluation index (EI). Among the lines MASN4 was selected based on EI and higher mean value for important characters viz., yield/10000 larvae (No), yield/10000 larvae (wt-kg) and shell%.

The selected line would be crossed with PM and CSR4 and hybrid would be evaluated among farmers.

Performance of MASN lines at RSRS-Ananthapur, Kodathi, Salem and Chamarajanagar under OST (Mean of 9 trials)

Lines	Fec. (No.)	Hat (%)	Larval period (Total)	Larval period (V instar)	Yield/ 10000 larvae (No)	Yield/ 10000 larvae (wt-kg)	SCW (g)	SSW (g)	Shell%	EI
MASN4	498	95.30	24.06	6.12	8148	10.923	1.529	0.308	20.11	59
MASN6	485	94.41	24.12	7.00	7756	10.268	1.510	0.303	20.06	51
MASN7	482	94.18	24.06	6.12	7251	9.371	1.481	0.289	19.56	40
Average	488	94.63	24.08	6.10	7718	10.187	1.507	0.300	19.91	
CD at 5%	0.98	0.974	1.002	0.998	0.232	0.003**	0.750	0.578	0.806	

Comparative analysis of MASN lines through t-test (Two-Sample Assuming Unequal Variances)						
Variable	MASN4 & MASN6		MASN4 & MASN7		MASN6 & MASN7	
Fecundity	t-value	Sig.	t-value	Sig.	t-value	Sig.
Hatching%	-0.19	0.85	-0.15	0.88	0.019	0.98
LP (Total)	-0.22	0.83	-0.09	0.92	0.134	0.89
LP (V instar)	0.003	0.99	0.006	0.92	0.002	0.97
Yield/10000 lar. (No)	-0.01	0.99	-0.005	0.95	-0.045	0.96
Yield/10000 lar.(wt-kg)	0.918	0.39	1.79	0.13	0.96	0.37
Single Cocoon wt. (g)	3.0	0.057	**3.99	0.01	2.72	0.07
Single Shell wt. (g)	-0.21	0.83	0.03	0.97	0.19	0.84
Shell%	0.26	0.799	0.84	0.42	1.13	0.29
	0.49	0.63	0.47	0.64	0.38	0.71

Under objective 2, MASN lines (MASN4, MASN6, MASN7) were maintained and P1 layings were prepared. The P1 layings thus prepared were supplied to NSSO for seed generation. A total of 3,115 P1 dfls were prepared and supplied to NSSO (MASN4-1900; CSR4-1215) for hybrid dfls preparation.

Evaluation of MASN hybridss

a) Cross Breed : A total of 63500 dfls of PM X MASN4 evaluated among farmers of Karnataka and Andhra Pradesh and an average yield of 58.0kg/ 100 dfls against 62.1kg/100 dfls in control (PM x CSR2) was obtained.

b) Bivoltine hybrid : A total of 97,700 dfls of MASN4 x CSR4 (Table) was evaluated among farmers of southern India and average yield obtained was 61.3kg/100 dfls against 68.25kg/ 100dfls in control (FC1 x FC2).

Performance of Crossbreed (PM x MASN4)					
Place	Hybrid	No. of dfls	No. of farmers (Rs.)	Yield / 100 dfls (kg)	Rate (Rs.)
Karnataka	PM x MASN4	23000	36	55.0	290
Karnataka	PM x MASN4	36000	72	53.0	268
Average/Total	PM x MASN4	59000	108	54.0	279
Andhra Pradesh	PM x MASN4	4500	13	62.09	271
Average/Total	PM x MASN4	63500	121	58.0	275
Control					
Karnataka	PM x CSR2	3500	18	66.0	298
Andhrapradesh	PM x CSR2	4350	15	58.2	208
Average/Total	PM x CSR2	7850	33	62.1	253

Performance of Bivoltine hybrid (MASN4 x CSR4)					
Place	Hybrid	No. of dfls	No. of farmers	Yield / 100 dfls (kg)	Rate (Rs.)
Karnataka	MASN4 x CSR4	43500	252	60.5	350
Andhra Pradesh	MASN4 x CSR4	31600	148	64.0	358
Tamilnadu	MASN4 x CSR4	12650	78	62.0	370
Maharastra	MASN4 x CSR4	3000	24	59.0	250
Average/Total	**MASN4 x CSR4**	**90750**	**502**	**61.3**	**332**
Control					
Karnataka	FC1 x FC2	16500	78	66.0	376
Andhra Pradesh	FC1 x FC2	12000	56	70.0	369
Tamilnadu	FC1 x FC2	10000	38	74.0	385
Maharashtra	FC1 x FC2	2500	16	63.0	325
Average/Total	**FC1 x FC2**	**41000**	**188**	**68.25**	**363.75**

AIT-3628: Assessment of SNP Variation in Silkworm (*Bombyx mori* L) by Genotyping by Sequencing and genome-wide association mapping of important commercial traits". (Funded by DBT) - Collaboration with RVCE, Bangalore (Dec. 2017 – Nov. 2020)

S. Manthira Moorthy, L. Kusuma, Sumathy, Bindhya (JRF) and Vidya Niranjan (RVCE, Bangalore)

Objectives: Identification of SNP variation in silkworm genotypes through genotyping by sequencing of diverse silkworm genotypes

Results:

A total of 100 diverse silkworm genotypes (60 bivoltine & 40 multivoltine), were collected from different sericulture R&D Institutes of India (CSRTI-Mysore, CSRTI-Berhampore, CSRTI-Pampore; CSGRC-Hosur; APSSRDI-Hindupur; KSSRDI-Thalaghattapura) were reared and maintained. These genotypes were subjected for phenotyping for five-qualitative traits (Egg colour, Larval colour, Larval marking, Cocoon colour and shape) and ten-quantitative traits [Survival% (Pupation%), Cocoon weight, Shell weight, Thermo tolerance, Disease tolerance (NPV), Filament Length; Reelability%; Raw silk%; Neatness, Evenness]

Phenotyping was carried out for nine cycles (Generations) in order to obtain higher homozygosity within the genotype and individuals/ progenies were selected based on phenotype data and taken for next generation rearing. Data thus obtained (Nine cycles) were subjected to ANOVA, Analysis of variance indicated significant differences among the genotypes for all the parameters studied. Pupation (survival) ranged from 54 – 97%, cocoon weight (0.72 - 1.77g), shell weight (0.089 - 0.412g), thermotolerance (20- 84%), NPV tolerance (15 - 83%), filament length (261 - 879m), reelability (69 - 91%), raw silk (6.75 – 14.5%), neatness (75 -92) and evenness (74 – 88).

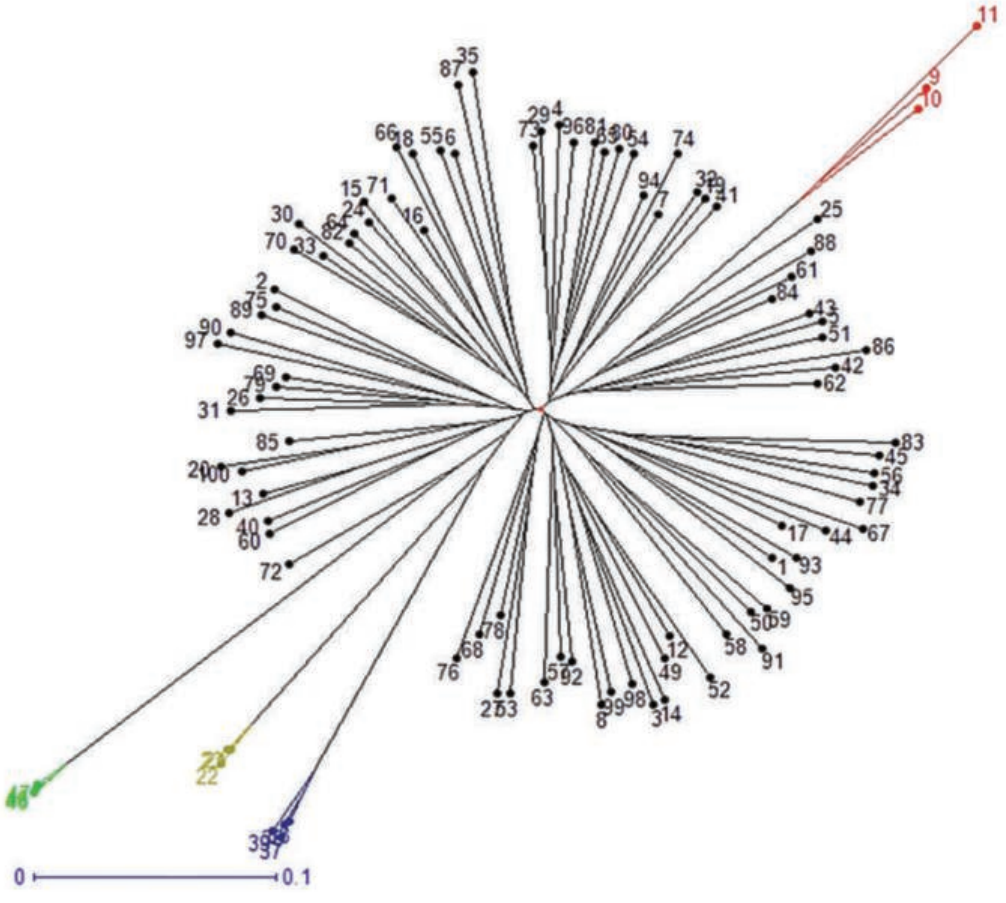
Genotyping

To understand genetic diversity and population structure, 20 SSR markers (based on earlier report) was selected and genotyped 100 silkworm genotypes. Based on the scoring data, simple matching dissimilarity coefficient was calculated using the Dice dissimilarity coefficient with the help of the software DARwin V5.0.158. The genetic differentiation parameters such as number of alleles (na), observed heterozygosity (HO), expected heterozygosity (HE) and polymorphic information content (PIC) were calculated for SSR markers.

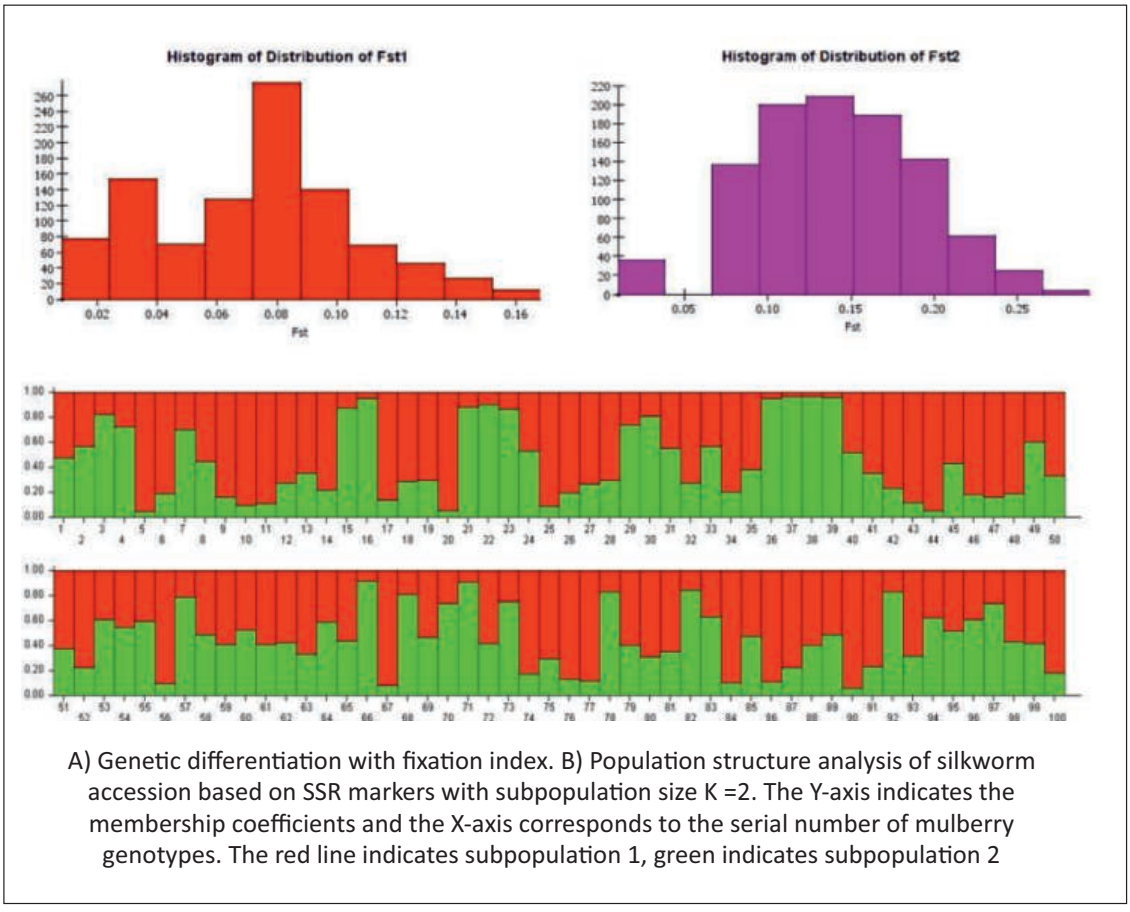
In the second scoring pattern the bands were scored based on their size. The clearest bands were scored from the each marker and these data were subjected to structural analysis using STRUCTURE programme (Pritchard, Stephens and Donnelly, 2000) to evaluate the population structure. The fixation index (Fst) for each subpopulation by the best 'K' was estimated by the STRUCTURE software. Result of SSR marker assay revealed that SSR markers were polymorphic with mean allele number of 4.3, polymorphic information content (PIC) of 0.47 and gene diversity of 0.51 (Table).

The higher disease (NPV), thermo tolerance, higher survival rate showing silkworm genotypes (Sarupat, M12 (W) and Nistari) and lower quantitative traits showing silkworms (Chinese farmer and D6 (P)) are represented in cluster 1with observable diversity (Fig.). The fixation index (FST), in subpopulation 1 (0.07) and in subpopulation 2 (0.14) shows the distribution of silkworm genotypes in two cluster with mixed capability in their traits.

The structure analysis placed most of the accessions into two subpopulations with highest diversity among the silkworm genotypes (Fig) and the allele frequency divergence of 0.0763 was estimated between the two subpopulations. The expected heterozygosity in subpopulation 1 was 0.7092, while subpopulation 2 recorded expected heterozygosity of 0.6893. The SSR marker based genotyping and population structure analysis further support the presence of enough genetic variability among the selected silkworm genotypes. SNP based genotyping (Genotyping by Sequencing) is under progress.



Dendrogram derived from UPGMA clustering based on Dice dissimilarity coefficients of SSR marker data of Silkworm genotypes



A) Genetic differentiation with fixation index. B) Population structure analysis of silkworm accession based on SSR markers with subpopulation size K =2. The Y-axis indicates the membership coefficients and the X-axis corresponds to the serial number of mulberry genotypes. The red line indicates subpopulation 1, green indicates subpopulation 2

AIB 3596: Development of multi-viral disease tolerant (NPV, IFV and DNV) bivoltine silkworm breeds/hybrids of *Bombyx mori* L. through marker-assisted selection (Oct. 2016 – Sep. 2020)

L. Satish, L. Kusuma, S.M. Moorthy, A.V. Mary Josepha

Objectives

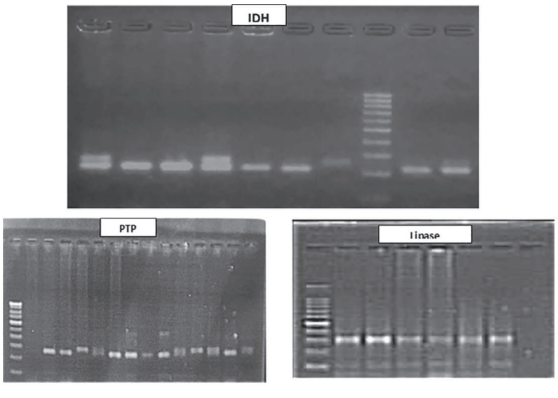
- Identification of multi-viral (BmDNV, BmNPV and BmIFV) tolerant bivoltine breeds using molecular markers.
- Development of multi-viral disease tolerant bivoltine silkworm breeds/hybrids through pyramiding of resistance.
- On station trial of identified hybrids at RSRSs/RECs.

Bombyx mori Densonucleosis virus (BmDNV1), *Bombyx mori* Infectious flacherie virus (BmIFV) and *Bombyx mori* nuclear polyhedrosis virus (BmNPV) are the primary viral pathogens that infect silkworm and causes huge crop loss in sericulture. The main objective of this work is to develop productive bivoltine breeds/hybrids tolerant/ resistant to the three viral infections through integrated conventional and molecular marker-assisted breeding. 120 bivoltine silkworm breeds from different geographical origin of India were reared and inoculated individually with BmDNV1, BmIFV and BmNPV inoculums at 10^{-2}, 10^{-2}, $2x10^{6}$ respectively, immediately after second moult. Tolerant/resistant populations were scored and recorded for survivability (%) and through directional selection the layings were prepared and screened using molecular marker like SSR markers for identification of tolerance/ resistant for viruses. Accordingly the breeds/hybrids tolerant to BmDNV1, BmNPV, and BmIFV were identified using SSR marker. 25 SSR markers were selected that had protein coding sequence (Miao *et al.,* 2005) and were used to evaluate multi-viral tolerant breeds. Among them Isocitrate dehydrogenase, glucose dehydrogenase, lipase, protein tyrosine phosphatase, attacin, ankyrin, alkaline tyrosine kinase were amplified between tolerant and susceptible breeds (Fig.). Sequences were submitted to NCBI and obtained accessions. Based on these results, best performing two parents were selected-HBM10 and PAM117 and hybrid was prepared. The SSR

marker results of multi-viral tolerant parents and hybrids are presented in Table below. The primer sequence, chromosomal location and amplicon size (AS) of each SSR marker are presented in Table. Based on this study SSR markers could be used in breeding programs involved in the development of breeds/hybrids for viral diseases resistant/tolerance. The potential characteristics with respect to pre and post cocoon properties were also analysed. Based on the results, few promising bivoltine breeds (Oval and Dumbbell) were short-listed for further evaluation at on station trails.

SSR marker evaluated in Parents and hybrids														
Breed	IDH216		LIP283		GDH306		PTP284		ATT		ANK165		ATK285	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
PAM117N	+	+	+	-	+	-	+	-	+	+	+	+	+	+
HBM10N	-	+	-	+	-	+	-	+	-	+	-	-	-	-
HBM10XPAM117	+	+	+	+	+	+	+	+	+	+	+	+	+	+
PAM117XHBM10	-	+	-	+		+	-	+	-	+	+	-	+	+

Detailed information of SSR markers					
Chr	Locus	F primer (5'---3')	R primer (5'---3')	AS	mRNA
Chr 3	S0311	AACTTCTTTATTCACAGATTTTGCCA	TTATGAAAATTGCACGGACGAA	283	Pancreatic lipase-related protein 2 (LIP283)
Chr 8	S0803	AAGTTCTTTACCAGTTCACAGACAGC	CGCCATGCAACTGTCGTCAC	216	Isocitrate dehydrogenase (IDH216)
Chr 17	S1708	GGTGGGTGGCGGCACTTAC	CCCAGTCACATGGAAACAGCG	306	Glucose dehydrogenase (GDH306)
Chr 5	S0515	TTTGAAGAGCAGGTCAGCCG	CGGGATCGATGGAAACAGCT	284	Protein-tyrosine phosphatase (PTP284)
Chr 6	C0601	ATGAGATAATAATGTATGGAGGTTTT	GATGAGGAATGATGTTGGGAA		Attacin (ATT)
Chr 21	S2106	CTCGGCACAAGCCTCGC	TAGGGATTGATTTAGGCAGGGTA	165	Ankyrin-2 (ANK165)
Chr 21	S2102	CGGTAACCACTCACCATCAGG	GAACAGGTGCCTAAATACCTTGTG	242	Protein-tyrosine sulfotransferase (PTP242)
Chr 18	S1802	CGCTTACGGAGGTCCATGAGG	CGCTTTTACCGATAAGACCGCT	285	ALK Tyrosine kinase (ATK285)



Amplification of SSR markers for multiviral diseases resistance silkworm breeds

Sequence of PAM117_IDH216 (NCBI Accession: MN422290)

CGCGTTCAGCCCTCCTTCGTATTACGTGTACACACACATGCACACACA-CACTCTTACGGTAACAAAGAATTTGTATTTGAAACTTCGATTCAAGA-CATTGTTGCAGAATCTGAATACTTTCTGACTATTATTTCACAGTAAGTGCT-TAGTTTAATTTGGCCAGTGACGACAGTTGCATAGCGA

Sequence of HBM10_IDH216 (NCBI Accession: MN422291)

TTAATAGTCAGAAATTATTCATTATTCTGCAACAATGTCTTGAAAT-GAATTTTCAAATACAAATTCTTTGTTACCGTAAAAGGGGGGGG-GGGCGGGGGGGGGGGGGGGGTGTGTGTGTGTGTGTGTACAT-TTAAAAAAAAAGAGGGAAGAGCGCCCCCTCCCCCCCTGCTCTGTGGGT-GAATAAAAAAAAAAAAAAAAAATATA

AIB-01002 MI: Evaluation of S8 x CSR16, a new bivoltine hybrid under authorization trials among the farmers of South India (Jul. 2018 – Jun. 2020).

C.M. Kishor Kumar (Upto Jun. 2019), R. Meenal, S.M. Hukkeri, Sashindran Nair, Shankara, R.S. Teotia (Upto Aug. 2020) and P. Tewary

Objectives

- To evaluate the field performance of newly evolved bivoltine hybrid, S8 x CSR16 for productivity and silk quality

Large scale evaluation of newly identified bivoltine single hybrid, S8 X CSR16 was undertaken with the farmers of South India. S8, CSR16 pure races were reared with selected ASRs and S8 x CSR16 hybrid dfls were prepared by SSPC, Ramanagara. During the period a total of 1,55,300 dfls were distributed to 595 farmers covering Karnataka, Andhra Pradesh and Tamil Nadu States. The hybrid was well accepted by farmers and has shown promising results. Rearing performance data recorded showed an average cocoon yield of 69.09 Kgs / 100 dfls as against 67.31 Kg in the control hybrid FC1 x FC2. The cocoon parameters recorded are single cocoon wt - 1.788g., single shell wt - 0.397g and shell ratio – 22.02%. The average rate fetched per Kg of cocoons was Rs.358/-. The cocoon lots were tested for silk quality at CSTRI, Bengaluru and it is graded from 2A-3A. The state wise rearing performance data of the hybrid are given below;

State	No. of dfls	No. of farmers	Actual yield (kg)	Yield / 100 dfls (Kg)	SCW (g)	SSW (g)	SR%	Rate/Kg (Rs.)	Yield / 100 dfls FC1 x FC2©
Karnataka	75900	295	53683	70.98	1.879	0.422	22.24	355.07	64.75
Andhra Pradesh	21000	108	14022	67.20	1.763	0.388	21.71	318.40	67.50
Tamil Nadu	58400	192	35365	69.10	1.722	0.381	22.10	400.03	69.67
Total/Average	**155300**	**595**	**103070**	**69.09**	**1.788**	**0.397**	**22.02**	**357.83**	**67.31**

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

K. N. Madhusudhan and CSR Agroproducts (Industrial partner)

Objectives:

- Extraction and purification of chitosan from pupal exuviae /spent pupae
- Characterization of Chitosan
- Standardization of protocols for commerical production/exploitation

Different combination of alkaline solutions (NaO^H & KOH) and acid (HCl) were utilized for extraction of chitin from pupal exuviae. Four combinations 2% NaOH with 1% HCl, 1% NaOH with 2% HCl, 2% KOH with 1% HCl and 2% KOH with 2% HCl were utilized. The best combination of 2% KOH and 1% HCl was found to be more effective in extracting chitin from the pupal exuivae with recovery of 50.8% followed by 2% NaOH with 1% HCl with recovery of 49.0%.

Recovery of chitin from 10g of pupal exuviae		
Chemical Combinations	Chitin recovered (g)	Recovery %
NaOH (2%) & HCL (1%)	4.90	49.0
NaOH (4%) & HCL (2%)	4.01	40.1
KOH (2%) & HCL (1%)	5.08	50.8
KOH (4%) & HCL (2%)	4.78	47.8

Continuous/ Other activities

Maintenance of bivoltine genetic resources

C. M. Kishor Kumar (Upto Jun. 2019), S. Manthira Moorthy, R. Meenal, K. N. Madhusudhan, M. S. Ranjini, L. Kusuma and L. Satish.

Productive bivoltine breeds (10), robust bivoltine breeds (11), thin denier bivoltine breeds (2) and sex limited breeds (5), amylase marker assisted selection breeds (15), NPV tolerant breeds (14) and morphological mutants (17) were maintained for conservation and evaluation. The values obtained for the traits were in conformity with the original breed characteristics.

Category	Breeds		Fecundity (Nos)	Pupa – tion Rate (%)	Cocoon wt. (g)	Shell Ratio (%)	Fil. Len. (m)	Raw Silk (%)	Denier
Productive breeds	CSR2 CSR3 CSR4 CSR5 CSR6	CSR12 CSR16 CSR17 CSR26 CSR27	>500	>85	>1.70-1.80	>22-24	>900	>17.0	2.7-3.0
Robust breeds	CSR18 CSR19 CSR46 CSR47 CSR50 CSR51	CSR52 CSR53 S8 D2 NB1	>500	>90	>1.60-1.80	>22-23	>900	>15.0	2.7-3.0
Thin Denier breeds	CSR48 JPN7		>500	>85	>1.60-1.80	>22-23	>1200	>15.0	2.2-2.4
Sex-Limited breeds	CSR2 (SL) CSR4 (SL) CSR8 (SL)	CSR27 (SL) CSR202 (SL)	>400	>85	>1.50-1.70	>20-21	>700	>13.0	2.6-2.9
Amylase Marker assited selection breeds	GEN1 GEN3 2C 2S 2M 3P 3C 3D	3N GEN2 4S 4C 4P 6P 6C	>450	>85	>1.50-1.70	>20-21	>800	>14.0	2.7-3.0
NPV Tolerant breeds	2N 5N 61N 63N 8 21 35	42 51 62 75 87 101 Rudra	>500	>85	>1.40-1.60	>20-21	>700	>13.0	2.6-2.9

Morphological mutant breeds	TMS 01 (White) TMS 01 (Knob) TMS 03 (Plain) TMS 03 (Green) TMS 04 TMS 13 TMS 18	TMS 19 TMS 23 TMS 34 TMS 40 TMS 42 TMS 45 TMS 47 TMS 52 TMS 53 TMS 59	>300	>80	>0.90-1.30	>13-16	>350	>10.0	2.1-2.5

SATELLITE SILKWORM BREEDING STATION – COONOOR

B. Mohan

Maintenance of Bivoltine Silkworm Germplasm Stocks

During the reporting year 4 new parental race *viz.,* MASN4, MASN6, MASN7 and CSR204 (SL) were added to the previous 34 breeders' stock *viz.,* CNR3, CNR4, CNR5, CNR15, SLD1, SLD8, SLD9, D1, D2, D11, D13, D15, D17, SSBS2, SSB3, SSBS4, SSBS5, SSBS6, SSBS7, SSBS9, SSBS10, SSBS11, SSBS12, SSBS16, SSBS17, CSR2, CSR4, CSR6, CSR16, CSR26, CSR27, CSR50,CSR51, CSR202, CSR204 thus a total of 39 bivoltine breeders' stock are being maintained.

Further, two conservation rearings/grainages were undertaken. The racial characters were confirmed during characterisation and important rearing parameters were recorded. All the stocks were found true-to-type and no significant deviation was found. After cocoon characterisation and stringent moth examination for pebrine, the dfls were conserved for further rearing. The rearing performance is tabulated below

Evaluation of New Bivoltine Silkworm Double Hybrid, SSBS5 x SSBS6 at Farmers' Level (Approved by CSB for small scale testing at RSRS Level)

SSBS5

SSBS6

SSBS-DH

Rearing performance of bivoltine silk worm germplasm stocks

Race	No. of Gen Completed	Avg. SC WT	Avg. SS WT	Avg. SR%
CNR3	16	1.864	0.387	20.74
CNR4	16	1.632	0.382	23.41
CNR5	16	1.812	0.392	21.61
CNR15	16	1.523	0.329	21.57
SLD1	16	1.832	0.378	20.64
SLD8	16	1.803	0.383	21.25
SLD9	16	1.645	0.352	21.25
SSBS2	17	2.054	0.435	21.20
SSBS3	17	1.985	0.447	22.51
SSBS4	17	2.017	0.456	22.61
SSBS5	17	2.038	0.471	23.12
SSBS6	17	1.785	0.370	20.72
SSBS7	17	1.900	0.416	21.87
SSBS9	17	1.687	0.379	22.47
SSBS10	17	1.684	0.380	22.54
SSBS11	17	1.737	0.377	21.70
SSBS12	17	1.730	0.392	22.66
SSBS16	17	1.600	0.336	20.97

Race	No. of Gen Completed	Avg. SC WT	Avg. SS WT	Avg. SR%
SSBS17	17	1.810	0.405	22.37
D1	16	1.740	0.381	21.90
D2	16	1.725	0.404	23.33
D11	16	1.607	0.353	21.94
D13	16	1.601	0.328	20.49
D15	16	1.653	0.356	21.51
D17	16	1.634	0.378	23.11
CSR2	15	1.714	0.372	21.52
CSR4	15	1.660	0.356	21.47
CSR6	15	1.672	0.341	20.32
CSR16	15	1.580	0.314	19.84
CSR26	15	1.654	0.332	20.02
CSR27	15	1684	0.384	22.84
CSR50	15	1.765	0.391	21.82
CSR51	15	1.756	0.373	21.59
CSR202	16	1.712	0.385	22.46
CSR204	16	1.726	0.389	22.54
CSR204(SL)	1	1.473	0.339	23.06
MASN4	6	1.865	0.371	19.89
MASN6	6	1.774	0.366	20.65
MASN7	6	1.642	0.307	18.70

Foundation crosses of SSBS double hybrid *viz.,* (SSBS3 x SSBS5) and (SSBS6xCSR51) were undertaken and a total of 908 dfls of SSBS double hybrid were prepared and consigned in cold storage for supply to RSRSs during October/ November' 19. A total of 650 dfls have been supplied to RSRS-Salem and the crop performance report is presented in Table below

Rearing Performance of SSBS Double Hybrid in RSRS-Salem								
RSRS	Season	dfls Tested	Cocoon Yield (kg)	Cocoon Yield /100 dfls (kg)	Av. SCW (g)	Av. SSW (g)	Av. SR (%)	Av. Cocoon Rate (Rs)
Salem	Nov. 19	650	377.00	62.90	1.670	0.353	21.13	390

P4 BASIC SEED FARM HASSAN

Bivoltine Silkworm Race Maintenance and Multiplication

V. Nishitha Naik and Dayananda

Objective: Systematic maintenance of mulberry garden, bivoltine silkworm races and supply of quality bivoltine eggs to downstream multiplication centers.

Systematic maintenance of mulberry garden: During the year two acres of mulberry plantation was maintained for the supply of mulberry leaves for silkworm rearing as per schedule (May-Jun 2019, Aug.-Sep. 2019, Nov-Dec. 2019 and Feb.-Mar. 2020) for four crops. Timely pruning and cultural operations viz., pruning, fertilizer application and plant protection measures were taken in regular and tree plantation. Glyricidina plants, left out mulberry leaves and shoots (5000 kg) were utilized for filling the trenches in the mulberry plots to enrich the soil. Generated 8 metric tons of vermi-compost and 11 metric tons of compost and utilized for the maintenance of mulberry garden. Spraying of DDVP and cow urine is made

as a regular practicefor every crop for management of pest and disease. Sprinkler Irrigation installed in the regular plots to overcome the scarcity of water during summer season. Supplied 7500 kg mulberry leaves for the ongoing programme viz., maintenance of 8 popular bivoltine silkworm breeds.

Maintenance of bivoltine silkworm breeds: Eight Bivoltine breeds viz., CSR2, CSR4, CSR6, CSR16, CSR17 CSR26, CSR27 and S8 were reared during 2019-20 by following Silkworm Race maintenance procedure. The performance of these breeds (Average of 4 crops) is presented in Table. All the eight silkworm breeds were maintained in conformity with the original breed characters.

Performance of authorized bivoltine breeds (Mean of 4 rearings)

Breed	ERR (No.)	ERR wt. (kg)	SCW (g)	SSW (g)	Cocoon Shell (%)
CSR2	9545±561	16.197±1.023	1.639±0.096	0.363±0.029	22.18±0.95
CSR17	9721±188	16.802±1.215	1.731±0.108	0.361±0.024	20.88±0.77
CSR27	9513±393	16.138±1.325	1.680±0.163	0.382±0.034	22.72±0.88
S8	9537±415	15.750±1.319	1.646±0.107	0.354±0.030	21.50±0.95
CSR4	9439±570	15.302±1.998	1.603±0.170	0.341±0.041	21.26±0.99
CSR6	9494±502	15.811±1.373	1.648±0.130	0.348±0.036	21.14±1.18
CSR16	9298±566	15.479±1.482	1.647±0.121	0.347±0.032	21.05±0.94
CSR26	9336±841	15.800±0.940	1.676±0.117	0.345±0.031	20.60±0.97

All the four crops were monitored for pebrine incidence. 1st and 4th crop was free from Pebrine disease however in 2nd & 3rd crop Pebrine incidence was observed (0.07% & 1.11%). The Average incidence of Pebrine disease for the four crops was 0.30%. During the year, 202.559 kg cocoons were produced, out of this 34.462 kg cocoons were utilized for seed production and 153.452 kg cocoons were marketed at Government cocoon market, Hassan.

Continuous/Other activities:

Raised tree mulberry plantation of V-1 variety in vacant plot No: 25 & 26.

A total of 12045 pure stock dfls were prepared for supply to P3 multiplication centres and farm use.

The dfls were supplied to four P3 station (845) *viz.*, Kaggundi, Kudige, Chikkonahally, Kumbarahally, NSSO (2750) and CSRTI-Mysuru (1566).

MULTIVOLTINE BREEDING LABORATORY

Concluded Projects

AIB: 3534 - Development of Improved Crossbreeds of Silkworm *Bombyx mori* L. suitable for South India.

(Mar. 2015 - Mar. 2019)

K. B. Chandrashekhar, C. M. Kishor Kumar (upto Jul. 2019), S. B. Kulkarni, P. V. Soudaminy, M. N. Chandrashekhar

Objectives: To develop crossbreed with high cocoon productivity and improved silk quality

Better performing 11 breeds were selected, Diallele model was applied for crossing, 36 crosses were obtained and reared for stabilization. During the process six ICB lines, ICB2, ICB7, ICB14, ICB17, ICB29 and ICB30 short listed. Among these, ICB29 out performed with ERR by number 8775, ERR by weight 11.79 kg, single cocoon weight 1.431g, single shell weight 0.274g, shell percentage 19.18%, reeling 67.84%, filament length 558m, raw silk percentage 9.72 % and neatness of 85.80 without any hibernation characters in the egg. Reeling characteristics were tested at CSTRI-Bengaluru which indicated “B” grade for silk yarn.

The performance of ICB lines was studied by line × tester method by crossing with bivoltine pure breeds and foundation crosses. The data was analyzed by multiple evaluation index method as well as Duncan’s Multiple Range Test (DMRT). The combined ranking results of AEI and DMRT indicate that ICB29 × S8, ICB29 × C. Oval and ICB29 × CSR27 were significantly superior. Reeling characteristics tested at CSTRI-Bengaluru have indicated “2A” grade silk in ICB29 × S8 at par with MV1 × S8 and superior over PM × CSR2. The other important outcome of the project is the eggs without hibernation in pure line as well as in the crossbreed.

In addition, the ICB lines were crossed with foundation crosses, combined ranking results of AEI and DMRT indicate that ICB7 x (S8 x D2), ICB29 x BFC1 and ICB30 x BFC1 are significantly superior.

Rearing and reeling performance of the shortlisted ICB lines and crossed with FCs analyzed by AEI and DMRT using alphabet notation (5% level of significance).

Treatment	ICB cross	ERR/10000 larvae		Single cocoon wt. (g)	Single shell wt. (g)	Shell %	Reeling %	Filament length (m)	Raw silk (%)	Neatness (p)	AEI
		No.	Wt. (g)								
T1	ICB2 × (S8 × D2)	8967 de	14.71 ab	1.681 a	0.322 a	20.75 a	89 ab	665 ab	58.7 b	85 a	53.63
T2	ICB2 × BFC1	9012 cd	14.27 de	1.647 a	0.334 a	19.17 abc	88 ab	614 c	50 de	84 a	51.57
T3	ICB2 × BFC7	8367 h	14.1 ef	1.717 a	0.356 a	20.3 a	86 b	530 d	51.4 de	83 a	50.00
T4	ICB7 × (S8 × D2)	8933 ef	15.8 ab	1.795 a	0.341 a	20.7 a	93 a	678 a	62.7 ab	85 a	61.81
T5	ICB7 × BFC1	9467 ab	15.67 ab	1.66 a	0.341 a	19.02 abc	89 ab	650 ab	52.9 cd	83 a	54.91
T6	ICB7 × BFC7	9633 a	15.2 ab	1.619 a	0.314 a	20.56 a	88 ab	529 d	46.5 efg	82 a	46.47
T7	ICB14 × (S8 × D2)	9067 bc	15.63 ab	1.806 a	0.312 a	19.46 ab	88 ab	530 d	61.7 ab	82 a	50.49
T8	ICB7 × BFC1	8500 gh	14.5 cd	1.5 b	0.27 d	17.27 d	85 b	521 d	55 c	81 a	38.62
T9	ICB14 × BFC7	8867 ef	15.1 ab	1.632 a	0.309 bc	18.33 cd	86 b	636 bc	47.1 efg	83 a	45.16
T10	ICB17 × (S8 × D2)	9123 bc	16.18 ab	1.812 a	0.349 a	18.94 abc	88 ab	531 d	53.1 cd	84 a	54.49
T11	ICB17 × BFC1	8796 fg	14.57 bc	1.639 a	0.325 a	19.26 abc	85 b	547 d	43.1 h	83 a	42.78
T12	ICB17 × BFC7	8456 h	14.11 ef	1.684 a	0.329 a	19.83 ab	86 b	530 d	45.6 g	82 a	43.81
T13	ICB29 × (S8 × D2)	9432 ab	15.46 ab	1.643 a	0.328 a	19.54 ab	88 ab	603 c	53.3 cd	84 a	53.39
T14	ICB29 × BFC1	9500 ab	16.08 ab	1.692 a	0.351 a	19.96 ab	88 ab	636 bc	59.4 b	83 a	58.38
T15	ICB29 × BFC7	9531 ab	16.26 a	1.729 a	0.346 a	20.01 ab	88 ab	600 c	63.8 ab	82 a	48.48
T16	ICB30 × (S8 × D2)	9133 bc	16.22 a	1.695 a	0.33 a	19.47 ab	88 ab	531 d	48.5 efg	84 a	49.67
T17	ICB30 × BFC1	9333 ab	16.12 ab	1.744 a	0.356 a	20.42 a	93 a	654 ab	49.4 ef	82 a	58.05
T18	ICB30 × BFC7	8500 gh	15.2 ab	1.7 a	0.306 cd	17.99 cd	88 ab	531 d	49 ef	81 a	42.08
T19	PM × FC2	9058 bc	13 f	1.61 a	0.33 a	20.5 a	86 b	610 c	50 de	82 a	47.02
	Mean	9036	15	1.7	0.3	20	88	586	10	53	
	SD	389	0.96	0.07	0.02	0.91	2.09	57	1.08	6	
	F - Value	6.77**	3.62**	1.09 NS	2.67*	3.25**	1.42NS	24.6**	11.8**	33.9**	
	P - Value	0.000	0.000	0.399	0.005	0.001	0.177	0.000	0.000	0.000	

Rearing and reeling performance of stabilized ICB lines analysed by AEI and DMRT method.

Treatment	ICB cross	ERR/10000 larvae		Single cocoon wt. (g)	Single shell wt. (g)	Shell %	Reeling %	Filament length (m)	Raw silk %	Neatness (P)	AEI Value
		No.	Wt.kg								
T1	ICB2	8589 ^{ab}	10.84 ^{cd}	1.318 ^{de}	0.231 ^{de}	17.49 ^{ab}	55.49 ^{def}	492 ^{ab}	9.64 ^{bc}	85 ^{ab}	48.23
T2	ICB7	8628 ^{ab}	11.62 ^{abc}	1.404 ^{abc}	0.254 ^{abc}	18.13 ^{ab}	55.76 ^{de}	506 ^{ab}	9.31 ^{cd}	84 ^{ab}	50.66
T3	ICB14	7917 ^{c}	10.28 ^{efg}	1.354 ^{bc}	0.246 ^{cde}	18.2 ^{ab}	56.9 ^{de}	536 ^{ab}	10.97 ^{b}	83 ^{ab}	47.73
T4	ICB17	8552 ^{ab}	10.55 ^{ef}	1.293 ^{e}	0.225 ^{ef}	17.38 ^{b}	50.73 ^{g}	509 ^{ab}	9.68 ^{bc}	84 ^{ab}	46.48
T5	ICB29	8775 ^{ab}	11.79 ^{abc}	1.431 ^{ab}	0.274 ^{ab}	19.18 ^{a}	67.84 ^{ab}	558 ^{a}	9.72 ^{bc}	86 ^{a}	57.10
T6	ICB30	8636 ^{ab}	11.91 ^{ab}	1.434 ^{ab}	0.261 ^{ab}	18.2 ^{ab}	66.68 ^{abc}	520 ^{ab}	9.55 ^{cd}	85 ^{ab}	54.06
T7	MV1	8820 ^{a}	12.44 ^{a}	1.466 ^{a}	0.278 ^{a}	19 ^{ab}	71.77 ^{a}	547 ^{ab}	13.07 ^{a}	85 ^{ab}	61.15
T8	PM	8524 ^{ab}	8.63 ^{g}	1.068 ^{f}	0.159 ^{g}	14.9 ^{c}	60.79 ^{bc}	376 ^{c}	9.26 ^{cd}	78 ^{c}	34.59
Mean		8555	11.01	1.346	0.241	17.81	60.74	505.5	10.15	84	
SD		277.66	1.211	0.127	0.038	1.334	7.316	56.79	1.29	2.55	
F.value		6.22**	14.64**	13.02**	29.98**	6.84**	8.51**	9.32**	13.95**	1.90	
P value		0.0003	0.000	0.000	0.000	0.0001	0.000	0.000	0.000	0.102	

*Mean values with same letter are not significantly different at 5% level of significance; * Higher mean value is represented by alphabet “a” and is significant to “b” but “a” and “ab” are not significant; ** denotes significant at 1% and * denotes significant at 5%.

AEI ranking and comparison of ICB crosses with control								
ICB Cross	AEI	Rank	ICB Cross	AEI	Rank	ICB Cross	AEI	Rank
ICB29 × S8	59.85	1	ICB2 × CSR2	53.03	10	ICB17 × C. Oval	49.99	19
ICB29 × C. Oval	57.80	2	ICB ×30 × C. Oval	52.75	11	ICB7 × S8	48.13	20
MV1 × S8	57.20	3	ICB30 × CSR2	51.77	12	ICB14 × CSR27	43.66	21
ICB29 × CSR27	55.67	4	ICB30 × S8	51.61	13	ICB2 × C. oval	41.71	22
ICB14 × S8	55.43	5	ICB2 × S8	51.21	14	ICB17 × S8	41.23	23
ICB7 × C. Oval	54.91	6	ICB30 × CSR27	50.68	15	ICB7 × CSR2	38.42	24
ICB17 × CSR2	54.76	7	ICB14 × C. Oval	50.43	16	ICB7 × CSR27	38.42	25
ICB2 × CSR27	54.36	8	ICB17 × CSR27	50.13	17	ICB14 × CSR2	35.12	26
ICB29 × CSR2	53.84	9	PM × CSR2	50.02	18			

Comparison of ICB29, ICB30 and its cross over the existing hybrids						
Parameters	ICB29 × CSR2	ICB29 × S8	ICB30 × CSR2	ICB30 × S8	MV1× S8	PM ×CSR2
Shell %	20.83	19.51	19.25	20.50	20.40	19.40
ERR. No.	9367	9344	9496	9169	8767	8522
ERR wt.(kg)	14.96	17.10	16.65	15.30	14.0	13.0
Reeling%	89.29	90.91	87.72	87.72	83.0	84.0
Filament length (m)	616	627	591	601	671	623
Raw silk %	10.31	11.00	9.70	10.70	12	13
Raw silk Recovery %	54.70	65.00	50.60	51.40	57	56
Neatness (p)	85	86	84	82	83	86
Hibernation of eggs	Nil	Nil	Nil	Nil	5% in winter	Nil

Comparison of reeling characteristics of ICBs along with control tested at CSTRI, Bengaluru					
Parameters	ICB29 × S8	ICB29 × CSR2	ICB30 × CSR2	MV1 × S8	PM × CSR2
Month	April	June	June	June	June
Single cocoon weight	1.44	1.892	1.594	1.841	1.607
Single shell weight	0.285	0.384	0.325	0.36	0.265
Shell ratio	19.79	20.3	20.39	19.55	16.49
Average filament length	735	816	911	906	736
Non broken filament length	731	570	618	735	534
Single cocoon filament Denier	2.47	2.94	2.52	2.76	2.66
Reelability	88.5	71.33	68.86	82	74.06
Raw silk %	7.2	14.5	15.8	13.5	10.2
Renditta (on green cocoons)	13.9	6.9	6.3	7.7	9.8
Raw silk recovery	70.3	71.4	77.7	66.5	62.1

Silk waste (on silk weight)	17.5	16.1	16.4	20.51	19.2
Average Size (d)	21.83	22.62	21.96	21.27	22.73
Standard size deviation	1.56	1.95	1.86	1.58	1.92
Evenness variation – I	100	110	100	140	100
Evenness variation – II	0	0	10	0	0
Cleanness	95	93	98	96	95
Neatness	93	90	96	92	95
Low Neatness	90	84	93	89	90
Maximum deviation	2.88	3.1	2.7	2.66	3.6
Winding Breaks / 10 skeins/hrs	4	4	4	4	10
Tenacity	3.8	3.7	3.9	4.1	3.9
Elongation	19	18	18	21	16
Cohesion	68	75	87	62	77
Overall grade	2A	A	A	2A	B

Ongoing Projects

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

K. B. Chandrashekar, S. M. Moorthy, K. M. Ponnuvelu, S. B. Kulkarni, S. M. Hukkeri, P. V. Soudaminy and L. Kusuma.

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.

Two multivoltine breeds MV1 (Superior fibre quality) and HB4 (Tolerant to Temperature and BmNPV) and indigenous bivoltine S8 and exotic bivoltine breed BM2 were utilized to prepare crossbreeds to identify multivoltine breeds with improved silk quality and productivity through Marker Assisted Selection. RNA analysis of 8 selected egg samples of different batches were analyzed for expression of diapause and non diapause genes, 3 samples showed expressed of Trehalose Transporter gene, 5 samples expressed Paralytic peptide binding protein and 2 samples expressed Sorbitol dehydrogenase with respect to diapause gene. F8 generation is under progress with new lines of different combinations.

AIB-01001MI: Evaluation of Cauvery Gold (MV1 × S8): An improved cross breed for cocoon productivity and silk quality. (Jun. 2018 - May 2020)

S.B. Kulkarni, K.B. Chandrashekhar, P.V. Soudaminy, N. Balachandran, S.M. Hukkeri, M. Noble Morrison, Dayananda, K.S. Nair and Shankar

Objective

- To evaluate the field performance of newly developed crossbreed Cauvery Gold (MV1 × S8) for productivity and silk quality.

Seed cocoons of MV1 and S8 were generated at Institute and farmer's level for the production of MV1 × S8. The cocoons were processed at SSPC Ramanagaram and Chinthamani under NSSO. During the year 2019-20

a total of 79175 dfls were produced and distributed to 245 farmers with an average yield of 60.12kgs. Seven cocoon samples collected from farmers were tested for reeling characteristics at CSTRI-Bengaluru have scored 2A grade silk (Table) and suites the improved reeling machines. This crossbreed cocoons fetched Rs.15-35 per kg higher more when compared to PM × CSR2.

Cocoon Characteristics	Farmer name and date							
	Harikrishna, V. Kota 04.02.19		Kishor, V. Kota 04.02.19		Chennaveerappa, Madivala 21.05.19		Somshekar, Gudibande 11.09.19	
SCW (g)	1.791		1.952		1.963		2.160	
SSW (g)	0.402		0.401		0.390		0.470	
Shell ratio (%)	22.05		20.31		19.87		21.76	
Average filament length (m)	877		874		961		1024	
Non broken filament length	738		749		762		992	
Single cocoon filament Denier	2.87		3.12		2.78		3.05	
Defective cocoon	8.3		9.7		11.5		9.40	
Reeling characteristics								
Reelability (%)	85.00		86.20		78		93.40	
Renditta (green cocoon wt.)	8.0		7.5		7.4		6.2	
Raw silk (%)	12.50		13.30		13.50		16.10	
Raw silk recovery %	56.70		65.40		68.0		74.0	
Silk waste (on silk weight) %	18.95		17.65		19.75		19.90	
	Value	**Grade**	**Value**	**Grade**	**Value**	**Grade**	**Value**	**Grade**
Average Size (d)	22.13		22.44		21.44		22.28	
Major Tests								
Standard size deviation	1.60	2A	1.58	2A	1.54	2A	1.56	2A
Evenness variation – I (Stripes)	130	4A	110	4A	90	4A	80	4A
Evenness variation – II (Stripes)	0	4A	0	4A	0	4A	0	4A
Cleanness (%)	95	3A	94	2A	94	2A	95	3A
Neatness (%)	93	3A	94	4A	93	3A	90	2A
Low Neatness (%)	85	3A	90	4A	90	4A	85	2A
Auxiliary Tests								
Maximum deviation	3.1	1	2.9	1	3.1	1	2.95	1
Evenness variation – II (Stripes)	0	1	0	1	0	1	0	1
Winding Breaks / 10 skeins/hrs	4	1	4	1	4	1	4	1
Tenacity (gpd)	4.1	1	4.3	1	3.9	1	3.7	1
Elongation (%)	21	1	21	1	20	1	20	1
Cohesion (Strokes)	62	1	61	1	74	1	68	1
Overall grade		**2A**		**2A**		**2A**		**2A**

AIB-01011 SI: Development of Multivoltine Foundation crosses for productivity and high silk Percentage (Mar. 2020 – Feb. 2023)

P. V. Soudaminy, K. B. Chandrashekar, S. B. Kulkarni, M. N. Chandrashekar

Objective: To develop multivoltine foundation crosses for the production of Multi × bivoltine double hybrids with high shell percentage and improved productivity.

A total of 13 parental breeds were identified from the germplasm stock of multivoltine breeding laboratory and carried out one rearing and recorded the rearing data.

Reeling test results of field samples tested at CSTRI-Bengaluru					
Breeds	Fec.	Hatching (%)	SCW (g)	SSW (g)	SR %
PM	432	94.01	1.201	0.182	15.04
AGL35	413	94.08	1.178	0.196	16.39
L3	450	19.38	1.266	0.226	17.84
L14	433	94.40	1.244	0.226	18.23
L15	440	93.50	1.222	0.208	16.88
ND5	460	95.59	1.274	0.234	17.84
ND7	439	94.38	1.180	0.212	17.92
ND10	441	94.86	1.339	0.247	18.63
NDV6	437	96.22	1.208	0.256	18.28
HB6	459	96.46	1.259	0.218	17.24
MO6	472	97.00	1.301	0.232	17.71
ICB 29	467	95.78	1.257	0.233	17.95
ICB30	451	96.07	1.273	0.237	17.96

List and progress of Inter-Institutional Collaborative Projects

AIB-3577: Evaluation of Multivoltine Germplasm to identify potential parent for developing cross breeds for Southern and Eastern India (in colloboration with CSGRC-Hosur*) (Jun. 2016 - May 2019)

K. B. Chandrashekar, P. V. Soudaminy, S. B. Kulkarni, N. Balachandran*, G. Punithavathy*

Two trials of total 20 cross breeds in 3 replications were conducted (Total of 6 crops). The rearing and reeling data were collected from different seasons. Ranking of the combination was done based on the average evaluation index values and percentage of improvement over the control as detailed below.

Overall Performance: Average data on the rearing and reeling performance of 20 shortlisted Multi × Bi combinations reared at CSRTI-Mysuru during all trials is presented in Table below. Among the 20 combinations, five combinations *viz.,* BMI-0054 × 290, BMI-0001 × 290, BMI-0055 × 290, BMI-0077 × 290 and BMI-0025 × 290 were found to be better combiners and scored EI values of >50 (52.95-55.26) and BMI-0054 × 290 exhibited 0.72% improvement over control.

Overall Rearing performance of multi x bi combinations

Continuous/Other activities:

Multi × bi combinations	Fec. (no.)	Hat. (%)	Wt. of 10 grown larvae (g)	ERR by no.	ERR by wt (kg)	Pupation rate (%)	SC wt.(g)	SS wt. (g)	SR %	Av. EI
BMI-0001 × 290	478	96.81	30.33	9703	14.23	96.10	1.498	0.269	18.060	55.46
BMI-0007 × 290	446	96.82	32.14	9677	11.71	95.51	1.343	0.245	18.060	43.77
BMI-0017 × 290	439	96.59	30.90	9806	13.44	97.00	1.455	0.249	17.180	49.57
BMI-0022 × 290	452	97.01	29.70	9660	13.28	94.94	1.505	0.239	16.030	45.66
BMI-0025 × 290	449	96.42	34.88	9769	13.92	96.40	1.490	0.261	17.530	53.56
BMI-0026 × 290	439	96.97	31.38	9695	12.67	95.64	1.500	0.261	17.510	48.43
BME-0030 × 290	467	95.96	32.58	9762	13.22	96.64	1.460	0.244	16.730	49.38
BME-0048 × 290	454	96.84	35.52	9743	14.09	96.00	1.549	0.284	18.320	58.37
BMI-0054 × 290	454	96.48	33.89	9789	13.22	96.48	1.439	0.257	17.930	52.13
BMI-0055 × 290	456	96.34	35.85	9685	12.93	95.79	1.384	0.246	17.760	48.37
BMI-0068 × 290	422	95.63	28.34	9749	13.79	96.06	1.509	0.281	18.550	47.21
BMI-0069 × 290	454	96.98	30.00	9674	13.43	95.06	1.465	0.270	18.380	50.28
BMI-0074 × 290	448	96.69	33.39	9669	13.16	95.08	1.535	0.266	17.420	50.27
BMI-0076 × 290	458	96.66	31.38	9432	12.30	92.79	1.498	0.288	19.280	45.47
BMI-0077 × 290	452	96.26	30.55	9669	12.96	95.71	1.447	0.283	19.480	50.09
BMI-0078 × 290	444	95.88	31.75	9641	12.13	95.05	1.450	0.283	19.320	46.30
BMI-0079 × 290	466	96.76	30.68	9575	13.36	94.40	1.553	0.301	19.230	53.49
BMI-0080 × 290	454	95.83	34.73	9712	13.18	95.34	1.390	0.252	18.160	47.39
BMI-0081 × 290	450	96.12	33.41	9704	13.92	95.56	1.534	0.303	19.690	56.02
BMI-0082 × 290	450	96.32	33.30	9737	12.24	96.35	1.430	0.260	18.150	48.81
Mean	451	96.469	32.235	9692	13.159	95.595	1.472	0.267	18.139	
SD	11.546	0.416	2.087	82.189	0.683	0.929	0.057	0.019	0.951	
CV	2.557	0.431	6.474	0.848	5.189	0.972	3.843	7.141	5.244	

Maintenance of polyvoltine silkworm breeds of *Bombyx mori* L.

K. B. Chandrashekar, S. B. Kulkarni, P. V. Soudaminy and M. N. Chandrashekar

Objective: Maintainance of polyvoltine breeds conforming to their original characters.

Thirty five polyvoltine breeds were maintained conforming to their original breed character for 5 generations. The average performance of some important evolved breeds are given in the following table.

Rearing performance of the Germplasm							
Races	Fec. (Nos)	Hat. %	By Nos	By Wt.	SC wt. (g)	SS wt. (g)	SR%
AGL-35	426	97.42	9350	13.5	1.435	0.255	17.77
APDR 15	420	97.14	9500	11.50	1.201	0.210	16.75
BL 24	417	95.44	8900	12.25	1.349	0.232	17.20
BL-65	421	95.01	9500	12.50	1.320	0.227	17.22
BL-67	423	97.16	8700	13.750	1.570	0.284	18.09
BL-68	409	96.82	9550	13.250	1.381	0.224	16.2
BM-005	399	92.48	9350	9.000	0.956	0.135	14.11
BM-078	420	95.24	9150	12.900	1.392	0.218	16.04
FVB1	428	96.26	9350	12.800	1.358	0.218	16.04
HB4	434	95.16	9700	15.00	1.534	0.275	17.91
HB6	475	94.95	9250	14.300	1.541	0.273	17.70
L1	465	94.84	8950	15.500	1.713	0.326	19.01
L3	463	93.95	8900	13.750	1.551	0.281	18.24
L14	432	96.99	9000	12.500	1.501	0.251	17.96
L15	431	95.59	9450	13.750	1.432	0.248	17.31
MH1	436	93.81	9400	13.250	1.488	0.232	16.60
MV1	428	92.99	9560	14.000	1.461	0.261	17.86
MO6	465	96.99	9300	14.750	1.580	0.258	16.32
ND2	457	94.31	9150	12.400	1.348	0.236	18.51
ND5	432	94.68	9000	13.250	1.471	0.268	18.22
ND7	445	97.08	9050	12.350	1.370	0.267	19.51
ND10	479	95.8	8700	13.000	1.487	0.248	16.69
NDV6	461	94.79	9300	12.550	1.582	0.274	17.33
Nistari	450	96.00	9050	8.950	0.982	0.121	12.33
NP1	445	94.82	8250	13.250	1.592	0.278	17.49
NP4	442	95.48	9200	12.600	1.352	0.223	16.49
PV1	436	96.10	9250	14.750	1.574	0.290	18.43
2000H	448	95.98	8950	11.900	1.309	0.237	18.08
RD1	420	95.24	9250	11.750	1.246	0.158	12.70
M. con1	460	95.43	9250	11.250	1.204	0.169	14.03
HSR 8	441	95.01	9150	10.250	1.111	0.173	15.57

Other Activities : - Evaluation of Improved Pure Mysore in the farms at Kunigal seed area evaluation of Cauvery Gold (MV1 × S8).

SILKWORM PHYSIOLOGY

Concluded Projects:

AIP 3568: Development of value added products from spent pupae of mulberry silkworm, *Bombyx mori* L. (Apr. 2016 - Mar. 2019)

Y. Thirupathaiah, E. Bhuvaneswari; M. Munirathnam Reddy (upto Feb.2017), V. Sivaprasad (upto Dec.2018), P. Tewary, M. Chandrashekaraiah (PI)*, N.M. Soren*, K.S.Prasad* * (NIANP-Bengaluru)

Objectives: i) Isolation and characterization of α- linolenic acid from pupae oil and establishment of pilot production plant (CSRTI-Mysuru).

ii) Development of DSWP meal enriching livestock feed as supplement for bypass protein and fat (NIANP-Bengaluru).

Work carried out at CSRTI-Mysuru:

Extraction of α- linolenic acid from silkworm pupae powder/oil by chemical, enzymatic and solid state fermentation: Omega-3 fatty acid particularly α-linolenic acid is a precursor for other essential omega 3-fatty acids in human body and also play an important role in maintenance of normal physiological function. α-linolenic acid cannot be synthesized by human body, it must be exclusively obtained from the diet. Silkworm, *Bombyx mori* pupae oil is known to be rich source of α-linolenic acid. Hence, process was developed for concentration of α-linolenic acid from silkworm pupae by different approaches for commercial explotation. Chemical, enzymatic and solid state fermentation technologies was applied for extraction of α-Linolenic Acid (ALA) from silkworm pupae oil/powder followed by urea inclusion complexation, fractional crystallization and silicon column chromatography purification. The maximum recovery of ALA was obtained in chemical extraction method (109.5 g/kg) than enzymatic extraction process (50g/kg). Eventhough, lower quantity of ALA was recovered by solid state fermentation process (10.2 g/kg), the process is economically viable when compared with enzymatic and chemical methods. Quantity of ALA obtained by chemical extraction from spent pupae was 90g/kg and with enzymatic extraction process 30.3g/kg, in direct extraction of ALA by solid state fermentation was 8.5g/kg.

Extraction of ALA by different extraction methods

Extraction method	Quantity of ALA g/kg oil/powder	
	Fresh pupae	Spent pupae
Chemical extraction	109.5 ± 1.80	90.10 ± 2.68
Enzymatic extraction	50.0 ± 3.0	30.36 ± 1.20
Solid state fermentation	10.26 ± 1.46	08.56 ± 0.47

Values expressed as mean ± SD of three independent replicates.

Work carried out at NIANP-Bengaluru:

I*n vivo* studies in sheep: 1st stage: Effect of incorporation of different levels of defatted silkworm pupae meal by replacing groundnut cake on intake, digestibility of nutrients and growth rate in sheep:

Four iso-nitrogenous concentrate mixtures were prepared with DSWP (Deoiled Silkworm Pupae Powder) replacing groundnut cake at 0, 50, 75 and 100% (GI, GII, GIII and GIV) in the concentrate. The DM and OM intakes recorded were significantly higher (p<.001) in GIII when compared to other groups. The digestibility of all the nutrients observed were significantly lower (p<.001) in GIV when compared to other groups. GIII recorded higher (p<.001) growth rates when compared to other groups. silkworm pupae meal' (SWPM) can be used as an alternative source of protein and as a source of bypass protein in the diet of sheep by replacing conventional protein of groundnut cake up to 75% in sheep diet without any detrimental effect and without compromising the growth and nutrient utilization in sheep. Developed protein supplements from unconventional sources and demonstrated that 'silk worm pupae meal' (SWPM) can be used as an alternative source of protein and as a

source of bypass protein in the diet of cattle and sheep. We have shown that SWPM can be used to replace conventional protein of soybean meal/ groundnut cake by 30% in cattle and upto 75% in sheep diet without any detrimental effect and without compromising the growth and nutrient utilization in sheep (Table).

2nd stage: Effect of incorporation of different levels of bypass fat prepared from silkworm pupae oil on intake, digestibility of nutrients and growth rate in sheep:

Four iso-nitrogenous concentrate mixtures were prepared with supplementation of different levels of bypass fat from silkworm pupae oil (SWPO) (0, 10, 15 and 20% - GI, GII, GIII and GIV) in the concentrate mixture. The DM and OM intakes recorded were significantly higher (p<.001) in GIII when compared to other groups. The digestibility of all the nutrients observed were significantly lower (p<.001) in GIV when compared to other groups. GIII recorded higher (p<.001) growth rates when compared to other groups. Developed product and process for preparation of bypass fat in life stock rations. The methodology developed by us removes the offensive smell of SWPO completely. *In vitro* studies using graded level of bypass fat from SWPO has shown that it can be included up to 20% without any significant effect on *in vitro* rumen fermentation and digestibility on straw based rations and can be used safely. *In vivo* studies conducted in sheep revealed that, bypass fat prepared from SWPO can be incorporated in the ration up to 15% in the concentrate mixture without compromising the growth and nutrient utilization in sheep (Table).

Effect of incorporation of different levels of defatted silkworm pupae meal on intake, digestibility of nutrients and growth rate in sheep

	G I	G II	G III	G IV	SEM	P-Value
Intake (g/d)						
Dry Matter (DM)						
Concentrate mixture	316^{c}	360^{ab}	394^{a}	329^{bc}	8.7	0.002
Super Napier	475	516	511	474	8.0	0.100
Total	791^{b}	876^{a}	905^{a}	803^{b}	14.8	0.006
Concentrate mixture % Body Weight	1.5	1.5	1.5	1.5	0.01	0.127
Super Napier% Body Weight	2.23	2.18	1.93	2.17	0.05	0.077
Total % Body Weight	3.68	3.67	3.45	3.65	0.04	0.220
Concentrate mixture /Metabolic Body Weight (g/Kg)	31.5^{c}	33.3^{ab}	33.8^{a}	32.5^{bc}	0.26	0.002
Super Napier / Metabolic Body Weight (g/Kg)	47.8	47.8	44.0	46.5	0.78	0.265
Total Metabolic Body /Weight (g/Kg)	79.3	80.8	77.8	79.2	0.73	0.577
Organic Matter (OM)						
Concentrate mixture	281^{c}	321^{ab}	351^{a}	294^{bc}	7.8	0.002
Super Napier	431	468	463	430	7.2	0.100
Total	711b	789^{a}	814^{a}	724^{b}	13.4	0.006
Concentrate mixture % Body Weight	1.30	1.35	1.33	1.32	0.01	0.241
Super Napier% Body Weight	2.02	1.97	1.75	1.95	0.04	0.099
Total % Body Weight	3.32	3.32	3.10	3.32	0.04	0.181
Concentrate mixture /Metabolic Body Weight (g/Kg)	28.00^{c}	29.63^{ab}	30.20^{a}	28.97^{bc}	0.23	0.001
Super Napier / Metabolic /Body Weight (g/Kg)	43.30	43.33	39.92	42.45	0.70	0.278
Total / Metabolic Body Weight (g/Kg)	71.35	72.98	70.07	71.47	0.67	0.523
Live weight gain (kg)						

Initial live weight	11.9	12.5	12.4	12.3	0.46	0.968
Final live weight	21.3^{b}	24.0^{ab}	26.5^{a}	22.0^{b}	0.61	0.005
Gain in weight	9.5^{c}	11.4^{b}	14.1^{a}	9.7^{c}	0.39	<0.001
Average daily gain (g/day)	79^{c}	96^{b}	117^{a}	81^{c}	3.20	<0.001
Apparent Digestibility						
Dry Matter (DM)	63.7^{c}	67.2^{b}	68.9^{a}	63.6^{c}	0.52	<0.001
Organic Matter (OM)	71.7b^{c}	73.1^{ab}	74.4^{a}	70.7^{c}	0.37	<0.001
Crude Protein (CP)	68.9^{ab}	71.2^{a}	72.1^{a}	67.6^{b}	0.64	0.031
Ether Extract (EE)	72.6^{c}	75.7^{bc}	78.7^{ab}	82.7^{a}	1.14	0.005
Neutral Detergent Fibre (NDF)	55.1^{b}	61.7^{a}	61.2^{a}	54.7^{b}	0.74	<0.001
Acid Detergent Fibre (ADF)	41.3^{c}	52.0^{ab}	56.2^{a}	48.4^{b}	1.40	<0.001
$^{a, b, c,}$ Values with different superscripts within the row differ significantly.						

Effect of incorporation of different levels of bypass fat from silkworm pupae on intake, digestibility of nutrients and growth rate in sheep

	G I	G II	G III	G IV	SEM	P-Value
Intake (g/d)						
Dry Matter (DM)						
Concentrate mixture	316^{b}	361^{ab}	398^{a}	334^{b}	9.68	0.008
Super Napier	475^{ab}	521^{a}	517^{a}	435^{b}	10.99	0.007
Total	791^{b}	882^{a}	915^{a}	768^{b}	18.97	0.007
Concentrate mixture % Body Weight	1.45^{b}	1.50^{a}	1.50^{a}	1.50^{a}	0.01	0.010
Super Napier% Body Weight	2.23^{a}	2.15^{ab}	1.98^{b}	1.93^{b}	0.044	0.037
Total % Body Weight	3.68	3.65	3.48	3.45	0.043	0.126
Concentrate mixture /Metabolic Body Weight (g/Kg)	31.55^{c}	33.05^{ab}	34.32^{a}	32.53^{bc}	0.290	0.002
Super Napier / Metabolic Body Weight (g/Kg)	47.78^{a}	47.97^{a}	44.77^{ab}	42.32^{b}	0.814	0.029
Total Metabolic Body /Weight (g/Kg)	79.38^{a}	81.05^{a}	79.07^{a}	74.83^{b}	0.808	0.032
Organic Matter (OM)						
Concentrate mixture	280.10^{b}	315.52^{ab}	346.48^{a}	289.52^{b}	8.329	0.012
Super Napier	430.40^{ab}	472.30^{a}	468.85^{a}	394.17^{b}	9.967	0.007
Total	710.83^{bc}	787.85^{ab}	815.38^{a}	683.68^{c}	16.870	0.007
Concentrate mixture % Body Weight	1.30	1.33	1.30	1.32	0.026	0.970
Super Napier% Body Weight	2.02	1.98	1.78	1.80	0.044	0.114
Total % Body Weight	3.30	3.32	3.10	3.13	0.060	0.488
Concentrate mixture /Metabolic Body Weight (g/Kg)	27.97	29.23	29.87	28.58	0.564	0.691
Super Napier / Metabolic /Body Weight (g/Kg)	43.30	43.77	40.38	38.85	0.815	0.089
Total / Metabolic Body Weight (g/Kg)	71.32	73.00	70.27	67.42	1.185	0.424
Live weight gain (kg)						

Initial live weight	11.9	12.3	12.0	12.5	0.50	0.973
Final live weight	21.3^{b}	24.2^{ab}	26.2^{a}	22.3^{b}	0.63	0.019
Gain in weight	9.5^{d}	11.9^{b}	14.2^{a}	9.8^{c}	0.40	<0.001
Average daily gain (g/day)	79^{d}	99b	119^{a}	81^{c}	3.34	<0.001
Apparent Digestibility						
Dry Matter (DM)	63.7^{ab}	64.2^{a}	64.4^{a}	62.4^{b}	0.25	0.014
Organic Matter (OM)	70.1^{a}	69.2^{a}	69.2^{a}	68.4^{b}	0.28	0.017
Crude Protein (CP)	68.9^{a}	65.1^{ab}	66.1^{ab}	64.2^{b}	0.77	0.0153
Ether Extract (EE)	72.6^{b}	86.0^{a}	87.5^{a}	85.8^{a}	1.35	<0.001
Neutral Detergent Fibre (NDF)	55.1^{a}	54.0^{a}	53.1^{a}	48.8^{b}	0.69	0.002
Acid Detergent Fibre (ADF)	41.3^{b}	48.8^{a}	49.4^{a}	37.4^{b}	1.52	0.003
$^{a, b, c,}$ Values with different superscripts within the row differ significantly						

On-going Project:

AIP-01006SI: Identification of probiotic consortium to improve the productivity in mulberry silkworm*, Bombyx mori* (Oct. 2019 - Sep. 2021)

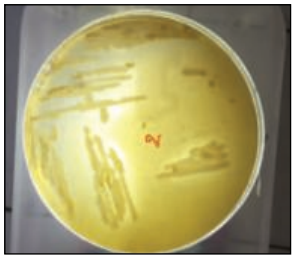
Y. Thirupathaiah, E. Bhuvaneshwari and Pankaj Tewary

Objective:

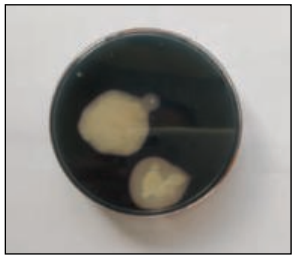
1. To characterize the probiotic properties of microbial cultures isolated from silkworm midgut.
2. To identify probiotic consortium to improve silk productivity.

Mulberry leaf and pupae protein based media

Mulberry leaf based media



Protease positive isolates



Amylase positive isolates

A novel microbial medium was formulated with different combinations of mulberry leaf powder, silkworm pupae powder along with organic and inorganic ingredients and evaluated for the screening of bacteria from silkworm midgut content. After incubation for 48 hours at 28˚C, maximum number of colonies (2.5×10^{4} CFUs/g) were obtained in one of the formulated media containing both mulberry leaf powder and silkworm pupae powder. Whereas, media with mulberry leaf powder alone as sole carbon and nitrogen source, the number of colonies obtained were 1.2×10^{3} CFUs/g. The colony size was also large in media containing both mulberry leaf powder and pupae powder as carbon and nitrogen source when compared with mulberry leaf powder alone. The selected bacterial colonies were further screened for the production of extracellular enzymes on respective selective agar media. The positive isolates are being evaluated for optimum production of enzymes at different environmental conditions.

Validation study/Other programme:

Evaluation of chawki feed supplement formulations in Technology Validation and Demonstration centre of (TVDC) of CSRTI-Mysore (Jun. 2019 - Jul. 2019)

Objective: To validate Chawki feed supplement formulation in TVDC

E. Bhuvaneswari and Y. Thirupathaiah

In house evaluation of Chawki Feed Supplement Formulation (CFSF) was carried out in the TVDC of CSRTI, Mysuru under conditions resembling farmer's conditions to find out the effect of CFSF on the chawki, late age silkworms as well as on the cocoon productivity. CFSF has been developed under the project AIP 3594 - Feed supplementation studies for improving young age silkworm rearing in chawki rearing centres. CFSF is nutrient supplement for chawki worms which contains vitamin, minerals, antimicrobial substances, immune enhancers, modulators, growth promoters and feed attractants. The supplement was given to I instar chawki worms first three days @ 10 ml for 100 dfls one feed per day through mulberry leaves. During second moult the chawki certification was carried out and continued shoot rearing in TVDC and evaluation was carried out for 100 dfls of bivoltine double hybrid FC1xFC2 silkworms in one crop during June-July 2019 with three replication.

Rearing performance: Chawki rearing carried out to compare the CFSF treated with control and the results showed that, supplementation reduced 59.62% of missing larval percentage, 37.50% of under sized larval percentage and improved the growth of chawki worms by 1.79% over the control group. The microscopic examination was carried out for the weak larvae in both batches and was found to be disease free. Similarly, the late age rearing and cocoon parameters *i.e.* the average single cocoon weight was 1.67g in treatment and 1.60g in control. The average shell weight was 0.37g with a shell ratio of 22.3% in treatment batch and 0.35g, 21.55% in control and the average cocoon yield was 59.06 kg under treatment and 52.0 kg in control for 100 dfls and the results obtained were statistically significant.

Validation outcome of chawki feed supplement formulations										
Parameters	Chawki Performance				Late age/ Cocoon parameters					
	Hatching (%)	Missing Larvae (%)	Under sized larvae (%)	Growth (wt./100L) (g)	Larval Wt. (g)	SC Wt. (g)	SS Wt. (g)	SR (%)	Pup. (%)	Yield (Kg)
Control	92.00	6.478 ± 0.678	5.333 ± 0.577	3.745 ± 0.091	43.11 ± 1.417	1.602 ± 0.020	0.345 ±0.016	21.55 ±0.537	93.00 ±0.557	52.00
CFSF Treated	92.05 NS	2.616 ± 1.174 (59.617) *	2.763 ± 0.577 (37.502) *	3.812 ± 0.027 (1.789) NS	45.89 ±0.520 (6.442) *	1.665 ±0.029 (3.730) *	0.371 ± 0.006 (7.536) *	22.30 ± 0.488 (3.480) *	94.00 ±1.000 (0.355) NS	59.06 (15.38)
Each value is the mean ± SD of three separate observations, percent change over control values in parentheses, *Significant at 0.05% level; NS- Non Significant										

REARING TECHNOLOGY & INNOVATION

Concluded Project:

AIB-3561: Identification of robust bivoltine silkworm hybrids suitable for different regions of high temperature and high humidity conditions (Mar. 2016 - Mar. 2018)

S. Purushotham, D. S. Somaprakash, N. Mal Reddy (upto May 2017), Vineet Kumar, Kariyappa and T. V. S. Rao.

Objectives:

- To evaluate silkworm breeds/hybrids under high temperature and high humidity.
- To determine factors influencing the post cocoon parameters under high temperature and high humidity.

In the project 18 bivoltine parental breeds were considered for the preparation of double hybrids and prepared 82 double hybrids with all possible combinations. All the hybrids were subjected to prevailing high temperature and high humidity conditions at farmers level in Tamilnadu and Andhra Pradesh out of which 4 double hybrid combinations (S8xD2)x(CSR4xSK6), (CSR2xCSR27)x(CSR6xSK6), and (CSR52x Gen1)x(CSR16xSK6) were found tolerant to high temperature and high humidity based on the rearing and reeling performance.

Performance of Double hybrids -Top 10 hybrids

Hybrid	Pup %	Coc wt (g)	Shell wt(g)	Shell %	Reel %	AFL (mts)	NBFL (mts)	De-nier	Raw silk %	Raw silk Rec%	Neat-ness (p)	EI value
DH07	63.7	1.36	0.27	19.85	82.1	749.61	615.46	2.43	14.89	74.98	94	50.16
DH10	57.1	1.3	0.28	21.54	74.3	810.33	602.06	2.46	16.84	78.19	97	53.73
DH37	57.1	1.3	0.26	20	77.63	810.46	629.18	2.41	16.61	83.03	98	53.10
DH45	63.7	1.36	0.28	20.59	74.82	832.48	622.85	2.37	15.84	76.96	98	55.42
DH31	51.6	1.25	0.28	22.4	77.9	742.91	578.71	2.54	16.62	74.17	97	51.47
DH38	50.5	1.24	0.25	20.16	80.92	739.28	598.2	2.48	16.26	80.66	98	48.9
DH68	64.8	1.37	0.27	19.71	72.33	620.76	448.98	2.7	13.48	68.42	98	44.6
DH46	59.3	1.32	0.26	19.7	75.74	773.34	585.7	2.46	15.88	80.63	98	50.9
DH06	46.1	1.2	0.28	23.33	67.51	651.02	439.48	2.5	14.55	65.38	98	42.2
FC1 x FC2	52.5	1.34	0.28	20.9	76.2	804.53	610	2.45	15.56	62.54	96	49.4
Mean	56.6	1.304	0.271	20.81	75.94	753.47	573.06	2.48	15.65	74.49	97.2	
SD	6.36	0.057	0.011	1.243	4.184	70.048	69.677	0.090	1.066	6.923	1.31	

Based on overall performance of double hybrid reared at different places, four best performed hybrids viz., DH10 [(S8xD2) x (CSR4xSK6)], DH37 [CSR2x27) x (CSR6xSK6)], DH45 [(CSR52 x GEN1) x (CSR6 x SK6)], DH46 [(S8 x D2) x (CSR6 x SK6)] are recommended for further evaluation. These hybrids can be

recommended for high temperature and high humidity zones of south India. However, it needs to be tested under limited scale at farmer's level.

Continuous/Other activities:

Large scale evaluation of new silkworm breeds/hybrids

S. Purushotham

Objective: To multiply new breeds/hybrids for production of hybrid dfls.

Conducted rearing of bivoltine/mulitvolitne Pure races of S8 and MV1 and the seed cocoons generated were utilized for further multiplication.

TECHNOLOGY VALIDATION & DEMONSTRATION CENTRE

N. Balachandran (upto Apr. 19), M. G. Sabita (Jun. 19 - Dec. 19), P. C. Santa (Jul. 19 - Jan. 2020) and R. Bhagya (From Jan. 2020 onwards)

Technology Validation and Demonstration Centre (TVDC) conducts large scale in-house evaluation of promising silkworm breeds and hybrids and validates them before recommending for further field testing and adoption. This exercise ensures a proper feed-back from the independent evaluation under simulated conditions resembling farmers' conditions and facilities to breeders enabling them to make corrections and modification required. During the reporting period the centre carried out the project mentioned below.

Multiplication of MVI & S8 Seed : Under the large scale in house evaluation and multiplication of MV1 and S8 breed under the project, four trials of silkworm rearing crops with MV1 & S8 breeds with a total quantity of 595 dfls were conducted during the period under report. Generated a total of 263kg. (Nos.1, 73,099) of cocoons. Evaluated the rearing performance of S8 & MV1. Results indicated an Av. ERR by No. 8125, Av. ERR by wt. 12.70 kg., Av. SCW 1.740g., Av. SSW 0.380g. & Av. SR% 21.82 for S8 and an Av. ERR by No. 8507, Av. ERR by wt. 12.57 kg., Av. SCW 1.560g., Av. SSW 0.274g. & Av. SR% 17.04 % for MV1. The silkworm rearing performance of MV1 and S8 were conforming to their original breed characteristics.

Production Details of Seed Cocoons: Total quantity of 263 kg. (Nos. 1, 73,099) cocoons were supplied to SSPC, NSSO, Ramanagaram. The target assigned for the period has been achieved.

Crop No	Race	No. of Dfls	Fec	Brushed on	Actual yield		ERR/10,000 larvae		SCW (g.)	SSW (g.)	SR%	Coc/ kg	Yield/ 100 Dfls (kg.)
					by No.	by wt.(kg)	by No.	by wt.(kg)					
1	S8 MV1	70 100	436 412	3.5.19 5.5.19	18,906 22,750	30.0 35.0	7608 7712	12.1 11.9	1.77 1.56	0.380 0.260	21.53 15.93	630 650	42.9 35.0
2	S8 MV1	50 100	405 402	22.7.19 26.7.19	16,536 29,240	26.0 43.0	8987 8033	14.1 11.8	1.75 1.61	0.401 0.277	22.91 17.21	636 680	52.0 43.0
3	S8 MV1	75 100	405 401	5.10.19 9.10.19	20.262 28,935	33.0 45.0	8338 8510	13.6 13.2	1.90 1.64	0.426 0.301	22.42 18.35	614 643	44.0 45.0
4	S8 MV1	40 60	462 485	13.2.20 16.2.20	13110 23360	19.0 32.0	7567 9775	11.0 13.4	1.54 1.54	0.315 0.257	20.45 16.68	690 730	47.5 53.3
Tot/ Avg		595			1,73,099	263							

Race	Supply	Cocoons		Invoice No. & Date
		By No.	By Wt. (kg.)	
S8 MV1	SSPC, NSSO, CSB, Ramanagaram	10,710 22,750	17.0 35.0	010 Dt. 31.5.19
S8 MV1	SSPC, NSSO, CSB, Ramanagaram	12,720 21,080	20.0 31.0	011 Dt. 26.8.19
S8 MV1	SSPC, NSSO, CSB, Ramanagaram	13,440 30,874	21.0 43.0	012 Dt. 6.11.2019
S8 MV1	SSPC, NSSO, CSB,Ramanagaram	13110 23360	19.0 32.0	013 Dt. 16.3.2020
Total			263	

- 525 Students/farmers visited TVDC rearing house and demonstrated automated disinfection unit and the shoot rearing technologies.

PEST MANAGEMENT LABORATORY

Ongoing Projects:

PRE 01005-CN: Demonstration and popularization of pheromone trap against silkworm uzi fly, *Exorista bombycis* (Dec. 2018-Nov. 2020)

J. B. Narendra Kumar (upto Jul. 2019); S. Mahiba Helen (From Jul. 2019). N. Bakthavatsalam; Noble Morrison, REC-Madivala; N. Dhahira Beevi, RSRS-Salem; B. Vijay Naidu, RSRS- Anantapur.

Objectives:

- To know the efficacy of pheromone based trap against uzi flies
- Patenting and commercialization of the pheromone based trap for the uzi fly

A field trial was conducted with two pheromone compounds and control (only traps) during Sep. 2019 in Kolar area. The results indicated good catches of uzifly with the uzifly pheromone trap 59.16 and 56.8 % respectively, compared to trap alone (26.0%). Since both the treatments are on par, it was decided to go with only one treatment in order to economize the technology. The results were encouraging with good catches of uziflies and also with the reduction in uzi fly incidence.

A field day was organized to popularize the technology on 26-10-2019 at kolar and 30 farmers attended demonstration plots were laid out with 100 farmers near Siddlaghatta and 30 farmers near Kolar.

Demonstration trials are under progress at Rasipuram, Namakkal District - 20 farmers, REC, Udumalpet -15 farmers, Kangayam – 2 farmers, REC –Krishnagiri- 20 farmers, Salem and Vennanthur area -12 farmers. Control was kept as sticky trap, uzi tablet and mulberry stick with bark removed and coated with gum.

Preliminary observation showed that more number of flies (maximum 22/day was trapped in two rearings in 4^{th} and 5^{th} age. REC-Krishnagiri conducted one awareness programme at Government Cocoon market, Hosur on 12-03-2020.

Demonstration trials have also been initiated at Hassan with 20 farmers. Pheromone traps have been installed on 17-03-2020 to 10 farmers at Khatharighatta Village, Channarayapatna Taluk, Hassan District and another 10 farmers traps have been installed on 21-03-2020 at Hassan.

PRE 01010-SI: "Development of Integrated Pest Management (IPM) module for leaf roller *Diaphania pulverulentalis* (Lepidoptera: Pyralidae) in mulberry" (Mar. 2020 - Feb. 2022)

S. Mahiba Helen, A. V. Mary Josepha Shery

Objectives:

- Evaluation of *Diaphania pulverulentalis* Nucleopolyhedrovirus (*Dp*NPV) for the management of Leaf roller in mulberry.
- Evaluation of egg, Larval and pupal parasitoids for the management of 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 leaf bouquets. Screening of newer insecticides and botanicals against leaf roller is under progress.

Continuous / Other activities:

Maintenance of mother culture for production of recommended bio-control agents and mass release of recommended bio-control agents of sericultural pests in CSRTI campus and farmers field.

S. Mahiba Helen (From Jul. 2019), J.B. Narendra Kumar (upto 16-07-2019), K.C. Mahalingappa (upto June 2019).

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

Nucleus cultures of three pupal parasitoids of uzi fly *viz., Nesolynx thymus*, *Trichomalopsis uziae*, and *Tetrastichus howardii*; and two predators of mealy bug (*Cryptolemous montrouzieri* & *Scymnus coccivora*) and host culture of Housefly and pink mealy bug were maintained throughout the year.

Initiated mass production of *Corcyra cephalonica* host culture for the production of egg parasitoid (*Trichogramma chilonis*) and larval parasitoid (*Bracon brevicornis*) for the management of leaf roller in mulberry. Supplied 216 units of *T. chilonis* and 209 units of *B. brevicornis* (one unit = 250 adults/pupae) to farmers of Karnataka, Tamil Nadu and Andhra Pradesh.

Initiated mass production of predators, *Chrysoperla zastrowi sillemi* and *Blaptostethus pallescens* for the management of thrips in mulberry. Supplied 19 units (19000 numbers) (1 unit = 1000 nymphs/adults) of *B. pallescens* to Karnataka and Tamil Nadu farmers. Following the introduction of predator, thrips incidence reduced from 34% to below 8%. 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.

Production of bio-control agents at CSRTI-Mysuru		
Biological control agents	Quantity Produced	Quantity sold
Nesolynx thymus (No. of pouches; 1 pouch=50 ml or 10,000 parasitoids)	6514	6261
Beetles: *Scymnus coccivora* (No. of boxes; 1 box=250 adults) *Cryptolaenus montrouzieri* (No. of boxes; 1 box= 125 adults)	60	47
Trichogramma chilonis (1 unit= 1 cc/1 card)	230	216
Bracon brevicornis (1 unit= 250 Nos.)	224	209
Blaptostethus pallescens (I unit= 1000 grubs/adults)	26	19

SILKWORM PATHOLOGY

Silkworm Disease Monitoring in South Indian States: Continuous programme

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 to prevent disease outbreak

Disease incidence was monitored in the 18 selected BSFs of Karnataka, Tamil Nadu and Andhra Pradesh and 26 mega clusters and 05 non-captive CPP clusters of Karnataka, Tamil Nadu, Andhra Pradesh, Telangana, Kerala, Madhya Pradesh and Maharashtra from Apr. 2019 - Mar. 2020. In the BSFs all the batches and in clusters 25 farmers' crops were monitored in every month. The survey data was uploaded in the website "Seri DM" created for Silkworm Disease Monitoring.

The average point prevalence of grasserie was 0.4%, flacherie 1.37% and muscardine 0.27% during the survey period.

In BSFs of Karnataka the grasserie incidence recorded up to 50.0% (average 2.2%), flacherie incidence noticed up to 10 % (average 0.32%) and muscardine incidence noticed up to 0.15% (average 0.04%). In Tamil Nadu BSFs the point prevalence of flacherie disease recorded up to 2.0% with an average incidence of 0.75% and muscardine up to 4.0 % with an average incidence of 0.5%. Pebrine incidence was not reported in any of the BSFs during the survey.

Following are the disease incidence in the clusters covered from Karnataka, Tamil Nadu and Maharashtra.

In Karnataka clusters point prevalence of grasserie was noticed up to 2.0% with an average of 0.2% and flacherie noticed up to 6.0% with an average of 1.3%. In Tamil Nadu clusters the point prevalence of grasserie was noticed up to 8.0% with an average of 0.24 % and flacherie was noticed up to 3.0% with an average of 0.71%. In Maharashtra clusters the point prevalence of flacherie was noticed up to 8.0% with an average of 1.0%.

The disease incidence data collected after the cocoon harvesting from the farmers in Karnataka was 5.0% grasserie and 10.0% flacherie with an average of 0.5% and 2.1% respectively. In Tamil Nadu grasserie incidence went up to 10% with an average incidence of 0.75% and flacherie incidences went upto 3.0% with an average of 0.5%. Whereas in Maharashtra a maximum of 10.0% flacherie with an average incidence of 1.3% was reported.

ARP-01012SI: Development of a knowledge base on the silkworm diseases and pests and their management :

A.V. Mary Josepha Shery, G. Mallikarjuna, Amit Saha, Guneswar Kumar Churendra, J. Justin Kumar, Mahiba Helen.

Duration : 2 years (Mar. 2020-Feb. 2022)

Objectives:

To develop a knowledge base on silkworm diseases and pests

To develop a web based silkworm disease and pests diagnosis system and calendar for the silkworm disease and pest occurrence in south India.

To develop a model for forewarning and forecasting of silkworm diseases and to issue the forewarning regularly.

To develop a virtual interaction platform for the sericulturists and scientists on the silkworm diseases and pests and management of silkworm diseases and pests.

As part of the data collection for the proposed knowledge base, papers published in national and international journals on the topic, Silkworm diseases and its management were collected and scanned them to upload

in the website. Collected the details about the projects on silkworm diseases and its management conducted by Institutes under Central Silk Board. The processing of the data on the disease incidence obtained from the project ARP:3519. "Silkworm disease monitoring of seed and commercial crop rearing of south Indian states" also initiated.

OTHER WORKS

1. Validation of M-LAMP assay:

To validate the technology of M-LAMP assay, a total of 529 samples of both mulberry and non-mulberry silkworm egg shells and moths samples collected from different seed multiplication levels viz., SSBS-Coonoor, P4 BSF Hassan, P3 BSF Mysuru and CTR&TI Ranchi were tested and the results were found to be confirmative to the microscopical examination.

As per the decision taken in the 19th Pebrine monitoring meeting, to validate the M-LAMP assay for tasar silkworms, two lots of tasar moths one each from BSMTC-Bilaspur and BSMTC-Pali were tested using M-LAMP assay and got positive results. The results were confirmative with the microscopic testing. Amplified the DNA of the spores obtained from the tasar moth, *Antheraea mylitta* received from CTR&TI, Ranchi using the primers, F3 and B3, used in M-LAMP assay. The sequence of the small subunit ribosomal RNA gene partial sequence obtained form it showed 93.43% similarity to that of *Nosema sp.* of *Bombyx mori*. Two sequences were submitted to NCBI and obtained accession numbers MN 416240 and MN416241.

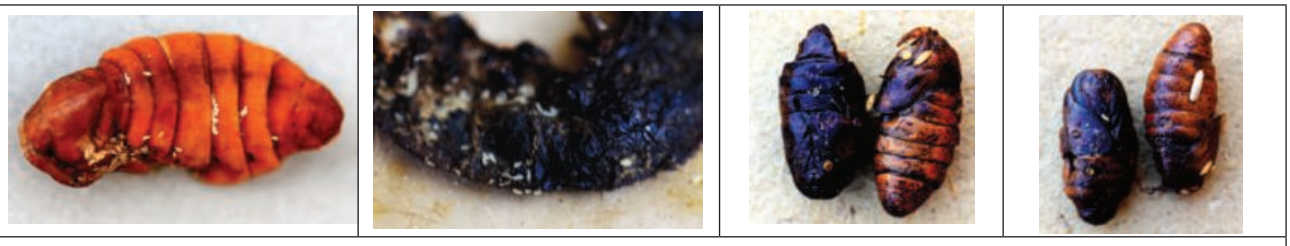
II. Residual analysis of the Vijetha dusted cocoon samples

Both multivoltine and bivoltine races were reared using Vijetha as the bed disinfectant to check the presence of paraformaldehyde residue in the Vijetha dusted cocoons. The rearing was conducted by following both rack rearing and tray rearing methods to check the difference if any, in these samples. Dusting of Vijetha was done as per the recommended schedule. The test results showed that there is no residue of the paraformaldehyde in the Vijetha dusted cocoon samples .

III. Studies on the life cycle and infestation of *Megaselia scalaris* on silkworm

Small *Drosophila* like flies was observed in the grainages whenever pupae kept for emergence during the rainy season. The flies were cultured in Silkworm Pathology Laboratory to study the life cycle and the mode of infection on silkworm pupae from October to December 2019. The flies exhibited remarkable reduction in size in the aged cultures after one generation. Both big and small sized flies were identified as, *Megaselia scalaris.* The common name of the flies are "humpbacked fly" as it is having an enlarged thorax that gives them a characteristic humpbacked appearance. They are also called as "coffin fly" as they were being found even in coffins buried six feet deep and "scuttle fly" because of the jerky, short bursts of running characteristics of the adult fly.

The flies were cultured on live silkworm, pre pupae, fresh pupae and 4 & 5 day old pupae. They do not prefer live larvae for colonising. Prepupal stage is the most preferred. Feeding on silkworm by the adult flies was never observed. The flies puncturing the pupae with the ovipositor was observed. The piercing of the pupae and prepupae make the entry of the hatched larvae into the host easier. The larvae enter through the forewing portion of the pupa which is the most vulnerable area of the pupa. The hatched larva penetrates the host and completes its larval period inside the pupa and maggots come out to pupate. When the infested pupae were kept near the healthy ones the larvae migrated to the healthy ones and infected them. The silkworm pupae failed to emerge when heavily infested. Even if it emerges the moths were weak. Only 32% emergence was observed in the infested batch. On silkworm pupae the flies had a life cycle of 14-18 days. The elongated eggs laid on the surface of the pupae hatched in 16-28 hrs and the larval duration was 5-6 days. The moth emerge after 8-10 days of pupation. The adult flies survived on 10% honey diet for 30-40 days.



Just hatched larva pupa and maggots on the silkworm pupae

Pupae of *Megaselia scalaris* placed along with a rice grain

Adult fly piercing live pupa

Adult fly: *Megaselia scalaris*

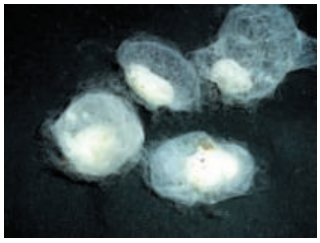
Different life stages of *Megaselia scalaris* on silkworm, *Bombyx mori* L

IV. Pathogenicity study of the entomopathogenic fungus *Isaria javanica* on silkworm, *Bombyx mori* L

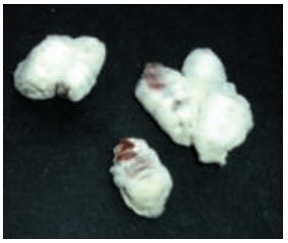
Fungus infection with white coloured fungi turning light grey after one week was observed in silkworm *Bombyx mori* L. larvae and pupae in the silkworm rearing batches of CSRTI-Mysuru. The silkworm expressed irregular moulting and stunted growth when inoculated with 2x 10^6 conidia/ml. The expression of the disease was more in the late instar after 10 DPI. Pupal mortality is a characteristic feature of this fungi. The infection leads to the development of flimsy cocoons and mummified pupae. Black spots of 1mm radius develops on the late instar larvae one day before the death. Mummified larvae and cocoons developed mycelial mat on the third day and sporulation occurred on the fifth day. The white coloured colony in PDA changed to greyish colour in the top after conidification. The colony was irregular 3.3- 8.0 cm in diameter on the 5th day with white colour and puffy cottony growth. Backside of the colony was light yellow in colour and developed concavity in old cultures. The spores were grey in colour.

The fungus has conidial chains formed from club shaped verticillate phialides on conidiophores. The conidia were fusiform-elliptical with a size of 3.90±0.53 X 1.05±0.01 µm. Chalydospores and synnemata not found. From the colony characters and morphological characters the isolate is identified as *Isaria javanica* (anamorphic *Cordycipitaceae*). The LD50 of the isolated strain is calculated as 3x10^5conidia/ml when inoculated after 2nd moult before feeding. The internal transcribed spacer (ITS) regions ITS1 and ITS2 (ITS1-5.8S-ITS2) sequences were used for molecular characterization of the fungus. The phylogenetic analyses showed maximum similarity to *Isaria javanica*. The GenBank accession numbers of the isolate is MH712278. This is the first report of *Isaria javanica* on silkworm *B. mori* L. from Karnataka. The isolate forms a clade with *Cordyceps fumosorosea* and *Cordyceps javanica.* When the isolate was compared with the isolates from silkworm *B. mori* L. it formed a clade with two samples of *Isaria farinosa* isolates from silkworm.

Dark spot is the point of entry of the pathogen



Infected pupae

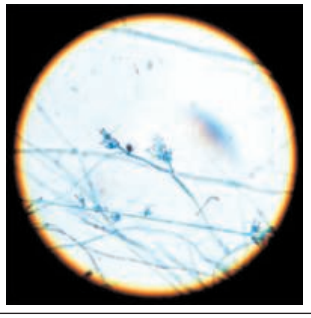


Mummified pupae 3rd day after death

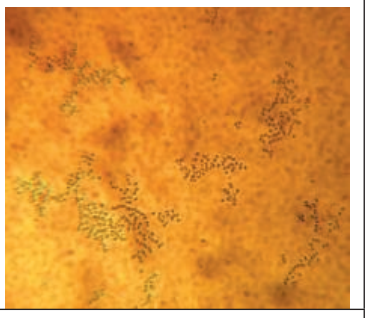
Larvae with grey coloured conidia 7th day after death

Culture on PDA front view

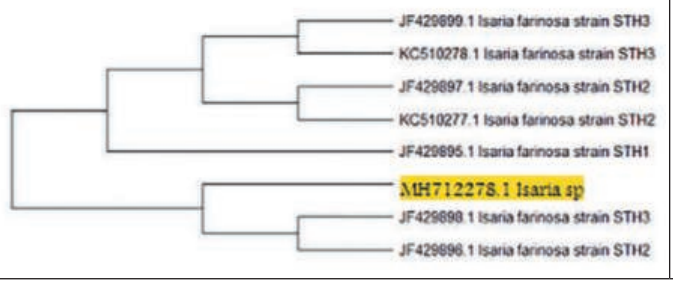
Culture on PDA back view

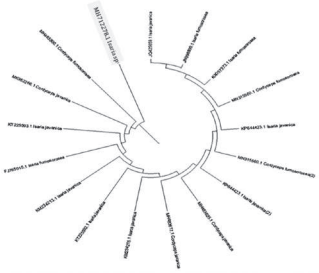


Mycelia with conidiophores



Conidia





Phylogenetic tree constructed with sequences of the ITS1-5.8S-ITS2 of rDNA region of entomopathogenic fungus *Isaria javanica* isolated from silkworm *B. mori* L. and sequences of *Isaria* species from GenBank (indicated by database code), using the neighbor-joining method and using p-distance for nucleotides, with the pairwise gap deletion option.

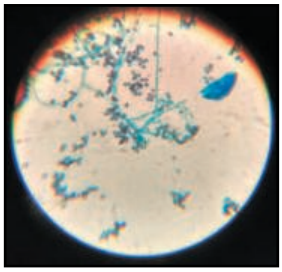
V. Molecular characterization of *Beauveria bassiana* isolated from silkworm *Bombyx mori*

Beauveria bassiana isolated from silkworm *Bombyx mori* L from the silkworm rearings of CSRTI, Mysuru was characterized using ITS-1 and ITS-4 primers as forward and backward primers. Amplified the ITS1-5.8S-ITS4 of rDNA region of the fungi and obtained accession number MT355427 from NCBI. It has shown 97.1% similarity to the type culture of *Beauveria bassiana* ARSEF 1564 from Italy.

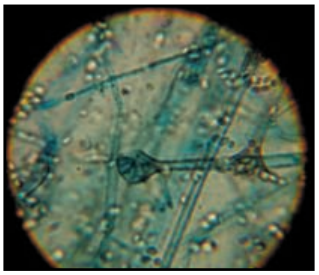
VI. First Report of *Mucor irregularis* infecting silkworm *B. mori* L. (Preliminary Study)

Mixed infection of fungus on silkworm followed by bacterial infection was observed in silkworms from field and also in the rearing conducted at CSRTI, Mysuru. Studied etiology of the disease and identified *Mucor irregularis* as one of the pathogenic fungi in all infected samples, an emerging fungal pathogen in silkworms. The mode of infection and pathogenicity studied in detail and the molecular characterization of the pathogen also has been carried out. Sequences of two isolates were submitted to NCBI and got the accession numbers MT355428.1 and MT355426.1. This is the first report of *Mucor irregularis* infection on silkworm.

Samples collected from Mandya showing the typical symptoms



Azygospores of the fungus (stained with lactophenol cotton blue 600X)



Columella and sporangiospores (stained with lactophenol cotton blue 1000X)

Mucor irregularis infected silkworm larvae and different stages of the pathogen

Continuous / Other activites:

a. Challenging of the breeding batches with pathogens

Challenging of the experimental rearings of bivoltine and multivoltine breeding laboratories with $2x10^6$ BmNPV polyhedra was done as and when required.

b. Maintenance of the pathogens: Maintained BmDNV, BmIFV and BmNPV virus stocks, pathogenic bacteria *viz., Staphylococcus aureus, Streptococcus faecalis, Bacillus thuringiensis and Serratia marcescens* and fungal pathogens *Beauveria bassianana* and different strains of microsporidia. Sub culturing of the bacteria and fungal pathogens and re inoculation of the viruses and microsporidia were done periodically. Virulence of all the pathogens tested periodically as per the procedure.

C. Field problems resolved: Resolved 36 field problems related to silkworm diseases and gave guidance for the farmers for proper disease management. Follow up action also done by contacting the farmers. Visited the farmer's field in two cases

d. Sensitization of stakeholders: 50 farmers

e. Pebrine monitoring: Conducted the 19th Pebrine monitoring meeting at SSBS, Coonoor on 25. 06. 2019 including all the team leaders and representatives of Commissioners of sericulture from Karnataka, Andhra Pradesh and Tamil Nadu.

Pebrine monitoring at Bivoltine and multivoltine breeding laboratories, P4 BSF Hassan, P3 BSF Mysuru , SSPC K.R. Nagar and P2 farm Ambuga (DoS) conducted by the scientists of silkworm Pathology.

Quality analysis: Issued 27 quality analysis reports for the different disinfectants and bed disinfectants developed by the section.

POST COCOON EVALUATION UNIT

Shivakumar M Hukkeri and M. N. Chandrashekar

Post Cocoon Evaluation Unit is working in collaboration in many research projects, Assessment of the cocoons through reeling performance, human resource development in post cocoon activities, demonstration of technologies, creation of awareness of technology, information of economics for start ups in post cocoon technologies to the visitors, trainees, are the Main activities carried out . The section has educated national and international sponsored trainees by demonstration of technologies, international grade silk. The section has worked as main link between CSRTI field units and the CSRTI breeders by reeling the cocoons produced in the field under different projects. Total of 1,916 cocoon lots, were received 501 lots from RSRS-Salem, RSRS-Kodathi, RSRS-Anantapur, REC-Rayachoty , REC-Madivala, REC-Udumalpet, P4-Hassan and SSBS-Coonoor and 1,415 lots tested, from Bivoltine Breeding Laboratory, Multivoltine Breeding Laboratory, Silkworm Physiology, Silkworm Genetics and Agronomy Division. Mono cocoon assessment was also carried out.

SERICULTURE ENGINEERING DIVISION

Preliminary study on Rearing Bed Cleaning

The farmers after completion of the harvesting, generally call workers for removal of the waste residue left in the rearing bed. As the residual bed is very thick the removal of it from the rearing house is cumbersome. Considering the above facts an attempt was made. To slove the problem, before commencement of the rearing, plastic straps were put and after the completion of the rearing, the bundles were made using strap packing tool. Then the compressed bed was cut into bundles of required size using electric saw. The bundles were removed very easily from the house.

The collected shoots were spread on the floor and the tractor with attachment were run over the material and hardly in five minutes the crushing was completed. With the crushed powder bale of 50 kg/ cake of 5kgs were prepared. The bale and cake are of very compact size and can be stored in small place and transported very easily in bulk quantity.

Crushing of mulberry shoots | Making the crushed material into 50 Kg Bale | Making of 5kg Cake using the mulberry crushed material

Demonstration of activities to visitors:

During the year under report, 5282 farmers, students, academicians, research scholars, DOS officers/officials and VIP's visited the section. They were educated with aid of AV tools and practical/live demonstration of the various technologies.

SERICULTURAL EXTENSION, ECONOMICS and MANAGEMENT DIVISION

N. G. Selvaraju, Anuradha H Jingade, Ravindra M Mattigatti, Joycy Rani Dasari, Amit Saha and G.S.Geetha

Cluster Promotion Programme (CPP): Cluster Promotion Programme (CPP) - XII plan (2012-2017), which was implemented by Central Silk Board in collaboration with the Department of Sericulture (DoS) of southern states, was extended for another three years and continued in 2019-20. The CPP clusters in the southern zone were monitored by CSRTI-Mysuru. Southern zone includes 26 Mega clusters (Karnataka - 11, Andhra Pradesh - 5, Telangana - 2, Tamil Nadu - 6 and Maharashtra - 2) and non-captive areas. Targets of the clusters for 2019-20 were fixed based on the farmers profile and potentiality. The Director, CSRTI-Mysuru is the South zone coordinator; the Heads of SEEM division and state wise RSRSs were the Nodal Officers for effective implementation of CPP. Each cluster is directly monitored by two Cluster Development Facilitators (CDFs) nominated by Central Silk Board and state department of Sericulture. The name and designation of the CDFs are provided below:

Cluster Development Facilitators (CDFs)

Karnataka		
Clusters	**CSB**	**DOS**
Mega cluster: Bengaluru Rural		
Andaralahalli	Shri. Iswar, Sci-D, RSRS-Kodathi (upto July 2019) Dr. M. Venkatachalapathy, Sci-D, RSRS-Kodathi	Shri. Sundar Raj, ADS, Chikkaballapura
Channarayapatna	Smt. P. Saraswathi, Sci-D, RSRS-Kodathi (upto July 2019) Dr. M. Venkatachalapathy, Sci-D, RSRS-Kodathi	Smt. Gayathri, ADS, Beerasandra
Gowribidanur	Dr. M. Venkatachalapathy, Sci-D, RSRS-Kodathi	Shri Muralidhar, ADS, Gowribidanur
Harohalli (B)	Dr. M. Venkatachalapathy, Sci-D, RSRS-Kodathi	Shri.M. Ramakrishna Reddy, ADS, Hosakote
Tubagere	Dr. M. Venkatachalapathy, Sci-D, RSRS-Kodathi	Shri. Udaya, ADS, Doddaballapura
Mega cluster: Tumkur		
Tumkur	Shri. S.K. Hanumantharayappa, Sci-D, RSRS-Kodathi	Shri D. Mohan, ADS, Sira
Tumkur	Shri. S.K. Hanumantharayappa, Sci-D, RSRS-Kodathi	Shri. S.K. Hanumantharayappa, Sci-D, RSRS-Kodathi
Tumkur	Shri. S.K. Hanumantharayappa, Sci-D, RSRS-Kodathi	Shri. R. Ranganath, ADS, Pavagada
Mega cluster: Ramanagara		
Bannikuppe	Smt. P. Saraswathi, Scientist-D, RSRS-Kodathi	Shri. Kumarasubramanya, ADS, DOS, Ramanagara
Doddalahalli	Shri. D.Guruswamy, Sci-C, REC-Maddur (upto Dec. 2019)	Shri. Muthuraj, ADS, DOS, Kanakapura
Harohalli (KKP)	Shri. D.Guruswamy, Sci-C, REC-Maddur(upto Dec. 2019) Smt. P. Saraswathi, Sci-D, RSRS-Kodathi	Shri. Muthuraj, ADS, DOS, Kanakapura
Kanakapura	Shri.D. Guruswamy, Sci-C, REC-Maddur (upto Dec. 2019) Smt. P. Saraswathi, Sci-D, RSRS-Kodathi	Shri. Muthuraj, ADS, DOS, Kanakapura
Mega cluster: Kolar		
Ithandahalli	Dr. M. Noble Morrison, Sci-D, REC-Madivala	Sri.S.N.Sreenivas, ADS, Bangarpet
Kurudumalai	Dr. M. Noble Morrison, Sci-D, REC-Madivala	Shri. M. Venketesh, ADS, DOS, Mulabagal
Shapur (Kolar)	Dr. M. Noble Morrison, Sci-D, REC-Madivala	Shri. Manjunatha, ADS, DOS, Kolar,

Clusters	CSB	DOS
Siddlaghatta	Dr. M. Reddy, Sci-C, SSPC-Vijayapura (upto May 2019) Dr. M. Noble Morrison, Sci-D, REC-Madivala	Shri Bojanna, ADS (upto December 2019) Shri H. Ramakrishnappa, ADS, Sidlaghatta
Tekal	Dr. J. Ravikumar, Sci.-D, SSPC-Chintamani (upto May 2019) Dr. M. Noble Morrison, Sci-D, REC-Madivala	Shri K.M.Ashwathnarayana, ADS, DOS, Malur
Yeldur	Dr. J. Ravikumar, Sci.-D, SSPC-Chintamani (upto May 2019) Dr. M. Noble Morrison, Sci-D, REC-Madivala	Shri. Nagaraj, ADS, DOS, Srinivasapur
Mega cluster: Chitradurga		
Challakere	Dr. Y. Srinivasulu, Sci-D, REC-Chitradurga	Sri.K. Kenchojirao, ADS, Challakere
Hagaribommanahalli	Dr. Y. Srinivasulu, Sci-D, REC-Chitradurga	Sri.V. Sudheer DD, Sandur Road, Kudligi
Hiriyur	Dr. Y. Srinivasulu, Sci-D, REC-Chitradurga	Smt. C.D. Usha ADS, Chitradurga
Mega cluster: Haveri		
Davanagere	Dr. Y. Srinivasulu, Sci-D, REC-Chitradurga	Sri. M.S. Patil, ADS, Haveri
Haveri	Sri. G. Papaiah, TA	Sri.A. Sreeharsha, ADS, Davanagere
Ranebennur	Sri. G. Papaiah, TA	Sri.Chikkappaanur SEO, Ranebennur
Mega cluster: Koppal		
Lingasugur	Shri J. Justin Kumar, TA, REC-Koppal	Sri. S. Rajendra Kumar, ADS, TSC, DoS, Lingasugur
Shirahatti	Dr. A. Umesha, Sci-C, REC-Koppal	Sri. C.H Mudagal, ADS , DoS, Gadag,
Yelburga	Dr. A. Umesha, Sci-C, REC-Koppal	Sri. C.H Mudagal, ADS, DoS, Hireharalihally
Mega cluster: Jamkandi		
Belagaum	Dr. A. Umesha, Sci-C, REC-Koppal	Sri. G. B. Mallannavara, ADS, DoS, Belagavi.
Bijapur	Sri A. P. Raghavendra, FA, REC-Koppal	Sri. B.Y. Biradar, ADS, DoS, Bijapur
Jamkhandi	Sri A. P. Raghavendra, FA, REC-Koppal	Sri. S.M. Deshpande, ADS, DoS, Jamkhandi
Mega cluster: Mandya		
Clusters	**CSB**	**DOS**
Bidarakote	Dr. D. Guruswamy, Sci-C, REC-SU, Maddur	Sri. Madesh, SEO, Maddur
Bevuru	Dr. D. Guruswamy, Sci-C, REC-SU, Maddur	Sri. D. G. Manjunath, ADS, Channapatna
D. Halasahalli	Dr.S.Purushotham, Sci-D, CSRTI-Mysuru (upto May 2019) Dr. D. Guruswamy, Sci-C, REC-SU, Maddur	Sri. Surendra Murthy, SEO, D. Halasahalli
Gajanuru	Dr. Ramesh H, Sci.-D, SSPC Malavalli (upto May 2019) Dr. D. Guruswamy, Sci-C, REC-SU, Maddur	Sri. M. P. Umesh, ADS, Malavally Sri. Mallikarjunaswamy, ADS, Malavally
Toresettihalli	Dr. D. Guruswamy, Sci-C, REC-SU, Maddur	Dr. M. S. Manjunath, SEO, Toresettihalli
Mega cluster: Mysuru		
B R Koppalu	Shri Kalaiah, TA, CSRTI-Mysuru	Sri.N.Mahesh Kumar Vage, AD, S R Patna
H D Kote	Dr. Madhusudhan K N., Sci-D, CSRTI-Mysuru (From Nov. 2019)	Sri. Umesh C., SEO, H D Kote

Clusters	CSB	DOS
K R Nagar	Dr. Madhusudhan K N., Sci-D, CSRTI-Mysuru	Sri. Siddaraju S, AD, (In charge), K R Nagar
T Narasipura	Dr. S. N. Pallavi Sci-D (Upto May, 2019) Shri. T. Sivasubramonian, Sci-D (From Jul. to Dec. 2019) Dr. Madhusudhan K N., Sci-D, CSRTI-Mysuru (From Jan. 2020)	Sri. Krishna C.R. AD, T Narasipura
Mega cluster: Bidar		
Aurad	Shri. Ramesh Kumar. S, Sci-C, REC-SU, Bidar	Sri. G.C.Biradar, Sericulture Inspector, TSC, Aurad
Kalburagi	Shri. Ramesh Kumar. S, Sci-C, REC-SU, Bidar	Shri Prakah Babu.S., AD, DOS Kalburagi
Humnabad	Shri. Ramesh Kumar. S, Sci.-C, REC-SU, Bidar	Shri M. Kodali, Sericulture Inspector, TSC-Humnabad

Andhra Pradesh		
Clusters	**CSB**	**DOS**
Mega cluster: Kalyandurgam		
Penukonda	Dr. P. Sudhakar, Sci-D, RSRS-Anantapur (From Apr. to Nov. 2019) Dr. K. P. Kiran Kumar, Sci-D, RSRS-Anantapur (From Dec. 2019 onwards)	Sri. T. Venkataramanappa, AD, DOS Penukonda
Kalyandurgam	Dr. K. P. Kiran Kumar, Sci-D, RSRS-Anantapur	Sri. O. Vijaya Kumar, AD, DOS, Kalyandurgam
Mega cluster: Hindupur		
Madakasira	B. Vijaya Naidu, Sci-D, RSRS-Ananthapur	Sri. A. Rathnam, AD, DOS, Madakasira,
Hindupur	B. Vijaya Naidu, Sci-D, RSRS-Ananthapur	Sri. M. Nagarangaiah, AD, DOS, Hindupur,
Mega cluster: Atmakur		
Atmakur	Dr. P. Venkataramana, Sci-D, REC-SU, Atmakur (Upto May, 2019) Dr. P. Sudhakar, Sci-D, RSRS-Ananthapur (Jun. 2019 onwards)	Sri. D. Anjaneyulu, Sericulture Officer, DOS, Atmakur
Giddalur	Dr. P. Venkataramana, Sci-D, REC-SU, Atmakur (Upto May , 2019) Dr. P. Sudhakar, Sci-D, RSRS-Ananthapur (From Jun. 2019 onwards)	Sri. G. Rama Rao, AD, DOS, Markapur
Pathikonda	Dr. P. Venkataramana, Sci-D, REC-SU, Atmakur (Upto May , 2019) Dr. P. Sudhakar, Sci-D, RSRS-Ananthapur (From Jun. 2019 onwards)	Sri. K. Raju, AD, DOS, Peapully
Mega cluster: Palamaner		
V.Kota	Sri. S. Nazeer Ahmed Saheb, Sci-C, REC-V.Kota (Upto Jun. 2019) Dr. P.S. Reddy, Sci-D, REC-V. Kota (From Jul. 2019 to Dec. 2019) Dr. B.T. Sreenivasa, Sci-D, REC-V. Kota (From Jan. 2020 onwards)	Sri. H. Hanumantharaya, Sericulture officer, TSC, DOS, V. Kota

Clusters	CSB	DOS
Palamaner	Dr. P.S. Reddy, Sci-D, REC-V.Kota (Upto Dec. 2019) Dr. B.T. Sreenivasa, Sci-D, REC-V.Kota (From Jan. 2020 onwards)	Sri. Sajida Begum, AD. DOS, Palamaner,
Chittoor	Dr. P.S. Reddy, Sci-D, REC-V. Kota (upto Dec. 2019) Dr. B.T. Srinivasa, Sci-D, REC-V. Kota (From Jan. 2020 onwards)	Sri. G. Babu, AD, DOS, Chittoor.
Mega cluster: Chebrolu		
Chebrolu	Dr. T.V.S. Srinivasa Rao, Sci-D, REC-Eluru	Sri. K. Appa Rao, Sericulture Officer, TSC, Chebrolu
Bhimadole	Dr. T.V.S. Srinivasa Rao, Sci-D, REC-Eluru	Sri. M. Subba Rao, Sericulture Officer, TSC, Bhimadole
Vijayawada	Shri. W. Veerabhadra Rao, TA, SSC, NSSO, Vijayawada (Upto Nov. 2019) Dr. T.V.S.Srinivasa Rao, Sci-D, REC-Eluru (From Dec. 2019 onwards)	Sri. L. K. V. D. Prasada Rao, ASO, DOS, Challapalle

Telangana		
Clusters	**CSB**	**DOS**
Karimnagar	Shri B.V. Sanjeeva Rao, Sci-D, RSRS-Mulugu	Shri Adi Reddy, ADS, Dept. of Horticulture and Sericulture, Karimnagar
Mega cluster: Siddipet		
Siddipet	Dr. K. Praveen Kumar, Sci-D, RSRS-Mulugu	Shri Nimma Indra Sena Reddy, Sericulture Officer, Siddipet Shri Anna Rao, Asst. Director of Sericulture and Liaison Officer, Nalgonda. Shri S. Veera Kumar, Sericulture Officer, Suryapet

Tamil Nadu		
Clusters	**CSB**	**DOS**
Mega cluster: Alangayam		
Alangayam	Dr. S. Balasaraswathi, Sci-D, RSRS-Salem	Sri.V. Babu Rao, JIS, TSC, Alangayam, ADS,Vaniyambadi
Mega cluster: Dindigul		
Dindigul	Sri. T. Sivasubramonian, Sci-D, REC-Samayanallur (upto Jun. 2019) Dr. S. Rajaram, Sci-D, REC-Samayanallur (From Jul. 2019)	Sri. Murugan, Deputy Director, DOS, Salem
Mega cluster: Gobichettipalayam		
Gobichettipalayam	Smt E. Rajalakshmi, Sci-D, REC-Gobichettipalayam	Ms. M. Sangavi, AIS., TSC, DOS, Bhavani and Gobichettipalayam.

Clusters	CSB	DOS
Annur Manurpalayam Dharapuram	Smt E. Rajalakshmi, Sci-D, REC-Gobichettipalayam	Shri. N. Chandran, AIS, TSC, DOS, Annur
Manurpalayam	Dr. P. Samuthiravelu, Sci-D, REC-Udumalpet (From Apr. 2019 to Sep. 2019) Smt.E.Rajalakshmi, Sci-D, REC-Gobichettipalayam	Shri. S. Muneeswaran , AIS, (Upto December, 2019) Smt. M. Mythili, AIS, TSC, DOS, Manurpalayam
Dharapuram	Dr. P. Samuthiravelu, Sci-D, REC-Udumalpet (From Apr. 2019 to Sep. 2019) Smt.E.Rajalakshmi, Sci-D, REC-Gobichettipalayam	Shri. S. Muneeswaran, Asst. Inspector of Sericulture, TSC, DOS, Dharapuram
Mega cluster: Krishnagiri		
Berigai	Dr. K. Jhansilakshmi, Sci-D, REC-Krishnagiri.	Shri. C. Balakrishna, AIS, TSC, Berigai
Dharmapuri	Sri. S. Kamaraj, Sci-C, RSRS-Salem (upto Sep. 2019) Dr. K. Jhansilakshmi, Sci-D, REC-Krishnagiri	Shri. R. Elangovan, AIS, TSC, Dharmapuri
Krishnagiri	Dr. K. Jhansilakshmi, Sci-D, REC-Krishnagiri.	Shri. R. Ashok, TA, ADS, Krishnagiri
Mega cluster: Tenkasi		
Tenkasi	Dr. S. Rajaram, Sci-D, REC-Samayanallur (upto Jun. 2019) Dr. A. Mahima Shanthi, Sci-D, REC-Samayanallur	Shri. P. Ramadurai, DD, DOS, Vellore
Mega cluster: Udumalpet		
Pollachi	Dr. P. Samuthiravelu, Sci-D, REC-Udumalpet.	Smt. R. Shobana, AIS, TSC, Pollachi,
Gudimangalam	Dr. P. Samuthiravelu, Sci-D, REC-Udumalpet.	Smt. P. Geethapriya, AIS, TSC, Gudimangalam.
Udumalpet	Dr. P. Samuthiravelu, Sci-D, REC-Udumalpet.	Shri. T. Prabu, AIS, TSC, Udumalpet
Pongalur	Smt.E.Rajalakshmi, Sci-D, REC-Gobichettipalayam (upto Sep. 2019) Dr. P. Samuthiravelu, Sci-D, REC-Udumalpet	Shri. R. Ramesh, AIS, TSC, Pongalur. Shri. R. Nagaraj, AIS, DOS, Pongalur

Maharashtra		
Clusters	**CSB**	**DOS**
Jalna	Dr. Ramprakash, Sci-D, REC-Aurangabad	Shri. G. Mishal, SDO, Dist. Sericulture Office, DOS Jalna
Beed	Dr. Ramprakash, Sci-D, REC-Aurangabad	Shri.Vinit Pawar, SDO, District Sericulture Office, DOS Beed
Mega cluster: Satara		
Satara	Shri.Y.Humayun Sharief, Sci-D, REC-Baramati	Shri. P. J. Patil, SDO-Grade-II, Sangli Shri. S. D. Bhule, STA

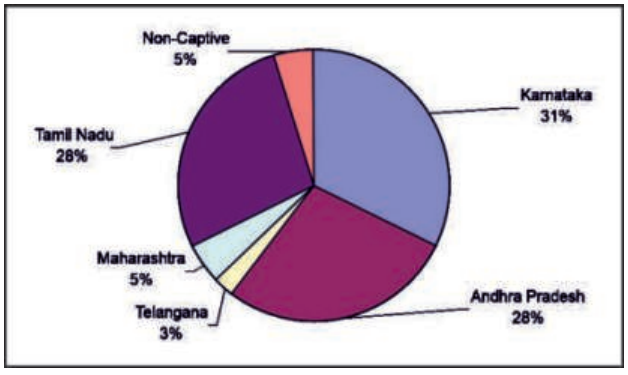
Non-captive areas		
Clusters	**CSB**	**DOS**
Zaheerabad (Telangana)	Dr. B. Srinath, Sci-D, REC-Vikarabad	Smt. M. Latha, Asst. Director, Dept. of Horticulture and Sericulture, Sanga Reddy, TS.
Nanded (Maharashtra)	Sh. A. J. Karande, Sci-D, REC-Parbhani	Smt. A. V. Wakure, SDO, Gr.II, DSO, Nanded
Akola (Maharashtra)	Shri R. V. Kushwaha, Sci-D, REC-Amravati	Shri. A. L. More, Sericulture Development Officer, Akola
Buldana (Maharashtra	Shri R. V. Kushwaha, Sci-D , REC-Amravati	Shri. Sanjai D. Dhamne, Sericulture Development Officer, Buldana
Wardha (Maharashtra)	Shri R. V. Kushwaha, Sci-D, REC-Amravati	Shri. P. S. Padvi Sericulture Development Officer, DSO, Wardha
Alangudi (Tamil Nadu)	Dr. A. Mahima Shanthi, Sci-D, REC-Samayanallur	Shri. Subramani, DD, DOS,Trichy
Palakkad (Kerala)	Smt. K. Sarala, Sci-D, REC-Palakkad	Smt. Sreekumari, Assistant Sericulture Officer, Palakkad
Hoshangabad	Mr. A. G. K. Daniel, Sci-D, REC-Hoshangabad	Mr. Arjun Singh Thakur, FO, DOS, Betul, MP Mr. Kailash Tatawat, Senior Sericulture Inspector, DOS Bankhedi, Hoshangabad, MP. Mr. Navneet Gaur, Junior Sericulture Inspector, DOS Hoshangabad, MP
Osmanabad	Shri. A. L. Jadhav, Sci-B, REC-SU, Osmanabad	Shri. S. B. Warat, Sericulture Development Officer-Gr I, Osmanabad

Performance of Clusters

Raw Silk Production: During this year, south zone clusters recorded an all time high production of 5054.50 MT of bivoltine raw silk production (95.36%) against the target of 5300.29 MT with an annual increment of 273.29 MT. Raw silk production in the clusters during the XII plan CPP is depicted below:

Raw silk production in south zone clusters (2013 - 2020)			
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

Contribution of States to Raw Silk Production (%) in 2019-20



State wise bivoltine raw silk production for 2019-20			
State	Raw Silk Production (in MT)		
	Target	Achievement	Achievement (in %)
Karnataka	1964.00	1623.27	82.65
Andhra Pradesh	1346.15	1426.37	105.96
Telangana	129.23	128.04	99.08
Maharashtra	207.50	228.14	109.95
Tamil Nadu	1460.77	1408.06	96.39
Non-Captive	192.64	240.62	124.91
Total	**5300.29**	**5054.50**	**95.36**

Crop Performance: A total of 452.88 lakhs dfls were distributed to the farmers against the target of 489.85 lakhs with an achievement of 92.44% . A total of 31765.69 MT bivoltine cocoons were produced with an average cocoon yield of 72.62 kg/100 dfls.

The cluster wise performance as per targets and achievements				
State	Dfls Target (in Lakhs)	Silkworm crops (Nos.)	Dfls brushed (in Lakhs)	Achievement (In %)
Karnataka	196.40	85430	158.98	80.95
Andhra Pradesh	125.00	44449	122.87	98.30
Telangana	12.00	3286	12.35	102.98
Maharashtra	20.70	8950	20.86	100.54
Tamil Nadu	126.60	67527	114.72	90.62
Non-Captive	24.45	11765	23.08	94.42
Grand Total	**489.85**	**221407**	**452.88**	**92.44**

The average cocoon yield for 100 Dfls was documented yearly, for all the clusters and the gradual increase over the XI plan is given in the following table:

State	Performance of south zone clusters							
	Average cocoon yield/ 100 dfls (kg)							
	XI Plan	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20
Karnataka	62.73	65.83	65.23	66.74	67.49	67.62	66.05	66.37
Andhra Pradesh	61.56	66.69	66.68	69.93	70.68	73.47	76.38	75.46
Telangana			65.08	66.11	70.62	70.89	68.08	67.35
Maharashtra	60.73	63.26	63.49	62.51	65.47	66.07	66.45	71.08
Tamil Nadu	71.13	74.46	75.54	77.86	78.33	80.32	79.59	79.78
Madhya Pradesh		52.93	53.93	47.66	49.12	51.68	46.08	
Kerala		76.45	75.88	75.69	81.68	84.05	86.13	
Non-captive								68.79
Average	**64.98**	**68.45**	**68.27**	**70.16**	**71.33**	**72.15**	**71.79**	**72.62**

The performance of each cluster was documented yearly and achievements are given in the table

Performance of Non-captive clusters for the year 2019-20								
Mega cluster	Dfls Annual Target (in Lakhs)	Dfls brushed (in Lakhs)	Ach. (%)	Cocoon yield (in MT)	Yield/100 dfls (kg)	Rate/kg (Rs.)	New plantation	
							Farmers (No.)	Area (Ac.)
B'lore Rural	10.30	9.27	90.00	603.32	66.27	380.42	498	684.77
Tumkur	26.55	19.52	73.51	1282.98	66.67	369.62	267	329.00
Ramnagara	12.60	9.10	72.22	629.67	70.71	397.92	944	1094.73
Kolar	27.85	20.80	74.68	1288.63	66.91	400.66	404	551.50
Chitradurga	31.65	26.06	82.32	1684.09	65.34	358.31	351	559.00
Haveri	20.60	19.47	94.52	1215.43	63.36	348.69	203	229.60
Koppal	12.00	9.47	78.92	625.80	67.86	353.55	232	418.40
Jamkhandi	18.50	14.43	77.98	929.20	67.67	340.53	517	661.05
Mandya	12.05	11.14	92.47	793.06	71.00	398.01	280	335.85
Mysuru	14.50	13.74	94.76	889.99	66.61	366.09	148	116.95
Bidar	9.80	6.00	61.21	336.83	56.77	360.93	112	77.60
Total/Avg.	**196.40**	**158.99**	**80.95**	**10279.01**	**66.37**	**374.54**	**3955**	**5058.45**

Performance of mega clusters in Maharashtra (2019-20)								
Mega cluster	Dfls Annual Target (in Lakhs)	Dfls brushed (in Lakhs)	Ach.(%)	Cocoon yield (in MT)	Yield/ 100 dfls (kg)	Rate/kg (Rs.)	New plantation	
							Farmers (No.)	Area (Ac.)
Aurangabad	15.10	16.68	110.46	1182.64	70.90	368.58	200	200.00
Satara	5.60	4.18	74.01	261.60	71.91	344.58	111	109.00
Total/Avg.	**20.70**	**20.86**	**100.54**	**1444.24**	**71.08**	**360.58**	**311**	**309.00**

Mega cluster wise cocoon yield (MT) in Andhra Pradesh								
Mega cluster	Dfls Annual Target (in Lakhs)	Dfls brushed (in Lakhs)	Achieve-ment. (%)	Cocoon yield (in MT)	Yield/ 100 dfls (kg)	Rate/kg (Rs.)	New plantation	
							Farm-ers (No.)	Area (Ac.)
Kalyanadurgam	16.70	17.15	102.68	1251.70	72.49	399.08	522	794.00
Hindupur	33.10	32.62	98.55	2119.26	74.30	396.50	932	1206.00
Atmakur	13.90	12.55	90.29	969.44	74.49	383.24	110	260.00
Palamaner	48.90	48.07	98.29	3599.92	78.88	389.92	695	1166.00
Chebrolu	12.40	12.49	100.70	799.64	70.22	345.62	169	376.00
Total/Avg.	**125.00**	**122.87**	**98.30**	**8739.96**	**75.46**	**380.58**	**2428**	**3802.00**

Performance of mega clusters in Telangana (2019-20)								
Mega cluster	Dfls Annual Target (in Lakhs)	Dfls brushed (in Lakhs)	Achieve-ment. (%)	Cocoon yield (in MT)	Yield/ 100 dfls (kg)	Rate/kg (Rs.)	New plantation	
							Farm-ers (No.)	Area (Ac.)
Karimnagar	6.00	4.24	70.68	265.49	65.31	374.08	116	319.00
Siddipet	6.00	8.12	135.27	545.12	68.39	365.55	52	177.00
Total/Avg.	**12.00**	**12.36**	**102.98**	**810.62**	**67.35**	**369.81**	**168**	**496.00**

Performance of Mega clusters in Tamil Nadu (2019-20)								
Mega cluster	Dfls Annual Target (in Lakhs)	Dfls brushed (in Lakhs)	Achieve-ment. (%)	Cocoon yield (in MT)	Yield/ 100 dfls (kg)	Rate/kg (Rs.)	New plantation	
							Farm-ers (No.)	Area (Ac.)
Alangayam	9.60	9.42	98.15	715.46	76.27	351.30	174	395.50
Dindigul	20.30	20.49	100.95	1584.18	79.10	366.67	337	661.50
Gobi	29.80	27.35	91.79	2225.13	81.21	389.83	230	369.85
Krishnagiri	27.50	24.05	87.47	1951.71	81.35	363.31	644	1453.00
Tenkasi	9.40	9.51	101.16	741.46	79.04	337.75	153	335.00
Udumalpet	30.00	23.89	79.64	1858.26	78.78	377.63	111	176.50
Total/Avg.	**126.60**	**114.72**	**90.62**	**9076.19**	**79.78**	**364.41**	**1649**	**3391.35**

Performance of Non-captive clusters across states									
State	Cluster	Dfls Annual Target (in Lakhs)	Dfls distributed (in Lakhs)	Ach. (in %)	Actual cocoon yield (in MT)	Yield/ 100 Dfls (kg)		New plantation	
							Rate/kg (Rs)	Far-mers (No.)	Area (Ac.)
Karnataka	Shahapur	1.50	0.73	48.50	41.05	70.84	311.71	6	18.75
Telangana	Zaheerabad	4.00	3.81	95.23	270.67	69.33	316.00	4	15.00
Maharashtra	Nanded	2.40	2.02	84.25	131.37	64.97	318.80	277	325.00
	Akola, Buldana, Wardha	4.30	3.77	87.69	236.43	68.81	317.22	192	200.00
	Osmanabad	4.60	4.76	103.40	250.32	68.54	356.60	176	186.00
Tamil Nadu	Alangudi	3.10	3.24	104.44	250.48	78.93	336.00	39	74.00
Madhya Pradesh	Hoshangabad	3.30	3.58	103.08	136.86	52.10	285.67	73	73.00
Kerala	Palakkad	1.25	1.19	59.30	98.50	83.06	317.50	91	358.00
Total/Avg.		**24.45**	**23.09**	**94.42**	**1415.68**	**68.79**	**319.94**	**858**	**1249.75**

Performance of Non-captive clusters for 2019-20

New Plantation in clusters: In order to increase the silk production in the clusters, more emphasis was given on horizontal expansion and 9369 farmers were motivated to plant improved mulberry varieties to the extent of 14306.55 acres in the 26 mega clusters along with non-captive areas.

State	New plantation	
	No. of Farmers	Area (acres)
Karnataka	3955	5058.45
Andhra Pradesh	2428	3802.00
Telangana	168	496.00
Maharashtra	311	309.00
Tamil Nadu	1649	3391.35
NON-CAPTIVE	858	1249.75
Grand Total	**9369**	**14306.55**

m-K*isan* portal:

m-Kisan portal was initiated under the Ministry of Agriculture, Government of India for the benefit of farmers. CSRTI-Mysuru as an identified user of m-*Kisan* portal, regular SMS are being sent once in every fortnight to transfer the technologies to the farmers across the nation in their vernacular languages. A total of 96 SMS messages, covering 75314 farmers over different states viz., Karnataka, Andhra Pradesh, Telangana, Tamil Nadu, Maharashtra, Madhya Pradesh and other states were sent during the year. The portal is highly useful in providing personalized and valuable information to the farmers on various sericulture technologies in their vernacular languages *i.e.* Kannada, Telugu, Tamil and Hindi.

Development of methodology to work out employment generation: Mulberry sericulture is proven to provide wide employment opportunities to rural farming community for empowerment and poverty alleviation. For development of methodology to work out employment generation in mulberry sericulture, data were collected from 168 farmers across different units in South India including MP and compiled. The establishment of mulberry garden in one acre for a period of one year provides employment of 127 mandays. For annual maintenance of mulberry garden (pruning and cleaning, inter-cultivation, manuring, fertilizer application, plant protection chemical application, weeding and maintenance of drip irrigation) and silkworm rearing activities (shoot harvesting, bed cleaning, feeding, mounting, disinfection, harvesting of cocoons and marketing and transportation of cocoons) around 573 mandays were generated on an average. In addition, a maximum of 266 mandays were employed indirectly for ancillary activities like construction of rearing house, operation of

equipments and installation of drip irrigation. On an average, 838 mandays were generated per annum in one acre of mulberry sericulture. The details of estimated state-wise employment generation from one acre of mulberry sericulture submitted to CO is as below

One District - One Product scheme in South Zone: For implementation of Sericulture Development Project under 'One District - One Product' vision of Hon'ble Prime Minister of India, 31 districts were selected in South zone. The details pertaining to geography, climatic conditions, predominant crops grown, socio-economic status of people, sericulture infrastructures already available, scope for development of sericulture were collected and submitted to CO. The resourceful districts were selected for the development of sericulture under the scheme, for a sizeable impact and will be known to be a Silk district, also as a model for other districts. With the coordination of Central Silk Board and the State Department of Sericulture, the district administration will play a lead role for successful implementation of the programme by extending support to the sericulture farmers under State Welfare Schemes along with the necessary technology support, training to farmers and field functionaries, extension support besides critical input support like construction of silkworm rearing houses, improved silkworm rearing equipments, post cocoon and post yarn support. The list of identified districts is as below

Continuous/Other Activities

Extension Communication programmes (ECP)

In order to transfer the technologies to the filed and make farmers aware of new sericulture technologies many extension communication programmes are being conducted at field levels in the states of Karnataka, Tamil Nadu, Andhra Pradesh, Telangana, Kerala, Maharashtra and Madhya Pradesh through extension units. The main ECPs conducted in the field are group discussions, farmer's days, field day/awareness programmes, workshops, Resham Krishi melas and exhibitions. During 2019-20 a total of 1220 Extension Communication Programmes were conducted and sensitized 73755 farmers. The main technologies topics covered were on new bivoltine sericulture technologies, wider spacing/tree mulberry; leaf roller and its control measures; awareness on use of rot fix, soil testing and its importance in mulberry cultivation; INM practices for mulberry, IPM; integrated disease management practices; disinfection and hygiene in silkworm rearing; popularization of new silkworm hybrids; demonstration of rotary mountages; mounting and spinning care etc.

Visitors' Service: During the year, a total of 5332 Sericulture related personnel have visited the Institute. Among these are Farmers, Students, Entrepreneurs, Departmental staff, International delegates, VIPs etc., 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 importance of the natural fibre Silk. Sericulture being skill based, women farmers were encouraged to take up Sericulture for their livelihood by highlighting the importance of skill in sericulture activities.

Category	No. of Persons visited
Farmers	2643
Students	2223
Foreigners	432
Others	34
Total	5332

State-wise Employment generation in pre-cocoon sector of sericulture (mandays/acre)								
Particulars	Maha rashtra	Andhra Pradesh	Tamil Nadu	Kerala	Madhya Pradesh	Karnat aka	Telang ana	Aver age
A. Establishment cost (Mulberry plantation)	111	142	103	140	134	136	122	127
B. Maintenance of mulberry garden (per acre/per annum)	98	176	160	155	291	212	186	183
C. Silkworm rearing (per annum)	678	378	706	328	327	213	99	390
D. Ancillary activities	56	97	100	170	96	181	266	138
Total	**943**	**793**	**1069**	**793**	**848**	**742**	**673**	**838**

Districts selected for 'one district one product' scheme			
Karnataka	Andhra Pradesh		Tamil Nadu
1.Bagalkot	1. Kurnool		1. Theni
2. Raichur	2. East Godavari		2. Namakkal
3. Gadag	3. West Godavari		3. Tiruvannamalai
4. Davanagere	4. Kadapa		4. Villuppuram
5. Chikmagaluru	5. Prakasam		5. Pudukkottai
	6. Srikakulam		6. Tirunelveli
Telangana	Maharashtra	Kerala	Madhya Pradesh
1. Jogulamba Gadwal	1. Nashik	1. Wayanad	1. Narsinghpur
2. Nirmal	2. Jalgaon		2. Chhindwara
3. Kamareddy	3. Thane		3. Jhabua
4. Mahabubnagar	4. Dhule		
5. Sanga Reddy	5. Nagpur		

Extension Communication Programmes Conducted		
ECP	Events	Farmers Sensitized
Resham Krishi Mela /Farmers' meet	3	4950
Field days	41	4439
Farmer’s Day	365	19633
Awareness Programme	78	9128
Group Discussion	641	16420
Technology demonstrations		
Enlightenment Programmes	35	658
Workshop/Seminar/Farmers' Meet	2	255
Field visits	1	4
Other activities	54	18268
Total	**1220**	**73755**

Resham Krishimelas:

Andhra Pradesh: RSRS-Ananthapur organized Resham Krishimela and Farmers' Workshop on Bivoltine Sericulture for sustainable income in Andhra Pradesh - Technologies for enhancing productivity at Madakasira in coordination with DoS-AP. 875 farmers participated in the programme benefited from the deliberations and exhibition on various aspects of importance of soil testing, improved mulberry varieties, tree cultivation, recommended package of practices for mulberry cultivation, INM, IPM, IDM, disinfection of rearing sheds, silkworm races, silkworm rearing and crop protection measures during rearing and tips for successful quality cocoon harvest. Dr. Pankaj Tewary, Director, CSRTI-Mysuru addressed the gathering and informed the services rendered by CSRTI, Mysuru for technological up gradation of the farmers and advised the farmers to fully utilize the opportunity to obtain more income by rearing bivoltine silkworms.

Tamil Nadu: RSRS-Salem organized a Resham Krishimela/ Farmers Workshop in coordination with DoS-Tamil Nadu at Senjeriputhur on 03-03-2020. 575 Sericulturists/officials participated in the Mela. A booklet on "New Sericulture technologies" was released on the ocassion. Dr. Pankaj Tewary, Director, CSRTI, Mysuru in his special address informed that Cluster Promotion Programme in Tamil Nadu in coordination with DoS is implemented covering 28 sericulture Clusters which are now merged into 6 mega clusters and 2 potential clusters.

Telangana: RSRS-Mulugu organized a Resham Krishi at Siddipet Mela Farmers Workshop in coordination with Directorate of Horticulture and Sericulture on 24.04.2020. With nearly 3500 farmers across the state participated in the programme. Many Scientists experts delivered lectures on various aspects and interactive sessions with farmers on adoption of new technologies in Sericulture were organised.

Activities of RECs attached to SEEM Division, CSRTI-Mysuru in Karnataka, Maharashtra and Madhya Pradesh

Centre	New Plantation		Dfls (Nos.)	Avg. Yield/ 100 dfls (Kg)	GD	Expo visit	FD	Field Day	AW	Exhib-ition	Demo. of techn-ology	Misc.
	Farmers (Nos.)	Area (Ac.)										
REC SU-Maddur	347	372.96	1213745	73.51	12	-	20	-	2	-	-	4
REC-Amaravati	795	954	377050	65.60	20	-	12	3	-	-	-	14
REC-Aurangabad	570	581	285000	69.72	32	7	8	2	1	4	6	4
REC-Parbhani	170	182	115900	64.26	12	-	4	-	2	1	-	7
REC SU-Osmanabad	176	186	475650	68.54	12	-	4	-	1	-	-	-
REC-Baramati	247	245.50	444375	72.12	18	-	16	-	3	3	1	-
REC-Hoshangabad	89	89	388000	51.17	18	-	12	2	-	-	-	11
GD: Group Discussion; FD: Farmers day; AW: Awareness Prog.												

Farmers Producer Organisation (FPO): In order to improve the status of sericulturists, technically, socially and economically by doubling their income and also to reach large number of beneficiaries efficiently and effectively so as to make them sustainable in Sericulture activities a Farmers Producer Organisation (FPO) was formally inaugurated by the Member Secretary, Central Silk Board, Sri Rajit Ranjan Okhandiar, on 03.07.2019 at REC SU-Maddur, Karnataka. Sri G. C. Vrushabhendra Murthy, IAS, Commissioner for Sericulture and Director of Sericulture, GoK, Dr. S. B. Dandin, Former Vice Chancellor of Horticultural University, Bagalkot, Sri N. Y. Chigari, Chief Executive Officer, FPO, Koppa, Dr. R. S. Teotia, Director, CSRTI- Mysuru and Joint Director of Sericulture, Mysore Division, Mysore, GoK, were present on the occasion besides 256 farmers from identified five CPP clusters viz., Bidarakote, Toreshetahally, Bevuru, Gajanur and D. Halasahalli.

Training/meetings organized

Training on Formation of Farmers Producer Organisation (FPO)

In view of the formation of mega clusters for increased silk production in the country, it was required that the clusters are to be supported with Farmers Producer Organizations for effective dissemination of technology to sericulture farmers besides linking forward and backward in sericulture sector. Since FPO concept was found new to extension personnel working at cluster level a training on Formation of Farmer Producer Organisation was organized on 2/3rd July 2019 at CSRTI, Mysuru. With nearly eighty CSB and DOS Counterparts of mega clusters across southern states and scientists from CSRTI, Mysuru participated in the training programme. The training facilitated the participants to learn the concept and ways and means of its implementation in sericulture sector in detail. The training experts were from Centre for Excellence for Farmer Producer Organisation, UASB campus GKVK, Bengaluru.

Extension Officers Meeting: Extension Officers meeting was convened to review the progress of CSRTI Extension units on 13th and 14th November 2019 at CSRTI-Mysuru. All in charge scientists of RSRSs/ RECs/REC SUs, SSBS Coonoor and P4 Hassan attended the meeting. Discussions were held on farm activities of land based units, progress of mega clusters and their future plan of action, training programme and accounts and administrative issues.

Publication of Sericulture Success Stories: A compilation depicting flourishing sericulturists titled "Sericulture Success stories" book was released on 30th Aug. 2019 at CSRTI-Mysuru. The book is the collection of 52 progressive farmers narrating their saga of sericulture life and appreciation on taking it as their way of life for sustainable livelihood. The books were distributed to all CSB institutes including NSSO and DOS offices across India.

Broadcasting of Technologies through All India Radio Mysuru: A series of six sericulture technologies were broadcasted in local language Kannada through AIR, Mysuru, Akashavani from Jan. 9th 2020 to 13th Feb. 2020. The recorded series were broadcasted on every Thursday from at 6.50 pm FM 100.6 Krishi Ranga. The identified subject matter specialists delivered lectures mainly on suitable soil for mulberry cultivation and measures to increase soil fertility, High yielding new mulberry varieties, Silkworm rearing techniques, new bivoltine and multivoltine breeds for quality silk production, Integrated Pest Management in mulberry and silkworm, silkworm disease management practices, new mountages for quality cocoon production.

Institute Village Linkage Programme (Seri Model Village)

H. M. Munikrishnappa

State	Cluster	Scientists
Karnataka	Kadakola	Shri. Kalaiah, TA, SEEM CSRTI-Mysuru
	K.M. Doddi	Dr.D.Guruswamy, Sci-C, REC,Maddur
	Hosakote	Shri. Iswar, Sci-D, RSRS,Kodathi (upto June 2019) Dr. Venkatachalapathy, Sci-D, RSRS,Kodathi(from July 2019)
	Chamarajanagar	Shri. Roop Kumar, TA, RSRS-Chamarajanagara
Tamil Nadu	Sathyamangalam	Smt.Rajalakshmi E, Sci-D, REC-Gobicehttpalayam
	Thondamathur	Smt. K. Sarala, Sci-C, REC-Palakkad
Andhra Pradesh	Rayachoty	Dr. A. Venugopal, Sci-D, REC- Rayachoty
	Vizanagaram	Dr. T.V.S. Srinivas Rao, Sci-D, REC- Chebrolu.
Maharashtra	Ahmednagar	Shri. Humayun Sharif Y, Sci-D, REC- Baramati
	Baramati,	Shri. Humayun Sharif Y, Sci-D, REC- Baramati
	Hoshangabad	Shri. A. Gnana Kumar Daniel, Sci-D, REC Hoshangabad

Objective: Transfer of technology through Institute Village Linkage Programme (IVLP) for sustainable/stable bivoltine cocoon production. IVLP was re-initiated in eleven clusters through CSRTI-Mysuru and its nested units (RSRSs/ RECs/REC-SUs) in the states of Karnataka (4), Andhra Pradesh(2), Tamil Nadu(2), Maharashtra(2) and Madhya Pradesh(1) with 1000 farmers identified covering nearly 1000 acres of mulberry plantation. Further, awareness programmes on various technologies was created through demonstrations and ECPs. A total 13.67 lakh dfls of bivoltine hybrids were reared with farmers and an average yield of 78.68 kg/100 dfls was recorded with 19.3% improvement in cocoon yield against the bench marks. Through the programme the cross breed rearing farmers were encouraged to rear bivoltine hybrids, a quantity of 129.61 MT of bivoltine raw silk was produced through IVLP.

IVLP Cluster-wise progress (Seri Model Village Programme) Apr. 2019 - Mar. 2020

State	IVLP Centre	Ann. Target (dfls)	Dfls Brushed	Benchmark yield (Kg/100 dfls)	Avg. Yield (Kg/100 dfls	% Improv-ement	Rate/ Kg (Rs.)	Ann. Target Est. raw silk (in MT)	Ach. Est. raw silk (in MT)
KA	Kadakola	150000	190380	60	69.33	11.5	380	14	18.02
	K.M.Doddi	100000	100847	55	71.15	29.36	375	9	9.00
	Hosakote	100000	68990	55	62.60	13.78	380	9	9.36
	Chamarajanagar	9000	1515	55	74.58	24.3	350	0.8	0.15
TN	Sathyamangalam	160000	202425	59	83.9	14.70	425	15	19.91
	Thondamuthur	160000	262210	67	80.0	20.00	380	15	21.75
AP	Rayachoty	100000	133000	60	75.2	11.70	335	9	9.8
	Vizanagaram	70000	63800	50	65.50	10.25	265	6	5.00
MH	Ahmednagar	100000	179470	60	77.30	28.83	436	9	19.60
	Baramati	100000	134910	60	77.20	28.66	437	9	14.87
MP	Hoshangabad	40000	30300	50	50.04	-	282	2	2.15
	Total	**1089000**	**1367847**	**57.63**	**78.68**	**19.30**	**368**	**97.8**	**129.61**

CAPACITY BUILDING AND TRAINING

J. B. Narendra Kumar and M. Muthulakshmi

Under Capacity Building and Training, several training programmes were designed to serve the needs of practitioners and facilitators and conducted at the Institute and its nested units. The target groups consisted of personnel of the state departments of Sericulture and Central Silk Board, students, researchers, entrepreneurs and practitioners including cocoon producers and chawki rearers, who were trained under different programmes such as Technology Orientation Programme (TOP), Farmers' Skill Training (FST), Need Based Training (NBT), Intensive Bivoltine Training (IBT) etc. Out of the 1553 persons trained during the year under report, 575 were trained at CSRTI, Mysuru and 978 at its Regional stations (RSRS) and Extension units (REC).

Programme	Name of the Course	Duration
Technology Orientation Programme	Refresher course	7
	Orientation programme	5
Farmers' Skill Training	Chawki rearing	10
	Late age silkworm rearing	15
	Mulberry cultivation technology	5
Need Based Training (Officials/Students)	Orientation Programme	15/35
	Popularization of high yielding mulberry varieties and silkworm races	3
	Mulberry and Silkworm and allied subjects	25

Programme	Name of the Course	Duration
Need Based Training (Farmers)	Chawki Rearing	10
	Intensive Training in Bivoltine Sericulture	90
	Awareness Programme	5
	Commercial Chawki Rearing	90
	Intensive Bivoltine Training	35
	Integrated Pest and Disease Management	5
	Sericulture Technology	5

Stake-holders trained (Programme-wise and State-wise)

Programme	Location	Trainee Category	State								Total
TOP	CSRTI- Mys	O	KA	AP	TS	TN	MH	MP	KER	OTH	
FST		F	--	--	11	20	16	--	--	--	47
STEP		O	17	09	10	--	--	--	--	--	36
Sub Total A			**15**	**06**	**--**	**03**	**07**	**02**		**--**	**33**
NBT		E/O	05	--	--	01	--	--	--	--	06
NBT		F/O	--	--	--	20	131			110	261
ITBS		F	04	--	--	--	--	--	--	--	04
IBT		F/E	10	4	--	--	1	--	--	21	36
ITEC/ JOCV		INTL	--	--	--	--	--	--	--	22	22
INTERN/ PROJ		S	26	08						04	38
Seed Act 90 days		F/E	53	--	--	07	14	--	--	--	74
Seed Act 7 days		F/E	18	--	--	--	--	--	--	--	18
	Sub Total B		**116**	**12**	**--**	**28**	**146**	**--**	**--**	**157**	**459**
FST	RSRS&RECs	F	50	226	150	250	221	15	25	--	937
IBT	RSRS& RECs	F	--	22	--	--	--	--	--	--	22
NBT	RSRS& RECs	F	--	--	--	--	--	--	19	--	19
	Sub Total C		**50**	**248**	**150**	**250**	**221**	**15**	**44**	**--**	**978**
	Grand Total		**181**	**282**	**173**	**305**	**393**	**17**	**44**	**158**	**1553**

TOP-Technology Orientation Programme; Farmers' Skill Training (FST);

O - Officers; F- Farmers; E - Entrepreneurs; INTL- International; S- Students; KA- Karnataka;
AP-Andhra Pradesh; TS-Telangana; TN-Tamil Nadu; MH-Maharashtra; MP-Madhya Pradesh;
KER-Kerala; OTH: Others include Bihar, Uttar Pradesh, Delhi, Jammu & Kashmir, Manipur and Nagaland

Number of persons trained at the nested units of CSRTI-Mysuru			
Unit	FST	*IBT/$NBT	Total
RSRS-Kodathi and RECs in Karnataka	-	-	0
RSRS-Chamarajanagar, Karnataka	**50**	**-**	**50**
RSRS-Ananthapur and RECs in Andhra Pradesh	226	*22	248
RSRS-Mulugu in Telangana	150	-	150
RSRS-Salem and RECs in Tamil Nadu and Kerala	275	$19	294
REC-Amaravati, Maharashtra	30	-	30
REC-Aurangabad, Maharashtra	120	-	120
REC-Baramati, Maharashtra	30	-	30
REC-Parbhani, Maharashtra	41	-	41
REC-Hoshangabad, Madhya Pradesh	15	-	15
Total	**937**	**41**	**978**

Training in Commercial Chawki Rearing for potential entrepreneurs: The programme is designed to train potential entrepreneurs who wish to establish Commercial Chawki Rearing centres (CRCs). The 90 days programme includes classroom sessions on technologies involved in chawki silkworm rearing, exclusive chawki garden maintenance, mulberry cultivation, crop protection, mechanization and economics of chawki rearing. The participants are exposed to hands on training in chawki silkworm rearing with over 9 crop cycles. Successful completion of this training is mandatory for registration of their enterprise. During the year, 74 entrepreneurs [KA-53; TN-7 and MH-14] were trained under this programme. Additionally, owners of 18 Commercial Chawki Rearing Centre were also given refresher training for 5 days to facilitate in renewal of their existing licenses.

Need Based Training Programmes [NBT]: These programmes are tailor made to suit the specific requirements of the target groups like state government personnel, sericulturists, unemployed youth, personnel from NGOs, Under Graduate/ Post Graduate students from Universities etc.

	Programme	Duration (days)	State						Total
			KA	AP	TN	MH	TS	OTH	
Officials	ITEC/JOCV	30	-	-	-	-	-	22	22
	Awareness Programme	5	-	-	-	-	-	70	70
	Total		**-**	**-**	**-**	**-**	**-**	**92**	**92**
Sericulturists	Chawki Rearing	10	-	-	-	93	-	-	93
	Integrated Pest and Disease Management	5	-	-	4	2	-	-	6
	Intensive Training in Bivoltine Sericulture	90	04	-	-	-	-	-	04
	Awareness Programme	5	-	-	-	38	-	60	98
	Intensive Bivoltine Training	35	10	4	-	1	-	21	36
	Seed Act	90	53	-	07	14	-	-	74
		5	18	-	-	-	-	-	18
	Total		**85**	**4**	**11**	**148**	**--**	**81**	**329**
Students	Internship/Project	21/45/60/90	26	08	--	--	--	04	38
	Total		**26**	**08**	**--**	**--**	**--**	**04**	**38**

Subject	Name of the College / University	No. of students	
		UG	PG
Microbiology/ Pathology	Maharani's Science College for Women-Mysuru	**-**	**03**
	Sri Padmavati Mahila Viswavidyalaya-Tirupati	-	04
Biochemistry/ Physiology	JSS University, Mysuru	-	04
	Maharani's Science College for Women-Mysuru	-	03
	Sri Padmavati Mahila Viswavidyalaya-Tirupati	-	04
Biotechnology	NMAMIT, Nitte	03	-
	Andhra University, Andhra Pradesh	-	02
	SKUAST, Kashmir-J&K	-	01
	Sri Krishna Arts College-Tamil Nadu	-	01
	Maharani's Science College for Women-Mysuru	-	04
	JSS College Ooty Road-Mysuru	-	03
	Central University of South Bihar-Gaya	-	03
	Sri Padmavati Mahila Viswavidyalaya-Tirupati	-	04
Bioinformatics	Sri Krishna Arts College-Tamil Nadu	-	02
Molecular Biology	St. Josephs College (Autonomous)- Bengaluru	06	
	Sri Padmavati Mahila Viswavidyalaya-Tirupati	-	02
Sericulture	Sri Padmavati Mahila Viswavidyalaya-Tirupati	-	02
	Total	**09**	**42**

Silkworm Rearing: Chawki and late age silkworm rearings as part of the training programmes for skill development was conducted. During the year 80,550 dfls were chawki reared and distributed to 549 rearers. Further, late age silkworm rearings were conducted in four batches to impart skills in the participants of training programmes. The details of chawki and late age silkworm rearings are presented in the tables below.

Details of chawki rearing			
Month	No. of Dfls reared	No. of farmers served	Cocoon yield per 100 Dfls
Apr. 2019	7,050	42	84.59
May 2019	6,750	46	86.24
Jun. 2019	7,900	46	88.12
Jul. 2019	7,750	51	87.26
Aug. 2019	6,850	47	81.34
Sept. 2019	8,650	58	83.65
Oct. 2019	7,200	53	79.95
Nov. 2019	4,800	37	79.0
Dec. 2019	5,250	40	81.8
Jan. 2020	5,400	40	79.9
Feb. 2020	6,900	49	81.2
Mar.2020	5,950	40	86.7
Total / Avg.	**80,550**	**549**	**83.31**

Details of late age rearing							
Season	Hybrids	No. of dfls	Hatching %	Single Cocoon Weight (g)	Single Shell Weight (g)	Shell %	Yield/100 dfls (Kg)
Mar. - Apr. 2019	Double Hybrid	100	92.00	1.372	0.311	22.78	67.000
Jul. - Aug. 2019	Double Hybrid	100	85.00	1.674	0.374	22.49	56.770
Sep. - Oct. 2019	Double Hybrid	100	85.00	1.495	0.304	20.33	50.720
Dec. 2019 - Jan.2020	Double Hybrid	50	92.00	1.372	0.332	24.19	36.770

International training programme on sericulture and silk industry under Indian Technical and Economic Co-operation (ITEC) sponsored by Ministry of External Affairs (MEA)

In order to assist sericulture industry in developing countries, an International training program on Sericulture and Silk Industry was held at the Institute from 2nd to 29th September 2019. Although the program was planned for 30 officials from different countries, only 19 officials/trainees from 9 countries participated. The countries were Bangladesh (02), Ethiopia (04), Ghana (01), Kenya (03), Madagascar (01), Nigeria (02), Thailand (02), Uganda (03) and Vietnam (01). All of them were well qualified with either diploma or graduation or PG in Life Sciences (Zoology, Entomology), Agriculture, Engineering, Textile, Business Administration etc.

The trainees were imparted with hands on training on silkworm rearing right from egg hatching and brushing till spinning. In addition, practical classes were also conducted on soil sampling, leaf and shoot harvesting, pruning and training of mulberry plants, identification of mulberry pests and diseases, disinfection of rearing house, use of disinfectants to control silkworm diseases, silkworm seed production technology and processing as well as cold storage of bivoltine eggs etc. Besides they were also taken on tour to cocoon markets where they got information on cocoon quality assessment, fixing of rates and bidding through e-marketing. They were also shown a large scale Automatic Reeling Machine (ARM) unit at Ramanagar and small scale filature units in nearby villages. Besides, they could see farmers' mulberry gardens, and many other sericulture related activities. They had an opportunity to even discuss and interact with farmers, reelers, weavers and other stake holders.

The trainees presented the current status of sericulture in their respective countries which revealed that except for Bangladesh, sericulture is in infant stage in majority of the countries and all of them opined that new sericulture technologies taught during the training program would definitely help them to popularize sericulture and uplifting poor farmers in their countries.

Feedback evaluation

Feedback evaluation was conducted for few training programmes at the end through a questionnaire. The course wise feedback of the same is tabulated below:

Course	Training Utility Index	Training Efficiency Index	Training Facilities Index	Course Coverage Index	Training Mngt. Index	Variance
TOP	79.50	77.18	71.80	78.66	76.79	11.79
STEP	80.52	81.40	77.68	80.30	79.97	14.97
NBT/SAMETI	72.40	78.96	74.82	76.00	75.54	10.54
ITEC	87.58	85.10	82.53	81.05	84.06	19.06

The overall Training Management Index for the training program (TMI) ranged from 75.54 to 84.06% against 65% required indicating 10.54 to 19.06% above the ISO standard. This shows a very positive opinion of the trainees about the program. The opinion by the trainees regarding the faculty, knowledge level of faculty, study tour, co-ordination and co operation of faculty and efforts of faculty and staff were most appreciated.

Revenue Generation during the year 2019-20						
Month	Course Fee	Regn. Fee	Sale of cocoons	Sale of Chawki	Hostel Rentals	Grand Total
Apr. 2019	1,69,000	0	16,976	70,500	36,100	2,92,576
May. 2019	3,57,000	0	0	67,500	14,100	4,38,600
Jun. 2019	1,79,000	54,000	0	79,000	36,850	3,48,850
Jul. 2019	2,19,000	0	15,949	77,500	45,500	3,57,949
Aug. 2019	1,12,000	48,000	0	69,500	37,850	2,67,350
Sep. 2019	0	0	0	58,500	22,300	80,800
Oct. 2019	8,000	0	13,140	69,500	23,850	1,14,490
Nov. 2019	39,000	10,000	0	78,500	16,050	1,43,550
Dec. 2019	42,000	1,47,000	0	52,500	15,500	2,57,000
Jan. 2020			16,855	54,000		70,855
Feb. 2020				69,000		69,000
Mar. 2020				59,500		59,500
TOTAL	**11,25,000**	**2,59,000**	**62,920**	**8,05,500**	**2,48,100**	**25,00,520**

Students enrolled for Project/Internship: The Institute also offered guidance and facilities to undergraduate and postgraduate students for carrying out research work as a partial fulfillment of their courses. During the year 09 undergraduate and 42 post-graduate students enrolled for dissertation work in the areas of Microbiology, Biochemistry, Biotechnology, Bioinformatics and Molecular Biology.

FARM MANAGEMENT SECTION

B. T. Sreenivasa (upto Oct. 2019) and Y. N. Sanath Kumar

Continuous Activities

- Maintained 19.0 acres of mulberry garden, 2.0 acres chawki garden and 3.0 acres tree plantation for continuous production of quality mulberry leaf with recommended package of practices, mechanization, synchronizing with the different rearing programmes of the institute.
- Maintained all the farm machineries i e., Tractors (two), Power tillers (four), Irrigation pump sets (nine), Pruning machines and other equipments for effective management of mulberry garden of the section, experimental plots of other sections, transportation facilities to different rearing sections for effective implementation of the research and related programmes and general upkeep of the Institute.
- Maintained chawki plot with recommended package of practices with V1 and G2 varieties, (4+3) x2, 8x2 and 4x4 spacing, for continuous supply of quality chawki leaf for chawki rearing.
- Supplied 94475.0 kg mulberry leaf and 53735.0 kg mulberry shoots from 9.0 acres to different rearing sections viz. BBL, MBL, Transgenic, SW Genetics, SW Physiology, SW Pathology, RTI, TVDC and Training divisions for rearing of 5283 Dfls under different projects/experiment/race maintenance programmes.
- Supplied 24555.00 kg mulberry chawki leaf from 2.0AC chawki plot to Commercial Chawki Rearing Centre of the Institute for quality chawki rearing of 84050 dfls
- Demarcated 5.0 acre V1, G2 and G4 mulberry garden for production and supply of seed cuttings for multiplication in field level.
- Supplied 23.706 MT of V1 mulberry seed cuttings to 32 farmers for 94.824 acres of new plantation and generated an income of Rs. 1,06,676.0.
- Supplied 1.208 MT of G2 mulberry seed cuttings to 4 farmers for 4.832 acres of new plantation and generated an income of Rs. 5,438.00.
- Supplied 2.583 MT of G4 mulberry seed cuttings to 5 farmers for 10.332 acres of new plantation and generated an income of Rs. 11,626.00.

BIOINFORMATICS CENTER (Sub-DIC under BTISNET)

R. Sumathy, S. Manthira Moorthy R. S. Teotia (upto Aug. 2019) and Pankaj Tewary

The Bioinformatics Centre at CSRTI-Mysuru is like a catalyst for bringing out the awareness in Bioinformatics among the students, scientists and researchers of various colleges, research institutes and biotechnology industries in and around the region thus contributing significantly for the Human Resource Development in the field of Biotechnology and Bioinformatics. This centre also develop software for utilisation by the researchers working in the field of sericulture, Seri-biotechnology and also support analysing data generated by scientists under different projects.

Research work carried out

During this period, centre has carried out the identification of protein kinase groups in silkworm *Bombyx mori* and functional annotation of transcriptome, differential expression of genes related to growth and identification of putative genic SSRs, SNPs and InDels.

Genome wide identification of protein kinase groups in silkworm *Bombyx mori*

The protein kinase (PK kinome) is one of the largest protein families in eukaryotes and regulates the aspects like signalling pathways, cell growth, development, DNA repair, apoptosis, cell cycle regulation, response to environ-

mental stimuli etc. Despite their important role, identification of PK gene family, their comprehensive functional classification and evolutionary analysis in the insect model yet to be performed. Silkworm *(Bombyx mori)* a monophagous insect is domesticated model organism and reared mainly for the production of natural fibre the silk. The identification and classification of PK gene families helps to understand regulatory role in many cellular process, cell development, host parasite interaction etc. In the present study, 441 protein families from the NCBI protein database and 213 proteins from silkpathdb (database) belongs to 8 kinase groups such as AGC, CAMK, CK1, CMGC, STE, RGC, TK and TK respectively. HMMER domain identification and GLAM2 algorithm from MEME software toolkit confirmed the presence of conserved motifs and kinase domains. Further, silkworm putative PKs identified in this study are required to be validated for functional role and to understand their various regulatory cellular functions. This will shed light on understanding the functional significance of protein kinases in silkworm as well as in other insect model.

Functional annotation of transcriptome, differential expression of genes related to growth and identification of putative genic SSRs, SNPs and InDels.

Growth is a complex trait associated with mulberry leaf yield and controlled by several genes. In this study, we have explored the molecular basis underlying growth using transcriptome profiling of contrasting genotypes. A total of 66.6 Mbp of primary transcriptomes from high growth (HGG)-Jalalgarah-3 and M. laevigata (H) and, low growth genotypes (LGG)-Harmutty and Vadagaraparai-2; resulting in 24210, 27998, 28085 and 28764 final transcripts respectively. Out of the 34096 pooled transcripts, 20249 transcripts matched with at least one sequence of the non redundant database. Functional annotation resulted in the categorization of 18970 transcripts into 3 Gene Ontology (GO) terms and 7440 were assigned to 23 Kyoto Encyclopaedia of Genes and Genomes (KEGG) pathway. Based on the differentially expressed genes and gene enrichment analysis, over expression of photosynthetic related transcripts in HGG and defence related transcripts in LGG were noted. Simple sequence repeats were mined from unique transcripts and the most abundant motifs were tri- (1883) followed by di- (1710), tetra- (192), penta- (68) and hexa- (40) repeats. Further, a total of 390897 high quality SNPs and 8081 InDels were identified by mapping onto *Morus notabilis* reference genome. The study provides an insight into the expression of genes involved in growth and further research on utilization in genetic improvement of the crop.

Continuous/Other Activities

Guidance: Two students of Bharathidasan University, Thiruchirappalli and Sri Krishna Arts and Science College, Coimbatore completed their dissertation work. One traineeship and one studentship completed their project work.

Database /Web servers developed

- MulSatDB - Mulberry microsatellite marker database (http://btismysore.in/mulsatdb/)
- SilkPPI - Silkworm protein-protein interaction database (http://btismysore.in/SilkPPI/)
- SilkTF - Silkworm specific transcription factor database (http://btismysore.in/SilkTF)
- Mulberry Genome databases - Mulberry molecular marker data database (http://btismysore.in/MulGenomeDb/mghome.html)
- Soilinfo - Mulberry cultivation soil information in south India (http://btismysore.in/soil)
- Silkprot - Silkworm protein database
- MulTF - Mulberry specific transcription factor database (http://btismysore.in/multf/)
- MulIndus - Mulberry DUS descriptors and test guidelines (http://btismysore.in/MID/)
- STRPLOT - Drawing STRUCTURE bar plots in user friendly interface (http://btismysore.in/strplot/)

REGIONAL SERICULTURAL RESEARCH STATIONS (RSRS)

Regional Sericultural Research Stations (RSRS) are established to address the regional problems of sericulturists through research and extension support of sericulture technologies in varied agro-climatic regions. Their main objective includes undertaking validation trials and demonstration of new sericulture technologies evolved by the main institute to the sericulturists. The proven technologies are transferred further to the field through Research Extension Centres (REC) and sub-units functioning under RSRS.

RSRS-KODATHI

Command Area	Scientists/Staff	
	In-charge Officer	Dr. Jalaja S Kumar, Scientist-D (upto 27.2.2020) Smt. M. G. Sabitha, Scientist-D (from 28.2.2020)
Karnataka	Scientists	05
	Technical Staff	09
	Administrative Staff	04

RSRS-Kodathi	Farm Based Units		
RECs	Unit	Total Area (Acres)	Mulberry Acreage
	RSRS-Kodathi	66.90	11.00
Chitradurga	REC-Bidaraguppe	7.00	2.07
	REC-Chitradurga	7.00	2.41
Madivala	REC-Madivala	8.00	3.50
	REC-Koppal	8.00	1.50
Koppal	Total	96.90	20.48

Cluster Promotion Programme (CPP): Bivoltine sericulture technologies like application of rot fix for root rot management, plastic mountages for saving labour for cocoon harvest, disinfection methods for successful bivoltine rearing, management of mulberry garden for quality leaf production etc. were disseminated in 36 clusters across Karnataka. A total of 132.74 lakh bivoltine hybrid dfls were distributed and achieved 78.87 % against the target (172.50 lakh dfls). An average yield of 64.57kg / 100 dfls was recorded and 4646.4 acres of new mulberry plantation was taken up with 3510 farmers.

Zone	Parameters	Target	Ach.
South Karnataka (19 Clusters)	No. of dfls (lakhs)	91.40	70.47 (82.15 %)
	Yield / 100 dfls (kg)		67.73
	Rate (Rs.)		386.24
North Karnataka (14 Clusters)	No. of dfls (lakhs)	81.10	62.26 (75.58 %)
	Yield / 100 dfls (kg)		61.42
	Rate (Rs.)		340.39
Total	No. of dfls (lakhs)	172.5	132.74 (78.87%)
	Yield / 100 dfls (kg)		64.57
	Rate (Rs.)		363.32

On Station Trials (OSTs)

Evaluation of new breeds and hybrids:

M. Venkatachalapathy, Ishwar (upto July 2019), Jalaja S.Kumar (upto 27.2.2020) and M.G. Sabitha (from 28.02.2020)

1. Rearing performance of improved crossbreeds (May - Jun. 2019):

The rearing performance revealed that, the breeds *viz.* S8 followed by ICB7, ICB7xCSR2 and ICB29xCSR2 performed better when compared to other breeds. The cocoon parameters were good in ICB29xCSR2, S8 and ICB30xCSR2.

Name of breed	Fecundity (No.)	Hatching (%)	ERR by		Yield/100 dfls	SC wt. (g)	SS wt. (g)	SR (%)
			By No.	By wt.				
ICB7	401	91	9822	13.750	50.00	1.40	0.230	16.42
ICB29	419	95	8822	12.08	45.88	1.37	0.241	17.59
ICB30	462	95	9339	12.140	52.30	1.3	0.217	16.69
PM4	452	95	9632	10.780	45.60	1.12	0.16	14.28
MV1	432	97	8462	9.985	41.20	1.18	0.238	20.16
ICB7xCSR2	404	98	9744	13.933	58.00	1.43	0.245	17.13
ICB29xCSR2	465	90	9720	16.320	65.00	1.68	0.357	20.05
ICB30xCSR2	465	94	6833	10.796	43.00	1.58	0.306	19.36
PM4xCSR2	383	98	7972	11.080	41.50	1.39	0.246	17.69
CSR2	561	95	9729	13.815	77.58	1.42	0.307	21.61
S8	556	95	9841	16.139	84.60	1.64	0.367	22.65
Mean	454.55	94.82	9083.2	12.800	54.97	1.41	0.26	18.51
SD	58.49	2.522	974.58	2.16	14.88	0.17	0.062	2.481

2. Rearing performance of improved Bivoltine breeds (Jun. - Jul. 2019):

The rearing performance revealed that, the ERR was better in HAB1 compared to HAB2. The cocoon parameters were better in HAB2.

Name of breed	Fecundity (No.)	Hatching (%)	ERR by		Yield/100 dfls	SC wt. (g)	SS wt. (g)	SR (%)
			By No.	By wt.				
HAB1	580	94	9460	14.480	78.20	1.41	0.266	18.87
HAB2	585	92	7433	12.320	66.25	1.53	0.298	19.48
Mean	582.5	93	8446.5	13.40	72.23	1.47	0.282	19.175
SD	1.41	1.41	1433.3	1.527	8.449	0.084	0.0226	0.431

3. Rearing performance of improved Bivoltine breeds (Aug. - Sep. 2019):

The rearing performance revealed that, the yield was better in BFC9 x BFC17 and BFC7 x BFC240. The cocoon parameters were better in all the breeds. Highest cocoon weights were recorded in BFC68 x BFC239 and BFC68 x BFC239.

Name of breed	Fecundity	Hatching (%)	ERR by		Yield/100 dfls	SC wt. (g)	SS wt. (g)	SR (%)
			By no.	By wt.				
BFC9xBFC17	425	97.5	9693	16.890	70.00	1.68	0.347	20.65
BFC1xBFC11	438	96	5049	8.540	35.88	1.69	0.350	20.71
BFC7xBFC240	468	96	7588	13.340	60.00	1.76	0.395	22.44
BFC68xBFC239	413	96	5750	10.100	40.00	1.80	0.401	22.27
BFC239xBFC103	550	97	3435	6.100	32.50	1.81	0.401	22.15
Mean	458.8	96.5	6303	10.994	47.68	1.748	0.3788	21.64
SD	54.94	0.707	2410.76	4.214	16.42	0.060	0.0277	0.886

4. Rearing performance of improved Bivoltine breeds (Oct. - Nov. 2019):

The rearing performance revealed that, highest cocoon yield was recorded in BFC244 followed by BFC239 and BFC403. The less cocoon yield was recorded in BFC205 and NB7.

Name of breed	Fecundity (No.)	Hatching (%)	ERR by		Yield/ 100 dfls	SC wt. (g)	SS wt. (g)	SR (%)
			By no.	By wt.				
BFC20	432	95	9316	14.000	57.50	1.50	0.350	23.33
BFC55	448	94	6269	9.498	40.00	1.51	0.371	24.56
BFC205	443	96	3715	5.878	25.00	1.58	0.384	24.30
BFC239	462	97	8355	13.389	60.00	1.60	0.334	20.87
BFC244	498	97	9784	17.598	85.00	1.79	0.356	19.88
BFC403	457	95	8569	13.821	60.00	1.61	0.371	23.04
NB7	465	95	3500	06.250	27.61	1.78	0.421	23.65
Mean	457.86	95.57	7072.5	11.490	50.73	1.62	0.37	22.80
SD	21.082	1.133	2612.5	04.388	21.22	0.117	0.027	1.763

5. Rearing performance of improved Bivoltine breeds (Dec. 2019 - Jan. 2020):

The rearing performance revealed that, the better yield of 61.25 kg was recorded in MV1xS8 followed by PMxCSR2 (56.7 kg) and NDV6xCSR51 (45 kg). The cocoon parameters were better in all the breeds.

Name of breed	Fecundity	Hatching %	ERR by		Yield/100 dfls	SC wt. (g)	shell wt. (g)	SR%
			By no.	By wt.				
MFC1xFC2	499	97	2275	3.92	19.00	1.75	0.350	20.00
MFC2xFC2	562	97	1929	3.08	16.67	1.60	0.350	21.87
MFC3xFC2	526	98	2694	4.85	25.00	1.85	0.400	21.62
HB4xS8	512	98	3155	5.83	30.47	1.70	0.350	20.58
NDV6xCSR51	471	97	5490	9.84	45.00	1.85	0.400	21.62
MV1xS8	442	96	8243	14.42	61.25	1.60	0.350	21.87
PMxCSR2	407	98	8374	14.20	56.70	1.70	0.300	17.64
Mean	488.43	97.29	4594.29	8.020	36.30	1.72	0.357	20.74
SD	52.57	0.76	2785.000	4.8	18.07	0.103	0.034	1.543

6. Rearing performance of improved Bivoltine breeds (Feb. - Mar. 2020):

Rearing performance of BH breeds revealed not much difference in yield and cocoon parameters. The cocoon yield ranged from 48 to 54 kg/100 dfls and the highest SR% was recorded in BH28.

Bivoltine	Fecundity (No)	Hatching (%)	ERR by		Yield/100 dfls	SC wt. (g)	SS wt. (g)	SR (%)
			By no.	By wt.				
BH28	600	95	7372	9.47	54.00	1.25	0.300	24.00
BH29	600	94	6752	8.86	50.00	1.25	0.250	20.00
BH30	600	95	7949	8.42	48.00	1.30	0.250	19.23
BH31	600	95	8989	8.56	48.80	1.30	0.275	21.15
Mean	600	94.8	7766	8.83	50.20	1.28	0.269	21.10
SD	-	0.50	950.9		0.466	0.039	0.024	2.09

Continuous/Other activities:

Popularization of new bivoltine breeds and mulberry varieties in the field : A total of 74151 dfls of bivoltine single, double hybrids and improved cross breeds were test verified with 278 farmers. Similarly new mulberry varieties *viz.,* G2, G4, V1, and RC1 saplings / cuttings were supplied to the farmers from RSRS, Kodathi and its nested units.

Unit	Dfls (Nos.)	Farmers (Nos.)
REC-Chitradurga	29000	129
REC-Madivala	43551	141
REC-Koppal	1600	08
Total	**74151**	**278**

Popularization of new mulberry varieties RSRS-Kodathi		
Variety	**Quantity**	**Amount realised in Rs.**
G2	3000 saplings were supplied to Chowdeswari CRC, Pandavapura and covered 6.5 acres	6000.00
G4	22200 cuttings were supplied to 2 farmers in Hosakote area and covered 50 acres. 500 saplings were supplied to SSTL and planted in 1 acre.	1994.00 1000.00
Earthworm	20.5 kg @ 200	4100.00
Leaf sold	7454.8 kg @ 2.50/kg	18637.00
	Total	**31731.00**

Extension Communication Programmes: Various ECPs were conducted by the RSRS and its nested units for the transfer of Bivoltine sericulture technology developed by the main institute and are fine-tuned. Overall 16526 farmers were sensitized with 273 programmes.

Institute Village Linkage Programme (IVLP), Sulibele.

M. Venkatachalapathy and Gurusiddappa

A total of 1,01,190 Dfls of Bivoltine hybrid were reared in IVLP cluster with an average yield of 62.6 Kg/100 Dfls and an improvement of 13.78 % cocoon yield over bench mark was recorded.

Progress of IVLP Programme

Name of the cluster	Annual Target (No.of dfls)	Dfls brushed	Avg. cocoon yield/ 100 dfls (kg)	Raw silk obtained (MT)
Sulibele	100000	101190	62.60	9.36

Institute Village Linkage Programme-Hosakote Tq (Sulibele-TSC)							
Month	Target	No of Dfls	Bench mark cocoon yld (Kgs)	Yield / 100 Dfls (Kgs)	Imp (%) over bench mark	Raw silk production Ann.target	Raw Silk Production Achievement (MT)
Apr. 2019	5000	4230	55	62.34	13.34	0.405	0.376
May 2019	6000	5650	55	62.78	14.14	0.547	0.508
Jun. 2019	7000	6260	55	61.00	10.90	0.587	0.545
Jul. 2019	9000	10500	55	61.50	11.81	0.993	0.922
Aug. 2019	10000	9950	55	62.00	12.72	0.949	0.881
Sep. 2019	10000	11750	55	63.45	15.36	1.114	1.065
Oct. 2019	10000	10500	55	62.50	12.72	1.615	1.110
Nov. 2019	10000	9000	55	61.00	10.98	0.984	0.738
Dec. 2019	10000	10000	55	65.00	18.8	0.846	0.928
Jan. 2020	10000	11000	55	67.00	21.81	1.010	1.130
Feb. 2020	8000	7500	55	62.50	13.63	0.70	0.70
Mar 2020	5000	4850	55	60.00	9.10	0.46	0.45
Total/Avg.	**100000**	**101190**		**62.60**	**13.78**	**10.20**	**9.36**

Production of Biological Control Agents : A total of 91050 ml of *Nesolynx thymus* were produced at REC Madivala and distributed to stakeholders for the management of uzi fly.

Farm rearing : A total quantity of 1256 dfls were reared at RSRS and nested units (REC- Madivala, Chitradurga and REC-Koppal). The average yield recorded was 64.00/100 dfls. A total of 1600 dfls of bivoltine hybrids were chawki reared and distributed to 8 farmers by REC- Koppal.

Farm maintenance : A total of 18.41 acres of mulberry garden was maintained by RSRS and farm based nested units and produced 80.67 MT mulberry leaf out of which 69.78 MT was utilized for farm rearing and 7.454 MT leaf was sold and generated a sum of Rs 18,637/- as revenue. Remaining leaf of 3.436 MT was utilized for compost and vermicompost preparation. Farm waste was recycled and produced a total 49.50 MT compost and 40 MT vermicompost and used for mulberry garden. The technologies adopted in the farm were demonstrated and explained to the farmers and students visited the station.

Training : During the year 2019-20, RSRS and its nested units carried out trainings at two Sericulture Resource Centers. 80 farmers were trained at B.G Kere under Chitradurga cluster, in 4 batches and 50 farmers were trained in 3 batches at B.S.Doddi under Kanakapura cluster. No financial support was extended by RSRS-Kodathi.

Cleanliness Programme: Cleaning of RSRS-Campus was taken up regularly. The waste materials were exclusively used for composting and vermi-composting.

Details of demonstrations conducted

Name of the cluster	Date	Place	No. of farmers	Topic
Tumkur	25.07.19	Jogenahalli	40	Rot fix application for root rot control in Mulberry
Channarayapatna	06.08.19	Mattabarlu	15	Rot fix application for root rot control in Mulberry
Sidlhagatta	23.08.19	Marathagatta	12	Disinfection of rearing house
Ithandahalli	04.09.19	Hangala, Bangarapet	29	Disinfection of rearing house
Ithandahalli	04.09.19	Kaluvanahalli	28	Disinfection of rearing house
Bannikuppe	13.09.19	Achalu	57	Composting technology for effective utilization of sericulture waste
Kanakapura	23.12.19	Baradanahaalli	25	Disinfection of rearing house
Total			**206**	

Success story recorded

Name of the cluster	Name of the farmer	Place	Topic
Yelaburga	Sri. A. Basappa	Kalburgi	CRC Business with a Social Cause
Yelaburga	Sri. B.Mallikarjun	Hubballi, Hosally	Technology Adoption for Better Returns
Lingasgur	Sri. M.P. gowda	-	A Visionary sericulturist
Lingasgur	Sri. Shivashankarappa	Honnalli	Hard works and rewards in sericulture
Bijapur	Sri.S. Pundalikar	Hirpur	Reaping the fruits of hard work
S Bijapur	Sri. Shiva marol	-	Chawki for quality cocoon
Sirahatti	Sri. Manthappa	-	Timely interventions in sericulture

Name of the cluster	Name of the farmer	Place	Topic
Sirahatti	Sri. Kharpade	-	Hope of trees in sericulture
Bannikuppe	Sri. Appaji	Ankanahalli	Evergreen sericulture for better life
Bannikuppe	Sri. Sunil Kumar	Kylancha	Bivoltine rewards suitable life

Visitors: During the period, a total of 278 Sericulturists (229 from Tamil Nadu and 49 from Koppal, Karnataka) have visited the station.

RSRS-Chamarajanagar

1. **Cluster Promotion Programme:** The annual target for dfl distribution in the T. Narasipura cluster was 270000. The achievement upto Nov. 2019 was 154887, later the cluster was merged with Mysuru mega Cluster. During the period total cocoon harvested was 100857 kg. The average yield /100 dfl was 66.7 kg and new plantation of 53.0 acres were established by 43 farmers.

2. **Silkworm disease monitoring of commercial crop:** The survey was conducted for every crop in the T. Narasipura cluster including 10 farmers. The Incidence of silkworm diseases was monitored periodically and necessary precautionary measures was also suggested to farmers. The disease incidence was 1.56%, 1.52% and 0.32% for grasserie, flacherie and muscardine respectively.
3. **IVLP Programme:** Under the IVLP programme 1515 dfls was brushed by 10 IVLP beneficieries and harvested 1130.15Kg of cocoons, the average yield /100 dfl was 86.3kg for CB and 70.18kg for BV

Incharge officer	V. Girish Naik (upto 31-1-2020) T. Sivasubramonian (from 01-02-2020)
Scientists	3
Technical staff	6
Administrative staff	6

4. **Extension Communication Programme:** Under the extension communication programme the centre conducted 22 programmes in the CPP and IVLP area it includes 14 Nos. of group discussion and 8 Nos. of farmers day in addition to that one exhibition also conducted at KVK Suttur.

Date	Venue	Farmers sensitized	CPP/ IVLP
Group Discussion			
21.9.19	Hirreyur	29	CPP
19.11.19	Hannur	23	CPP
20.11.19	Muttige	20	IVLP
20.11.19	Annapura	19	IVLP
23.11.19	Jinakanahalli	20	IVLP
27.11.19	Madegowdahundi	21	CPP
27.11.19	Hittuvalli	27	CPP
28.11.19	Hemmige	24	CPP
3.12.19	Nanjapura	22	CPP
3.12.19	Heguru	24	CPP
7.12.19	Mangala	20	IVLP
9.12.19	Hempainahundi	29	CPP
19.2.20	Handarkallimole	32	IVLP
13.3.20	T.Doddapura	20	CPP
	Total	330	
Farmers Day			
28.5.19	Yachanahalli	51	CPP
21.10.19	Harale	37	IVLP
28.11.19	Dodanahundi	61	CPP
5.2.20	Dodamaluguda	87	CPP
12.2.20	Senapathihalli	65	CPP
11.3.20	Melaji pura	50	IVLP

13.3.20	Muguru	64	CPP
18.3.20	Chennappanapura	60	IVLP
	Total	475	
	G.Total	805	
Exhibition			
21.1. 20 to 26.120	Suttur	5806	

Extension Communication Programme

5. **Farmers Skill Training:** Under farmers skill training programme 50 sericulture farmers were given training for three days. 16 Farmers (28,30,31 Dec. 2019); 15 Farmers (24,25,26 Feb. 2020) and 19 Farmers (12,13,16 Mar. 2020)
6. **Farm Rearing:** During the year 900 dfls were reared In the farm
7. **Visitors:** 564 farmers in 12 batches from DOS Karnataka and 80 farmers in and around Chamarajanagara visited the RSRS and improving the in knowledge in sericulture.

RSRS SALEM

TOTAL AREA: 14.02 Acres

MULBERRY ACREAGE: 10.0 Acresv

REC & Sub-Units
Tamil Nadu
REC-Samayanallur
REC-Krishnagiri
REC-Udumalpet
REC-Gobichettipalayam
Kerala
REC-Palakkad

Command Area	Staff	
	In-charge Officer	Dr. N. Dhahira Beevi
Tamil Nadu	Scientists	11
	Kerala	16
	Administrative & supporting Staff	13

Farm Based Units		
Unit	Total Area (Acres)	Mulberry Acreage
RSRS-Salem	20.0	3.4
REC-Krishnagiri	2.77	2.5
REC-Samayanallur	2.62	0.6

Concluded research project:

PRP 3567: Assessing the efficacy of recommended chemicals in insect/ disease/weed management and their impact on soil biota of mulberry ecosystem in South India (Apr. 2016 - Mar. 2019)

S. Balasaraswathi, M. Noble Morrison, B. Vijaya Naidu and S. N. Pallavi

Objectives:

- To assess the efficacy of chemicals in mulberry cultivation for the management of insect pests/ diseases /weeds
- To assess the factors influencing the efficacy of chemicals utilized for mulberry insect pests/ diseases / weed management
- To study the effect of pesticides on soil biota
- To analyze the residual toxicity of pesticides in mulberry ecosystem

Data on the efficacy of DDVP revealed the maximum % reduction of *Maconellicoccus hirsutus* at RSRS-Salem and Ananthapur (80.0 and 80.39%). The maximum % reduction of *Diaphania pulverulentali*s (82%) recorded at REC-Madivala followed by RSRS-Salem and Chamarajanagara. Similarly, Dimethoate showed the minimum population of *Pseudodendrothrips mori* at RSRS-Salem (1.75/3 leaves). Among herbicides Glyphosate and Gramaxone recorded less no. of weeds ($50/m^{2)}$ at RSRS-Salem and ($3.4/M^2$) RSRS-Ananthapur.

The correlation values with pest incidence, weather factors and the population of natural enemies in RSRS-Salem, Ananthapur, Chamarajanagara and REC-Madivala, during 2016-17, 2017-18 and 2018-19 for incidence of *D.pulverulentalis* showed positive correlation with rainfall where as incidence of *M.hirsutus* showed negative correlation to rainfall in all four centres. The incidence of *M. hirsutus and Paracoccus marginatus* showed positive correlation with temperature in all the four centres. Among the natural enemies the population of coccinellids showed negative correlation with temperature where as spiders showed positive r values.

The treatments Dimethoate, Gramaxone, Glyphosate recorded the minimum population of earthworms/ cu.ft of soil after two years in all centre compared to the control. In the first year no significant reduction of population of ground beetles/cu.ft of soil was recorded except REC-Madivala. However at the end of the second year significant reduction of population was recorded in all the four stations.

Results on the enumeration of soil microbes showed minimum bacterial population with Dimethoate (17.2 to 72.0 $X10^6$ CFUs/g of soil) in the first year at all centres followed by Dichlorvos 0.2% and reached almost nearer to the population of precount at the end of second year. No significant reduction was recorded with herbicides Glyphosate and Gramaxone except at RSRS, Salem (75.5 CFUs/g of soil). Again, Dimethoate revealed low number of fungal population in the first year as well as at the end of second year in all centres since it could not recovered (15.4 to 14.2 CFUs/g of soil) at RSRS-Salem. Bavistin and Mancozeb induced a regular inhibition of the total count of fungi (3.2 X $10^4$and 4. 2 X 10^4 CFUs/g of soil) at RSRS-Salem. Similarly there was no significant reduction of fungal population by application of Navinya at RSRS-Salem (11.4 X 10^4CFUs/g of soil) compared to pre treatment count where as at RSRS-Chamarajanagar and REC-Madivala the fungal population increased in first year and sustained in the second year (22 X 10^4 CFUs/g of soil).

The results on pesticide residue analysis revealed residue of Bavistin in the soil samples of RSRS-Salem and REC-Madivala 0.35 and 0.23 ppm. The soil samples of all the four centres revealed residue of Gramaxone upto 0.06 ppm in the first year. In the second year, the soil samples of all centres revealed the residue of Gramaxone ranging from 0.07 to 0.16 ppm.

Pesticide residues in soil (in ppm)								
Treatments	RSRS- Ananthapur		RSRS-Chamarajanagar		REC-Madivala		RSRS-Salem	
No. of years	I	II	I	II	I	II	I	II
Dichlorvos	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Dimethoate	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Bavistin	BDL	BDL	BDL	BDL	0.35	BDL	0.23	BDL
Mancozeb	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Glyphosate	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Gramaxone	0.05	0.15	0.06	0.13	0.05	0.16	0.06	0.07
Control	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
BDL – Below Detectable Level (< 0.05 ppm)								

Inference/Recommendation

The results obtained strongly recommend not to use insecticide Dimethoate and herbicide Gramaxone in pest/weed management in the mulberry ecosystem in south India in order to sustain the soil fertility in the long run. As alternatives the use of botanicals *viz.,* neem, pungam oil and their seed kernel extracts, adopting IPM strategies including release of bio control agents and application of organic cakes may be encouraged by creating awareness among the sericulturists.

PPA-3580: Soil Health Cards for sericulture farmers in states of Karnataka, Tamil Nadu, Andhra Pradesh, Telangana, Kerala, Maharashtra and Madhya Pradesh (Jul. 2016 - Jun. 2019)

N. Dhahira Beevi

Objectives:

- To monitor the soil fertility status of mulberry gardens of Karnataka, Tamil Nadu, Andhra Pradesh, Telangana, Kerala, Maharashtra and Madhya Pradesh to recommend balanced fertilizers and manures and create database.

During the period 1957 soil samples from clusters of Tamil Nadu and Kerala under cluster promotion programme, other sericulture farmers from different parts of Tamil Nadu and DOS farm samples have been analyzed for pH, EC, OC%, available phosphorus, available potassium, boron and sulphur.

Soil test report along with recommendations and suitable reclammation measures were also given to the farmers and DOS farms in the format in local language. A total of 1957 samples were processed and sent to SSC, CSRTI, Mysuru for analysing available Nitrogen, Zn, Fe, Mn and Cu. Details on farmers profile and results of the parameters analysed at RSRS, Salem and recommendations were entered in the NIC portal for individual farmers and 3501 soil health cards printed and distributed to farmers. Total no.of soil samples analysed per cluster and fertility rating of samples analysed during the year are presented below.

Details of cluster-wise soil samples received and analyzed	
Name of the cluster	No.of samples
Pudukottai	217
Tiruvannamalai	153
Trichy	96
Krishnagiri	197
Anthiyur	48
Annur	19
Udumalpet	55
Bhavani	46
Dharmapuri	172
Gobi	11
Non-captive area	838
DOS farm	105
Total	**1957**

Fertility ratings of soil samples			
Parameters	Status		
pH	Acidic	Neutral	Alkaline
Ratings	< 6.5	6.5 -7.5	> 7.5
% Samples	2.05	32.36	65.59
EC Ratings	Normal	High	Toxic
mmhos/cm	<1	1-2	>2
(% sample)	98.85	0.63	0.52
OC status	Low	Medium	High
%	<0.65	0.65-1.00	>1.00
(% samples)	35.64	49.48	14.88
Available P	Low	Medium	High
Kg/ha	<10	10-20	>20
(% samples)	2.39	52.67	44.94
Available K	Low	Medium	High
%	<120	120-240	>240
(% samples)	5.36	49.68	44.96
Sulphur	Low	Medium	High
ppm	<10	10-15	>15
(% sample	45.03	50.47	4.50

On-going research projects:

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

S. Gandhi Doss, Jalaja S Kumar, G. S. Aruna Kumar, B. Vijaya Naidu, S. Kamaraj and Pankaj Tewary

Objectives:

- 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 conditions.

Planting work completed in optimal, sub- optimal plots and survival data recorded on 30th and 90th day after planting. Due to water logging no cultural operations were carried out for six months. After draining of water first pruning was taken up and triploid cuttings were planted in nursery for studying the performance of these triploids for nursery parameter under Salem condition.

All India Co-ordinated Experimental trial for Mulberry varieties (AICEM-Phase-IV)

Apr. 2019- Mar. 2025

Zonal Co-ordinator: Dr Pankaj Tewary, Director, CSRTI-Mysuru.

S. Gandhi Doss, G. S. ArunaKumar, P. M. Pratheesh Kumar, S. K. Hanumantharayappa, Jalaja S Kumar, M. Noble Morrison, K. Jhansi lakshmi, P. Sudhakar, B. Vijaya Naidu, B. Srinath and A. Venugopal

Objectives:

To identify and authorize suitable mulberry varieties for commercial use in different agro-climatic mulberry cultivation zones of India.

Details of the experiment:

No. of varieties	: 5
No. of replications	: 6
Experimental Design	: RBD
Spacing	: 90 cm x 90 cm
No. of plants/plot	: 81

Raised the saplings of test entries, planted in the experimental plot at REC, Krishnagiri and is being maintained with protective irrigation, timely intercultural operations and plant protection measures.

Continuous /other activities:

Silkworm disease monitoring in seed and commercial crop rearing of South Indian states

Silkworm disease survey conducted monthly in 10 selected farmers' rearing (in each CPP cluster) and data collected has been uploaded in the internet site www.seridm.csrtimys.res.in of CSRTI-Mysore for further compilation and analysis.

On Station Trials:

A. Testing of Improved crossbreeds:

Rearing performance of Improved Crossbreeds (Season: May - Jun. 2019)

Evaluation of superior triploid for yield and adaptability under varied agro climatic condition -Survival % (30 days)						
Optimal input plot				Sub optimal input plot		
Name of the Triploid	No. of plants planted	No. of plants survived	Survival %	No. of plants planted	No. of plants survived	Survival %
Trip - 1	144	78	54.1	36	03	08.3
Trip - 5	144	88	61.1	36	06	16.5
Optimal input plot				Sub Optimal input plot		
Name of the Triploid	No.of plants planted	No of plants survived	Survival %	No. of plants planted	No. of plants survived	Survival %
Trip - 8	144	67	46.5	36	03	08.1
Trip - 9	144	100	69.5	36	03	08.3
Trip - 10	144	56	38.5	36	00	-
G - 4	144	138	96.5	36	28	77.7
Vishala	-	-	-	-	-	-

Evaluation of superior triploid for yield and adaptability under varied agro climatic Condition -Survival % (90 days)						
Optimal input plot				Sub optimal input plot		
Name of the Triploid	No. of plants planted	No. of plants survived	Survival %	No. of plants planted	No. of plants survived	Survival %
Trip - 1	144	69	47	36	09	25
Trip - 5	144	93	64	36	09	25
Trip - 6	144	29	20	36	10	27
Trip - 8	144	92	63	36	11	30
Trip - 9	144	74	51	36	15	41
Trip - 10	144	92	63	36	16	44
G - 4	144	131	90	36	23	63
Vishala	144	58	40	36	14	38

Name of the Hybrids	Fecun-dity (No.)	ERR By No.	ERR by Wt. (kg)	Yld/100 dfls (Kg)	SCW (g)	SSW (g)	SR (%)
ICB 7	386	6374	8.052	40.262	0.968	0.165	17.05
ICB 29	429	6517	5.626	28.128	0.901	0.157	17.43
ICB 30	349	2483	1.237	6.184	0.479	0.086	17.95
PM4	409	9772	7.975	39.873	0.820	0.125	15.24
ICB-7x CSR2	436	7833	11.331	56.656	1.471	0.275	18.70
ICB- 29 x CSR2	461	9490	15.308	76.538	1.619	0.344	21.25
ICB-30 x CSR2	434	9508	13.507	67.535	1.447	0.294	20.32

On station trial with the above combinations of the seven ICBs evaluated, ICB 29 x CSR2 performed better for all parameters compared to other ICBs tested.

B. Testing of New Bivoltine Hybrids: Three rearing trials conducted with three new bivoltine hybrids *viz.,* MASN4 x CSR2, O2 x D and BH-25.

Rearing performance of MASN4 x CSR2 (Season: Jul.-Aug. 2019)							
Name of the Hybrids	Fec. (No.)	ERR (by No.)	ERR Wt. (kg)	Yld/100 dfls (kg)	SCW (g)	SSW (g)	SR (%)
MASN4 x CSR2	412	7325	13.167	65.833	1.891	0.376	19.88
S8 x CSR16 (Control)	431	8922	16.000	80.000	2.198	0.466	21.20

Rearing performance of O2 x D (Season: Sep. - Oct. 2019)							
Name of the Hybrids	Fec. (No.)	ERR (by No.)	ERR by Wt. (kg)	Yld/100 dfls (kg)	SCW (g)	SSW (g)	SR (%)
O2 x D	420	8432	11.232	56.159	1.545	0.217	14.05
FC2 x FC1 (Control)	600	8328	13.333	66.667	1.601	0.294	18.36

Rearing performance of BH-25 (Season: Jan. - Feb. 2020)							
Name of the Hybrids	Fec. (No.)	ERR (by No.)	ERR Wt. (kg)	Yld/100 dfls (kg)	SCW (g)	SSW (g)	SR (%)
BH-25	590	7398	11.294	56.471	1.526	0.323	21.17
FC1xFC2	625	8459	13.984	69.62	1.653	0.365	22.08

On Farm Trials: Newly developed bivoltine silkworm hybrids were test verified in farmer's field by RSRS-Salem and its nested units.

Name of the centre	Race / Combination	No. of dfls	No. of farmers	Actual Yield (kg)	Yield/100 dfls (kg)
RSRS-Salem	S8 x CSR16	47500	165	31744	66.83
	MV1 x S8	125	1	78.75	63.0
	MASN4 X CSR4	1500	13	509.75	34.00
	O2 x D	1700	9	1065.5	62.67
	D x O2	190	2	121.12	60.56
	D x O3	185	1	103.60	55.00
	O3 x D	700	5	458.70	65.30
	FC1 x FC2 (SSBS Coonoor)	600	3	377.00	62.90
REC-Udumalpet	S8 x CSR16	1000	8	750.00	75.0
	MASN4 X CSR4	4000	21	1656.00	41.4
Total (combination wise)	S8 x CSR16	48500	173	32494.0	70.92
	MV1 x S8	125	1	78.75	63.00
	MASN4 X CSR4	5500	34	2166.0	38.00
	O2 x D	1700	9	1065.5	62.67
	D x O2	190	2	121.12	60.56
	D x O3	185	1	103.60	55.00
	O3 x D	700	5	458.70	65.30
	FC1 x FC2 (SSBS Coonoor)	600	3	377.00	62.90
	Total / Average	**57500**	**228**	**39270.67**	**68.30**

Extension Communication Programme: Various kinds of ECPs were conducted by RSRS and its nested units for the transfer of technologies developed by the main institute.

Extension Communication Programmes conducted by RSRS-Salem and its nested units								
Centre	Technology demonstration		Group Discussion		Awareness Prog./ Field day		Farmers Day	
	Far.	Exp.	Far.	Exp.	Far.	Exp.	Far.	Exp.
RSRS-Salem	-	-	879 (39)	36250	382 (4)	59300	756 (16)	76660
REC-Krishnagiri	-	-	624 (27)	22853	309 (3)	45000	500 (11)	55000
REC-Samayanallur	262 (11)	-	1056 (56)	46015	907 (9)	105975	1116 (29)	123010

Centre	Technology demonstration		Group Discussion		Awareness Prog./ Field day		Farmers Day	
REC-Udumalpet	15 (4)	-	936 (49)	48200	609 (6)	90000	759 (20)	100000
REC-Gobichettipalayam	287 (21)	-	638 (31)	31000	232 (3)	45000	648 (16)	80000
REC-Palakkad	-	-	301 (15)	15000	169 (2)	25150	325 (8)	40000
Total	564 (36)	-	4434 (217)	199318	2608 (27)	370425	4114 (100)	474670

Extension Communication Programmes conducted by RSRS-Salem and its nested units						
Centre	Exhibition		Success Stories Word		Success Stories Video	
	Far	Exp.	Far	Exp.	Far	Exp.
RSRS-Salem	-	-	-	-	-	-
REC-Krishnagiri	-	-	-	-	-	-
REC-Samayanallur	4300 (1)	-	15 (239)	-	8 (971)	
REC-Udumalpet	-	-	2 (2)	-	-	-
REC-Gobichettipalayam	-	-	1 (1)	-	-	-
REC-Palakkad	-	-	-	-	-	-
Total	4300 (1)	-	18 (242)	-	8 (971)	-
Figures in parentheses denotes number of programmes						

Transfer of Technology Programme: The OFTs undertaken in transfer of technology programmes were evaluated for their impact based on the bench mark/ diagnostic study and the effectiveness of the technologies is presented below:

Centre	Rot Fix (kg)	G2 (ac)	G4 (ac)	RC1 (ac)	RC2 (ac)	V1 (ac)	Pheromone trap for uzifly	Serifit
RSRS-Salem	24 (15)	-	5.5 (4)	-	-	1.5 (1)	60 (12)	-
REC-Gobichettipalayam	67.650 (125)	-	-	-	-	-	50 (10)	3875(423)
REC-Udumalpet	125 (120)	-	-	-	-	-	75 (15)	500 (45)
REC-Samayanallur	-	-	0.36 (2)	-	-	0.02 (1)	-	-
REC-Krishnagiri	58 36)	0.03 (1)	3.5 (4)	-	-	0.05 (1)	100 (20)	-
REC-Palakkad	20 (14)	-	-	-	-	-	-	-
Values in parentheses denote number of farmers covered.								

Resham Krishimela / Workshop:

Resham Krishi Mela and Farmers Workshop	Date: 03.03.2020 Venue: Senjeriputhur, Coimbatore district
488 farmers and 87dignitaries, DOS, CSB and other officials participated.	Tamil booklet on “New sericulture technologies” was released.

Cluster Promotion Programme: Bivoltine sericulture technologies were disseminated in 12 mega clusters, two potential clusters across Tamil Nadu and one cluster in Kerala. A total of 117.96 lakh Dfls and 1.186 lakh Dfls were distributed and harvested an average cocoon yield of 79.80 and 86.06 kg / 100 dfls in Tamil Nadu and Kerala respectively.

IVLP: A total of 4.64 lakh dfls of bivoltine hybrids were reared with 200 farmers in two clusters *viz.,* Sathyamangalam and Thondamuthur and recorded an average yield of 82.37 kg/100 dfls with 17.35% improvement on productivity against the bench mark.

A. Capacity Building Farmers Training Programme

Unit	Farmers Skills Training	
	Prog. (No.)	Farmers (No.)
RSRS-Salem	3	75
REC-Krishnagiri	3	60
REC-Samayanallur	2	75
REC-Gobichettipalayam	3	60
REC-Udumalpet	3	60
REC-Palakkad	1	25
Total	**15**	**355**

B. Chawki Rearing Training: Five Chawki rearers and one DOS staff of Govt. Silk farm, Papparapatti were trained at RSRS, Salem under Seed Act sponsored by NSSO from 16.03.2020 to 22.03.2020.

Mass multiplication and distribution of Bio-control Agents				
Name of the Biocontrol agents	Target Host	Units supplied	Numbers supplied (Nos.)	No. of Farmers covered
Acerophagus papayae (1 unit=250 nos.)	Papaya mealybug	1043	2,60,750	399

Sericulture Resource Centres (SRC): Sericulture Resource Centre at Manupatty village-(REC, Udumalpet) 3 batches of Sericulture training was conducted benefitting a total 62 farmers in co-ordination with the lead farmer Sri.Ponnusamy.

Survey and surveillance for pests and diseases in RSRS, Salem command area: Fortnightly survey was conducted for monitoring pest and disease of mulberry and silkworm. Remedial measures demonstrated / suggested for prevention and control.

Incidence of mulberry/ silkworm pests and diseases under RSRS-Salem command area							
Month	Thrips (%)	Tukra (%)	Leaf webber (%)	Powdery mildew (%)	Root rot (%)	Grasserie (%)	Flacherie (%)
Apr. 2019	-	11.45	-	-	-	3.22	4.50
May 2019	14.90	12.00	-	-	5.52	8.61	3.75
June 19	7.30	9.34	-	-	8.57	4.57	1.09
July 19	10.80	10.55	-	-	9.21	2.60	-
Aug. 2019	8.88	5.73	-	-	-	3.35	6.78
Sep. 2019	3.30	6.46	-	-	-	-	5.67
Oct. 2019	-	5.54	-	-	6.50	-	6.12
Nov. 2019	-	2.36	1.55	3.36	8.40	-	1.37
Dec. 2019	-	-	11.04	11.93	-	-	-
Jan. 2020	-	-	14.09	9.85	2.06	-	-
Feb. 2020	-	2.12	12.59	6.18	-	-	-
Mar. 2020	3.15	4.57	-	-	3.72	-	2.95
Mean	4.27	5.84	3.27	2.61	3.66	1.86	2.68

Visitors: RSRS-Salem is a regular visiting place for Sericulture farmers, students and officials for enriching knowledge on new technologies of silkworm rearing and mulberry cultivation and biological control agents.

Ph.D. Students: Periyar University, Salem recognized RSRS-Salem as Centre for higher studies in Botany and Sericulture for doing M.Phil., and Ph.D. At present 9 students are pursuing Ph.D. under Periyar University, Salem.

RSRS-ANANTHAPUR

Command area	Staff	
	In-Charge officer	Dr. P. Sudhakar
Andhra Pradesh	Scientists	10
Telengana	Technical staff	21
Karnataka	Administrative staff	11

Farm based units		
Unit	Total area (Acres)	Mulberry acreage
RSRS-Anantapur	40.73	6.00
REC-Rayachoty	5.00	1.25
REC-Vikarabad	5.50	1.86
REC SU-Bidar	11.33	5.50

REC & Sub units
Andhra Pradesh
REC-Rayachoty
REC-Eluru
REC-V. Kota
Telengana State
REC-Vikarabad
Karnataka State
REC SU- Bidar

Concluded research projects:

1. **PPA 3580: Soil health cards for sericulture farmers in states of Karnataka, Tamilnadu, Andhra Pradesh, Telangana, Kerala, Maharashtra and Madhya Pradesh (2016 - 2019).**

B. Vijaya Naidu and P. Sudhakar

Objectives:

- To make the farmers aware about the importance of soil fertility on the production of quality mulberry leaves by issuance of soil health cards

957 soil samples collected from V. Kota, Chittoor, Palamaner and Eluru during the year 2019-20. Analysis of soil samples for pH, EC, OC% completed and these soil samples were sent to CSRTI, Mysore for further analysis of phosphorus, potash and other micro nutrients.

Continuous /other activities:

Cluster Promotion Programme: Bivoltine sericulture technologies were disseminated in 13 clusters in Andhra Pradesh state and 1 cluster in Telangana State. 126.75 lakhs dfls of bivoltine hybrids were reared with an achievement of 98.26% against the target of 129 lakhs dfls and recorded the cocoon yield of 75.29 kg/ 100 dfls. The raw silk production achievement was 1471.92 MT against the target of 1389.231 MT.

Adarsha Gram (IVLP): A total of 2,10,650 dfls of bivoltine hybrids were reared in two clusters (Rayachoty and Vizianagaram) and average yield recorded was 70.85 kg 100 dfls which is an improvement of 9% against the bench mark.

On Station Trials (OST):

Evaluation of new bivoltine double hybrids:

One rearing trial (Oct. - Nov. 2019) of 1 new bivoltine hybrid was conducted

Silkworm hybrids	Fec. (No.)	Hatching (%)	ERR		SCW (g)	SSW (g)	SR %
			By No.	By Wt. (kg)			
NB6	445	95.00	8867	13.832	1.560	0.322	20.64

Evaluation of new bivoltine hybrid

One rearing trial (Nov.- Dec. 2019 of 1 new bivoltine hybrid was conducted.

Silkworm hybrids	Fec. (No.)	Hatching (%)	ERR		SCW (g)	SSW (g)	SR %
			By No.	By Wt. (kg)			
MASN4 x CSR4	467	96.40	8705	15.756	1.810	0.383	21.60

OST-3 Evaluation of new bivoltine hybrid

One rearing trial (Feb. - Mar. 2020) of 1 new bivoltine hybrid was conducted

Silkworm hybrids	Fec. (No.)	Hatching (%)	ERR		SCW (g)	SSW (g)	SR %
			By No.	By Wt. (kg)			
BH20	436	96.10	8629	16.049	1.860	0.392	21.07

On Farm Trials (OFT):

Newly developed silkworm hybrids (Bivoltine hybrids and Improved Crossbreeds) were test verified with the farmers by RSRS-Ananthapur and its nested units.

Unit	Hybrid combination	dfls (No.)	Yield/100 dfls (kg)	Rate/kg (RS.)
REC-Eluru	S8 x CSR16	4500	63.00	298
	CSR16 x S8	1000	62.00	292
	MASN4 x CSR4	9600	65.00	338
REC-V. Kota	S8 x CSR16	6000	62.23	357

Production of bio control agents :

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N. thymus was produced using house fly pupa and supplied to different areas as per their requirement. During this year 2019-20, 1236 pouches of *N. thymus* (50 ml, 2000 pupa) were produced and supplied to 326. Significant decrease in the Uzi infestation (14.8% to. 3.64%) through integrated control measures adopted.

Extension Communication Programmes:

Workshops, Group discussions, Awareness Programmes, Field Days, Farmers Days and Exposure visits were conducted by RSRS-Ananthapur and its nested units for transfer of technologies developed by main institute

Centre/ Cluster	Group Discussion		Farmers' Day		Field Day / Awareness Prog.		Resham Krishi Mela	
	Prog. (No)	Far. (No)	Prog. (No)	Far. (No)	Prog. (No)	Far. (No)	Prog. (No)	Farmers (No)
A. Andhra Pradesh								
Ananthapur	2	67	4	253	4	482	1	875
Hindupur	1	41	3	205	1	133	-	-
Madakasira	2	97	4	309	1	118	-	-
Kalyandurg	6	189	4	252	2	272	-	-
Penukonda	6	201	4	246	2	270	-	-
Atmakur	-	-	3	182	2	240	-	-

Pathikonda	-	-	3	194	2	198	-	-
Giddalur	-	-	2	122	1	107	-	-
Eluru (Bhimadole)	6	171	4	223	2	211	-	-
Chebrole	6	199	4	209	2	318	-	-
Vizianagaram	2	63	1	69	-	-	-	-
Rayachoty	6	156	4	199	2	234	-	-
V. Kota	6	226	5	292	3	371	-	-
Palamaner	6	194	4	243	3	374		
Chittoor	6	194	3	177	-	-	-	-
B. Telangana								
Vikarabad	6	174	4	197	2	183	-	-
C. Karnataka								
Bidar	6	178	4	320	-	-	-	-
Total	**67**	**2150**	**60**	**3692**	**29**	**3511**	**1**	**875**

Resham Krishimela/ Farmers' workshop: A Resham Krishimela was conducted at Madakasira on 11-03-2020. 875 Farmers including DoS staff, CSB scientists/ staff attended the Resham Krishimela workshop. Dr. Pankaj Tewary, Director, CSRTI-Mysuru, Smt. C. Aruna Kumari, Additional Director of Sericulture, Govt. of A.P., Chittoor, Dr. S. Purusotham, Dr. S. Manthira Moorthy, Scientist-D, CSRTI, Mysuru and Smt. D. Padmamma, Joint Director of Sericulture, Ananthapur participated in the workshop.

Development of new mulberry plantation at Clusters		
Unit	Farmers	Acres
A. Andhra Pradesh		
Hindupur	432	530
Madakasira	500	676
Kalyandurg	242	426
Penukonda	280	368
Atmakur	35	85
Pathikonda	17	46
Giddalur	58	129
Eluru (Bhimadole)	15	40
Chebrolu	116	223
Vijayawada	38	113
V. Kota	189	297
Palamaner	345	616
Chittoor	161	253
Rayachoty	58	60
Total	2486	3862
B. Telangana		
Vikarabad (Zaheerabad)	4	15
Total	2490	3877

Popularization of improved mulberry varieties:

A total of 3897 acres of were planted with improved mulberry variety among 2505 farmers.

Farm Source		
Unit	Farmers	Acres
RSRS-Anantapur	3	1.50
REC SU-Bidar	12	18.50
Total	15	20.00

Capacity Building and Training: RSRS and its nested units conducted 16 Farmers skill training programmes and Intensive bivoltine training and trained 288 farmers on various sericulture technologies.

Radio Programmes: Five radio programmes were also conducted by RSRS-Ananthapur and its RECS.

Swachh Bharat Abhiyan: Swachh Bharat Abhiyan was implemented as per the mandate/guidelines.

Visitors: RSRS-Ananthapur is a regular visiting place for sericultural farmers, students and officials for enriching knowledge on new technologies of mulberry cultivation and silkworm rearing.

RSRS-Mulugu

The Regional Sericultural Research Station, Mulugu in Siddipet district of Telangana state is functioning in the campus of Sri Konda Laxman Telangana state Horticultural University, Mulugu. The unit is located around 18 kms away from Hyderabad/ Secunderabad. As Telangana state is upcoming state in sericulture sector the RSRS, Mulugu is focussing more on extension communication activities and capacity building.

Scientist D and Head	Dr K.Praveen Kumar
Scientists	02
Administrative and Technical staffs	01+03

During the year 2019-20 RSRS, Mulugu implemented the CPP programme under as mentioned below

Details of various Extension Communication Programmes organised during 2019-20

Name of the event	Target for 2019-20		Achievement during 2019-20		
	Physical	Financial (Rs.)	Achi.	No. of farmers / Staff attended	Expenditure incurred (Rs.)
Group Discussions	35	35,000	30	741	24,499-00
Farmers Days	20	1,00,000	18	996	81,042-00
Awareness Programmes/Field Days	6	90,000	5	487	79,831-00
Resham Krishimela	1	2,50,000	1	3,500	2,49,694-00
Seed Act Awareness Programme by NSSO	1	25,000	1	110	25,000-00
Grand Total	63	5,00,000	55	5,834	4,60,066-00

Training programmes organised by RSRS, Mulugu during 2019-20

Name of the event	Target for 2019-20		Achievement during 2019-20		
	Physical	Financial (Rs.)	Achi.	No. of farmers / Staff attended	Expenditure incurred (Rs.)
CBT	150	5,25,000	150	150	4,74,322/-

Resham Krishimela and Farmers workshop at RSRS-Mulugu

RSRS -Mulugu organized a Resham Krishi Mela in coordination with DOS on 24-01-2020 at Agriculture Cotton Market, Siddipet. Sri T. Harish Rao, Hon'ble Minister of Finance, Telangana presided over the event. Sri S.Niranjan Reddy, Hon'ble Minister of Agriculture, Horticulture & Sericulture, Marketing, Civil Supplies & Cooperation, Telangana was the chief guest. Sri C. Parthasarathi, IAS, APC, Principal Secretary, Agriculture and Cooperation Dept. and Sri P. Venkatrami Reddy, IAS, District Collector, Siddipet District were the guests of honour. Shr. Rajit Ranjan Okhandiar IFS Member Secretary, Central Silk Board also attended the function.

Dr. P.J. Raju, Director , APSSRDI, Hindupur, A.P., Sri Mahadevaiah, Scientist - D , RSTRS, Dharmavaram, Sri Sathyanarayana Raju Scientist - D (Retd.), Dr. T. Mogili, Scientist - D (Retd.), Dept. of Horticulture and Sericulture Officers and Officials from different districts of Telangana attended. Around 3,500 farmers from different districts also attended the event.

The detailed technical aspects presentation in Hindi and in regional language by Sri B.V. Sanjeeva Rao, Scientist - D, RSRS, Mulugu on care to be taken by the farmers for Bivoltine Sericulture to obtain good quality and yield, emphasizing the importance of environmental factors. An exhibition on various technologies and release of booklets by dignitaries was also arranged. The support by CSB to states and the advantages of the existing national schemes in sericulture sector details were by the Member Secretary, Central Silk Board, Bengaluru. Some of the successful farmers from different districts and a farmer from neighbouring state Andhra Pradesh shared their experiences.

ADMINISTRATIVE REPORT

Main Institute

Central Sericultural Resarch & Training Institute – Mysuru

State/Units	RSRS	RECs	REC-SUs
Karnataka	Kodathi	3	3
	Chamarajanagara	-	-
Andhra Pradesh	Ananthapur	3	1
Telangana	Mulugu	1	-
Tamil Nadu	Salem	4	-
Kerala		1	-
Maharashtra		4	1
Madhya pradesh		1	1
	Total	**17**	**6**
P4 Basic Seed Farm –Hassan[KA]			
Satellite Silkworm Breeding Station – Coonoor [TN]			

R&D and Administrative Personnel of CSRTI and Nested Units		
R & D Personnel		
DIRECTORS	**Scientist-C**	**Nested Units**
Dr. RS Teotia (Upto 31-08-2019)	Sanath Kumar YN	**Karnataka**
Dr.Pankaj Tewary (From 01-09-2019)	Sibayan Sen	**Scientist-D**
	Vinod Kumar Yadav (Upto 15-06-2019)	Jalaja S. Kumar (Upto 27-02-2020)
Scientist-D	Arunkumar GS	Sabitha MG (From 12-12-2019)
Anuradha H Jingade	Bhuvaneswari E	Venkatachalapathy M
Babu CM (From 17-06-2019)	Gayathri T	Hanumantharayappa SK
Balachandran N	Joycy Rani D	Saraswathi P
Bhagya R (From 17-01-2020)	Kusuma L	Srinivasulu Y
Chandrashekar KB	Mallikarjuna G	Noble Morrison M
Chandrashekar MN	Satish L	Girish Naik V (Upto 31-01-2020)
Gandhi Doss. S	Sobhana V	Sivasubramonian T(From 01-07-2019)
Kishor Kumar CM (Upto 15-06-2019)	Tanmoy Sarkar	Nishita Naik
Kulkarni SB	Yeruva Thirupathaiah	Dayanand
Mahalingappa KC (Upto 30-06-2019)	Ranjini MS	Iswar (upto July 2019)
Manthira Moorthy S	Ravindra	**Scientist-C**
Mary Josepha A.V.	**Scientist-B**	Serani Nagendra
Meenal R	Bhavya MR	Ramesh Kumar
Muthulakshmi M	Dhaneshwar Padhan	Umesha A
Narendra Kumar JB	Divya Singh	Guruswamy D
Pratheesh Kumar PM	Vipin Kumar (Upto 31-01-20)	
Purushotham S	Amit Saha (From 05-04-2019)	
Rajashekar K (Upto 30-04-2019)		
Raveendra M Mattigatti (From 01-07-2019)	SRA (SS)	
Sabitha MG (From 12-05-2019 to 11-12-2019)	Geetha GS	
Santha PC		
Selvaraju NG	Deputy Director (Stat.)	
Shivakumar M. Hukkeri	Rekha M.	
Soudaminy PV	Deputy Director (Comp.)	
Srinivasa BT (Upto 31-10-2019)	Ganesan V	
Vineet Kumar	Assistant Director (SM)	
Madhusudhan KN	Munikrishnappa HM	
Mahima Santhi A (Upto 15-06-2019)	Sumathy R-Info.Officer (DBT-Sub DIC)	

Tamil Nadu	**Telangana**
Scientist-D	**Scientist-D**
Dahira Beevi N	Praveen Kumar K
Balasaraswathi S	Sanjeeva Rao BV
Sakthivel N	**Scientist-C**
Jessy Daniel	Vinod Kumar Yadav (From 18-06-2019)
Jhansi Lakshmi K	
Rajalakshmi E	**Maharashtra**
Samuthiravelu P	**Scientist-D**
Rajaram S	Karande AJ
Mahima Santhi A (From 17-06-2019)	Kushwaha RV
Sivasubramonian T (Upto 30-06-2019)	Ram Prakash
Chandrashekaran K (Upto 15-06-2019)	Humayun Sherief Y
Babu CM (Upto 15-06-2019)	Scientist-B
Mohan B	Jadhav AL
Scientist-C	Madhya Pradesh
Kamaraj S	**Scientist-D**
	Pradeep Shukla (Upto 30-10-2019)
Kerala	Gnana Kumar Daniel A
Scientist-D	
Sarala K	
Andhra Pradesh	
Scientist-D	
Sudhakar P	
Vijaya Naidu B	**Administrative Personnel**
Venugopal A	Malathi K. DD (A&A)
Srinivasa Rao TVS	Mohan DD (A&A)
Srinath B	Talawar BY LIO (Upto 31-05-2109)
Srinivasulu Reddy P (Upto 31-12-2019)	Pappu BS AD (Pub) (Upto 31-05-2109)
Venkataramana P (Upto 31-05-2019)	Vishwanath BS AD (A&A) (Upto 31-07-2019)
Kiran Kumar P	S.K. Upadyay, DD (OL)
Srinivasa BT (From 11-11-2019)	Venkatareddy GR AEE

Details of Review Meetings at CSRTI-Mysuru	
Meeting	Date
44th Research Advisory Committee RAC)	22nd July 2019
62nd Research Council (RC)	2nd - 3rd May 2019
63rd Research Council (RC)	11th -12th December 2019

Research Advisory Committee	
Chairman Prof. S.R. Niranjana Dept. of Studies in Biotechnology, University of Mysore, Manasagangotri, Mysore – 570 006.	The Commissioner of Sericulture Govt. of Andhra Pradesh TTPCBuilding, First Floor, Old Market Yard Chuttugunta (Besides Mini Rythu Bazar) Guntur - 522 007, Andhra Pradesh
Members Dr. Chandrasekharaiah Director (Rtd.), APSSRDI-Hindupur #595, 1st Cross, Kempegowda layout BSK III Stage Bengaluru - 560 085	The Commissioner of Sericulture Govt. of Telangana Road No. 72, Prashasan Nagar Adjacent to Water Tank, Jubilee Hills Hyderabad - 500 033, Telangana
Dr. A. Ramesh Sundar Principal Scientist, Plant Pathology Sugarcane Breeding Institute (ICAR) Coimbatore - 641 007,	The Director of Sericulture Department of Sericulture Govt. of Maharashtra New Administrative Building No.2, B-Wing, Civil Lane, VI Floor Nagpur - 440 010, Maharashtra
Prof. Ranganathan Ramani Director (Rtd.) (IINRG) 2A, Visakha, Doshi Nakshatra 1, Old SBI Colony, West Tambaram, Chennai 600 045	The Commissioner Commissionerate of Rural Development Govt. of Kerala LMS Compound, VikasBhavan Thiruvananthapuram - 695 033, Kerala
Prof. K.C. Narayana Swamy Department of Sericulture University of Agricultural Sciences (UAS) GKVK, Bengaluru - 560 065	The Commissioner Directorate of Sericulture Govt. of Madhya Pradesh Lower Basement, SatpuraBhavan Bhopal - 461 004, Madhya Pradesh
Invitees The Commissioner Sericulture Development & Director of Sericulture, Govt. of Karnataka 5th Floor, M. S. Building, Dr. B. R. AmbedkarVeedhi Bengaluru - 560 001, Karnataka	The Director (Tech) Central Silk Board CSB Complex, BTM Layout Madivala, Bengaluru - 560 068, Karnataka
The Director of Sericulture Department of Sericulture Govt. of Tamil Nadu , Nethaji Nagar, Hasthampatty Salem - 636 007,Tamil Nadu	The Director CSTRI ,Central Silk Board CSB Complex, BTM Layout Madivala, Bengaluru - 560 068, Karnataka
Mr. S. Hanumantharayappa S/o Patel Sanne Gowda Yaliyur Village, Yaliyur Post Devanahalli Taluk Benagaluru Rural District, Karnataka	Mr. S. Perumal, S/o Saravanan Nathakadu, Vellalapuram Village Chinnappampatti Post, Edapaddi taluk Salem District
Sri. Mohammed Anwar S/o Abdul Salamsab,1st TMC Layout Sidlaghatta – 562102 Chikkaballapur District	

Meteorological Data 2019: CSRTI-Mysuru							
Month	Temperature [^{0}C]			Humidity [%]			Rainfall [mm]
	Max.	Min.	Avg.	Max.	Min.	Avg.	
January	31.50	19.10	25.30	92.00	56.00	74.00	0.0
February	35.60	20.80	28.20	82.00	48.00	65.00	10.0
March	37.90	21.60	29.75	86.00	43.00	64.50	0.0
April	37.30	23.40	30.35	79.00	60.00	69.50	33.0
May	36.40	24.20	30.30	98.00	73.00	85.50	240.6
June	33.90	23.80	28.85	92.00	83.00	87.50	39.0
July	31.90	21.40	26.65	95.00	85.00	90.00	59.2
August	31.70	20.80	26.25	96.00	95.00	95.50	235.6
September	32.20	21.50	26.85	95.00	91.00	93.00	172.0
October	31.90	21.60	26.75	96.00	90.00	93.00	162.6
November	31.50	21.20	26.35	95.00	86.00	90.50	93.6
December	30.80	20.70	25.75	90.00	81.00	85.50	5.6
					Total Rainfall (mm)		1051.20
					No. of rainy days (d)		67

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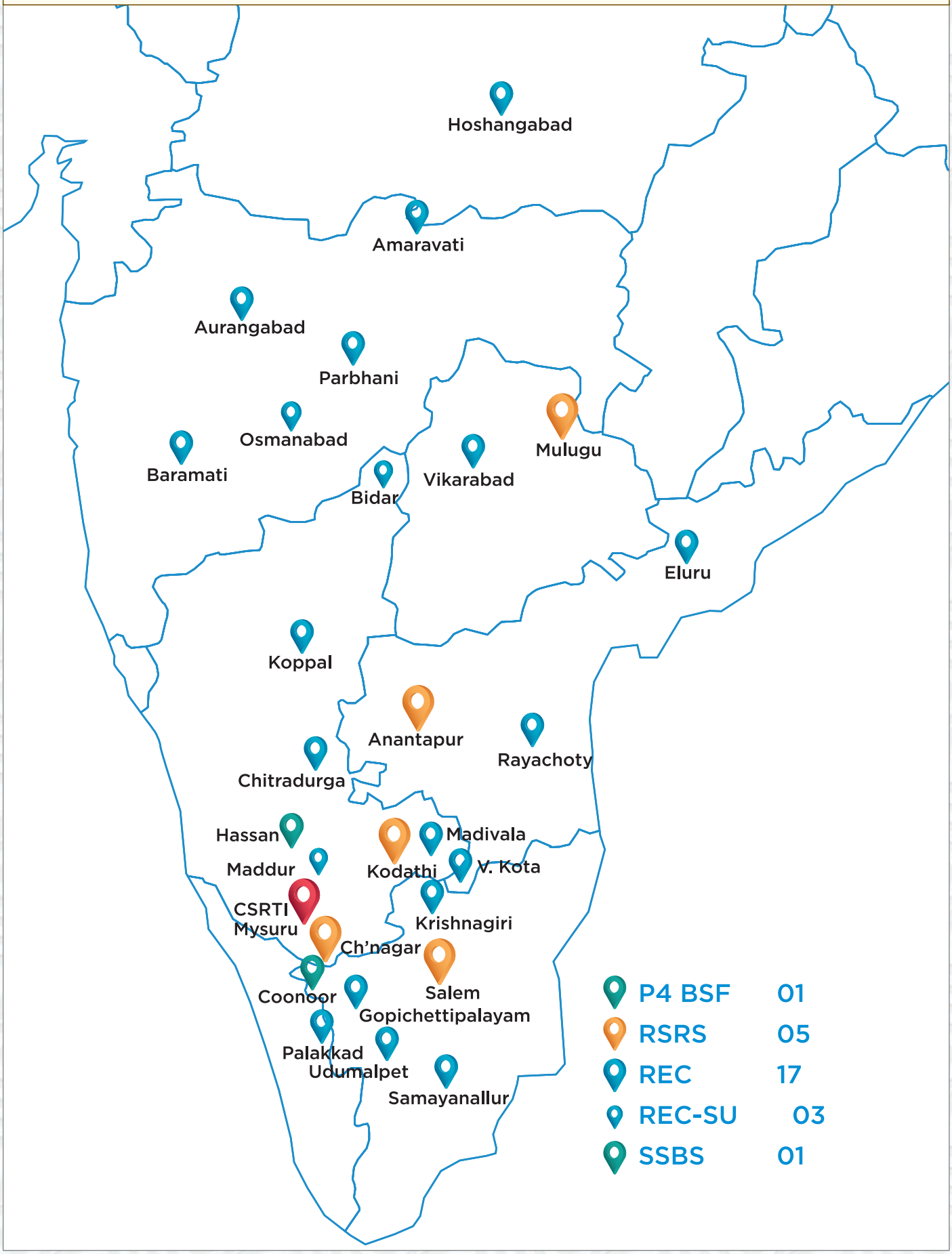

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