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वार्षिक प्रतिवेदन
ANNUAL REPORT
2018-19

केन्द्रीय रेशम बोर्ड भारत
CENTRAL SILK BOARD INDIA

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CSGRC, Hosur

वार्षिक प्रतिवेदन

ANNUAL REPORT
2018 - 19

केन्द्रीय रेशम जननद्रव्य संसाधन केन्द्र

Central Sericultural Germplasm Resources Centre

केन्द्रीय रेशम बोर्ड, वस्त्र मंत्रालय, भारत सरकार, होसूर - 635 109

Central Silk Board, Ministry of Textiles, Govt. of India, Hosur- 635 109

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Disclaimer

The Annual Report of CSGRC includes the research work related to the experiments conducted during the year 2018-19 and they are not conclusive recommendations or findings of the department unless or otherwise stated in this report. The data are under the process of publication in due course.

प्रस्तावना

केन्द्रीय रेशम जननद्रव्य संसाधन केंद्र , होसुर ने भावी पीढ़ी के लिए समृद्ध जैव विविधता के संरक्षण हेतु अपनी यात्रा को सफलतापूर्वक जारी रखा है। केंद्र व्यवस्थित रूप से 1200 से अधिक शहतूत और 450 रेशमकीट आनुवंशिक संसाधनों के अमूल्य संग्रह का संरक्षण करता है। अद्‌वितीय राष्ट्रीय अभिगम संख्या प्रदान करते हुये **राष्ट्रीय पादप आनुवांशिक संसाधन ब्यूरो** (रपअसब), **भाकृअप, नई दिल्ली** ने शहतूत जननद्रव्य के लिए और **राष्ट्रीय कृषि कीट संसाधन ब्यूरो** (रककसब), **भाकृअप, बेंगलुरु** ने रेशमकीट जननद्रव्य के लिए नेशनल एक्टिव जर्मप्लाज्म साइट (NAGS) के रूप में केंद्र को मान्यता दी है। केंद्र ने पेरियार विश्वविद्‌यालय, सेलम, तमिलनाडु से एम.फिल में शोध और पीएचडी कार्यक्रम के लिए उन्नत अनुसंधान केंद्र के रूप में भी मान्यता प्राप्त की।

अजैविक तनाव, जलवायु लचीलापन, पूर्व प्रजनन आदि पर ध्यान केंद्रित करते हुए फसल सुधार मे सहायता हेतु आन्तरिक तथा अन्य सीएसबी और गैर-सीएसबी अनुसंधान संस्थानों के साथ सहयोगात्मक नेटवर्किंग अनुसंधान परियोजनाओं के माध्यम से शहतूत और रेशमकीट आनुवांशिक संसाधनों का संग्रह, व्यवस्थित लक्षण वर्णन और मूल्यांकन के साथ-साथ अधिकतम विविधता सुनिश्चित करता है। संस्थान की वर्ष 2018-2019 की वार्षिक रिपोर्ट पेश करने में मुझे बहुत खुशी है, जिसमें जननद्रव्य अनुसंधान और विकास में महत्वपूर्ण उपलब्धियां केंद्रित हैं।

रिपोर्ट वर्ष के तहत, फसल सुधार में संभावित माता-पिता के रूप में उपयोग के लिए जलवायु परिवर्तन के लचीलापन हेतु कार्यात्मक लक्षण एवं शारीरिक दक्षता और पत्ती गुणवत्ता के संबंध में शीर्ष प्रदर्शन वाले शहतूत आनुवंशिक संसाधनों की पहचान की गई। केंद्र ने सीएसबी संस्थानों के साथ चयनित अभिगमो के संकरण का भी संचालन किया। परिणामी संतान का उपयोग बरसाती सेरीकल्चर के लिए सूखा सहिष्णु शहतूत किस्मों, उत्तर-पश्चिम भारतीय राज्यों के लिए और उत्तर पश्चिम भारत में पहाड़ी खेती के लिए बेहतर शहतूत की किस्मों के विकास के तहत हैं। सीएसआर एंड टीआई, बेरहामपुर से चौदह नए रेशमकीट आनुवंशिक संसाधनों को एकत्र किया गया था ताकि जर्मप्लाज्म स्टॉक को आगे और अधिक समृद्ध किया जा सके। विभिन्न कृषि-जलवायु वाले स्थानों पर सी एस आर 2 / सी एस आर 4 के साथ चयनित मल्टीवोल्टाइन और विदेशी बायोल्टाइन रेशमकीट के संयोजन के मूल्यांकन ने शीर्ष क्षेत्र विशिष्ट पेरफोरमर्स की पहचान की जो संभावित माता-पिता के रूप में कार्य कर सकते थे।

मैं केंद्रीय रेशम बोर्ड, बैंगलोर के अध्यक्ष, केंद्रीय रेशम बोर्ड, बेंगलुरु; सदस्य सचिव, केंद्रीय रेशम बोर्ड, बेंगलुरु; अध्यक्ष, आरएसी के साथ-साथ उनकी टीम के सदस्यों और अन्य विशेषज्ञों को उनके व्यावहारिक मार्गदर्शन और शोध गतिविधियों के सुधार के लिए सुझाव हेतु अपनी ईमानदारी से धन्यवाद व्यक्त करता हूं । मैं अपने सभी सहयोगियों को उनकी उपलब्धियों और योगदान के लिए बधाई और उनकी सराहना करता हूं। वार्षिक रिपोर्ट में सुधार के लिए कोई सुझाव हैं तो अवश्य दे ।

दिनांक: 15-11-2019

डॉ आर के मिश्रा
निदेशक [अतिरिक्त प्रभार]

PREFACE

The Central Sericultural Germplasm Resources Centre, Hosur has successfully continued its journey committed to conservation of the rich seribiodiversity for posterity. The Centre systematically conserves the priceless collection of more than 1200 mulberry and 450 silkworm genetic resources. The National Bureau of Plant Genetic Resources (NBPGR), ICAR, New Delhi recognized the centre as a National Active Germplasm Site (NAGS) for mulberry germplasm and National Bureau of Agricultural Insect Resources (NBAIR), ICAR, Bengaluru for silkworm germplasm assigning them unique National Accession numbers. The centre also obtained recognition as Advanced Research Centre for conducting research in M.Phil. and Ph.D Programmes from Periyar University, Salem, Tamilnadu.

The collection of mulberry and silkworm genetic resources ensures maximum diversity with systematic characterization and evaluation through in-house as well as collaborative networking research projects with other CSB and non-CSB research institutes focusing on abiotic stress, climate resilience, pre-breeding etc. to aid crop improvement. It gives me immense pleasure in presenting the Annual Report of the Institute for the year 2018-2019, wherein the significant achievements in germplasm research and development are focussed.

During the year under report, top performing mulberry genetic resources with respect to functional traits for resilience to climate change and for physiological efficiency and leaf quality for utilization as potential parents in crop improvement were identified. The centre also carried out hybridization of selected accessions with CSB institutes. The resultant progeny are under utilization for development of drought tolerant mulberry varieties for rainfed sericulture, superior mulberry varieties for North-West Indian states and for rainfed hill farming in North West India. Fourteen new silkworm genetic resources were collected from CSR&TI, Berhampore for further induction and enrichment of the germplasm stock. Evaluation of combinations of selected exotic bivoltine and multivoltine silkworm accessions with CSR2 / CSR4 at different agro-climatic locations identified top region specific performers that could function as potential parents.

I express my sincere thanks to the Chairman, Central Silk Board, Bangalore; Member Secretary, Central Silk Board, Bangalore, Chairperson, RAC as well as members and other experts for their insightful guidance and suggestions for improvement of research activities. I congratulate and appreciate all my colleagues for their achievements and contributions. Any suggestions for improvement of the annual report are solicited.

Date: 15-11-2019

Dr.R.K.Mishra
Director *[Addl. charge]*

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1. अनुसंधान की मुख्य विशेषताएं

केंद्रीय रेशम जननद्रव्य संसाधन केंद्र, होसुर भारत में प्रमुख अनन्य केंद्र है जो भावी पीढ़ी के लिए शहतूत और रेशमकीट जैव विविधता संरक्षण हेतु प्रतिबद्ध है। केंद्र को क्रमशः राष्ट्रीय पादप आनुवंशिक संसाधन ब्यूरो (रापाअसंब), भाकृअप, नई दिल्ली और राष्ट्रीय कृषि कीट संसाधन ब्यूरो (राकृकसब), भाकृअप, बेंगलुरु द्वारा शहतूत और रेशमकीट जर्मप्लाज्म के लिए "नेशनल एक्टिव जर्मप्लाज्म साइट्स" के रूप में मान्यता प्राप्त है। वर्ष 2018-19 में केंद्र की उपलब्धियाँ निम्नावत है:

शहतूत विभाग

- शहतूत आनुवंशिक संसाधनों के संरक्षण के तहत, क्षेत्र जीन बैंक में 1292 अभिगमों का संरक्षण किया गया।
- शहतूत जननद्रव्य सूचना प्रणाली (एम जी आई एस) में कुल 23 नए शहतूत अभिगमों के अभिलक्षण और डेटाबेस को अद्यतित किया गया।
- केरेजसंके होसुर, केरेअवप्रसं, मैसूर और क्षरेअसं अनंतपुर में जलवायु परिवर्तन की लचीलाता के लिए कार्यात्मक लक्षण हेतु शहतूत आनुवांशिक संसाधनों के मूल्यांकन से पांच शीर्ष पेरफोरमेर्स अर्थात: MI-0256, MI-0622, ME-0007, MI-0458, ME-0251 को दर्शाया जिनका शहतूत फसल सुधार हेतु उपयोग किया जा सकती है।
- क्रियात्मक दक्षता और पत्ती गुणवत्ता के लिए शहतूत जननद्रव्य मुख्य सेट का मूल्यांकन विभिन्न विशेषता विश्लेषण के आधार पर 10 शीर्ष पेरफोरमेर्स अर्थात: MI-0167, MI-0231, ME-0262, MI-0252, MI-0310, ME-0027, ME-0156, ME-0001, ME-0220, MI-0290 का पता चला जिनका उपयोग शहतूत प्रजनन कार्यक्रमों में किया जा सकता है।
- केरेअवप्रसं, बेरहमपुर और पामपोर के साथ सहयोगी के रूप में, केंद्र ने चयनित अभिगमों के संकरण को अंजाम दिया और परिणामी बीजों की आपूर्ति केरेअवप्रसं, बेरहमपुर को वर्षा आधारित रेशमुद्योग हेतु सूखा सहिष्णु शहतूत की किस्मों के विकास के लिए की गई और उत्तर-पश्चिम के लिए श्रेष्ठ शहतूत किस्मों के विकास के लिए एवं उत्तर पश्चिम भारत में वर्षा आधारित पहाड़ी खेती के लिए उपयुक्त शहतूत किस्मों के बीजों की आपूर्ति केरेअवप्रसं, पामपोर को की गई।

रेशमकीट विभाग

- रेशमकीट आनुवांशिक संसाधनों के संग्रह, अभिलक्षण, मूल्यांकन और संरक्षण के निरंतर कार्यक्रम में, केरेअवप्रसं, बेरहमपुर से 14 नए रेशमकीट अभिगमों को एकत्र किया गया और पंजीकरण और

परिग्रहण हेतु संगरोध पालन किया गया।

- रेशमकीट आनुवांशिक संसाधनों के संरक्षण और रखरखाव के तहत, 475 (83 मल्टीवोल्टाइन, 369 बाईवोल्टाइन और 23 म्यूटेंट) अभिगमों को पूरी तरह से लक्षण वर्णन और मूल्यांकन के बाद रोग मुक्त परिस्थितियों में संरक्षित किया गया था और डेटाबेस को रेशमकीट जननद्रव्य सूचना प्रणाली (एसजीआईएस) में अद्यतन किया गया।
- विभिन्न कृषि-जलवायु स्थानों पर CSR2 / CSR4 के साथ विदेशी बायोल्टाइन अभिगमों के 20 संयोजनों का केरेजसंके होसुर, केरेअवप्रसं, मैसूर, बरहामपुर और पांपोर में मूल्यांकन से पता चला कि, संयोजन BBE-0197 x 291 ने केरेजसंके, होसुर, केरेअवप्रसं, मैसूर और पांपोर में बेहतर प्रदर्शन किया, जब की केरेजसंके बरहामपुर में, BBE-0163 x 290 के संयोजन ने बेहतर प्रदर्शन किया।
- CSR2 के साथ मल्टीवोल्टाइन अभिगमों के 20 संयोजनों के मूल्यांकन से पता चला कि, BMI-081 x CSR2 और BMI-048 x CSR2 सभी मौसमों के दौरान सभी स्थानों पर बेहतर प्रदर्शन किया।

उन्नत अनुसंधान केंद्र के रूप में मान्यता

- इस अवधि के दौरान एम.फिल व पीएचडी अनुसंधान कार्यक्रम के लिए उन्नत अनुसंधान केंद्र के रूप में केंद्र ने पेरियार विश्वविद्यालय, सलेम, तमिलनाडु से मान्यता प्राप्त की है।
- दो वैज्ञानिक अर्थात: डॉ एम माहेश्वरी, वैज्ञानिक-डी और डॉ जी लोकेश, वैज्ञानिक-डी को एम.फिल व पीएचडी अनुसंधान कार्यक्रम के लिए अनुसंधान मार्गदर्शक / पर्यवेक्षक के रूप में पेरियार विश्वविद्यालय, सलेम, तमिलनाडु के तहत मान्यता दी गई है।

1. RESEARCH HIGHLIGHTS

The Central Sericultural Germplasm Resources Centre, Hosur is the premier exclusive centre in India committed to overall conservation of mulberry and silkworm biodiversity for posterity. The Centre is recognized by the National Bureau of Plant Genetic Resources (NBPGR), ICAR, New Delhi as a National Active Germplasm Site (NAGS) for mulberry germplasm and by the National Bureau of Agricultural Insect Resources (NBAIR), ICAR, Bengaluru for silkworm germplasm. The following are the research highlights of the centre for the year 2018-19:

Mulberry Division

- Under conservation of mulberry genetic resources, 1292 accessions were conserved in the field gene bank.
- A total of 23 new mulberry accessions were characterized and database updated in the Mulberry Germplasm Information System (MGIS).
- Evaluation of mulberry genetic resources for functional traits for resilience to climate change at CSGRC Hosur, CSR&TI Mysuru and RSRS Ananthpur revealed five top performers *viz.* MI-0256, MI-0622, ME-0007, MI-0458, ME-0251for leaf yield which can be utilized for mulberry crop improvement.
- Evaluation of core set of mulberry germplasm for physiological efficiency and leaf quality revealed 10 top performers based on multiple trait analysis *viz*. MI-0167, MI-0231, ME-0262, MI-0252, MI-0310, ME-0027, ME-0156, ME-0001, ME-0220 and MI-0290 which can be utilized in mulberry breeding programs.
- As collaborator with CSR&TI Berhampore and CSR&TI Pampore, the centre carried out hybridization of selected accessions and the resultant seeds were supplied to CSR&TI Berhampore for development of drought tolerant mulberry varieties for rainfed sericulture and to CSR&TI Pampore for development of superior mulberry varieties for North-West Indian states and suitable for rainfed hill farming in North West India.

Silkworm Division

- In the continuous programme of Collection, Characterization, evaluation and conservation of Silkworm Genetic Resources, 14 new silkworm races were collected from CSR&TI, Berhampore, quarantine rearing was conducted for further registration and accessioning.
- Under conservation and maintenance of silkworm genetic resources, 475 (83 multivoltine, 369 bivoltine and 23 mutants) accessions were conserved under disease free conditions after thorough characterization and evaluation and the database was updated in the Silkworm Germplasm Information System (SGIS).
- Evaluation of 20 combinations of exotic bivoltine accessions with CSR2 / CSR4 at

different agro-climatic locations *viz*., CSGRC Hosur, CSR&TIs, Mysuru, Berhampore and Pampore revealed that, the combination BBE-0197 x 291 showed better performance at CSGRC, Hosur, CSR&TI, Mysuru and Pampore, while, at CSR&TI, Berhampore, the combination BBE-0163 x 290 performed better.

- Evaluation of 20 combinations of multivoltine accessions with CSR2 / CSR4 revealed that, BMI-081 x CSR2 and BMI-048 x CSR2 performed better at all locations during all seasons.

Recognition as Advanced Research Centre

- During the period the centre has obtained recognition as Advanced Research Centre for conducting research in M.Phil. and Ph.D Programmes from PERIYAR UNIVERSITY, Salem, Tamilnadu.
- Two Scientists *viz.* Dr. M. Maheswari, Scientist-D and Dr. G.Lokesh, Scientist-D have been recognized as Research Guides / Supervisors for M.Phil. and Ph.D candidates under the PERIYAR UNIVERSITY, Salem, Tamilnadu.

2. प्रस्तावना

केंद्रीय रेशम जननद्रव्य संसाधन केंद्र (केरेजसके), होसूर केंद्र रेशम बोर्ड (केरेबो) द्वारा एक विशेष संस्थान है, जिसके अधिदेश में शहतूत रेशम आनुवांशिक संसाधनों को इकट्ठा करने, लक्षण वर्णन, मूल्यांकन और संरक्षण के साथ-साथ उक्त पहलूओं पर जागरूकता और कर्मियों को प्रशिक्षण देने शामिल है। प्रजनकों की अधिकारों के रक्षा के लिए संसाधन पंजीकरण समिति द्वारा विभिन्न संस्थानों में विकसित रेशम आनुवांशिक संसाधनों को पंजीकृत करने हेतु इस केंद्र को केरेबो द्वारा अधिकृत किया गया हैं। केंद्र को क्रमशः राष्ट्रीय पादप आनुवांशिक संसाधन ब्यूरो (रपअसब), भकृअप, नई दिल्ली और राष्ट्रीय कृषि कीट संसाधन ब्यूरो (रककसब), भकृअप, बेंगलुरु द्वारा शहतूत और रेशमकीट जननद्रव्य के लिए "नेशनल एक्टिव जर्मप्लाज्म साइट्स" के रूप में मान्यता प्राप्त है। इस केंद्र में संरक्षित संसाधनों को पूर्वोक्त संस्थानों द्वारा राष्ट्रीय अभिगम संख्याएं दी गई हैं। केरेजसके होसुर बेहतर प्रदर्शन करने वाले पैतृक स्टॉक की पहचान के उद्देश्य से विभिन्न स्वदेशी संसाधनों के मूल्यांकन के लिए कई आंतरिक और सहयोगी परियोजनायें लागू कर रहा है जो फसल सुधार में प्रजनकों की सहायता करेंगे।

अधिदेश

- संग्रह, संरक्षण, प्रलेखन, मूल्यांकन का उपयोग करना और रेशम जननद्रव्य संसाधनों पर अनुसंधान।
- अन्य के रे बो अ व प्र संस्थानों के सहयोग से हितधारकों के लिए जननद्रव्य का सतत उपयोग।
- रेशम जननद्रव्य संसाधनों के संरक्षण और उपयोग पर हितधारकों की जागरूकता और प्रशिक्षण का सृजन।

गतिविधियाँ

- शहतूत एवं रेशमकीट जननद्रव्य का अन्वेषण, संग्रहण तथा पुनर्स्थापन करना।
- आनुवंशिक संसाधनों के उपयोग को प्रोत्साहित करने हेतु जननद्रव्य संग्रहणों का लक्षण वर्णन, वर्गीकरण, प्रारंभिक मूल्यांकन तथा सूचीबद्धकरण।
- रेशम आनुवंशिक संसाधनों के राष्ट्रीय परिग्रहण एवं दीर्घकालिक राष्ट्रीय भंडार के रूप में सेवा प्रदान करना।
- महत्वपूर्ण जननद्रव्य संसाधनों के पंजीकरण तथा उद्गत केंद्र के लिए केंद्रक अभिकरण के रूप में कार्य करना।
- रेशम जननद्रव्य के स्क्रीनिंग / परीक्षण मूल्यांकन के लिए / अंतरसंस्थागत सहयोग हेतु प्रमुख भूमिका निभाना।

- आगामी जननद्रव्य की संगरोध जांच एवं जननद्रव्य निर्यात हेतु फाइटोसैनिटरि प्रमाण पत्र जारी करने समेत जननद्रव्य आयात और निर्यात का समन्वय करना।
- रेशम आनुवंशिक संसाधनों के राष्ट्रीय डेटाबेस और वनस्पति संग्रहालय प्रदर्शन के /तौर पर सेवा करना।
- सभी जरूरतमंद संगठनों को जननद्रव्य की आपूर्ति करना।
- रेशम जननद्रव्य संसाधन प्रबंधन में प्रशिक्षण प्रदान करना।

रेसल्ट्स फ्रेमवर्क डोकुमेंट [आर एफ डी]

<u>दृष्टिकोण</u>

रेशम आनुवंशिक संसाधनों के पंजीकरण, मूल्यांकन, संरक्षण के लिए नोडल एजेंसी बनना।

<u>मिशन</u>

भारत में रेशम आनुवंशिक संसाधनों को पंजीकृत करना, फसल सुधार कार्यक्रम के लिए रेशम आनुवंशिक संसाधनों के उपयोग को सुविधाजनक बनाने के लिए अनुसंधान गतिविधियाँ, राष्ट्रीय भावी पीढ़ी को विलुप्त होने से बचाने के लिए रेशम आनुवंशिक संसाधनों का संरक्षण।

<u>रोड मैप</u>

लघु अवधि योजनाएं

1. विभिन्न राज्यों में जलवायु तनावग्रस्त क्षेत्रों में अनन्वेषित इलाकों का सर्वेक्षण तथा नए शहतूत आनुवंशिक संसाधनों के संग्रह के लिए विभिन्न देशों के मार्ग का पता लगाना।
2. विविधता और जीन समृद्ध केन्द्रों से शहतूत आनुवंशिक संसाधनों के स्वस्थाने संरक्षण को बढ़ावा देना।
3. संग्रह द्वारा संसाधनों का संवर्धन और तनाव के प्रति सहिष्णुता हेतु आनुवंशिक संसाधनों को इकट्ठा करने / पहचानने के लिए होटस्पॉट क्षेत्रों में मूल्यांकन।
4. शहतूत आनुवंशिक संसाधनों की रक्षा करने तथा उपयोगिकरण को बढ़ावा देने के लिए जलवायु अनुरूप रेशम उत्पादन को अपनाना।
5. आनुवंशिक वृद्धि के लिए पूर्व प्रजनन कार्यक्रम।
6. अजैविक और जैविक प्रतिबल हेतु रेशम आनुवंशिक संसाधनों का मूल्यांकन।
7. मार्करों के माध्यम से आनुवंशिक संसाधनों का आण्विक लक्षण वर्णन।

दीर्घकालिक योजनाएं

1. एनबीपीजीआर क्षेत्रीय स्टेशनों और अन्य वन विभागों के सहयोग से अस्पष्टीकृत और कठिन क्षेत्रों का सर्वेक्षण।
2. एनबीपीजीआर, नई दिल्ली / आईएससी, के रे बो कॉम्प्लेक्स, बैंगलोर के माध्यम से विदेशी शहतूत (मोरस) प्रजातियों का पुर:स्थापना ।
3. पर्यावरण हितैषी और जैविक कृषि तकनीकों को अपनाना।
4. शहतूत प्रजनकों द्वारा नोवेल जीन / अल्लील का उपयोग करने और आधार विस्तार करण के साथ-साथ हेटेरोसिस के काम में लाने के लिए जंगली जीनों के अंतःक्षेपण के लिए प्रीब्रीडिंग कार्यक्रमों का कार्यान्वयन।
5. भू प्रजातियों को उनके जन्मज कृषि परिस्थिति में संरक्षित करने हेतु स्टृक्चेर्ड एवं संपोषणीय ऑन-फार्म और इन सिटू संरक्षण।
6. बैक अप के साथ लागत प्रभावी संरक्षण के लिए उन्नत जैव प्रौद्योगिकी के साधनों को अपनाने वाले शहतूत और रेशम के कीटाणु जीन बैंकों के लिए एक्स सिटू संरक्षण रणनीतियों का उन्नयन।
7. आनुवांशिक वृद्धि हेतु पूर्व प्रजनन कार्यक्रम के लिए आणविक उपकरणों का उपयोग कर जंगली और भू-प्रजाति में होनहार जीन की पहचान।
8. केंद्र के आवश्यक अधिदेश के रूप में जीनोमिक्स को शामिल करके विभिन्न अजैविक तनावों / कार्यात्मक लक्षणों के प्रति सहिष्णुता के लिए सेरी-आनुवंशिक संसाधनों की जांच के लिए आणविक उपकरणों का उपयोग।
9. कठिन श्रम घटौती के लिए मेजबान संयंत्र की खेती और रेशम कीट पालन में मशीनीकरण।
10. जलवायु परिवर्तन लचीलाता के लिए विशिष्ट कार्यात्मक लक्षणों के साथ शहतूत जननद्रव्य की पहचान।
11. लक्षण वर्णन और मूल्यांकन डेटा के साथ आणविक आईडी जोड़के सेरी-आनुवंशिक संसाधनों के राष्ट्रीय डेटा बेस का विकास।

2. INTRODUCTION

The Central Sericultural Germplasm Resources Centre (CSGRC), Hosur is an exclusive institute established by the Central Silk Board (CSB) with a mandate to collect, introduce, characterize, evaluate, conserve mulberry serigenetic resources as well as to create awareness and train personnel on the said aspects. The centre is authorized by the CSB to register serigenetic resources developed by various institutes through the Germplasm Registration Committee to protect authorship rights of the breeders. The centre is recognized as "National Active Germplasm Sites" for mulberry and silkworm germplasm by the National Bureau of Plant Genetic Resources (NBPGR), ICAR, New Delhi and the National Bureau of Agricultural Insect Resources (NBAIR), ICAR, Bengaluru, respectively. The germplasm conserved at this centre are assigned national accession numbers by the aforesaid institutes. CSGRC Hosur has been implementing several inhouse and collaborative projects for evaluating serigenetic resources aiming at identification of better performing parental stock that will aid breeders in crop improvement.

Mandate

1. *Collection, conservation, documentation, evaluation, utilization of and research on sericultural germplasm resources.*
2. *Sustainable utilization of germplasm for stakeholders in collaboration with other CSB R&D institutes.*
3. *Creation of awareness and training of stakeholders on conservation and utilization of sericultural germplasm resources.*

Activities

- *To explore, collect and introduce mulberry and silkworm germplasm.*
- *To undertake characterisation, classification, preliminary evaluation & cataloguing of germplasm collection for promoting utilization of genetic resources.*
- *To serve as the long-term national repository of sericultural genetic resources and national accessioning.*
- *To act as a nodal agency for registration and reference centre for important germplasm resources.*
- *To play a lead role in the inter-institutional collaboration for screening /testing / evaluation of sericultural germplasm.*
- *To co-ordinate import and export of genetic resources along with quarantine check pertaining to incoming germplasm and issuing phytosanitary certificate for export of germplasm.*
- *To serve as the national database and herbarium / display of sericultural genetic resources.*

- *To supply the germplasm to all needy organizations.*
- *To impart training in sericultural germplasm resource management.*

Results framework document [RFD]

Vision: To become the nodal agency for registration, evaluation and conservation of serigenetic resources.

Mission: Register the serigenetic resources in India, Research activity facilitating utilisation of serigenetic resources for crop improvement programme, Conservation of serigenetic resources, National posterity and prevention of extinction.

Road map

Short term plans

1. Survey unexplored areas from climate stressed regions in different states and explore avenues from different countries for collection of new mulberry genetic resources to enrich the genetic stock.
2. Promotion of *in situ* conservation of mulberry genetic resources from the centers of diversity and gene richness.
3. Enrichment of germplasm through collections and evaluation in hotspot areas to collect / identify genetic resources for tolerance to stress.
4. Adoption of climate resilient sericulture to protect mulberry genetic resources
5. Implementation of pre-breeding programmes for genetic enhancement.
6. Evaluation of silkworm genetic resources for abiotic and biotic stress.
7. Molecular characterization of seri-genetic resources through markers.

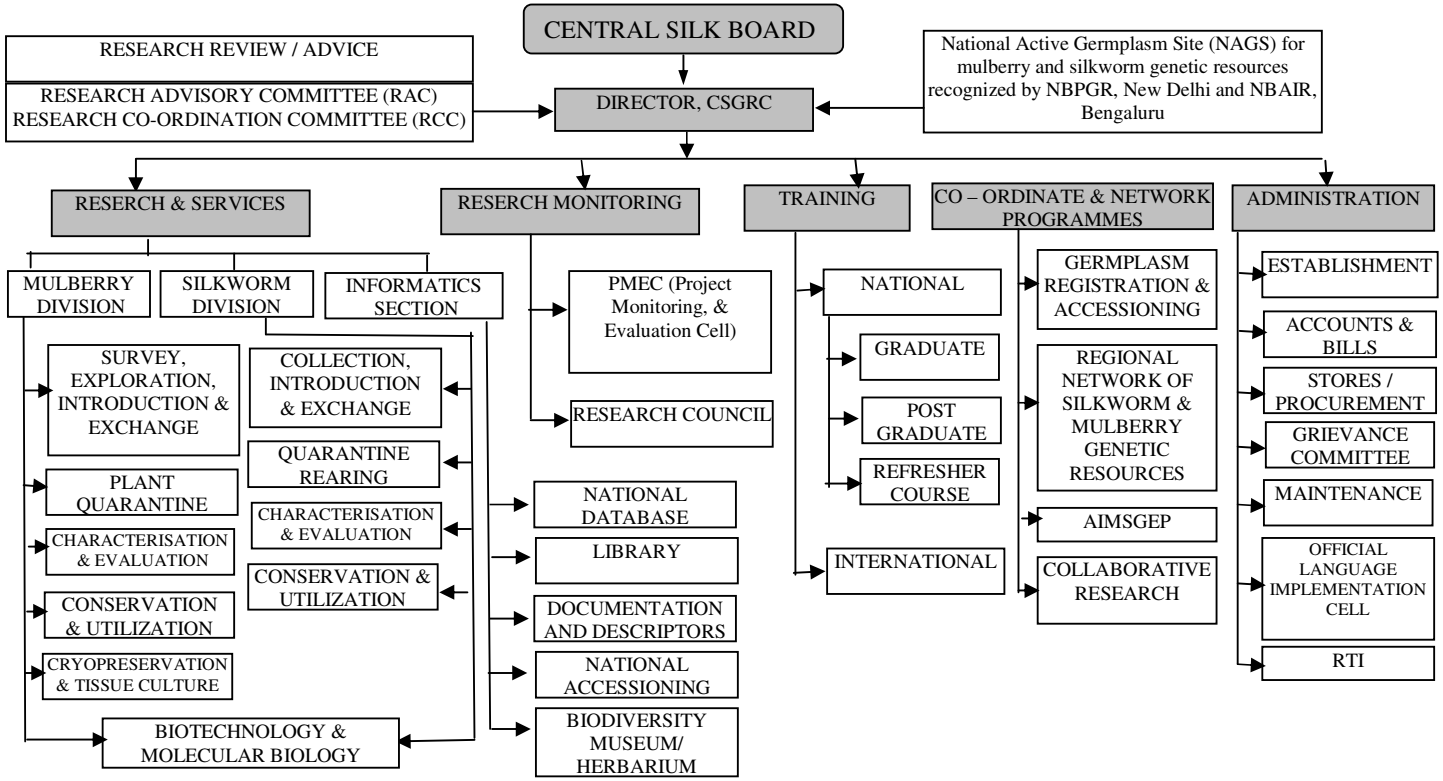
Long term plans

1. Survey of unexplored and difficult areas in collaboration with NBPGR regional stations and other Forest departments.
2. Introduction of exotic mulberry (*Morus*) species through NBPGR, New Delhi / ISC, CSB Complex, Bangalore.
3. Adoption of eco friendly and organic farming techniques.
4. Implementation of prebreeding programs for introgression of wild genes into the agronomic varieties to facilitate use of novel genes/alleles by mulberry breeders and for

base broadening as well as exploitation of heterosis.

5. Implementation of structured and sustainable on-farm and *in situ* conservation of landraces in their native agro-ecological environments.
6. Upgradation of *ex situ* conservation strategies for mulberry and silkworm gene banks adopting advanced biotechnological tools with back up for cost effective conservation.
7. Identification of promising genes in wild and land races using molecular tools for utilization in pre-breeding programme for genetic enhancement.
8. Utilization of molecular tools for screening seri-genetic resources for tolerance to different abiotic stresses / functional traits by including Genomics as an essential mandate of the centre.
9. Mechanization in host plant cultivation and silkworm rearing for drudgery reduction.
10. Identification of mulberry germplasm with specific functional traits for resilience to climate change.
11. Development of National Data Base of Seri-genetic Resources with molecular IDs along with characterization and evaluation data.

3. ORGANISATIONAL SETUP OF CSGRC, HOSUR



4. LIST OF RESEARCH PROJECTS

PROJECT CODE	TITLE OF PROJECT	DURATION
MULBERRY DIVISION		
Continued during 2018-19		
PIE – 3575	Evaluation of mulberry genetic resources for functional traits for resilience to climate change (CSGRC Hosur with RSRS Ananthpur & CSR&TI Mysuru)	May.16 to May.19
PIB – 3505	Development of drought tolerant mulberry varieties for rainfed sericulture (CSR&TI Berhampore with CSGRC Hosur)	Feb.14 to Dec.19
PIB – 3586	Development of superior mulberry varieties through controlled hybridization for North-West Indian states (CSR&TI Pampore with CSGRC Hosur)	Mar.17 to Feb.22
PIB - 3629	Development of Mulberry Genotypes Suitable for Rainfed Hill Farming in North - West India (RSRS, Jammu with CSGRC, Hosur)	Jan.18 to Dec. 21
Continued through and concluded during 2018-19		
PIE - 3566	Evaluation of core set of mulberry germplasm for physiological efficiency and leaf quality	Mar.16 to March.19
New initiated during 2018-19		
PIE-06001 SI	Collection, Characterization, Evaluation, Conservation and Supply of Mulberry Genetic Resources	Nov.18 to Nov.21
PIC 01003 CN: NW4B	Sugar-Mimic Alkaloids in Mulberry and their Role in Modulating Host Plant-Insect Interactions.) (CSB-DBT funded Multi-Component Network Project: Genetic Enhancement of Mulberry through Genomic Approaches)	Jun.18 to Jun. 21

SILKWORM DIVISION		
Continued during 2018-19		
AIB – 3577	Evaluation of multivoltine germplasm to identify potential parents for developing cross breeds for Southern and Eastern India (CSGRC Hosur with CSR&TI Mysuru & CSR&TI Berhampore)	Jun.16 to May'19
AIB – 3578	Evaluation of exotic bivoltine silkworm breeds to identify promising parental genetic resources (CSGRC Hosur with CSR&TI Mysuru, CSR&TI Berhampore & CSR&TI Pampore).	Jun.16 to Aug.19
New initiated during 2018-19		
AIE - 06002 MI	Evaluation of bivoltine silkworm genetic resources for tolerance to abiotic stress in selected hotspots	Mar.19 to Feb. 22
Routine programme	Collection, characterization, evaluation, conservation and supply of silkworm genetic resources (Phase IX)	Continuous

5. OUTCOME OF CONCLUDED RESEARCH PROJECTS

MULBERRY DIVISION

1. PIE-3566: Evaluation of coreset of mulberry germplasm for physiological efficiency and leaf quality (Mar.16 – Mar.19)

K. Jhansilakshmi, PI (till Jun.18), G.Thanavendan, PI (from Jul, 2018) & N. Boopathi, SRF

Though mulberry leaf yield increased gradually through crop improvement, most of the variations observed were for yield associated traits. Hence, further increase in yield potential is possible only through utilizing other unexploited variations available in mulberry germplasm. One such possibility is improving photosynthetic efficiency for improved yield at high CO_2, reducing yield loss under high temperature which is anticipated in lieu of climate change while maintaining/ improving leaf quality. The project was thus taken up to evaluate the mulberry accessions for different physio-biochemcial and leaf quality/nutritional parameters to identify promising mulberry accessions through high physiological efficiency traits with leaf yield. The objectives were:

1. To identify important physiological parameters associated with high leaf yield
2. To estimate variability for different leaf nutritional components which reflect leaf quality
3. To identify MGRs with high physiological efficiency and leaf quality to enhance mulberry leaf yield and leaf quality.

Methodology

Experimental design	ARBD
No. of Accessions	150
No. of plants/ Accession	7
No. of pruning per year	3
Spacing	(5+3) X 2 ft.
Standard Check	V1, Vishala, S-13
Location	CSGRC, Hosur

Results and discussion

Evaluation of 150 selected mulberry accessions revealed highest variability in physiological parameters in early vigour (LAI) (CV - 60.83%) followed by Sprouting percentage (34.45%), Leaf fall per cent (45.45%), Total chlorophyll (19.60%), Glutamine synthetase (42.28%), Stomatal conductance (40.36%), Intrinsic WUE (51.37%) and Transpiration rate

(34.89%). Similarly leaf nutritional components that revealed highest variability were in Leaf yield (CV – 61.88%) followed by Nitrogen (56.98%), Water use efficiency (38.36 %), Leaf area (35.28%), Ascorbic acid (35.13%), Potassium (23.87%), Phosphorus (22.05%), Leaf Temperature (17.72%), Protein (12.81%), Water soluble carbohydrates (12.99%) and Moisture (6.50 %). The details of top performing accessions for different physio-biochemical and leaf quality parameters and physiological efficiency with leaf yield cum nutritional components based on multiple traits are presented in **Tables 1, 2, 3, 4 & 5**.

Table 1: Variability statistics of different physiological parameters for 150 mulberry accessions

Parameter	Mean	Min.	Max.	SE	CV%
Sprouting Percentage (% @ 15 DAP)	65.39	10.22	100.00	2.47	34.45
Early vigour (LAI @ 25 DAP)	0.88	0.41	2.54	0.60	60.83
Leaf fall or Yellowing (% @ 70 days)	45.60	8.33	90.83	2.27	45.45
Photosynthetic rate (A) ($\mu molm^{-2}s^{-1}$)	13.77	7.36	26.80	0.37	24.29
Glutamine synthetase (mg/g fwt γ-glutamylhydroxamate)	0.46	0.24	1.24	0.20	42.28
Stomatal conductance (gs) ($molm^{-2}s^{-1}$)	0.34	0.10	3.78	0.45	40.36
Transpiration rate (T) ($mmolm^{-2}s^{-1}$)	5.98	1.86	11.59	0.23	34.89
Intrinsic WUE (A/gs)	47.27	9.18	94.69	24.28	51.37
Intercellular CO_2/ Ambient CO_2 (iCO_2/aCO_2)	0.61	0.30	0.91	0.13	21.52
Total chlorophyll (mg/ g.fwt.)	2.17	1.56	3.45	0.50	19.60
Leaf yield/plant (g)	525.74	41.00	1498.42	41.65	61.88

Table 2: Top performing mulberry accessions for different physio-biochemical parameters

Parameter	Range	Accession Number
Sprouting Percentage (% @ 15 DAP)	100-87.50	MI-0272, MI-0187,MI-0231,MI-0020,MI-0224, V1, MI-0099, MI-0011, MI-0108, Vishala, MI-0214, MI-0286, MI-0665,MI-0376, MI-0341, ME-0220, MI-0173
Early vigour (LAI at 25 DAP)	3.11-1.63	V1, MI-0099, MI-0011, MI-0108, Vishala, MI-0214, MI-0286, MI-0665, MI-0376, MI-0341, ME-0220, MI-0173, MI-0625, ME-0198, MI-0252, MI-0007, ME-0004 MI-G2

Parameter	Range	Accession Number
Leaf fall or Yellowing (% @ 70 days)	5-8	S-13, MI-0621, ME-0056, MI-0290, MI-0625, MI-0643, MI-0014, ME-0004, V1, MI-0099, MI-0011, MI-0108, MI-0214, MI-0286, MI-0665, MI-0376,MI-0341,ME-0220,MI-0173
Photosynthetic rate ($\mu molm^{-2}s^{-1}$)	26.06-18.16	MI-0214, MI-0286, MI-0665,MI-0376,MI-0341, ME-0220, MI-0173, MI-0099, MI-0011, MI-0108, MI-0179, MI-0290, ME-0052, MI-0231, S13, MI-0061, ME-0253, MI-G2
Glutamine synthetase (mg/g fwt γ-glutamyl-hydroxamate)	54.64-24.44	ME-0220, MI-0173 MI-0214, MI-0286, MI-0665, MI-0376,MI-0341,MI-0099,MI-0011, MI-0108,MI-0179,MI-0290,ME-0052,MI-0231, S13, MI-0061, ME-0253, MI-G2
Stomatal conductance ($molm^{-2}s^{-1}$)	0.614-0.432	ME-0254,MI-0065,Vishala, MI-0285,MI-0043, MI-0214,MI-0286,MI-0665, MI-0376, MI-0341 ME-0220,MI-0173,MI-0099,MI-0011,MI-0108, MI-0179, MI-0290, ME-0052, MI-0231, S13, MI-0061, ME-0253, MI-G2
Transpiration rate ($mmolm^{-2}s^{-1}$)	2.424-6.69	MI-0179,MI-0290,ME-0052MI-0214, MI-0286, MI-0665, MI-0376,MI-0341,ME-0220,MI-0173 MI-0099, MI-0011, MI-0108, MI-0231, S13, MI-0061, ME-0253, MI-G2
Intrinsic WUE (A/gs)	94.69-63.639	MI-0029,MI-0214,MI-0286,MI-0665,MI-0376, ME-0220,MI-0173,MI-0099,MI-0011,MI-0108, MI-0179,MI-0290,ME-0052,MI-0341,MI-0231, S13, MI-0061
Intercellular CO_2 /Ambient CO_2 (iCO_2/aCO_2)	0.91-0.744	MI-0029,MI-0214,MI-0286,MI-0665, MI-0376, ME-0220,MI-0173,MI-0099,MI-0011,MI-0108, MI-0179, MI-0290, ME-0052, MI-0341, MI-0231, S13, MI-0061, ME-0253, MI-G2
Total chlorophyll (mg/ g.fwt.)	3.45-3.142	MI-0029,MI-0214,MI-0286,MI-0665, MI-0376, ME-0220,MI-0173,MI-0099,MI-0011,MI-0108, MI-0179, MI-0290, ME-0052, MI-0341, MI-0231, S13, MI-0061, ME-0253
Leaf yield/plant (g)	1378-724	MI-0167,MI-0231,ME-0262,MI-0252,MI-0310, ME-0220,MI-0173,MI-0099,MI-0011,MI-0108, MI-0179, MI-0290, ME-0052, MI-0341, MI-0231, S13, MI-0061, ME-0253

Table 3: Variability statistics for different leaf yield and nutritional components in the 150 mulberry accessions

Parameter	Mean	Min.	Max.	SE	CV%
Moisture content (%)	67.66	52.88	79.38	4.39	6.50
Water soluble carbohydrates (% dwt.)	12.14	3.30	22.70	0.04	12.81
Protein (% of dwt.)	8.83	4.61	13.21	0.01	12.99

Nitrogen (% of dwt.)	2.29	0.63	6.93	0.17	56.98
Phosphorus (% of dwt.)	0.22	0.15	0.35	0.01	22.05
Potassium (% of dwt.)	1.70	1.08	2.93	0.05	23.87
Ascorbic acid (mg/g)	0.42	0.20	0.93	0.02	35.13
Water use efficiency (WUE)	2.54	0.90	6.67	0.12	38.36
Leaf area (sq. cm)	201.26	29.67	331.33	71.00	35.28
Leaf Temp. (°C)	31.77	14.69	44.62	5.63	17.72
Leaf yield/plant (g)	525.74	41.00	1498.42	41.65	61.88

Table 4: Top performing mulberry accessions for leaf yield and nutritional components

Parameter	Range	Accession Number
Moisture content (%)	79.38-72.33	MI-G2,MI-0665,ME-0144,MI-0238,MI-0214, ME-0253, ME-0262, MI-0138, MI-0667, V1, MI-0173, MI-0221, MI-0376, MI-0272,ME-0052, MI-0341, MI-0416, ME-0220, MI-0219, MI-0222, MI-0107, MI-0099
Water soluble carbohydrates (% dwt.)	3.26-2.44	ME-0052,MI-0376,MI-0220,MI-0290, ME-0058, MI-0118,MI-0286,MI-0291,MI-0173, MI-0013
Protein (% of dwt.)	54.64-24.44	MI-0774, MI-0218, MI-0110, MI-0219, MI-0086, MI-0643,MI-0803,MI-0058,MI-0337, MI-0775,MI-0170,MI-0073, ME-0253
Nitrogen (% of dwt.)	6.93-3.5	ME-0016,MI-0777,MI-0034,MI-0138, MI-0028, MI-0058,MI-0087,MI-0168, MI-0179, MI-0221, MI-0222, ME-0002, ME-0005, V1, ME-0232, MI-0054, MI-0026
Phosphorus (% of dwt.)	0.37-0.29	ME-0056, MI-0138, MI-0225,ME-0071, MI-0258, MI-0173, MI-0184, ME-0220,MI-0337, ME-0001, ME-0253, MI-0065, Vishala, MI-0285, MI-0043
Potassium (% of dwt.)	2.93-2.25	MI-0099,MI-0011,MI-0108,MI-0095, MI-0187, MI-G2,MI-0192, MI-0034,MI-0138, MI-0170, ME-0071, MI-00063, MI-0290, ME-0052, MI-0341, MI-0231, S13, MI-0061
Ascorbic acid (mg/g)	0.93-0.568	MI-0029, MI-0214, MI-0286, MI-0665, MI-0376, ME-0220, MI-0173 MI-0099, MI-0011, MI-0108, MI-0179, MI-0290, ME-0052, MI-0341, MI-0231, S13, MI-0061

Parameter	Range	Accession Number
WUE (A/T)	6.596-3.304	MI-0029,MI-0214,MI-0286,MI-0665,MI-0376, ME-0220, MI-0173 MI-0099, MI-0011, MI-0108, MI-0179, MI-0290, ME-0052, MI-0341, MI-0231, S13, MI-0061, ME-0253, MI-G2
Leaf area (sq. cm)	331.33-251.333	MI-0029, MI-0214, MI-0286, MI-0665, MI-0376, ME-0220, MI-0173 MI-0099, MI-0011, MI-0108, MI-0179, MI-0290, ME-0052, MI-0341, MI-0231, S13, MI-0061, ME-0253
Leaf Temp. (°C)	14.69-28.647	MI-0044, MI-0231, V1, MI-0225, ME-0220, MI-0192,MI-0667,MI-0290,MI-0185,MI-0221,S13, MI-0168,MI-0083,MI-0031,MI-0665
Leaf yield/plant (g)	1498.42-689.667	MI-0029, MI-0214, MI-0286, MI-0665, MI-0376, MI-0179, MI-0290, ME-0052, MI-0341, ME-0220, MI-0173 MI-0099, MI-0011, MI-0108, MI-0231, S13, MI-0061, ME-0253

Table 5: Top performing accessions for different physio-chemical and leaf nutritional components based on multiple trait analysis

Acc. No.	No. of Traits	Parameter (value)
MI-0099	12	1(100), 2(1.077), 3(0.58), 4(14.513), 6(5.003), 7(2.901), 8(38.667), 13(0.854), 14(2.148), 15(2.622), 16(68.67), 18(1315.667)
MI-0011	12	1(87.5), 2(1.405), 3(0.564), 4(16.73), 5(0.565), 6(5.036), 7(3.322), 8(32), 9(3.29), 13(0.878), 14(2.166), 17(952)
ME-0033	12	1(87.5), 5(4.972), 6(2.675), 7(23.667), 8(70.66), 9(2.59), 10(0.936), 12(0.24), 13(1.76), 15(13), 17(511.444), 18(1136)
MI-0108	11	1(87.5), 2(1.395), 3(0.478), 6(3.683), 7(3.211), 9(2.45), 10(0.29), 11(2.03), 13(0.923), 15(2.503), 18(801)
MI-0214	11	1(87.5), 2(1.738), 4(15.59), 6(5.437), 7(2.867), 10(0.23), 11(1.93), 12(0.496), 13(0.96), 16(73.48), 18(696),
MI-0286	11	1(70), 4(14.471), 6(4.75), 7(3.047), 9(2.73), 10(0.24), 13(0.892), 14(2.574), 15(3.124), 16(71.78), 18(1089.667)
MI-0665	11	1(87.5),3(0.602),5(0.415),8(36.54),9(3.08),12(0.492),13(0.841), 14(2.159), 15(2.78), 16(76.92), 18(646.333)
MI-0376	11	1(75), 4(22.498), 7(2.968), 8(30.333), 9(2.8), 10(0.23), 13(0.837), 14(2.699), 15(2.53), 16(71.29), 18(717.667)
Victory -1 Check_1	11	1(87.5), 2(15.496), 5(4.038), 7(20.628), 8(72.09), 10(0.851), 13(2.132), 14(17.478), 15(12), 17(685), 18(1068.25)
MI-0341	10	4(17.114), 6(3.714), 7(4.608), 8(35.167), 9(2.45), 10(0.24), 12(0.426), 14(2.235), 16(70.62), 18(1121.667)

ME-0220	10	4(20.892), 5(0.474), 8(25.333), 10(0.3), 11(1.78), 13(0.909), 14(2.158), 15(3.243), 16(70.29), 18(792.333)
MI-0173	10	1(87.5), 2(2.278), 4(15.606), 6(4.764), 7(3.276), 10(0.31), 11(2.06), 13(0.902), 14(2.519), 16(72.33)
MI-0197	10	1(75), 2(1.368), 4(18.506), 6(5.404), 7(3.425), 9(3.71), 10(0.26), 11(1.8), 13(0.874), 15(2.67)
MI-0290	10	1(75), 2(1.094), 4(14.106), 6(2.659), 7(5.305), 8(17), 12(0.493), 13(0.877), 14(2.646), 16(68.33)
MI-0068	10	1(87.5), 2(15.835), 3(0.476), 6(2.955), 7(16.333), 10(0.882), 12(0.31), 13(2.13), 14(13.136), 16(4.46)
MI-0231	10	1(87.5), 2(2.019), 6(3.131), 7(2.968), 10(0.862), 12(0.598), 14(2.427), 15(3.096), 16(71.82), 17(1136)
Vishala -Check_3	10	1(87.5), 2(1.372), 3(0.458), 4(14.77), 5(0.42), 8(18.7), 12(0.431), 13(0.848), 14(2.214), 16(69.014),
S.13 - Check_2	9	2(0.987), 5(1.316), 8(19.3), 9(2.555), 10(0.242), 12(0.499), 15(3.098), 16(70.13), 18(1086.667)

Figures in parenthesis indicates the actual value of the traits

1. Sprouting (2 WAP); 2. Early vigour (LAI at 25 DAP); 3. Glutamine synthetase; 4. Photosynthetic rate; 5. Stomatal conductance ($molm^{-2}s^{-1}$); 6. Transpiration rate ($mmolm^{-2}s^{-1}$); 7. Water Use Efficiency; 8. Leaf fall; 9. Nitrogen (% of dwt.); 10. Phosphorus (% of dwt.); 11. Potassium (% of dwt.); 12. Ascorbic Acid (mg/g); 13. Protein (% of dwt.); 14. Water soluble carbohydrates (% dwt.); 15. Total Chlorophyll; 16. Moisture content (%); 17. Leaf yield/plant (g)

Recommendations : The mulberry germplasm conserved at this centre cannot be used directly for breeding programs. The evaluation of 150 mulberry accessions for physiological efficiency and leaf nutritional components resulted in identification of 15 top performers, viz., MI-0099, MI-0011 ME-0033, MI-0108, MI-0214, MI-0286, MI-0665, MI-0376, MI-0341, ME-0220, MI-0173, MI-0197, MI-0290 MI-0068 and MI-0231 in all the seasons at par with the respective checks. These identified mulberry genetic resources could be utilized by other institutes as potential parents for crop improvement programmes.

6. PROGRESS OF ONGOING RESEARCH PROJECTS

MULBERRY DIVISION

Continued through 2018-19

Inter-institutional *[as PI from institute]*

1. **PIE 3575: Evaluation of mulberry genetic resources for functional traits associated with resilience to climate change** (May.2016 – May.2019) (CSGRC, Hosur with CSRTI, Mysuru, RSRS Ananthpur & Berhampore)

CSGRC, Hosur: *K. Jhansilakshmi, PI (till June'18), S.Masilamani, PI (July'18 – May'19), G.Thanavendan, (from Jul'18), Raju Mondal (from Jan'19)*

CSRTI, Mysore: *S. Gandhi Doss, Gayathri.T*

RSRS, Anantapur: *P.Sudhakar*

REC-SU, Koppal: *A.Umesh*

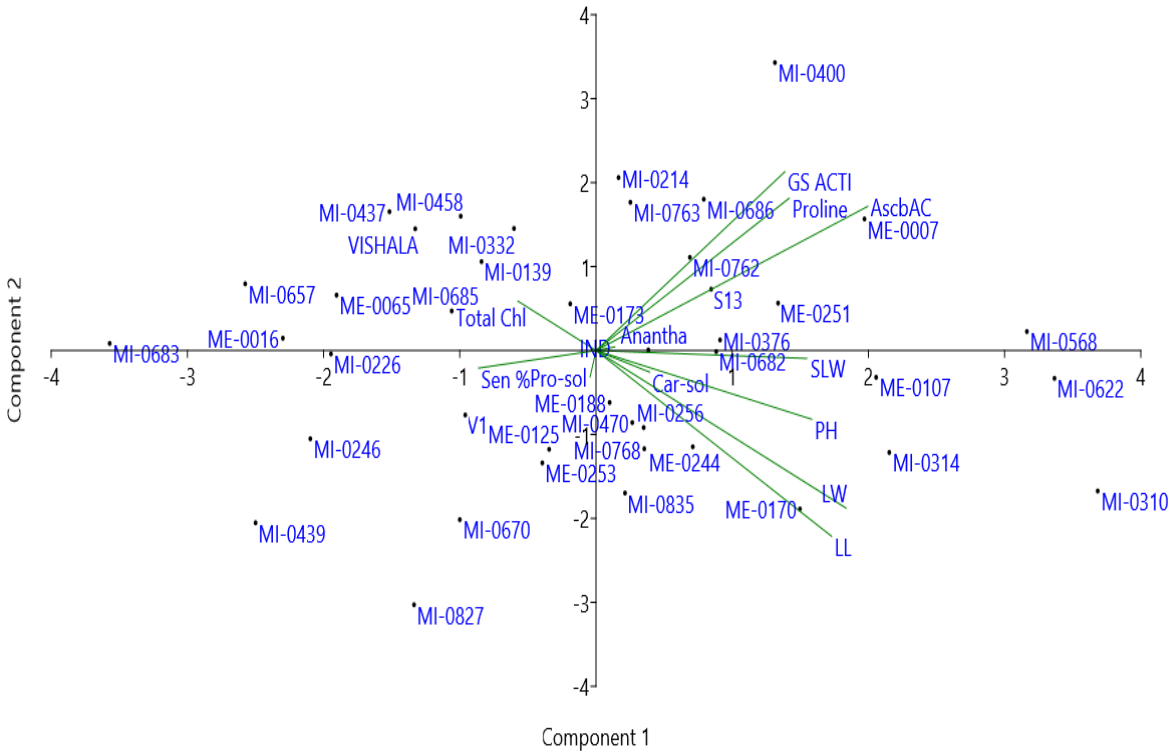
The project aims to evaluate 39 short-listed mulberry genetic resources at different locations, viz., RSRS, Anantapur (high temperature and low rainfall), CSGRC, Hosur and CSRTI, Mysuru (favourable climate) to identify genetic resources for functional traits associated with climate resilience. Data on morphological and biochemical traits were collected for two years during rainy, winter, and summer seasons and subjected to statistical analysis using Past3 and Windowstat v.9.3 softwares.

Data analysis of all the trials in all the three locations revealed that, 9 accessions *viz.* MI-0400, MI-0376, MI-0214, ME-0007, MI-0762, MI-0686, MI-0763, ME-0251, MI-0568 as top performers at CSGRC Hosur against check varieties S-13 and Anantha with the accession MI-0568 being the best performer. At CSR&TI Mysuru 8 accessions *viz.* MI-0437, MI-0310, MI-0683, ME-0173, MI-0246, MI-0685, MI-0762, ME-0256 were the top performers against the check varieties S-13 and Anantha with MI-0762 being the best performer. Similarly, at RSRS Ananthpur 11 accessions were top performers *viz.* MI-0439, MI-0437, MI-0400, ME-0107, MI-0332, MI-0686, ME-0253, ME-0251, MI-0458, MI-0139 and ME-0256 against the check variety S-13. Overall, accessions MI-0473, MI-0400, MI-0686, MI-0762, ME-0251 including checks S-13, Anantha revealed highly adaptive significance across all the experimental locations. These accessions can be utilized as donor parents by other Institutes for breeding programme.

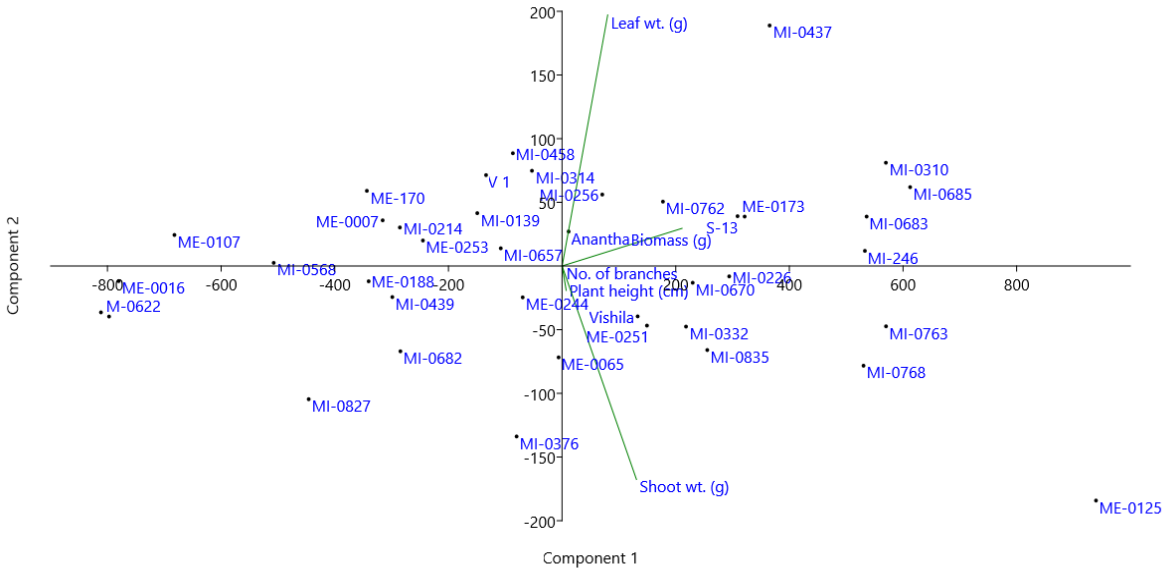
The biochemical traits *viz.* Glutamate synthase activity and ascorbic acid content known to be correlated to drought tolerance were positively correlated to biomass, shoot weight and

leaf weight. Hence, these parameters could function as screening tools for identifying desired genotypes for the said functional traits. The analysis of variance showed that the 39 accessions had significant differences for most of the traits studied (Stomatal frequency (no./sq.mm), Leaf yield/plant, Moisture content (%), Chlorophyll-a (mg/g fr.wt.), Chlorophyll-b (mg/g fr.wt.), which is due to diversity in the measured traits (**Fig.1**).

A. CSGRC- Hosur



B. CSR&TI Mysuru



C. RSRS Ananthpur

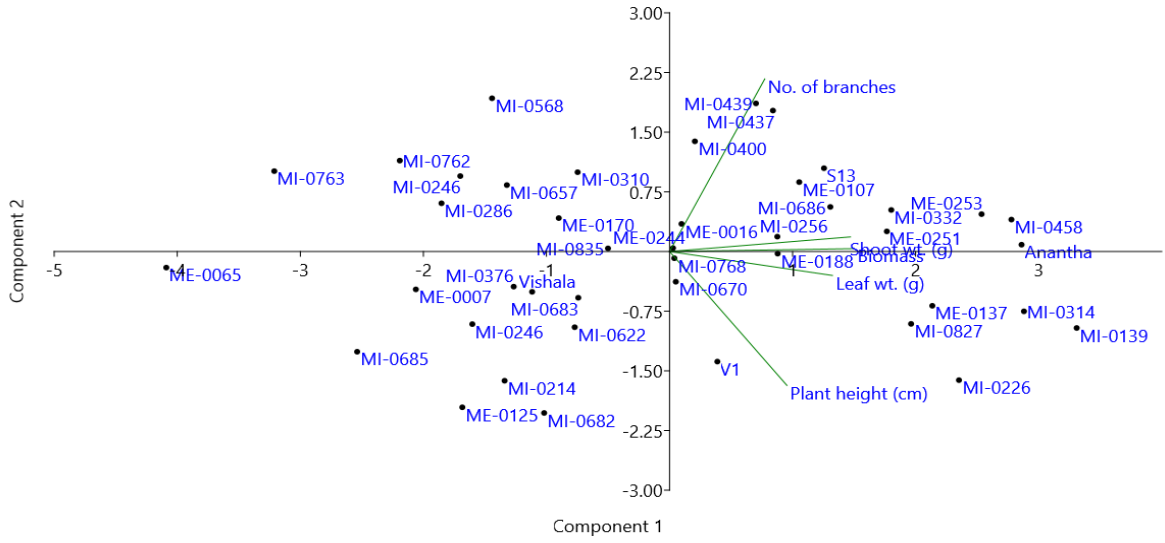


Fig. 1: Principal components based on physiochemical characters for 39 *Morus sp.* accessions

Based on morphological traits 14 accessions were observed to be better for biomass against the check variety S13 and 18 against the check variety Anantha. Ten accessions performed better for shoot weight against S13 and 20 accessions against Anantha. Similarly, 19 accessions were better for leaf weight against S13 and 19 against Anantha. Based on biochemical analysis 13 accessions were better for Glutamate synthase activity against S13 and 10 against Anantha, 9 accessions were better for Ascorbic acid content against S13 and 17 against Anantha, while, 14 accessions fared better for Proline content against S13 and 21 against Anantha at CSGRC, Hosur.

Inter-institutional *[as CI from Institute]*

2. PIB 3505: **Development of drought tolerant mulberry variety for rainfed sericulture** (Jan.14 – Dec.19) (CSR&TI Berhampore with CSGRC, Hosur)

CSR&TI Berhampore: *K Suresh, (PI), D. Chakravarty, Anil Pappachan, Maloy Lasker, JRF*
CSGRC Hosur: *K. Jhansilakshmi (till Jun.18), G. Thanavendan (from Jul.18)*

Background

The project aims to develop drought tolerant mulberry variety from selected progenies developed through hybridization of selected mulberry genetic resources.

Progress

Ten crosses were prepared using selected mulberry genetic resources at CSGRC Hosur and the resultant seeds were supplied to CSR&TI Berhampore. Thirty selected progenies from the ten crosses established in ARBD with two replications along with three check varieties S1635, C1730 and C2038 were assessed at CSR&TI Berhampore based on drought tolerant indices and leaf yield per plant. Leaf yield per plant recorded significant positive association with mean productivity (MP), geometric mean productivity (GMP), harmonic mean (HM), yield index (YI), stress tolerance index (STI) and modified stress tolerance indices (K_1STI and K_2STI) and hence would be effective in identifying high yielding drought tolerant mulberry genotypes. Among the seventeen traits studied, specific leaf area, fresh leaf moisture, relative water content, primary shoots per plant and total shoot length recorded significant positive association with leaf yield indicating their importance in yield-based selection. The results of principal components analysis (PCA) and biplot indicated six genotypes as drought tolerant and high yielding.

Data of 30 progenies along with three checks revealed highly significant difference ($p<0.05$) among the progenies for the traits. Among the 30 genotypes evaluated, 10 recorded significantly high annual leaf yield over check C2038 under rainfed condition.

3. PIB 3586: **Development of superior mulberry varieties through controlled hybridization for North-West Indian states** (Mar.17 – Feb.22) (CSR&TI Pampore with CSGRC, Hosur)

CSRTI, Pampore: *Rajesh Kumar (PI), Pawan Saini, Aftab A. Shabnam*
CSGRC, Hosur: *K. Jhansilakshmi, G. Thanavendan (from July, 2018)*
CO, Bangalore: *K. Vijayan*

Background

Project implemented by CSR&TI, Pampore with CSGRC Hosur as one of the collaborators aims to develop high yielding mulberry variety with early sprouting and cold tolerance for North West India.

Progress

CSGRC Hosur has screened selected exotic mulberry germplasm, identified promising parental accessions, carried out hybridization of selected crosses, prepared seeds and supplied to CSR&TI Pampore for further processing. Some of the F1 seeds were sown in the nursery and saplings of the same were maintained as backup. During the year, CSGRC Hosur supplied 215 F1 seedlings to CSR&TI Pampore for progeny row trial.

4. PIB-3629: Development of drought tolerant mulberry genotype suitable for rainfed hill farming in North-west India (Jan.18 to Dec.21)(CSGRC, Hosur with RSRS, Jammu)

RSRS Jammu: *Chhattar Pal (PI), Jadhav Ashok Limbaji (till Nov.18), Murali Suvanna*
CSGRC, Hosur: *K. Jhansi Lakshmi (till Jun.18), G.Thanavendan (from Jul.18)*

Background

The project aims to develop drought tolerant mulberry genotypes for rainfed hill farming in North West India.

Progress

Parental selection

Eleven female and five male parents (**Table 6**) were selected based on pre-breeding data for drought tolerance, leaf structure, root and shoot characteristics and flower synchrony. During parental selection preference was given to select dioecious female parents. These parents are being maintained at *ex-situ* field gene bank of CSGRC, Hosur.

Table 6: List of selected parents and their cross combinations:

SN	CROSS	SN	CROSS
1	MI-0877 × MI-0836	7	MI-0324× MI-0313
2	ME-0256 × MI-0836	8	MI-0310 × MI-0012
3	MI-0827 × MI-0836	9	MI-0439 × MI-0012
4	MI-0868× MI-0836	10	MI-0675 × MI-0440
5	MI-0853 × MI-0836	11	MI-0853 × MI-0125
6	MI-0835 × MI-0313	12	MI-0486 × MI-0012

Flowering Staggered pruning

Selected females and corresponding male plants were pruned at 2-2.5 feet height from the crown level and in few cross combinations male plants were only top clipped. To synchronize male and female flowering, male plants were pruned 3-6 days in advance to female plants. For each cross combination three female plants were utilised. Pruning operation was performed using sharp pruning secateurs (Falcon) and old attached leaves were removed.

Bagging of Selected Parental Plants

To cover the female and male catkins, bags were prepared from 70 GSM butter paper. Bagging of young females was done at the stage when at least 75 percent buds were opened on the selected branch. The male plants were also bagged to avoid any possible pollen contamination from adjoining plants of other accessions.

Hybridization of Parents

Hybridization programme was carried out during January-February 2019 at *ex-situ* Field Gene Bank of Central Sericultural Germplasm Resource Centre, Hosur. To pollinate young receptive females, fresh pollen grains were collected from identified male parents. Pollen grains were collected in the late morning hours when anthesis occurred. The collected pollen grains were dusted on receptive female catkins, and repeated twice.

New projects initiated during 2018-19

1. PIE- 06001 SI: Collection, Characterization, Evaluation, Conservation and Supply of Mulberry Genetic Resources (Nov. 18 to Nov.21)

S. Masilamani (PI) (till May'19), G. Thanavendan (PI) (from Jun.19),
M.C. Thriveni (from Jan. 19), Raju Mondal (from Jan. 19)

Background

The project aims to collect mulberry genetic resources to enrich the gene bank of the centre, characterize, evaluate and conserve available genetic resources and supply them to needy indentors for utilization.

Progress

S-01: Survey and collection of new Mulberry Genetic Resources

Two new mulberry germplasm are received from CSR&TI, Berhampore were planted in net house nursery, the details of which are as indicated hereunder (**Table 7**).

Table 7: Details of new collection of mulberry genetic resources

SN	Passport Information			
	Variety	CSGRC accn.no.	Place of collection	Scientific Name
1	TR - 23	MI - 0204	Berhampore	*Morus* spp.
2	C - 2038	MI - 1013	Berhampore	*Morus* spp.

S-02: Characterization of Mulberry Genetic Resources

E-01: Morphological characterization of mulberry genetic resources

Seven newly inducted genetic resources are under establishment in *ex situ* field gene bank with recommended cultural practices. A set of 24 accessions were characterized as per prescribed descriptors *viz.* morphological (19 descriptors), anatomical (14 descriptors) and reproductive (26 descriptors) traits. The accessions were evaluated for propagation traits, growth-yield and biochemical parameters. Data documented was updated in the Mulberry Germplasm Information System (MGIS) data base (**Table 8**).

Table 8: Mulberry Genetic Resources characterized under Phase IX 2018-19

SN	Institute Acc-No.	National Acc. No.	Variety Name	Region	Sci. Name	Date of Collection	State
1	MI-0813	IC573034	Tashi sospol-1	North India	*M.alba*	03/12/2005	J&K
2	MI-0814	IC573035	Nurla-1	North India	*M.alba*	03/12/2005	J&K
3	MI-0815	IC573036	Nurla-2	North India	*M.alba*	03/12/2005	J&K
4	MI-0816	IC573037	Sanjak	North India	*M.alba*	03/11/2005	J&K
5	MI-0837	IC573058	Hunder-2	North India	*M.alba*	31/03/2005	J&K
6	MI-0838	IC573059	Beema	North India	*M.alba*	03/11/2005	J&K
7	MI-0839	IC573060	Hunder-3	North India	*M.alba*	31/03/2005	J&K
8	MI-0840	IC573061	Pashkyum-1	North India	*M.alba*	03/10/2005	J&K
9	MI-0841	IC573062	Biagdong	North India	*M. alba*	31/03/2005	J&K
10	MI-0857	IC590589	Delhi	North India	*M.laevigata*	24/11/2008	New Delhi
11	MI-0858	IC590590	Dunera	North India	*M.indica*	24/11/2008	Punjab
12	MI-0859	IC590591	Batwa	North India	*M.alba*	24/11/2008	Punjab
13	MI-0860	IC590592	Naloh	North India	*M.indica*	24/11/2008	Punjab
14	MI-0869	IC590601	Sumarpur-2	North India	*M.indica*	20/11/2008	Rajasthan
15	MI-0877	IC590609	Kawnpui-1	North East India	*M.indica*	11/10/2009	Mizoram
16	MI-0878	IC590610	Kawnpui-2	North East India	*M.laevigata*	11/11/2009	Mizoram
17	MI-0900	IC590629	Changhar -1	North West India	*M.indica*	24/10/2009	HP
18	MI-0962	IC599858	Thalaghattapura-31	Thalghatapura	*Morus* sp.	31/03/2011	Karnataka
19	MI-0966	IC599862	Thalaghattapura-35	Thalghatapura	*Morus* sp.	03/08/2011	Karnataka
20	MI-0970	--	Namche-2	North East India	*M.indica*	17/11/2011	Sikkim
21	MI-0973	--	Mapusa	West India	*M.indica*	21/11/2012	Goa
22	MI-0974	--	Colangate	West India	*M.indica*	21/11/2012	Goa
23	MI-0975	--	Mudavadi	West India	*M.indica*	21/12/2012	Goa
24	MI-0980	--	Madathanthop	West India	*M.indica*	13/03/2013	Pondicherry

During the project report period, 24 mulberry accessions were characterized for different morphological descriptors (16) and the details are presented in **Table 9.**

Table 9: Morphological characterization of mulberry accessions

Parameter	Frequency	%
Branching Nature		
Erect	10	41.66
Semi erect	2	08.33
Spreading	12	50.00
Total	**24**	**100.00**
Colour of young shoot		
Green	12	50.00
Greenish brown	3	12.50
Light green	6	25.00
Purple green	3	12.50
Total	**24**	**100.00**
Phyllotaxy		
1/2	5	20.83
1/3	6	25.00
1/3, 1/4	1	4.16
1/3, 1/5	5	20.83
1/4	1	4.16
1/4, 5/5	1	4.16
1/5	1	4.16
2/5	2	8.32
Total	**24**	**100**
Leaf colour		
Deep green	3	05.41
Green	17	70.83
Light green	4	16.67
Total	**24**	**100**
Leaf margin		
Crenate	8	33.33
Dentate	3	13.63
Serrate	13	54.16
Total	**24**	**100**
Leaf shape		
Narrow	2	8.34
Narrow ovate	2	8.33
Ovate	8	33.33
Wide ovate	12	50.00
Total	**24**	**100**
Leaf surface		
Rough	4	16.67
Slightly rough	8	33.33
Smooth	12	50.00
Total	**24**	**100**

Parameter	Frequency	%
Curve or straightness of the branch		
Slightly curved	12	50.00
Straight	12	50.00
Total	**24**	**100.00**
Colour of Mature shoot		
Brown	1	4.76
Greenish brown	10	47.62
Grey brown	2	9.52
Grey green	8	38.10
Total	**24**	**100**
Leaf nature		
Heterophyllous	12	50.00
Homophyllous	12	50.00
Total	**24**	**100**
Stipule duration		
Free- lateral	24	100
Leaf texture		
Chartaceous	12	50.00
Coriaceous	8	33.33
Membranous	4	16.67
Total	**24**	**100**
Leaf lobation type		
Deep lobed	2	8.33
Medium lobed	10	41.66
Multiple lobed	3	12.50
Shallow lobed	2	8.33
Un lobed	7	29.17
Total	**24**	**100**
Leaf apex		
Acuminate	14	58.33
Acute	6	25.00
Caudate	4	16.67
Total	**24**	**100**
Leaf base		
Cordate	13	54.16
Lobate	8	33.33
Truncate	3	13.63
Total	**24**	**100**

Most of the accessions characterized, have spreading branching nature (50%), greenish brown mature shoot (47.62%), heterophyllous leaf (50%), 1/3 (25%) phyllotaxy, medium lobed leaves (41.66%), chartaceous (50%) in leaf texture, acuminate leaf apex (58.33%), serrate leaf margin (54.16%), cordate leaf base (54.16%) and vide ovate leaf shape (50%).

E02: Leaf anatomical characterization of mulberry genetic resources

Among the different anatomical parameters, highest coefficient of variability (39.97%) was observed for Idioblast length (**Table 10**) that varied from 10.35 to 37.24 per sq.mm among the accessions. The stomatal frequency varied from 372.06 to 1210.45 / sq. Mm with lowest stomatal frequency in MI-0860 *i.e. Morus laevigata* collected from Nagaland. Maximum leaf thickness was 193.79 µm and minimum 109.65 µm. The number of chloroplasts / stomata an indicator for ploidy level, varied from 8 to 12.8. The range of variations and top performing accessions for different anatomical traits are presented in **Table 11.**

Table 10: Variability statistics for different anatomical traits

Parameters	Mean	Min	Max	SD	SE	CV%
Stomatal size (sq.µm)	252.34	180.43	429.26	60.78	15.69	24.09
Stomatal frquency (no./sq.mm)	718.29	372.06	1210.45	233.79	60.36	32.55
Idioblast length (µm)	20.64	10.35	37.24	7.40	1.91	35.85
Idioblast width (µm)	26.21	17.24	39.65	6.93	1.79	26.43
Idioblast frequency no./sq.mm)	16.52	9.50	31.26	5.18	1.34	31.37
Palisade thickness (µm)	55.61	35.17	80.00	12.87	3.32	23.14
Spongy thickness (µm)	61.98	41.38	73.56	9.65	2.49	15.57
Palisade-spongy ratio	0.92	0.72	1.07	0.10	0.03	10.82
Upper cuticle thickness (µm)	7.60	5.75	11.03	1.45	0.37	19.03
Lower cuticle thickness (µm)	4.24	2.87	6.80	1.09	0.28	25.61
Upper epidermis thickness (µm)	22.47	15.86	33.10	5.11	1.32	22.75
Lower epidermis thickness (µm)	9.27	6.90	18.39	3.64	0.94	39.25
Leaf thickness (µm)	161.16	109.65	193.79	24.19	6.24	15.01
No. of chloroplasts/stomata (no.)	10.73	8.00	12.80	1.16	0.30	10.76

Table 11: Top performing accessions for anatomical traits

Parameter	Range	Accessions
Stomatal size (sq.µm)	**429.26-227.716**	MI-0980, MI-0858, MI-0857, MI-0981, MI-0877, MI-0869, MI-0900, MI-0970, MI-0966, MI-0975
Stomatal frquency (no./sq.mm)	**1210.45-644.742**	MI-0981, MI-0970, MI-0860, MI-0973, MI-0980, MI-0900, MI-0859, MI-0858, MI-0975, MI-0857
Idioblast length (µm)	**37.24-16.475**	MI-0962, MI-0973, MI-0878, MI-0975, MI-0900, MI-0877, MI-0869, MI-0966, MI-0970, MI-0858
Idioblast width (µm)	**39.65-22.758**	MI-0962, MI-0877, MI-0858, MI-0900, MI-0878, MI-0869, MI-0857, MI-0973, MI-0970, MI-0966
Idioblast frequency no./sq.mm)	**31.26-14.966**	MI-0860, MI-0858, MI-0859, MI-0857, MI-0878, MI-0900, MI-0975, MI-0877, MI-0869, MI-0981
Palisade thickness (µm)	**80-50.344**	MI-0900, MI-0858, MI-0877, MI-0857, MI-0974, MI-0980, MI-0860, MI-0869, MI-0878, MI-0981
Spongy thickness (µm)	**73.56-59.309**	MI-0857, MI-0877, MI-0858, MI-0860, MI-0974, MI-0859, MI-0869, MI-0980, MI-0900, MI-0975
Upper cuticle thickness (µm)	**11.03-6.896**	MI-0981, MI-0975, MI-0973, MI-0966, MI-0974, MI-0858, MI-0962, MI-0869, MI-0857, MI-0900
Lower cuticle thickness (µm)	**6.8-4.023**	MI-0860, MI-0857, MI-0980, MI-0975, MI-0962, MI-0974, MI-0973, MI-0966, MI-0981, MI-0858
Upper epidermis thickness (µm)	**33.1-21.455**	MI-0900, MI-0869, MI-0858, MI-0859, MI-0966, MI-0878, MI-0981, MI-0975, MI-0860, MI-0877
Lower epidermis thickness (µm)	**18.39-6.896**	MI-0877, MI-0869, MI-0975, MI-0857, MI-0860, MI-0878, MI-0858, MI-0859, MI-0981, MI-0962
Leaf thickness (µm)	**109.65-173.08**	MI-0970, MI-0962, MI-0966, MI-0973, MI-0975, MI-0878, MI-0981, MI-0859, MI-0980, MI-0860
No. of chloroplast/stomata	**12.8-10.4**	MI-0966, MI-0859, MI-0962, MI-0980, MI-0869, MI-0981, MI-0860, MI-0857, MI-0973, MI-0970

E03: Reproductive characterization of mulberry genetic resources

The data on variability of different reproductive characters are presented in **Table 12**. Among the different characters, highest coefficient of variability was observed in style length (98.23) followed by stigma length (61.73). Maximum number of female flowers / catkin was 116 and for male 49. Out of 23 accessions characterized maximum fruit weight was in the accession MI-0962 (2.54 g). The top performing accessions are given in **Table 13.**

Table 12: Variability statistics for different reproductive traits

Parameters	Mean	Min.	Max.	SD	SE	CV%
Male inflorescence length (cm)	1.51	1.44	1.56	0.064	0.045	4.248
Male inflorescence diameter (cm)	0.52	0.44	0.58	0.072	0.05	13.86
Female inflorescence length (cm)	1.834	1.24	4.64	0.80	0.18	44.09
Female inflorescence diameter (cm)	0.66	0.42	0.92	0.12	0.02	19.38
Male peduncle length (cm)	0.6	0.36	0.94	0.30	0.21	50.44
No. of male flowers	38.86	33.2	49.2	8.96	6.33	23.06
No. of female flowers	44.28	29.8	115.6	18.92	4.34	42.74
Style length (cm)	0.85	0.18	2.9	0.83	0.2	98.23
Stigma length (cm)	4.01	1.08	8.84	2.47	0.6	61.73
Fruit length (cm)	1.85	1.2	3.74	0.57	0.13	30.83
Fruit diameter (cm)	0.87	0.62	1.28	0.19	0.04	22.28
Fruit weight (g)	0.91	0.21	2.54	0.56	0.13	61.21

Table 13: Top performing accessions for reproductive characters

Parameters	Range	Accessions
Male inflorescence length (cm)	1.56-1.54	MI-0815, MI-0860
Male inflorescence diameter (cm)	0.58-0.54	MI-0980, MI-0815
No. of flowers/ catkin (male)	49.2-34.2	MI-0980, MI-0860
Female inflorescence length (cm)	4.98-0.96	MI-0866, MI-0867, MI-0870, MI-0872, MI-0930, MI-0908, MI-0932, MI-0920, MI-0904, MI-0942
Female inflorescence diameter (cm)	0.8-0.56	MI-0904, MI-0942, MI-0867, MI-0946, MI-0875, MI-0930, MI-0928, MI-0866, MI-0917, MI-0932
No. of flowers/ catkin (female)	152-32.2	MI-0867, MI-0866, MI-0872, MI-0870, MI-0930, MI-0932, MI-0904, MI-0942, MI-0920, MI-0917
Style length (cm)	2.9-0.44	MI-0974, MI-0975, MI-0970, MI-0973, MI-0900, MI-0877, MI-0962, MI-0878, MI-0869, MI-0857
Stigma length (cm)	8.84-3.06	MI-0973, MI-0974, MI-0975, MI-0878, MI-0900, MI-0857, MI-0970, MI-0877, MI-0838, MI-0869
Fruit length (cm)	3.74-1.8	MI-0878, MI-0857, MI-0962, MI-0814, MI-0974, MI-0975, MI-0966, MI-0900, MI-0816, MI-0973

Parameters	Range	Accessions
Fruit width (cm)	1.28-0.86	MI-0962, MI-0839, MI-0966, MI-0973, MI-0974, MI-0838, MI-0975, MI-0814, MI-0837, MI-0900
Fruit peduncle (cm)	0.2-0.44	MI-0966, MI-0859, MI-0970, MI-0962, MI-0816, MI-0877, MI-0814, MI-0838, MI-0837, MI-0975
Fruit weight (g)	2.54-0.86	MI-0962, MI-0966, MI-0839, MI-0814, MI-0878, MI-0973, MI-0837, MI-0975, MI-0974, MI-0816

S-03: Evaluation of Mulberry Genetic Resources

Evaluation for preliminary growth and yield (12 descriptors) as well as propagation (17 descriptors) parameters along with recording of natural incidence of diseases and pests for 2 seasons in the *ex situ* field gene bank was carried out. The different biochemical parameters such as total chlorophyll, protein and carbohydrate were estimated as per standard methods using fresh leaves from 7^{th} - 9^{th} position after 75 days of pruning. The data on characterization and evaluation was documented in Mulberry Germplasm Information System (MGIS).

E-01: Evaluation of mulberry genetic resources for propagation traits

Wide variations were observed for propagation traits among the 24 accessions tested (**Table 14**). The highest coefficient of variation was recorded for fresh shoot weight (52%) followed by dry root weight / sapling (47%). The coefficient of variation for survival percentage varied from 48 to 93 and for shoot length from 33 to 54. Top performing accessions for different propagation traits are presented in **Table 15**.

Table 14: Variability statistics for propagation traits

Parameters	Mean	Min	Max	SD	SE	CV%
Survival %	72.66	18.33	93.33	18.77	9.38	25.83
No. of leaves/sapling	11.86	8.44	14.44	2.18	1.09	18.37
Leaf length (cm)	15.72	10.36	22.72	4.45	2.22	28.29
Leaf width (cm)	11.36	7.83	15.15	3.06	1.53	26.93
Fresh leaf weight/sapling (g)	15.57	9.36	23.02	5.18	2.59	33.26
Dry leaf weight/ sapling (g)	4.14	2.29	5.82	1.30	0.65	31.37
Shoot length(cm)	42.71	32.77	54.33	9.93	4.97	23.25
Fresh shoot wt./ sapling(g)	8.96	3.52	15.12	4.66	2.33	51.96
Dry shoot wt/ sapling(g)	1.85	0.79	2.58	0.68	0.34	36.60

Parameters	Mean	Min	Max	SD	SE	CV%
Shoot diameter(cm)	0.60	0.44	0.66	0.09	0.05	15.23
Total fresh biomass/ sapling (g)	24.54	12.88	35.31	9.11	4.56	37.13
Total dry biomass/ sapling (g)	5.99	3.09	8.41	1.96	0.98	32.69
No. of roots/ sapling	5.04	3.00	6.88	1.60	0.80	31.79
Fresh root wt/sapling (g)	2.19	1.21	3.18	0.80	0.40	36.50
Dry root wt/sapling (g)	0.62	0.30	1.04	0.29	0.15	47.02
Longest root length/ sapling (cm)	21.25	11.66	28.27	6.67	3.33	31.36
Root volume/sapling (ml)	2.58	1.11	3.53	0.97	0.48	37.43

Table 15: Top performing accessions for different propagation traits

Parameters	Range	Accessions
Survival %	93.33-78.333	MI-0877, MI-0966, MI-0869
No. of leaves/sapling	14.44-12.222	MI-0877, MI-0858, MI-0869
Leaf length (cm)	22.72-15.222	MI-0878, MI-0966, MI-0877
Leaf width (cm)	15.16-10.5	MI-0878, MI-0966, MI-0877
Fresh leaf weight/sapling (g)	23.02-16.408	MI-0878, MI-0966, MI-0877
Dry leaf weight/ sapling (g)	5.83-4.308	MI-0878, MI-0877, MI-0966
Shoot length(cm)	54.33-37.667	MI-0877, MI-0878, MI-0966
Fresh shoot wt./ sapling(g)	15.12-7.183	MI-0877, MI-0878, MI-0966
Dry shoot wt/ sapling(g)	2.59-1.844	MI-0878, MI-0877, MI-0869
Shoot diameter(cm)	0.44-0.644	MI-0858, MI-0877, MI-0869
Total fresh biomass/ sapling (g)	35.32-24.008	MI-0878, MI-0877, MI-0966
Total dry biomass/ sapling (g)	8.41-6.084	MI-0878, MI-0877, MI-0966
No. of roots/ sapling	6.89-5.667	MI-0869, MI-0877, MI-0878
Fresh root wt/sapling (g)	3.18-2.061	MI-0877, MI-0878, MI-0869
Dry root wt/sapling (g)	1.05-0.614	MI-0877, MI-0878, MI-0869
Longest root length/ sapling (cm)	28.28-24.444	MI-0878, MI-0869, MI-0877
Root volume/sapling (ml)	1.11-2.5	MI-0858, MI-0869, MI-0966

E-02: Evaluation of mulberry genetic resources for growth and yield parameters in the field gene bank

High variability was observed for all growth and yield parameters except leaf moisture (**Table 16**). The coefficient of variation was highest for total shoot length (108.64%) followed by number of branches (67.05%) and weight of lamina (58.08%). The highest value for total shoots length of 466.67cm were recorded in MI-0970 and least of 154.67cm in MI-0813. The top performing accessions for different growth and yield parameters are presented in and **Table 17**.

Table 16: Variability statistics for growth and yield parameters

SN	Parameters	Mean	Min	Max	SD	SE	CV %
1	No. of branches	27.03	4.333	85.00	18.12	3.95	67.05
2	Length of longest shoot	117.57	38	201.66	44.89	9.79	38.18
3	Internodal distance (cm)	4.23	2.93	7.16	1.01	0.22	23.85
4	Wt. of single leaf (gm)	3.26	0.7	8.23	1.87	0.4	57.42
5	Lamina length	15.167	9.75	22.667	4.065	0.867	26.80
6	Lamina width	12.374	7.25	19.167	3.092	0.659	24.98
7	Petiole length	4.362	2.9	6.00	1.007	0.215	23.07
8	Petiole width	0.272	0.2	0.467	0.079	0.017	28.98
9	Weight of lamina	2.868	0.55	7.233	1.666	0.355	58.08
10	Density of lenticels	5.703	3.667	8.33	1.135	0.242	19.89
11	Total shoot length	2034.02	154.67	4666.67	1347.45	287.28	66.25
12	Total shoot weight	0.833	0.036	3.025	0.905	0.193	108.64

Table 17: Top performing accessions for growth and yield parameters

SN	Parameters	Range	Accessions
1	No. of branches	85.00-23.00	MI-0838, MI-0970, MI-0837, MI-0857, MI-0858, MI-0860, MI-0859, MI-0839, MI-0966, MI-0815
2	Longest shoot length (cm)	201.67-129	MI-0966, MI-0974, MI-0967, MI-0975, MI-0857, MI-0973, MI-0970, MI-0962, MI-0858, MI-0878
3	Total shoot length (cm)	4666.67-1827.57	MI-0970, MI-0966, MI-0857, MI-0838, MI-0858, MI-0837, MI-0967, MI-0860, MI-0859, MI-0839
4	Internodal distance (cm)	7.16-4.191	MI-0857, MI-0973, MI-0878, MI-0966, MI-0975, MI-0974, MI-0962, MI-0837, MI-0967, MI-0814

SN	Parameters	Range	Accessions
5	Lamina weight (g)	7.23-3.105	MI-0966, MI-0816, MI-0857, MI-0973, MI-0878, MI-0962, MI-0814, MI-0975, MI-0974, MI-0967
6	Petiole weight (g)	1-0.467	MI-0966, MI-0814, MI-0816, MI-0975, MI-0838, MI-0878, MI-0962, MI-0973, MI-0970, MI-0974
7	Leaf yield/ plant (kg)	3.14-0.617	MI-0857, MI-0966, MI-0967, MI-0838, MI-0858, MI-0837, MI-0970, MI-0973, MI-0816, MI-0878
8	Total shoot weight (kg)	3.02-0.512	MI-0838, MI-0857, MI-0966, MI-0967, MI-0858, MI-0970, MI-0973, MI-0839, MI-0837, MI-0974
9	Total biomass (kg)	6.01-0.97	MI-0857, MI-0838, MI-0966, MI-0967, MI-0858, MI-0970, MI-0837, MI-0973, MI-0878, MI-0962
10	Moisture content (%)	71.43-66.667	MI-0966, MI-0857, MI-0869, MI-0878, MI-0962, MI-0975, MI-0974, MI-0900, MI-0858, MI-0970
11	MRC after 6 hours (%)	30-50	MI-0970, MI-0839, MI-0877, MI-0859, MI-0860, MI-0813, MI-0815, MI-0837, MI-0816, MI-0814
12	MRC (%)	21.43-58.824	MI-0970, MI-0877, MI-0839, MI-0860, MI-0813, MI-0869, MI-0859, MI-0815, MI-0858, MI-0900
13	Leaf length (cm)	22.67-15.333	MI-0878, MI-0966, MI-0975, MI-0973, MI-0974, MI-0857, MI-0970, MI-0980, MI-0816, MI-0962
14	Leaf width (cm)	19.17-13	MI-0857, MI-0878, MI-0966, MI-0970, MI-0973, MI-0975, MI-0816, MI-0974, MI-0962, MI-0814
15	Petiole length (cm)	6-4.767	MI-0973, MI-0962, MI-0966, MI-0816, MI-0859, MI-0837, MI-0858, MI-0814, MI-0857, MI-0813
16	Petiole width (cm)	0.47-0.3	MI-0857, MI-0966, MI-0878, MI-0973, MI-0838, MI-0962, MI-0975, MI-0816, MI-0813, MI-0837

E-02: Evaluation of mulberry genetic resources for Biochemical parameters in the field gene bank

Among the different biochemical parameters estimated, highest variability was observed for total chlorophyll (24.96%) followed by chlorophyll a (24.48%) and chlorophyll b (10.65%). Maximum total chlorophyll (3.43 mg/g fwt) was observed in MI-0980 and minimum in MI-0859 (1.63 mg/g fwt) (**Table 18**). Top performing accessions for different biochemical parameters are presented in **Table 19**.

Table 18: Variability statistics for biochemical parameters

Parameters	Mean	Min	Max	SD	SE	CV%
Chlorophyll a	2.26	1.58	2.55	0.38	0.08	24.48
Chlorophyll b	0.83	0.35	0.92	0.03	0.07	10.65
Total chlorophyll	3.05	1.63	3.43	0.45	0.11	24.96

Table 19: Top performing accessions for biochemical parameters

Parameters	Range	Accessions
Chlorophyll- a	2.55-1.58	MI 980, MI 981, MI 975, MI 877, MI 970, MI 974, MI 839, MI 966, MI 857, MI 814
Chlorophyll- b	0.92-0.35	MI 878, MI 857, MI 970, MI 980, MI 877, MI 973, MI 974, MI 839, MI 816, MI 838
Total chlorophyll	3.43-1.63	MI 859, MI 973, MI 878, MI 813, MI 962, MI 815, MI 816, MI 858, MI 837, MI 860

S-04: Conservation and supply of mulberry genetic resources

The diverse collections of mulberry genetic resources from different geographical regions were maintained in *ex situ* field gene bank as dwarf trees (four plants per accession) with spacing of 2.4m x 3.0m. The plants in the conservation block were trained at 1.5 m crown height following one pruning after the onset of monsoon (June-July). Immediately after pruning, manure application was taken up followed by intercultural operations for weed management. Chemical fertilizers @ 100:50:50 kg NPK/ha/yr was applied after sprouting (30 days after pruning). Irrigation was provided through drip irrigation system during non-rainy days as per requirement. Special attention was given for accessions that were planted after grafting. Basal branches from the root stock were regularly removed and plant protection measures were taken up as per the pest and disease infestation and time bound requirement.

Ex situ conservation of mulberry genetic resources in field gene bank

Twenty three new mulberry collections were inducted into the *ex situ* field gene bank and a total of 1292 accessions were conserved of which 285 were exotic and 1007 indigenous (**Table 20**).

Table 20: Details of mulberry genetic resources collected

SN	National	No. of Accns
1	Andaman & Nicobar	15
2	Arunachal Pradesh	10
3	Andhra Pradesh	4
4	Assam	11
5	Bihar	9
6	Chattisgarh	4
7	Goa	11
8	Gujarat	16
9	Haryana	13
10	Himachal Pradesh	36
11	Jammu & Kashmir	41
12	Jharkhand	17
13	Karnataka	159
14	Kerala	71
15	Madhya Pradesh	12
16	Maharashtra	32
17	Manipur	12
18	Meghalaya	23
19	Mizoram	8
20	Nagaland	9
21	New Delhi	3
22	Orissa	1
23	Pondicherry	4
24	Punjab	18
25	Rajasthan	60
26	Sikkim	15
27	Tamil Nadu	86
28	Tripura	2
29	Uttar Pradesh	146
30	Uttaranchal	8
31	West Bengal	151
	TOTAL	**1007**

SN	International	No. of accns
1	Afghanistan	3
2	Australia	2
3	Bangladesh	5
4	China	55
5	Cyprus	1
6	Egypt	3
7	France	32
8	Hungary	1
9	India	1007
10	Indonesia	8
11	Italy	7
12	Japan	72
13	Myanmar	7
14	Nepal	1
15	Pakistan	8
16	Papua New Guinea	1
17	Paraguay	4
18	Philippines	1
19	Portugal	1
20	Russia	1
21	South Korea	6
22	Spain	2
23	Sri Lanka	2
24	Thailand	11
25	Turkey	1
26	USA	4
27	Venezuela	1
28	Venosa	1
29	Vietnam	5
30	Zimbabwe	11
	Unidentified	28
	GRAND TOTAL	**1292**

Indigenous (1007) + Exotic (285) = 1292

Supply of mulberry genetic resources

During the project period, a total of 364 mulberry accessions (includes repeat supply) comprising of 62 exotic and 302 indigenous accessions were supplied to 5 indenters (**Table 21**) for different purposes *viz.* screening for root rot resistance, discovery of QTLs, UG and PG education, project works of Ph.D. students and cultivation for fruits etc.

Table 21: Details of mulberry germplasm supply during 2018-19

SN	Name of Indenter	No. of Accessions			Purpose
		Indigenous	Exotic	Total	
1	The Director, CSR&TI, CSB, Mysuru	258	48	306	Multi network projects of Mulberry under DBT-CSB funded projects and DUS projects
2	The Principal, K. K. High School, Varthur, Bengaluru 560087.	5	0	5	School fruit Tree Plantation work
3	Dr. Basavaiah (Retd. Professor), Department of Sericulture, University of Mysuru, Mysuru.	13	6	23	PG and Ph.D Research purpose
4	The Dean, A.D.A.C and R.I., TNAU, Trichy -27.	12	8	20	For UG and PG Sericultural Research & Education Purpose
5	The Scientist- D RSRS, Kodathi, Bengaluru.	10	0	10	Establishment of Fruit yielding accns
GRAND TOTAL (2018-19)		**302**	**62**	**364**	

2. **PIC 01003CN – NW4b: Sugar-Mimic Alkaloids in Mulberry and their Role in Modulating Host Plant-Insect Interactions** (Jun.18 – May' 21) (CSGRC, Hosur, UAS-GKVK, Bengaluru, CSRI-NCL-Pune, CSR&TI, Mysuru)

UAS GKVK Bengaluru: *R. Uma Shanker, N. Nataraja Karaba*
CSIR-NCL-Pune: *H.V. Thulasiram*
CSGRC-Hosur: *G. Thanavendan*

A multi-institutional project funded by DBT and CSB, Govt. of India was taken up to explore the diversity of sugar-mimic alkaloids in the mulberry germplasm including a range of *Morus* species, geographical provenances, examine their insecticidal activity, study the biochemical and molecular basis of the insecticidal activity caused by the sugar-mimic alkaloids and understand the molecular basis of resistance in those pests that are able to overcome mulberry plants' defenses. CSGRC Hosur is also one of the collaborators in the aforesaid project with the work plan of maintenance of mulberry genetic resources shortlisted for the study, supply of samples of leaf and latex for further biochemical and other studies. In this connection, as on date the centre has supplied leaf and latex samples of the mulberry accessions *viz.* V1, S1 and S13.

SILKWORM DIVISION

Inter-institutional *[As PI from Institute]*

1. **AIB 3577: Evaluation of multivoltine germplasm to identify potential parents for developing cross breeds suitable for Southern and Eastern India** (Jun.16 – May'19). (CSGRC, Hosur with CSR&TI, Mysuru & Berhampore)

CSGRC, Hosur: *N.Balachandran (PI) (till Jun.18), G. Punithavathy (PI) (from Jul.18), M.Muthulakshmi (till Jun.18), G.Thanavendan (till Jun.18), S.Nivedita (till Jun.18), Jameela khatoon (from Jul.18) & D S Somaprakash (from Jul.18)*
CSRTI, Mysuru: *K.B. Chandrasekar, P.V.Soudaminy & G.C. Das*
CSR&TI Berhampore: *N.Chandrakanth*

Background

The project aims to test selected combinations of multivoltine parental genetic resources with CSR2 and identify potential resources for utilization in development of productive cross breeds for Southern and Eastern India.

Progress

During the year under report, conducted three rearings with 20 short listed MV Cross breed combinations and the database was updated for 12 rearing and 8 reeling trait data. Disease free layings of the short listed 20 hybrid combinations for rainy, winter and summer trials were prepared by crossing with CSR2 (BBI-0290) and sent to the collaborating institutes *viz.* CSR&TI, Mysuru and CSR&TI, Berhampore for rearing in addition to at CSGRC, Hosur. The data collected from CSR&TI, Mysuru, Berhampore and CSGRC, Hosur for 3 crops *i.e.* Rainy, summer and winter crops was subjected to general statistics analysis and the same is presented in **Tables 22,25 & 28**.

Further based on Mano index , the overall studies revealed that the combination BME-0079 x BBI-0290 performed best followed by BMI-0080 x BBI-0290, BMI-0081 x BBI-0290, BMI-0048 x BBI-0290 and BMI-0025 x BBI-0290 at CSGRC, Hosur (**Table 23**). At CSR&TI, Mysuru, BMI-0079 x BBI-0290 followed by BME-0048 x BBI-0290 and BMI-0025 x BBI-0290 were the best performers (**Table 26**), while, BMI-0080 x BBI-0290 followed by BMI-0048 x BBI-0290 and BMI-0025 x BBI-0290 were the top performers at CSR&TI Berhampore (**Table 29**). Further the reeling performances of the top performing multivoltine combinations are presented in **Tables 24, 27 & 30**.

Table 22: Variability statistics on the performance of Multivoltine accessions as a hybrids of three trials conducted at CSGRC, Hosur

Traits	Mean	Min	Max	SD	CV%
Fecundity(No.)	477	437	516	19.33	4.05
Hatching %	97.13	95.87	98.12	0.61	0.63
Wt. of V Instar larvae(g)	37.90	34.46	42.08	2.09	5.51
Total larval duration(h)	546	546	550	0.89	0.16
V age larval duration(h)	149	149	150	0.22	0.15
ERR. by no. (10000 larvae)	9753	9552	9855	76.07	0.78
ERR.by wt. (kg)	15.38	13.33	17.22	1.17	7.59
Pupation rate (%)	97.11	94.95	98.19	0.87	0.89
Single cocoon weight(g)	1.53	1.42	1.64	0.06	3.77
Single shell weight(g)	0.28	0.25	0.31	0.02	5.69
Shell ratio (%)	18.87	17.92	20.01	0.65	3.45

Table 23: Performance of top multivoltine accessions as a hybrid for individual traits reared at CSGRC, Hosur with Mano values

Combinations	Fecundity(no.)	Hat	Wt. of 10 larvae	ERR/ No.	ERR/ wt.	Pupation rate	SCW	SSW	SR	Cum_EI
BMI-0079 X BBI 290	70.26	62.84	54.49	51.50	64.31	50.11	55.01	63.51	67.26	59.92
BMI-0080 X BBI 290	45.94	58.08	49.08	53.87	65.17	54.14	62.62	64.74	61.43	57.23
BMI-0081 X BBI 290	50.60	43.15	69.61	57.81	51.63	58.86	59.16	60.45	58.20	56.61
BME-0048 X BBI 290	60.43	54.14	58.99	56.63	55.06	57.94	55.88	53.09	47.91	55.56
BMI-0025 X BBI 290	42.83	43.15	70.00	60.70	59.86	60.93	59.86	53.09	43.92	54.93

Table 24: Reeling performance of top multivoltine accessions as hybrids reared at CSGRC, Hosur

Combinations	Avg.filament legth (m)	Non breakable fil.length (m)	Denier
BMI 079 x BBI 290	778.88	778.88	2.6
BMI 080 x BBI 290	834.43	834.43	2.5
BMI 081 x BBI 290	844.45	844.45	2.6
BMI 048 x BBI 290	764.92	764.92	2.8
BMI 025 x BBI 290	791.79	749.39	2.6

Table 25: Variability statistics on the performance of Multivoltine accessions as a hybrids of three trials conducted under CSR&TI, Mysuru

Traits	Mean	Min	Max	SD	CV%
Fecundity (No.)	443	394	468	15.06	3.40
Hatching %	95.92	94.15	96.87	0.74	0.77
Wt. of V Instar larvae (g)	31.46	27.54	34.70	2.13	6.77
Total larval duration (h)	564	564	568	0.89	0.16
V age larval duration (h)	132	132	135	0.67	0.51
ERR. by no. (10000 larvae)	9744	9658	9840	49.20	0.50
ERR.by wt. (kg)	13.19	11.10	14.59	0.88	6.71
Pupation rate (%)	96.06	94.98	97.20	0.60	0.62
Single cocoon weight (g)	1.42	1.18	1.58	0.09	6.44
Single shell weight (g)	0.25	0.20	0.29	0.03	10.18
Shell ratio (%)	17.93	14.99	19.73	1.14	6.36

Table 26: Performance of top multivoltine accessions as a hybrid for individual traits reared at CSR&TI, Mysuru with Mano values

Combinations	Fecundity (no.)	Hat	Wt. of 10 larvae	ERR/ No.	ERR/ wt.	Pupation rate	SCW	SSW	SR	Cum_EI
BMI0079 X BBI 290	53.15	55.20	53.78	65.91	53.17	68.51	62.92	64.90	58.26	59.53
BME0048 X BBI 290	56.47	55.74	65.24	47.83	64.36	43.05	68.04	64.52	53.88	57.68
BMI0025 X BBI 290	66.43	62.95	50.77	48.84	65.83	59.47	56.81	54.48	51.25	57.42
BMI0054 X BBI 290	61.12	54.24	53.87	63.27	53.28	57.96	45.03	46.37	50.11	53.92
BMI0081 X BBI 290	45.85	36.29	54.57	51.48	55.32	50.59	58.34	66.45	65.71	53.84

Table 27: Reeling performance of top multivoltine accessions as hybrids reared at CSR&TI, Mysore

Combinations	Avg.filament legth (mtr)	Non breakable fil.length (mtr)	Denier
BMI 079 x BBI 290	726.28	702.72	2.7
BMI 048 x BBI 290	657.33	552.74	3.2
BMI 025 x BBI 290	834.70	691.96	2.7
BMI 0054 x BBI 290	778.96	778.96	2.8
BMI 081 x BBI 290	877.45	877.45	2.7

Table 28: Variability statistics on the performance of Multivoltine accessions as a hybrids of three trials conducted under CSR&TI Berhampore

Traits	Mean	Min	Max	SD	CV%
Fecundity(No.)	450	370	515	39.40	8.75
Hatching %	95.72	93.43	98.21	1.32	1.38
Wt. of V Instar larvae (g)	36.50	34.01	39.56	1.68	4.60
Total larval duration (h)	587	579	595	5.93	1.01
V age larval duration (h)	199	192	208	5.66	2.84
ERR. by no.(10000 larvae)	8177	6111	9342	899	11.00
ERR. by wt. (kg)	11.55	8.50	13.37	1.52	13.16
Pupation rate (%)	79.87	58.84	92.53	9.32	11.67
Single cocoon weight (g)	1.46	1.39	1.59	0.05	3.20
Single shell weight (g)	0.26	0.24	0.28	0.01	4.84
Shell ratio (%)	18.07	16.91	19.21	0.61	3.37

Table 29: Performance of top multivoltine accessions as a hybrid for individual traits reared at CSR&TI, Berhampore with Mano values

Combinations	Fecundity (no.)	Hat	Wt. of 10 larvae	ERR/ No.	ERR / wt.	Pupation rate	SCW	SSW	SR	Cum _EI
BMI-0080 x BBI 290	60.85	46.72	63.94	59.11	61.33	59.78	61.23	69.74	68.70	61.27
BME-0048 x BBI 290	66.44	45.97	60.36	48.96	54.22	48.62	76.99	69.74	52.45	58.19
BMI-0025 X BBI 290	56.28	47.40	63.88	54.66	59.16	54.10	50.16	49.37	50.97	54.00
BMI-0079 X BBI 290	49.68	47.33	43.61	59.50	61.99	59.54	51.86	50.94	48.01	52.50
BMI-0022 X BBI 290	59.07	63.36	46.47	45.22	40.47	44.52	50.16	57.21	62.95	52.16

Table 30: Reeling performance of top multivoltine accessions as hybrids reared at CSR&TI, Berhampore

Combinations	Avg.filament legth (mtr)	Non breakable fil.length (mtr)	Denier
BMI 080 x BBI 290	844.00	844.00	2.5
BMI 048 x BBI 290	693.00	594.00	2.6
BMI 025 x BBI 290	756.00	696.00	2.5
BMI 079 x BBI 290	710.50	511.50	2.7
BMI 022 x BBI 290	711.00	711.00	2.4

2. AIB-3578: Evaluation of exotic bivoltine silkworm breeds to identify promising parental genetic resources (Jun.16 – Aug.'19) (CSGRC Hosur with **CSR&TI** Mysuru, Berhampore and Pampore)

CSGRC, Hosur: *M.Muthulakshmi (PI) (till Jun.18), M. Maheswari (PI) (from Jul.18), Nivedita S (till Jun.18), G. Lokesh (from Jul.18) & Jameela Khatoon (from Jul.18)*
CSR&TI, Mysuru: *C.M. Kishore kumar & M.S. Ranjini*
CSR&TI, Berhampore: *Gopal Chandra Das & Chandrakanth*
CSR&TI, Pampore: *Babulal & Sivakumar*

Background

The project aims to test selected combinations of exotic bivoltine parental genetic resources with CSR2 and CSR4 to identify potential resources for development of improved breeds.

Progress

Under report, so far 3 trials were conducted to evaluate the rearing performance of the hybrid combinations prepared from the shortlisted 20 exotic bivoltine silkworm breeds alongwith control CSR2 x CSR4 under CSGRC,Hosur (June-July'17, Sept-Oct'17 & Sept-Oct'18), CSRTI,Mysuru (Aug-Sept'17, Oct-Nov'17 & Aug-Sept'18), CSRTI, Berhampore (Oct-Nov'17, Feb-Mar'18 & Oct-Nov'18), and 2 trials at CSRTI,Pampore (Aug-Sept'2017 and Apr-May'2018) .

The data on rearing performance of three trials of the hybrid combinations of exotic breeds of each test centre was subjected to general statistics as well as Mano analysis and reeling performance of the combinations were also analyzed. The analysed data revealed that, the following breeds were found as better combiners with CSR2 and CSR4 at the respective testing centres *viz.*CSGRC, Hosur - BBE-0197 x 291 followed by BBE-0163 x 290, CSR&TI, Mysuru - BBE-0197 x 291 followed by BBE-0266 x 290. At CSR&TI Berhampore, BBE-0164 x 291 followed by BBE-0232 x 290 was the best combiners with CSR4. In case of CSR&TI, Pampore, two trials was conducted, it revealed better performance with BBE-0329 x 290 followed by BBE-0197 x 291*(290-CSR2 and 291-CSR4)* (**Tables 31 to 42**).

Table 31: Variability statistics on the three trials rearing performance of exotic bivoltine accessions as hybrids conducted under CSGRC, Hosur

Traits	Mean	Min	Max	SD	CV%
Fecundity (No.)	440	363	486	31.13	7.08
Hatching %	96.43	93.73	98.43	1.24	1.29
Wt. of V Instar larvae (g)	43.09	40.17	45.67	1.67	3.88
Total larval duration (h)	538	529	552	5.84	1.09
V age larval duration (h)	139	131	147	3.96	2.84
ERR. by no. (10000 larvae)	8958	8297	9361	301.58	3.37
ERR.by wt.(kg)	13.72	10.33	15.22	1.17	8.53
Pupation rate (%)	83.52	71.40	89.32	5.21	6.24
Single cocoon weight (g)	1.67	1.57	1.77	0.06	3.40
Single shell weight (g)	0.31	0.29	0.35	0.01	4.64
Shell ratio (%)	18.89	18.16	20.57	0.63	3.32

Table 32: Rearing performance of top exotic bivoltine accessions as hybrids for individual traits reared at CSGRC, Hosur with Mano values

Acc-No.	Fecundity	Hat	Wt. of 10 larvae	ERR/ No.	ERR/ wt.	Pupation rate	SCW	SSW	SR	Cum_EI
BBE-0197 X BBI-0291	64.83	52.38	65.37	54.30	61.22	53.06	57.98	75.54	76.68	62.37
BBE-0163 X BBI-0290	55.25	62.17	53.83	56.59	62.79	59.59	56.57	47.49	38.25	54.72
BBE-0267 X BBI-0291	56.58	62.20	47.45	52.47	56.67	49.61	57.45	53.65	48.20	53.81
BBE-0177 X BBI-0291	59.85	43.67	52.12	61.82	60.23	60.80	35.23	43.39	55.81	52.55
BBE-0225 X BBI-0290	32.01	54.06	64.59	50.03	41.14	40.55	53.75	66.65	69.09	52.43

Table 33: Reeling performance of top exotic bivoltine accessions as hybrids reared at CSGRC, Hosur

Acc-No.	Avg.filament legth (mtr)	Non breakable fil.length (mtr)	Denier
BBE-0197 X BBI-0291	921.30	640.30	2.62
BBE-0163 X BBI-0290	854.07	502.49	2.90
BBE-0267 X BBI-0291	946.20	540.97	2.47
BBE-0177 X BBI-0291	909.00	880.62	2.84
BBE-0225 X BBI-0290	864.20	635.70	2.91

Table 34: Variability statistics on the three trials rearing performance of exotic bivoltine accessions as hybrids conducted under CSR&TI, Mysuru

Traits	Mean	Min	Max	SD	CV%
Fecundity(No.)	431	374	500	35.32	8.19
Hatching %	91.79	85.25	96.04	2.42	2.63
Wt. of V Instar larvae(g)	42.24	40.06	44.66	1.09	2.57
Total larval duration(h)	543	538	546	2.12	0.39
V age larval duration(h)	141	136	144	2.12	1.50
ERR. by no. (10000 larvae)	9036	8356	9371	283.59	3.13
ERR.by wt.(kg)	13.87	12.31	15.08	0.75	5.41
Pupation rate(%)	84.53	77.28	89.41	3.31	3.92
Single cocoon weight(g)	1.63	1.55	1.740	0.042	2.55
Single shell weight(g)	0.31	0.28	0.344	0.015	4.86
Shell ratio (%)	19.27	17.86	20.54	0.707	3.66

Table 35: Rearing performance of top exotic bivoltine accessions as hybrids for individual traits reared at CSR&TI, Mysuru with Mano values

Acc-No.	Fecundity (no.)	Hat	Wt. of 10 larvae	ERR/ No.	ERR / wt.	Pupation rate	SCW	SSW	SR	Cum_EI
BBE-0197 X BBI-0291	50.43	50.63	65.16	50.97	57.18	54.62	66.08	70.73	64.05	58.87
BBE-0266 X BBI-0290	60.84	52.31	48.92	59.74	65.17	62.41	54.80	56.91	56.01	57.46
BBE-0169 X BBI-0291	62.25	46.48	52.09	45.76	57.62	42.41	75.43	67.44	55.54	56.11
BBE-0201 X BBI-0290	48.85	55.94	53.31	60.18	56.29	64.70	46.64	56.25	61.34	55.94
BBE-0154 X BBI-0290	48.13	22.92	72.19	61.12	66.07	60.09	52.40	52.30	51.50	54.08

Table 36: Reeling performance of top exotic bivoltine accessions as hybrids reared at CSR&TI Mysuru

Acc-No.	Avg.filament length (mtr)	Non breakable fil. length (mtr)	Denier
BBE-0197 X BBI-0291	985.68	895.27	2.63
BBE-0266 X BBI-0290	891.00	827.68	2.77
BBE-0169 X BBI-0291	982.23	949.99	2.63
BBE-0201 X BBI-0290	938.54	891.64	2.55
BBE-0154 X BBI-0290	890.87	878.96	2.80

Table 37: Variability statistics on the three trials rearing performance of exotic bivoltine accessions as hybrids conducted under CSR&TI, Berhampore

Traits	Mean	Min	Max	SD	CV%
Fecundity(No.)	509	440	578	30.14	5.92
Hatching %	96.45	90.26	97.83	1.73	1.79
Wt. of V Instar larvae(g)	39.27	36.56	41.74	1.53	3.91
Total larval duration(h)	571	534	578	8.88	1.56
V age larval duration(h)	173	172	178	2.41	1.39
ERR. by no. (10000 larvae)	5792	2440	7666	1347.86	23.27
ERR.by wt.(kg)	7.89	3.72	12.00	1.88	23.86
Pupation rate(%)	51.53	22.24	70.78	12.99	25.22
Single cocoon weight(g)	1.44	1.37	1.53	0.04	3.05
Single shell weight(g)	0.29	0.26	0.31	0.03	9.69
Shell ratio (%)	20.60	18.30	20.58	2.91	14.11

Table 38: Rearing performance of top exotic bivoltine accessions as a hybrid for individual traits reared at CSR&TI,Berhampore with Mano values

Acc-No.	Fecundity (no.)	Hat %	Wt. of 10 larvae	ERR/ No.	ERR/ wt.	Pupation rate	SCW	SSW	SR %	Cum_EI
BBE-0164 X BBI-0291	56.53	57.78	48.29	58.78	60.42	58.30	42.92	85.08	90.87	62.11
BBE-0232 X BBI-0290	37.78	53.40	63.07	53.96	53.57	55.41	55.82	51.13	48.59	52.53
BBE-0163 X BBI-0290	59.73	51.99	43.95	54.45	53.31	53.92	58.54	49.73	46.90	52.50
BBE-0267 X BBI-0291	57.67	54.23	55.26	57.86	59.09	59.02	36.12	43.43	48.08	52.31
BBE-0050 X BBI-0291	38.80	48.90	54.66	57.02	56.20	56.80	58.99	50.78	47.90	52.23

Table 39: Reeling performance of top exotic bivoltine accessions as a hybrid reared at CSR&TI Berhampore

Acc-No.	Avg.filament length (mtr)	Non breakable fil. length (mtr)	Denier
BBE-0164 X BBI-0291	777.94	747.40	2.57
BBE-0232 X BBI-0290	834.97	779.33	2.81
BBE-0163 X BBI-0290	749.62	714.48	2.72
BBE-0267 X BBI-0291	878.82	714.48	2.46
BBE-0050 X BBI-0291	878.08	569.26	2.56

Table 40: Variability statistics on the two trials rearing performance of exotic bivoltine accessions as hybrids of conducted under CSR&TI, Pampore

Traits	Mean	Min	Max	SD	CV%
Fecundity(No.)	411	377	484	22.18	5.39
Hatching %	93.64	92.03	95.83	0.87	0.93
Wt. of V Instar larvae(g)	37.34	34.92	42.43	1.46	3.90
Total larval duration(h)	703	678	704	5.67	0.81
V age larval duration(h)	159	150	159	1.96	1.24
ERR. by no. (10000 larvae)	9601	9387	9800	107.97	1.12
ERR.by wt.(kg)	14.07	12.63	14.85	0.52	3.69
Pupation rate(%)	94.79	92.50	97.13	1.32	1.39
Single cocoon weight(g)	1.62	1.57	1.78	0.04	2.70
Single shell weight(g)	0.32	0.30	0.33	0.01	2.75
Shell ratio (%)	19.93	18.78	20.67	0.45	2.27

Table 41: Rearing performance of top exotic bivoltine accessions as a hybrid for individual traits reared at CSR&TI, Pampore with Mano values

Acc-No.	Fecundity (no.)	Hat. %	Wt. of 10 larvae	ERR/ No.	ERR/ wt.	Pupation rate	SCW	SSW	SR	Cum_EI
BBE-0329 X BBI-0290	54.68	75.04	41.10	63.46	56.44	60.74	50.26	64.32	64.88	58.99
BBE-0197 X BBI-0291	50.17	49.41	49.69	68.40	61.75	67.84	53.47	60.93	57.04	57.63
BBE-0050 X BBI-0291	54.04	47.51	51.86	51.73	56.76	55.16	49.57	64.32	65.95	55.21
BBE-0143 X BBI-0291	47.39	45.83	48.82	60.68	37.52	57.45	51.41	66.58	66.32	53.56
BBE-0163 X BBI-0290	52.35	65.59	42.24	62.54	51.17	62.00	42.48	42.84	48.34	52.17

Table 42: Reeling performance of top exotic bivoltine accessions as a hybrid reared at CSR&TI Pampore

Acc-No.	Avg.filament length (mtr)	Non breakable fil. length (mtr)	Denier
BBE-0329 X BBI-0290	758.50	705.50	2.77
BBE-0197 X BBI-0291	750.00	661.50	2.78
BBE-0050 X BBI-0291	750.50	697.00	2.66
BBE-0143 X BBI-0291	768.50	715.00	2.55
BBE-0163 X BBI-0290	698.50	647.50	2.63

Further, one rearing of the shortlisted 20 bivoltine silkworm breeds was taken up along with testers (CSR2 and CSR4) and dfls of hybrid combinations were prepared and conserved in cold storage in order to take up the 3rd and 4th trials at the testing centres.

New Projects initiated during 2018-19

***Inter-institutional** [As PI from Institute]*

1. AIE-06002MI: Evaluation of bivoltine silkworm genetic resources for tolerance to abiotic stress in selected hotspots (Mar.19 – Mar.22).

CSGRC, Hosur: *M. Maheswari (PI), G. Lokesh, Jameela Khatoon & Geetha N Murthy*
SBRL, Kodathi: *K.S.Tulsi Naik*
REC, Chitradurga-CSRTI, Mysuru: *Y. Srinivasulu*
CSRTI, Berhampore: *N. Chandrakanth & G. C Das*
RSRS, Jammu-CSRTI, Pampore: *Sardar Singh & S. Murali*

Background

The project aims to evaluate selected bivoltine germplasm resources with presence of markers linked to thermo tolerance against abiotic stress at selected hot spots and identify suitable bivoltine breeds.

Progress

The project was initiated during March 2019, SGIS data was analysed for the shortlisting of 40 bivoltine accessions for further screening using SSR DNA markers to identify thermotolerant linkage.

Continuous Programme: Collection, characterization, evaluation, conservation and supply of silkworm genetic resources (SWGRs)

D.S. Somaprakash, M. Maheswari, G. Punithavathy, G. Lokesh, Jameela Khatoon, Geetha N Murthy

CSGRC Hosur is the exclusive centre for conserving mulberry silkworm genetic resources for utilization by various CSB and non-CSB research institutes / universities. As per mandate, the centre is conserving 475 seri-genetic resources [83 multivoltine, 369 bivoltine and 23 mutants] with due characterization, evaluation, updation of database and promotion of utilization.

S-01: Collection of Silkworm Genetic Resources

During the period, 14 bivoltine silkworm genetic accessions (D5, D6 (M), BHR-2, MJ-1, MJ-2, MC4 (E), MC4 (O), MC2, BG (W), SK3C, SK4N, NBO-2, NBO-3 and NBP4) were

collected from CSR&TI, Berhampore. All the accessions were subjected for quarantine rearing (first trial) to ensure disease freeness. Evaluation studies revealed the breeds exhibiting variability in terms of origin, nature of breed as well as qualitative and quantitative traits. The gene bank currently holds a total of 475 indigenous and exotic silkworm genetic resources collected from 9 States of the country and 14 countries across the world. It includes 83 multivoltine (indigenous-73 & exotic-10), 369 bivoltine (indigenous-209 & exotic-160) and 23 mutant genetic stocks (exotic) representing 14 countries including India (**Table 43**).

Table 43: Phase wise silkworm germplasm collection

Year	Phase	Bivoltine	Multivoltine	Mutant	TOTAL
1993-1997	I	169	57	-	**226**
1997-2000	II	103	-	-	**103**
2000-2003	III	40	8	19	**67**
2003-2006	IV	25	7	1	**33**
2006-2009	V	2	1	-	**3**
2009-2012	VI	11	1	-	**12**
2012-2015	VII	15	7	-	**22**
2015-2018	VIII	4	2	3	**9**
Grand Total		**369**	**83**	**23**	**475**

S-02: Characterization and Preliminary Evaluation of Silkworm Genetic Resources

Morphological characterization was carried out for all the 475 silkworm genetic resources using 27 descriptors on various growth stages *viz*. egg, larva, cocoon, pupa and moth stages to confirm its maintenance true to catalogue data and the data generated were updated in the Silkworm Germplasm Information System [SGIS] database. The silkworm genetic resources were characterized for different descriptors as per standard protocol and evaluated for 11 important economic parameters that paves a way to manage the gene bank efficiently with authentic database. The database will aid in ascertaining the variability or similarity of new germplasm with existing accessions in the gene bank during registration.

E-01: Morphological characterization of SWGRs

Morphological characterization was carried out using 27 descriptors for 475 silkworm accessions (83 multivoltine, 369 bivoltine and 23 mutants) on various growth stages *viz*. egg, larva, cocoon, pupa and moth stages to confirm its maintenance true to catalogue data. The

variability in the morphological features of all the silkworm accessions for each descriptor was found true to catalogue data. The data on the important morphological parameters of the 83 multivoltine silkworm accessions are presented in **Table 44**. Multivoltine silkworm accessions revealed three types of larval patterns *viz.* plain, marked and mixed. The analysed data on morphological characters of multivoltine accessions indicated, maximum accessions with plain larval pattern (46 accns, 55.4%) followed by marked (33 accns; 39.8%) and mixed (4 accns; 4.8%). In case of cocoon colour, maximum accessions revealed greenish yellow colour (35 accns; 42.2 %) followed by white (22 accns; 26.5%), chrome yellow (20 accns; 24.1%), yellow cocoons (4 accns; 4.8%) and creamy white (2 accns; 2.4%). Similarly the cocoon shape revealed maximum oval shaped cocoons (31 accns; 37.3%) followed by elongated with narrow constriction (24 accns; 28.9%), spindle shape (19 accns; 22.9%), spatulate (4 accns; 4.8%), dumbbell (3 accns; 3.6%) and elongated (2 accns; 2.4%).

Table 44: Morphological trait variations in multivoltine SWGRs

Parameters	Frequency	Percentage
Larval Pattern		
Plain	46	55.4
Marked	33	39.8
Mixed	4	4.8
Cocoon colour		
Greenish yellow	35	42.2
White	22	26.5
Chrome yellow	20	24.1
Yellow	4	4.8
Creamy white	2	2.4
Cocoon shape		
Oval	31	37.3
ENC	24	28.9
Spindle	19	22.9
Spatulate	4	4.8
Dumb-bell	3	3.6
Elongated	2	2.4

Morphological characterisation of the 369 bivoltine silkworm accessions revealed variability for important morphological characters and is presented in **Table 45**. There are four types of larval patterns with majority accessions revealing plain pattern (221 accessions 59.9%) followed by marked (128 accessions 34.7%), mixed (18 accessions 4.9%) and sex limited (2

accessions 0.5%). The cocoon colour revealed maximum accessions with white cocoons (343 accns; 93%) followed by chrome yellow (9 accessions 2.4%), flesh cocoons (6 accessions 1.6%), greenish yellow (4 accessions 1.1%) and mixed (2 accessions 0.5%). In the same way, cocoon shape revealed maximum accessions with elongated constricted cocoons (164 accns; 44.4%) followed by oval (126 accns; 34.1%), elongated non-constricted (37 accns; 10%), elongated faint constriction (9 accns; 2.4%), spindle cocoons (6 accns; 1.6%) and elliptical (1 accn; 0.3 %).

Table 45: Morphological trait variations in bivoltine SWGRs

Traits	Frequency	Percentage
Larval pattern		
Plain	221	59.9
Marked	128	34.7
Mixed	18	4.9
Sex limited	2	0.5
Cocoon colour		
White	343	93.0
Chrome yellow	9	2.4
Flesh	6	1.6
Creamish white	5	1.4
Greenish yellow	4	1.1
Mixed	2	0.5
Cocoon shape		
Elongated constricted	164	44.4
Oval	126	34.1
Elongated non-constricted	37	10.0
Dumb-bell	26	7.0
Elongated faint constricted	9	2.4
Spindle	6	1.6
Elliptical	1	0.3

E-02: Preliminary evaluation of multivoltine SWGRs for growth and reproductive traits

Totally, 114 conservation crops of multivoltine SWGRs are completed. During the period, preliminary evaluation and data analysis of 5 conservation crops of multivoltine SWGRs were carried out for 11 important rearing and 3 reeling traits. The variability in economic traits and the individual trait-wise performance of the accessions along with mean and CV % is presented in

Table 46. The analysed data depicts that maximum fecundity was recorded as 512(BMI-0080), and minimum as 322 (BMI-0026), maximum weight of 10 larvae was 35.20g (BMI-0083) and minimum was 17.27g (BME-0047), ERR by no. was minimum in accession BMI-0067 (9329) and maximum in BMI-0079 (9858), whereas, accession BMI-0037 recorded minimum yield (7.52 kg) and BMI-0084 maximum (12.82 kg). Minimum single cocoon weight, single shell weight and SR%, respectively were recorded in accessions BMI-0031(0.733 g), BMI-0021(0.095 g) and BMI-0011 (11.90%), whereas accession BMI-0083 recorded maximum single cocoon weight (1.438 g), single shell weight (0.273 g) and SR% (19.06 %). The details of individual trait-wise top performing ten accessions for all the 11 rearing parameters along with the range values are presented in **Table 47**.

Table 46: Economic trait-wise range of variability in multivoltine SWGRs

Traits	Mean	Min	Max	SD	SE	CV%
Fecundity (No.)	401	322(BMI-0026)	512 (BMI-0080)	24.54	2.71	6.12
Hatching (%)	97.11	93.90(BMI-0077)	98.05 (BME-0048)	0.60	0.07	0.62
Wt. of 10 Larvae (g)	21.87	17.27(BME-0047)	35.20 (BMI-0083)	3.47	0.38	15.86
Total larval duration (h)	491	468(BMI-0082)	562 (BMI-0001)	13.71	1.51	2.79
V Larval duration (h)	114	101(BMI-0013)	145(BMI-0083)	9.14	1.01	8.05
ERR (No.) (10000 larvae)	9741	9329(BMI-0067)	9858 (BMI-0079)	66.67	7.36	0.68
ERR (wt. in kg)	8.93	7.52(BMI-0037)	12.82 (BMI-0084)	0.93	0.10	10.41
Pupation rate (%)	95.81	91.73(BMI-0067)	97.83 (BMI-0079)	0.90	0.10	0.94
Single Cocoon Wt (g)	0.91	0.733(BMI-0031)	1.438 (BMI-0083)	0.12	0.01	13.11
Single Shell Wt (g)	0.12	0.095(BMI-0021)	0.273 (BMI-0083)	0.03	0.00	25.65
Shell Ratio (%)	13.54	11.90(BMI-0011)	19.06 (BMI-0083)	1.57	0.17	11.62

Table 47: Trait-wise top performing multivoltine SWGRs

Trait	Range	Accession No.
Fecundity (No.)	512-434	BMI-0080, BMI-0084, BMI-0078, BMI-0077, BMI-0079, BMI-0081, BMI-0083, BMI-0082, BMI-0007
Hatching (%)	98.05-97.72	BMI-0068, BME-0048, BMI-0007, BMI-0031, BME-0050, BMI-0025, BMI-0018, BME-0049, BMI-0010, BMI-0078, BME-0047
Wt. of 10 Larvae (g)	35.2-26.22	BMI-0083, BMI-0084, BMI-0078, BMI-0074, BMI-0076, BMI-0081, BMI-0080, BME-0048, BMI-0077
ERR (By No.)	9858-9816	BMI-0079, BMI-0065, BMI-0025, BMI-0069, BMI-0073, BMI-0009

ERR (By Wt.) Kg.	12.82-9.94	BMI-0084, BMI-0083, BMI-0078, BMI-0074, BMI-0081, BME-0048, BMI-0076, BMI-0009, BMI-0024
Pupation rate (%)	97.83-96.76	BMI-0079, BMI-0081, BMI-0076, BMI-0084, BMI-0083, BMI-0074, BMI-0065, BMI-0070, BMI-0071, BMI-0073, BMI-0069, BMI-0053
Single Cocoon Wt. (g)	1.438-1.026	BMI-0083, BMI-0084, BMI-0078, BMI-0076, BMI-0080, BMI-0081, BMI-0074, BME-0048, BMI-0024
Single Shell Wt. (g)	0.273-0.158	BMI-0083, BMI-0084, BMI-0076, BMI-0078, BMI-0074, BMI-0081, BMI-0080, BMI-0073
Shell Ratio (%)	19.06-15.13	BMI-0083, BMI-0084, BMI-0076, BMI-0074, BMI-0078, BMI-0081, BMI-0073, BMI-0080, BMI-0079, BMI-0014, BME-0012

The multiple trait evaluation for the 11 rearing traits (**Table 48**) revealed that, accession BMI-0083, BMI-0084, BMI-0081 and BMI-0078 ranked first with best performance for 7 traits followed by BMI-0074 and BMI-0076 for 6 traits; BMI-0080 for 5 traits.

Table 48: Top performing multivoltine SWGRs for multiple traits

Accession No.	No. of traits	Trait No. and Values
BMI-0083	7	1(438), 3(35.2), 5(12.12), 6(97.17), 7(1.438), 8(0.273), 9(19.06),
BMI-0084	7	1(454), 3(34.74), 5(12.82), 6(97.25), 7(1.34), 8(0.244), 9(18.53),
BMI-0081	7	1(441), 3(28.93), 5(10.42), 6(97.3), 7(1.099), 8(0.18), 9(16.54),
BMI-0078	7	1(454), 2(97.76), 3(31.98), 5(11.38), 7(1.197), 8(0.196), 9(16.56),
BMI-0074	6	3(29.76), 5(10.98), 6(96.89), 7(1.091), 8(0.181), 9(16.84),
BMI-0076	6	3(29.66), 5(10.26), 6(97.26), 7(1.146), 8(0.209), 9(18.35),
BMI-0080	5	1(512), 3(28.26), 7(1.103), 8(0.178), 9(16.3),

Figures in parenthesis indicate the actual value of the traits.
1.Fecundity (No.), 2.Hatching (%), 3.Wt of 10 larvae (g), 4.ERR (No.), 5.ERR (Wt.), 6.Pupation Rate (%), 7.Single Cocoon Wt (g), 8.Single Shell Wt (g), 9.Shell Ratio (%)

The data on the reeling parameters of multivoltine germplasm and the top performing multivoltine accessions for the important reeling traits are presented in **Tables 49 & 50.**.

Table 49: Reeling performance of Multivoltine germplasm resources

Parameters	Average	Min.	Max.	SD	CV %
Average Filament Length (mtr)	398.727	271.405	844.710	103.154	25.871
Non breakable filament length(mtr)	318.745	93.335	804.990	111.670	35.034
Average Filament Denier	2.045	1.520	3.045	0.291	14.219

Table 50: Top ranking Multivoltine accessions identified for reeling traits

Parameters	Range	Multivoltine accessions
Average Filament Length (mtr)	815.63-525.26	BMI - 0076, BMI - 0083, BMI - 0078, BMI - 0081, BMI - 0074, BMI - 0073, BMI - 0080, BMI - 0024, BMI - 0084, BMI - 0007
Non breakable filament length(mtr)	815.63-485.33	BMI - 0076, BMI - 0078, BMI - 0073, BMI - 0081, BMI - 0024, BMI - 0007, BMI - 0079, BMI - 0080, BMI - 0023, BMI - 0008
Average Filament Denier	1.51-1.72	BMI - 0021, BMI - 0053, BME - 0015, BMI - 0008, BMI - 0056, BMI - 0062, BME - 0052, BME - 0013, BMI - 0022, BMI - 0058

E-03: Preliminary evaluation of bivoltine silkworm genetic resources for growth and reproductive traits

The 369 bivoltine silkworm genetic resources were evaluated in three batches for 11 important growth and reproductive traits in three conservation crops. Variability statistics analysis of the data generated for important quantitative traits is presented in **Table 51.** The fecundity (number of eggs / dfl) ranged from 236 (BBE-0238) to 591 (BBI-0030), hatching percentage from 75.2 (BBI-0140) to 98.6% (BBI-0387), the larval weight for 10 larvae ranged from 18.45 g (BBI-0092) to 46.30 g (BBI-0171). In case of total larval duration it ranged from 504 h (BBE-0002) to 624 h (BBE-0171). Accession BBE-0005 recorded minimum fifth age larval duration (96h), while, maximum was in BBE-0026 (168h). The ERR by number was minimum in BBE-023 (7200) and maximum in BBI-0092 (9917). Accession BBI-093 recorded minimum ERR by weight (7.75 kgs), whereas BBI-0282 recorded maximum (15.70 kgs). Similarly pupation rate ranged from **(**60.17% to 98.00%), minimum in BBE-023 (60.17%) and maximum in BBE-0180 (98.00%). Accession BBI-0141 recorded minimum single cocoon weight (1.006g) and maximum in BBE-039 (1.766g). In case of accession BBI-0141 recorded minimum single shell weight and shell ratio %, respectively (0.123 & 12.25, repectively). Maximum single shell weight was recorded in BBE-0014 (0.342) and shell ratio % in BBE-186 (21.07%). The coefficient of variation was highest for fecundity (14.64%) followed by weight of 10 V Instar larvae (13.83), V age larval duration (12.48) and single shell weight (11.88%) which reflects the high variations for the traits among the accessions.

Table 51: Economic trait-wise range of variability in bivoltine silkworm genetic resources

Traits	Mean	Min	Max	SD	SE	CV%
Fecundity(No.)	396	236 (BBE-0238)	591 (BBE-0030)	58.02	3.033	14.65
Hatching (%)	93.91	75.22 (BBI-0140)	98.65 (BBI-0387)	3.59	0.188	3.83
Wt. of V Instar larvae (g)	35.90	18.45 (BBI-0092)	46.30 (BBE-0171)	4.97	0.260	13.86
Total larval duration (h)	576	504 (BBE-0002)	624 (BBE-0171)	38.95	2.040	6.75
V age larval duration(h)	153	96 (BBE-0005)	168 (BBE-0026)	19.04	0.992	12.48
ERR by no. (10000 larvae)	9397	7200 (BBE-0023)	9917 (BBI-0092)	430.25	22.490	4.58
ERR by wt.(kg)	12.93	7.75 (BBI-0093)	15.70 (BBI-0282)	1.21	0.063	9.32
Pupation rate (%)	90.02	60.17 (BBE-0023)	98.00 (BBE-0180)	5.72	0.299	6.36
Single cocoon wt(g)	1.462	1.006 (BBI-0141)	1.766 (BBE-0039)	0.12	0.007	8.55
Single shell wt(g)	0.264	0.123 (BBI-0141)	0.342 (BBE-0014)	0.03	0.002	11.88
Shell ratio %	18.12	12.25 (BBI-0141)	21.07 (BBE-0186)	1.10	0.057	6.05

The better performing bivoltine accessions shortlisted based on ANOVA as well as multiple trait analysis for individual and multiple important economic traits are presented along with the range values in **Tables 52 & 53,** respectively.

Table 52: Top performing bivoltine germplasm accessions for individual traits

Traits	Range	Top Bivoltine accessions
Fecundity (No.)	**454.5 - 591**	BBE-0030, BBE-0031, BBI-0048, BBE-0019, BBI-0279, BBI-0335, BBI-0325, BBI-0063, BBI-0047, BBI-0085, BBI-0084, BBI-0358, BBI-0278, BBI-0061, BBE-0023, BBE-0038, BBI-0073, BBE-0018, BBE-0007, BBI-0044, BBI-0328, BBE-0041, BBI-0286, BBE-0034, BBI-0285, BBI-0068, BBE-0027, BBE-0169, BBE-0201, BBE-0220, BBI-0355, BBE-0036, BBI-0082, BBI-0203, BBI-0344, BBI-0091, BBI-0062, BBI-0287, BBI-0077, BBE-0202, BBE-0329, BBI-0290, BBI-0281, BBI-0074, BBI-0071, BBI-0359, BBE-0010, BBI-0124, BBI-0067, BBE-0212, BBI-0380, BBE-0261, BBI-0086, BBE-0016, BBI-0378

Traits	Range	Top Bivoltine accessions
Hatching (%)	**97.512-98.651**	BBI-0387, BBI-0389, BBI-0114, BBE-0181, BBE-0191, BBI-0369, BBI-0361, BBE-0260, BBI-0283, BBE-0193, BBE-0187, BBI-0362, BBI-0276, BBE-0012, BBE-0022, BBI-0365, BBI-0385, BBE-0188, BBI-0370, BBE-0020, BBE-0021, BBI-0373, BBI-0374, BBI-0360, BBE-0015, BBI-0277, BBI-0302, BBE-0263, BBI-0357, BBI-0258, BBE-0018, BBI-0304, BBE-0225
Wt. of V Instar larvae(g)	**40.9 - 46.3**	BBE-0039, BBI-0285, BBE-0003, BBI-0328, BBE-0024, BBE-0013, BBE-0050, BBE-0040, BBE-0035, BBE-0280, BBI-0284, BBI-0290, BBI-0066, BBI-0046, BBE-0329, BBI-0364, BBI-0293, BBE-0034, BBI-0079, BBI-0044, BBI-0045, BBI-0381, BBE-0031, BBI-0287, BBI-0281, BBE-0146, BBE-0032, BBI-0063, BBI-0068, BBI-0279, BBE-0002, BBI-0291, BBE-0038, BBI-0085, BBI-0056, BBE-0014, BBI-0282, BBI-0057, BBI-0343, BBI-0067, BBI-0075, BBI-0302, BBE-0043, BBI-0359, BBE-0049, BBE-0051, BBI-0367, BBI-0078, BBE-0033, BBE-0008, BBI-0076, BBI-0380, BBI-0387, BBI-0324, BBI-0084, BBI-0072, BBI-0366, BBI-0047, BBI-0062, BBI-0060, BBI-0124, BBE-0007, BBI-0053, BBE-0023, BBI-0065, BBE-0016, BBI-0384, BBI-0048, BBI-0071, BBI-0082, BBE-0001
ERR. by no. (10000 larvae)	**9833- 9916.5**	BBI-0092, BBE-0177, BBI-0110, BBI-0295, BBI-0325, BBI-0324, BBI-0140, BBI-0354, BBI-0330, BBI-0346, BBE-0150, BBI-0084, BBE-0180, BBE-0163, BBE-0159, BBE-0152, BBI-0286, BBI-0336, BBI-0243, BBI-0352, BBI-0283, BBI-0281, BBI-0387, BBI-0294
ERR.by wt.(kg)	**14.15 -15.7**	BBI-0282, BBE-0014, BBI-0291, BBI-0328, BBE-0199, BBI-0285, BBE-0003, BBE-0002, BBI-0287, BBI-0293, BBI-0324, BBI-0290, BBE-0174, BBI-0284, BBE-0018, BBE-0004, BBI-0079, BBI-0082, BBE-0182, BBE-0001, BBI-0080, BBE-0186, BBE-0177, BBI-0084, BBI-0351, BBE-0187, BBI-0305, BBE-0039, BBI-0044, BBI-0057, BBI-0359, BBE-0198, BBI-0326, BBI-0068, BBI-0077, BBE-0184, BBI-0279, BBE-0197, BBE-0049, BBE-0007
Pupation rate (%)	**95.833 -98.00**	BBE-0180, BBE-0177, BBI-0243, BBI-0330, BBI-0344, BBI-0325, BBI-0285, BBI-0286, BBE-0166, BBI-0273, BBI-0336, BBI-0346, BBI-0354, BBI-0092, BBI-0172, BBI-0283, BBI-0281, BBE-0030, BBI-0084, BBE-0224, BBI-0082, BBI-0352, BBI-0140, BBI-0324, BBI-0349, BBI-0339, BBI-0295, BBE-0280, BBI-0259, BBE-0150, BBI-0068, BBI-0287, BBI-0110, BBI-0326, BBE-0147, BBE-0159, BBI-0296, BBI-0294, BBI-0215, BBE-0227, BBI-0347, BBI-0355, BBE-0240, BBE-0163

Traits	Range	Top Bivoltine accessions
Single cocoon weight(g)	**1.588 -1.766**	BBE-0039, BBI-0044, BBE-0014, BBE-0038, BBE-0034, BBI-0377, BBI-0291, BBE-0023, BBE-0003, BBI-0133, BBI-0328, BBE-0035, BBI-0293, BBI-0282, BBI-0360, BBE-0050, BBE-0007, BBI-0285, BBI-0359, BBI-0349, BBE-0043, BBE-0024, BBE-0040, BBI-0361, BBI-0378, BBI-0324, BBI-0385, BBE-0002, BBI-0290, BBI-0379, BBI-0303, BBI-0057, BBI-0383, BBI-0336, BBI-0380, BBI-0367, BBI-0382, BBE-0004, BBI-0287, BBI-0366, BBE-0149, BBE-0033, BBI-0284, BBI-0375, BBI-0365, BBI-0131, BBI-0389, BBI-0344, BBI-0339, BBE-0018, BBI-0079, BBI-0052, BBE-0051, BBE-0001
Single shell weight(g)	**0.296 -0.342**	BBI-0044, BBE-0014, BBE-0007, BBI-0290, BBE-0038, BBE-0039, BBI-0328, BBE-0034, BBI-0324, BBI-0291, BBE-0003, BBI-0293, BBI-0326, BBI-0282, BBE-0040, BBI-0287, BBI-0080, BBI-0055, BBE-0186, BBI-0359, BBE-0050, BBE-0033, BBI-0358, BBE-0023, BBE-0002, BBI-0325, BBI-0053, BBI-0278, BBI-0351, BBI-0284, BBI-0285, BBE-0035, BBE-0031, BBI-0057, BBE-0024, BBI-0082, BBI-0133, BBE-0146, BBE-0154, BBI-0079, BBE-0043, BBI-0380, BBE-0149, BBE-0004
Shell ratio (%)	**19.234 -21.069**	BBE-0186, BBI-0358, BBI-0326, BBI-0081, BBI-0325, BBE-0188, BBI-0290, BBE-0007, BBI-0278, BBI-0055, BBE-0263, BBE-0014, BBE-0010, BBE-0173, BBE-0252, BBE-0171, BBI-0324, BBE-0182, BBI-0327, BBI-0354, BBI-0328, BBE-0200, BBE-0178, BBI-0294, BBI-0053, BBI-0078, BBE-0162, BBE-0181, BBI-0351, BBI-0065, BBE-0212, BBI-0044, BBI-0080, BBE-0031, BBI-0066, BBE-0179, BBI-0291, BBE-0038, BBI-0085, BBE-0034, BBI-0296, BBE-0280, BBI-0072, BBE-0329, BBE-0187, BBI-0074, BBE-0201, BBI-0286, BBE-0146

Table 53: Top ranking bivoltine germplasm accessions identified for multiple traits

Acc.No.	No. of traits	Trait No. and values
BBI-0324	7	3(41.3), 4(9883.5), 5(15.35), 6(96.334), 7(1.639), 8(0.326), 9(19.868),
BBI-0044	6	1(484), 3(42.95), 5(14.5), 7(1.752), 8(0.342), 9(19.575),
BBI-0285	6	1(480), 3(45.45), 5(15.55), 6(97), 7(1.652), 8(0.301),
BBE-007	6	1(487), 3(41.15), 5(14.15), 7(1.652), 8(0.334), 9(20.23),
BBI-0287	6	1(464), 3(42.35), 5(15.4), 6(96.166), 7(1.619), 8(0.308),
BBI-0290	6	1(462.5), 3(43.55), 5(15.25), 7(1.63), 8(0.331), 9(20.283),
BBI-0328	6	1(482), 3(45), 5(15.65), 7(1.668), 8(0.33), 9(19.796),
BBI-0082	5	1(470.5), 3(40.9), 5(14.85), 6(96.5), 8(0.298),

Acc.No.	No. of traits	Trait No. and values
BBI-0084	5	1(495), 3(41.3), 4(9866.5), 5(14.7), 6(96.5),
BBI-0291	5	3(42.1), 5(15.7), 7(1.684), 8(0.326), 9(19.426),
BBI-0325	5	1(513), 4(9900), 6(97), 8(0.304), 9(20.558),
BBI-0359	5	1(460.5), 3(41.65), 5(14.4), 7(1.652), 8(0.308),
BBE-0038	5	1(489.5), 3(41.95), 7(1.706), 8(0.33), 9(19.408),
BBE-0034	5	1(480.5), 3(43.2), 7(1.698), 8(0.326), 9(19.308),
BBE-0014	5	3(41.85), 5(15.7), 7(1.721), 8(0.342), 9(19.916),

Figures in parantheses indicates the actual value of the traits

1.Fecundity (Nos.), 2.Hatching (%), 3.Wt of 10 larvae (g), 4.ERR (No.), 5.ERR (Wt.), 6.Pupation Rate (%), 7.Single Cocoon Weight (g), 8.Single Shell Weight (g), 9.Cocoon Shell Ratio (%)

Data analysis indicated that, accession BBI-0324 was the best performer qualifying for seven traits followed by BBI-0044, BBI-285, BBE-007, BBI-0287, BBI-290, BBI-328 for six traits and BBI-0082, BBI-0084, BBI-0291, BBI-0325, BBI-0359, BBE-0038, BBE-0034 and BBE-0014 for 5 traits. The data on the reeling parameters of bivoltine germplasm and the top performing bivoltine accessions for the important reeling traits are presented in **Tables 54 & 55**.

Table 54: Reeling performance of Bivoltine germplasm resources

Parameters	Average	Min.	Max.	SD	CV %
Average Filament Length (mtr)	809.094	268.760	1166.960	118.915	14.697
Non breakable filament length(mtr)	683.929	54.850	1067.850	176.065	25.743
Average Filament Denier	2.476	1.500	3.490	0.307	12.399

Table 55: Top ranking Bivoltine accessions identified for reeling traits

Parameters	Range	Bivoltine accessions
Average Filament Length (mtr)	1166.96-1031.74	BBI-0326, BBI-0328, BBI-0279, BBI-0044, BBE-0332, BBI-0359, BBE-0280, BBE-0179, BBI-0290, BBI-0291
Non breakable filament length(mtr)	1067.85-977.72	BBI-0359, BBI-0284, BBI-0328, BBI-0358, BBI-0080, BBI-0172, BBI-0044, BBI-0138, BBE-0332, BBI-0380
Average Filament Denier	1.5-1.9	BBE-0189, BBI-0248, BBE-0218, BBI-0237, BBE-0233, BBE-0246, BBI-0256, BBE-0260, BBI-0259, BBE-0176

E-04: Preliminary evaluation for growth and reproductive traits of mutant silkworm genetic resources

Evaluation of 23 mutant genetic stocks revealed the following variability statistics on the 11 important economical traits and is presented in **Table 56.**

Table 56: Variability in economical traits of 23 mutant genetic stocks

Traits	Mean	Min	Max	SD	CV%
Fecundity(No.)	337	303	350	10.90	3.23
Hatching (%)	96.05	93.04	97.34	1.25	1.31
Wt. of V Instar larvae(g)	25.45	17.01	38.97	4.91	19.29
Total larval duration(h)	491	456	504	14.23	2.90
V age larval duration(h)	155	120	168	14.23	9.16
ERR. by no. (10000 larvae)	9136	8367	9600	387.73	4.24
ERR.by wt.(kg)	10.08	6.60	12.50	1.67	16.58
Pupation rate (%)	89.05	80.33	94.50	4.25	4.77
Single cocoon weight (g)	1.12	0.81	1.35	0.13	11.94
Single shell weight (g)	0.15	0.11	0.25	0.04	25.01
Shell ratio (%)	13.25	11.32	17.92	1.89	14.24

Statistical analysis of data revealed higher co-efficient of variation for weight of 10 5th Instar larvae (19.3), ERR by weight (20.33), Single cocoon weight (19.59), single shell weight (31.84) and shell ratio % (15.50).

S-03: A- 01: Conservation of Multivoltine SWGRs

All the 83 multivoltine accessions were conserved by conducting rearing for five conservation crops (110^{th} to 114^{th} generation) and the eggs were preserved at a temperature of 5º C for 35 days with backups for 45 and 60 days in the cold storages located at Hosur and Mysuru. The multivoltine accessions were maintained true to type on par with catalogue data without any loss ensuring disease freeness.

S-04: A- 01: Conservation of Bivoltine SWGRs

All the 369 bivoltine accessions were conserved by conducting rearing in three batches and the layings were preserved under 10 months hibernation schedule with one crop per year. As a backup, all the three batch accessions were conserved under 12 month hibernation schedule in the cold storages located at Hosur and Mysuru. The accessions were maintained true to type on par with the catalogue data without any loss and ensuring disease freeness. So far, first and second batch accessions have completed 15 generations each and third batch 14 generations from the year 2004.

S-05: A-01: Conservation of Mutant SWGRs

All the 23 bivoltine mutant genetic stocks were conserved following 6 months hibernation schedule @ 2 crops per year. These 23 mutant accessions have completed 34 - 35 generations. As a back-up, the accessions are conserved under 8 months hibernation schedule in the cold storages located at Hosur and Mysuru. The accessions were maintained true to type on par with the catalogue data without any loss and ensuring disease freeness.

S-03: S-04, S-05 A- 02: Supply and Utilization of SWGRs

During the year, 18 Bivoltine and 21 Multivoltine accessions were utilized by research institutes on indent basis. Under the project AIB-3578, 20 exotic bivoltine hybrids were supplied to CSR&TI, Mysuru, Berhampore and Pampore alongwith control in order to conduct evaluation trials. Under the project AIB-3577, 20 multivoltine hybrids were supplied to CSR&TIs, Mysuru and Berhampore for evaluation trials (**Tables 57 & 58)**. The feedback formats as per NBPGR guidelines were sent to all indenters and have indicated that most of the germplasm were used for research purposes.

Table 57: Supply of Bivoltine silkworm genetic resources

SN	Indenter	No. of times	No. of SWGRs	Purpose
1	CSRTI, Berhampore	2	21	Evaluation research project (AIB-3578)
2	CSRTI, Pampore	1	21	
3	CSRTI, Mysuru	1	20	
		3	15	Research project
4	Marathwada Agricultural University, Parbhani	1	2	Breeding and evaluation
5	NEHU, Shillong	3	1	PG Research
Total		**11**	**80**	

Table 58: Supply of Multivoltine silkworm genetic resources

SN	Indenter	No. of times	No. of MV SWGRs	Purpose
1	CSRTI, Berhampore	3	20	Evaluation research project (AIB-3577)
		1	3	Research project
2	CSRTI, Mysuru	2	20	Evaluation research project (AIB-3577)
		1	13	Research project
3	Navsari Agricultural University, Navsari	1	4	Research project
4	Bangalore University, Bengaluru	1	1	Research project
Total		**09**	**61**	

7. TRAINING PROGRAMMES

Training imparted

Sl. No.	Training Programme	Place	Faculty from Institute
1	Training for sericultural farmers of Tamil Nadu state (2 classes per week for 40 weeks)	TNSTI, Hosur	Dr.N.Balachandran, Dr.M.Muthulakshmi, Smt. G. Punithavathy, Dr.S.Masilamani Dr.G. Thanavendan
2	Orientation Programme for Junior Inspector of Sericulture Trainees, Dept. Of Sericulture, Govt. of Tamilnadu. (Batch-I: 11.12.2018-10.01.2019; Batch-II:21.01.2019-20.02.2019)	TNSTI, Hosur	Dr. Satish Verma, Dr. D.S.Somaprakash, Dr. Masilamani, Dr.Geetha N Murthy, Dr. M. Maheswari, Smt.G.Punithavathy, Dr. Jameela Khatoon Dr. G. Lokesh, Dr.G.Thanavendan

Trainings attended:

Sl. No.	Training Programme	Place	Faculty from Institute
1	Presentation Skills for CSB Scientists" CBD Section, CSB Bengaluru (29th & 30th May 2018)	CSB, Bengaluru	Dr. Nivedita S, Dr. M. Muthulakshmi, Dr. G. Lokesh Dr. G. Thanavendan
2	Orientation Training Programme for Seed Officers and Seed Analysts" (19th & 20th December 2018)	SSTL, Kodathi	Dr. G. Lokesh
3	Image J open software for morphological characterization of mulberry genetic resources (13th and 14th August 2018)	IFGTB, Coimbatore	Dr.G. Thanavendan
4	IPR Issues on plant Genetic resources (8th to 18th October 2018)	Department of IP Cell, GKVK, University of Agicultural Sciences, Bangalore	Dr.G. Thanavendan

8. PUBLICATIONS

International Journals

1. G. Lokesh, Geetha N Murthy, Veeranna Gowda, Alok Sahay and Gargi (2018). Conservation of wild silkworm genetic resources through cryopreservation: Standardization of sperm processing. *Journal of Applied and Natural Sciences*. 10(2):544-547.
2. G. Lokesh, Geetha N Murthy, Gargi, Jayaprakash Pandey and Alok Sahay (2019). Semen collection and artificial insemination in wild silk moth *Antheraea mylitta* Drury for effective conservation of tasar genetic resources. *Journal of Entomology and Zoology Studies* 7*(2): 501-504.*

Workshop / Conference / Seminar / Meetings

1. Satish Verma (2019). An Enthalpy Based Environment Management System (Eems) For Silkworm Rearing. *Abstract in Report on 6th Asia Pacific Congress of Sericulture and Insect Biotechnology held at* Mysuru *from 2nd – 4th March 2019, p 80.*
2. S.Masilamani, G.Thanavendan, K.Vijayan, S.Sekar and Satish Verma (2019). Mulberry germplasm resources: What is in store for future? *Abstract in Report on 6th Asia Pacific Congress of Sericulture and Insect Biotechnology held at Mysuru from 2nd – 4th March 2019, p 43.*
3. Geetha N. Murthy, D.S.Somaprakash, M.Maheswari, G.Punitavathi, G.Lokesh, Jameela Khatoon, S.Sekar and Satish Verma (2019). Conservation of mulberry silkworm biodiversity for sustainable utilization. *Abstract in Report on 6th Asia Pacific Congress of Sericulture and Insect Biotechnology held at Mysuru from 2nd – 4th March 2019, p 84.*
4. Jameela Khatoon, Subash V Naik, M.K.Ghosh, K.Jaganathan and Sheetal Palaskar (2019). Objective evaluation of comfort properties of some silk woven fabrics *Abstract in Report on 6th Asia Pacific Congress of Sericulture and Insect Biotechnology held at Mysuru from 2nd – 4th March 2019, p 200.*
5. G.Punithavathy and D.S.Chandrasekar (2019). Screening of elite bivoltine hybrid silkworm breeds (*Bombyx mori* L.) in Tiruppur district of Tamil Nadu. *Abstract in Report on National Conference on challenges and innovative approaches in Agriculture and Allied Science Research. Biotic Science Congress (BIOSCON) held at Salem on 26th and 27th July 2019.*

Popular articles

1. S.Nivedita, Geetha N.Murthy, Veeranna Gowda and Alok Sahay (2018). Diversification of sericulture by-products. *Indian Silk 9: 5-6*
2. डॉ गीता एन मूर्ति, गार्गी व शीबा वी एस (2018). रेशम उद्योग: महिला सशक्तिकरण का एक साधन। *रेशम भारती 29: 21-23*

9. PARTICIPATION IN CONFERENCE / SEMINAR / MEET / WORKSHOP

- Dr. Satish Verma, Director I/c and Dr. Masilamani, Scientist –D participated in a workshop on Biomaterial / Byproduct utilization at Central Office, CSB, Bengaluru.
- Dr. M. Maheswari, Scientist-D, Dr. Jameela Khatoon, Scientist-D, Dr. Masilamani, Scientist-D and Dr. Satish Verma, Executive Engineer participated in the International Seminar APSERI-2019 during March 2019 at Mysuru and presented papers.
- G.Punithavathy participated as Resource person in International Seminar on "Economic prospects of Life Science"organized by GVG college, Tiruppur & DBT, Delhi during January, 2019.

10. VISITORS

Dr.S.Ayyappan, Chairman, RCC, CSB visited the centre and held interactions with the scientists and staff and also visited the germplasm collections and different sections. He appreciated the work carried out and the well maintained germplasm collections.

Shri Satish Kumar, Director (Fin), Central Silk Board, Bengaluru also visited the Centre and held interactions with the scientists and staff. He also visited different sections and the germplasm collections, quarters, Guest house and expressed his appreciation for neat maintenance of the Centre.

Dr. K.Selvam and Dr. S. Kannan, Professors from the Departments of Botany and Zoology, Periyar University, Salem visited the centre for inspection of the work carried out, the laboratories, library, germplasm collections and other facilities. They appreciated the facilities and activities and submited a report on the same in view of which the centre was recognised as a Research Centre for carrying out M.Phil and Ph.D research works.

Farmers from various districts of Tamil Nadu and school as well as college students and scientists from private companies also visited this centre and obtained firsthand knowledge on the activities of the centre as explained by the scientists. The list of visitors to the centre is as indicated below:

SN	Name / Institution	Particulars	No of Visitors
1.	Smt. S.R.Vijaya, Teacher, Chinmaya Upasana, Chinmaya Mission, Anchettipalli, Kelamangalam road, Hosur.	Students and Staff	29
2.	Dr. Basavaiah, Professor (Retd.), Dept. in Sericulture Science, University of Mysuru, Mysuru	Professor & Students	03
3.	Dr. Hemalatha, HOD of Sericulture, Sree Siddhartha First Grade College, Tunukur.	Students and Staff	56
4.	Smt. Madhu Malathi, Sri Chaithanya Techno School, Dinnur-Hosur.	Students and Staff	181

5.	Mr. Sandeep Mandal, Feather A Radha Hotel, Chennai	Business people	15
6.	Dr. P. Mangammal, Assistant Professor, Dept. of Sericulture, FC & RI, TNAU, Coimbatore.	Students and Staff	27
7.	Shri. S.Lakahmanan, Assistant Director, TNSTI, Hosur	DoS Staff	30
8.	Shri. S.Lakshmanan, Assistant Director, TNSTI, Hosur.	DoS Staff	33
9.	Shri. Veera, ASM (Sales), Radharegent Hotel, Bengaluru.	Business people	04
10.	Prof. Fayaz Ahmad kulkiloo, SKUAST-Kashmir, College of Agriculture and Technology, Kashmir.	Professor & Students	17
11.	Shri. Faruk , Inspector of Sericulture, TNSTI Hosur	Sericulture Farmers	35
12.	Dr. Sudhakar Rao, Scientist-D, SSTL- NSSO Kodathi, Bangalore.	Students and SRFs	07
13	Shri. J. Sakthivel, Teacher, Shemford School, Hosur.	Students	125
14.	Smt. Richa Mishra, Litera Valley Zee School, Hosur	Students,Staff and Teachers	402
15.	Dr. Vidyadhara. B, Block Technology manager, Dept. of Agriculture, Hoskote, Bangalore**.**	Sericulture Farmers	45
16.	Prof. Ravi, Agricultural Entomology, AC & RI, TNAU, Killikulam, Vallandu, Thoothukudi-628 252.	Sericulture Students	43
		TOTAL	**1052**

11. COMPOSITION OF COMMITTEES

Research Advisory Committee

Dr. Chandish R. Ballal, Director, National Bureau of Agricultural Insect Resources	**Chairperson**
Dr. K.S. Varaprasad Project Director (Retd), Directorate of Oilseeds Research Rajendranagar, Hyderabad	Member
Dr. B. Sarath Babu Principal Scientist & Head, ICAR-NBPGR Regional Station, ARI Campus, Rajendra Nagar, Hyderabad	Member
Dr. Modhumita Dasgupta, Scientist F, Institute of Forest Genetics and Tree Breeding (ICFRE)	Member
Director (Tech), Central Silk Board, CSB Complex, Bangalore	Member
Director, Central Sericultural Germplasm Resources Centre, P.B.No.44, Thally Road, Hosur	Member - Convener

Research Council

Director, Central Sericultural Germplasm Resources Centre P.B.No.44, Thally Road, Hosur - 635 109	**Chairman**
Scientist-D, Central Sericultural Germplasm Resources Centre P.B.No.44, Thally Road, Hosur - 635 109	Member – Convener

Germplasm Registration Committee

Director (Tech.), Central Silk Board, Bangalore - 560 068	**Chairman**
Director, Central Sericultural Research and Training Institute, Mysuru - 570008	Member
Director, Central Tasar Research and Training Institute Ranchi -835 303	Member
Director, Central Muga and Eri Research and Training Institute, Lahdoigarh -785 700	Member
Director, Central Sericultural Germplasm Resources Centre, Hosur - 635 109	Member – Convener

Germplasm Supply & Exchange Committee

Director, Central Sericultural Germplasm Resources Centre Hosur - 635 109	**Chairman**
Director (Tech.), Central Silk Board, Bangalore – 560 068	Member
Scientist-D, Central Sericultural Germplasm Resources Centre, Hosur – 635 109	Member
Scientist-D, Central Sericultural Germplasm Resources Centre, Hosur – 635 109	Member – Convener

12. राजभाषा कार्यान्वयन

कार्यशाला

- के.रे.ज.सं.के., एस.एस.पी.सी., ई.एस.एस.पी.सी., होसूर, आरइसी, बेरेगइ के समस्त वैज्ञानिकों / अधिकारियों / कर्मचारियों को दिनांक 25.06.2018 को "परिभाषिक शब्दावली" विषय, दिनांक 29.09.2018 को "बोलचाल की हिन्दी" विषय पर, दिनांक 07.01.2019 को "राजभाषा नीति एवं नियम" विषय पर व दिनांक 26.03.2019 को राजभाषा हिन्दी के विषय पर हिन्दी कार्यशालायें आयोजन की गयी।

राभाकास की बैठक

- राभाकास की बैठक दिनांक को 30.06.2018, 29.09.2018, 07.01.2019, 26.03.2019 आयोजित की गई।

अन्य गतिविधियां

- दिनांक 1 मई से 23 जुलाई 2018 तक हिंदी प्रबोध, प्रवीण एवं प्राज्ञ पूर्णकालिक गहन प्रशिक्षण का कार्यक्रम अयोजित किया गया। हिंदी शिक्षण योजना, चेन्नई के श्री. कोमल सिंह, सहायक निदेशक (राजभाषा), द्वारा उक्त पाठ्यक्रम का संचालन किया गया। इस केंद्र में केंद्रीय हिंदी प्रशिक्षण संस्थान, नई दिल्ली द्वारा वर्ष 2018 में हिंदी प्रबोध, प्रवीण एवं प्राज्ञ अल्पकालिक गहन प्रशिक्षण तथा पाठ्यक्रम आयोजित किया गया।

  हिंदी प्रबोध, प्रवीण एवं प्राज्ञ अल्पकालिक गहन प्रशिक्षण तथा पाठ्यक्रम के सत्रावधि निम्न है:

गहन पाठ्यक्रम	कार्य दिवस	प्रशिक्षण की अवधि
प्रबोध	25	02.05.2018 से 04.06.2018 तक
प्रवीण	20	05.06.2018 से 02.07.2018 तक
प्राज्ञ	15	03.07.2018 से 23.07.2018 तक

- केन्द्र को प्रबोध, प्रवीण एवं प्राज्ञ से संबंधित प्रमाण पत्र प्राप्त हुए है।
- केंद्र द्वारा खरीदे गए नई मिसिलों के मुख्य पृष्ठ को भंडार अनुभाग द्वारा द्विभाषी किया गया।
- दिनांक 14.09.2018 से 29.09.2018 तक के.रे.ज.सं.के., एस.एस.पी.सी., ई.एस.एस.पी.सी., होसूर के समस्त वैज्ञानिकों / अधिकारियों / कर्मचारियों के साथ हिन्दी पखवाडा मनाया गया। कुल चार प्रतियोगिताओं का आयोजन किया गया।
- कार्यालय द्वारा प्रकाशित न्यूजलेटर व वार्षिक प्रतिवेदन द्विभाषी में किये गये।
- केन्द्र के वेबसाइट के आर टी आई, स्टाफ लिस्ट, लेटर हेड आदि को द्विभाषी में अपडेट किया जा रहा है।
- केन्द्र के हिन्दी अनुभाग ने एसएसपीसी कार्यालय को कुल 30 द्विभाषी सील तैयार कर हिन्दी के अतिरिक्त कार्य को संभाला है।
- वित्तिय वर्ष 2018-19 के दौरान केन्द्र की एक वैज्ञानिक एवं 04 कर्मचारियों को सरकारी कामकाज मूल रूप से हिंदी में संपादित करने हेतु प्रोत्साहन राशि से सम्मानित किया गया।

13. OTHER ACTIVITIES

Research Advisory Committee Meeting

The 37th meeting of the RAC of the Centre was organized on 10th October 2018. The committee and participants deliberated upon the research work undertaken at the Centre presented by the Scientists of the Centre and action to be taken for improvement were recommended.

ISO Management System

ISO certification has been renewed with upgraded version of ISO:9001-2015 from 14.09.2018 for three years.

Pebrine Monitoring

The scientists nominated in the Pebrine Monitoring Team visited the centre and tested samples of different growth stages of the multivoltine and bivoltine genetic resource conservation crops as per schedule and certified. During the period under report no incidence of pebrine was reported in the crops.

Swatch Bharat

Swatch Bharat activities including general cleaning works in the campus were carried out on a regular basis spreading awareness on the necessity to maintain neat surroundings. Swachh Abhiyan was organized in Thally Road, Sericulture village, Nallur and Tamil Nadu State Training school, Hosur. Swachhta Hi Seva Campaign (18.09.2018 to 02.10.2018) and Swachhta Pakwada was organized at CSGRC, Hosur (01.03.2019 to 15.03.2019) to educate and create awareness on Recycling of waste & maintenance of hygiene/sanitation.

14. ADMINISTRATIVE AND FINANCIAL REPORT

a. Staff Position as on 31.03.2019

Category	Sanctioned	Filled	Vacant
Director	1	-	1
Scientific	15	10	5
Technical	8	5	3
Field Assistant	1	1	--
Administrative	22	15	7
Total	**47**	**31**	**16**
Supporting (Skilled Farm workers)	39	35	4

b. Personnel posting position as on 31.03.2019

Division / Section	Name	Designation
	Dr. Gargi	Director (up to 31.05.2018)
	Dr. Geetha N. Murthy	Director I/c (01.06.18 to 06.07.18)
	Dr. Satish Verma	Director I/c (07.07.18 to 9.01.19)
	Dr. R.K. Mishra	Director Addl. Charge (from 10.01.19)
Mulberry	Dr. K. Jhansilakshmi	Scientist-D (up to 02.07.18)
	Dr. S. Masilamani	Scientist-D (from 19.06.18)
	Dr. C.R. Nagaraj	Scientist-D (from 26.07.18 to 18.12.18)
	Dr. G. Thanavendan	Scientist-B
	Dr. M.C.Thriveni	Scientist-B (from 03.01.19)
	Shri. Raju Mondal	Scientist-B (from 01.01.19)
Silkworm	Dr. D. S. Somaprakash	Scientist-D (from 02.07.2018)
	Dr. Geetha N.Murthy	Scientist-D
	Dr. M. Maheswari	Scientist-D
	Dr.N.Balachandran	Scientist-D (up to 02.07.18)
	Dr.M.Muthulakshmi	Scientist-D (up to 02.07.18)
	Smt. G. Punithavathy	Scientist-D (from 02.07.2018)
	Dr.G.Lokesh	Scientist-D
Post Cocoon Technology	Dr.Nivedita. S	Scientist-D (R&S) (up to 20.06.18)
	Dr. Jameela Khatoon	Scientist-D (R&S) (from 02.07.18)
Computer Section	S. Sekar	Assistant Director (Computer)
Administration	M.Jagajeevan	Assistant Director

Superannuation / Voluntary Retirement from Service (VRS)

The following officers / officials superannuated during the year under report:

1. Dr.Gargi, Director
2. Dr. Satish Verma, Executive Engineer
3. Dr.C.R. Nagaraj, Scientist-D [VRS]
4. Shri. T. Vijayakumar, Technical Assistant

Transfers

The following officers/officials were transferred during the year under report:

1. Dr. Nivedita. S., Scientist-D to CSTRI Bengaluru
2. Dr.K.Jhansilakshmi, Scientist-D to REC Krishnagiri
3. Dr.N.Balachandran, Scientist-D to CSR&TI, Mysuru
4. Dr.M.Muthulakshmi, Scientist-D to CSR&TI Mysuru
5. Shri. Hafeez Ahmed, AS (A&A) to CO, CSB, Bengaluru
6. Shri. P.C.Burman, Sr. Steno. to CO, CSB, Bengaluru
7. Shri. Keshava Murthy, AS to CO, CSB, Bengaluru

c. Abstract of receipts and expenditure statement for the year 2018-19 [Rs. In lakhs]

Fund Head	GIA received [Rs.]	Expenditure [Rs.]	Balance surrendered [Rs.]
Plan General	73.77	71.71	1.65
Plan Capital	57.21	57.19	0.02
Total (PL)	**130.98**	**128.90**	**1.67**
Plan Salary **(PLS)**	502.72	502.72	--
SCSP	69.70	69.70	--
TSP	4.65	4.59	0.06
Total (PLS)	**577.07**	**577.01**	**0.06**
Grand total (PL+PLS)	**708.05**	**705.91**	**1.73**

15. METEOROLOGICAL DATA

Month and Year	Average Temperature degree Celsius (°C)			Average Relative Humidity (%)			Total Rain fall (mm)	No. of Rainy Days	Avg. Wind Speed (km/hr)	Average Sun duration (in Hr)
	Min.	Max.	Avg.	Min.	Max.	Avg.				
April,18	19.50	34.90	27.20	23.80	95.30	59.60	66.00	4.00	4.99	9.85
May,18	20.30	31.60	26.00	49.00	100.00	74.50	159.00	14.00	5.09	11.20
June,18	20.50	28.80	24.60	61.10	100.00	80.50	65.00	10.00	3.58	5.62
July,18	19.41	28.26	23.80	59.74	100.00	79.87	26.00	8.00	2.91	5.58
Aug,18	20.19	28.40	24.30	58.20	100.00	79.10	51.00	8.00	2.89	5.55
Sep,18	21.60	29.80	25.70	50.90	100.00	75.50	224.00	14.00	5.90	5.42
Oct,18	18.20	27.91	23.05	48.16	100.00	74.08	75.00	8.00	5.55	5.44
Nov,18	21.24	28.08	24.66	47.48	94.13	70.81	71.00	4.00	3.73	9.08
Dec,18	20.56	27.15	23.90	50.95	91.56	71.26	78.00	2.00	3.24	8.25
Jan,19	19.19	26.47	22.83	25.63	88.26	56.95	11.00	2.00	3.43	8.69
Feb,19	22.89	30.85	26.87	29.85	92.77	61.31	68.00	2.00	3.77	9.17
Mar,19	25.66	34.02	29.84	21.36	88.37	54.87	0.00	0.00	3.31	9.91
					TOTAL		**894**	**76**		

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