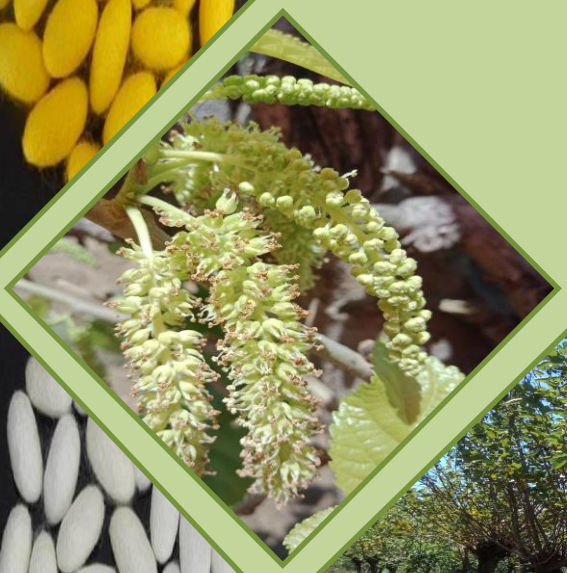
वार्षिक प्रतिवेदन

ANNUAL REPORT 2020-21



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

Visit of Principal Secretary and Director Department of Sericulture, Tamil

Visit of Director, Department of Sericulture, Tamil Nadu

Visit of Board members of Central Silk Board

Director along with a batch of students from TNAU, Mettupalyam

Dr.K.P.Mohapatra,ARS, Principal Scientist, NBPGR. New Delhi

वार्षिक प्रतिवेदन

ANNUAL REPORT 2020 - 21

केन्द्रीय रेशम जननद्रव्य संसाधन केन्द्र

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प्रस्तावना

केन्द्रीय रेशम जननद्रव्य संसाधन केन्द्र, होसूर, की स्थापना 1991 में हुई थी, और केंद्र ने संग्रह, लक्षण वर्णन, मूल्यांकन, संरक्षण तथा इसके उपयोग के अधिदेशानुसार व्यवस्थित रूप से शहतूत और रेशमकीट आनुवंशिक संसाधनों के संरक्षण को संबोधित किया है। इस केंद्र को शहतूत जननद्रव्य के लिए राष्ट्रीय पादप आनुवंशिक संसाधन ब्यूरो (एनबीपीजीआर), आईसीएआर, नई दिल्ली द्वारा राष्ट्रीय सक्रिय जननद्रव्य साइट (रासजस) तथा रेशमकीट जननद्रव्य को राष्ट्रीय कृषि कीट संसाधन ब्यूरो (एनबीएआईआर), आईसीएआर, बेंगलुरु द्वारा मान्यता प्राप्त है। तदनुसार, शहतूत जननद्रव्य किस्मों/ रेशमकीट जननद्रव्य अभिगमों को विशिष्ट राष्ट्रीय अभिगम संख्याएं दी गई।

यह केंद्र 1317 शहतूत और 489 रेशमकीट आनुवंशिक संसाधनों के विशाल संग्रह का प्रबंधन तथा अधिकतम विविधता सुनिश्चित करता है और पारंपरिक तरीकों, जैव रासायनिक और आणविक मार्करों के साथ-साथ क्रायोप्रिजर्वेशन जैसी अन्य तकनीकों को नियोजित करके आनुवंशिक विविधता, आनुवंशिक अखंडता, जनसंख्या संरचना, प्रजातियों के संबंधों, विशेषता विशिष्ट होनहार अभिगमों की पहचान आदि के व्यवस्थित विश्लेषण पर जोर देता है। केरेजसंके, होसुर शहतूत और रेशमकीट जननद्रव्य संसाधन के फसल सुधार और फसल संरक्षण में सहायता करने हेतु शहतूत आनुवंशिक संसाधनों की साइटोलॉजिकल स्थिति, डुप्लिकेट की पहचान हेतु शहतूत आनुवंशिक संसाधनों के आणविक लक्षण वर्णन एवं उनके प्रभावी उपयोग, जैविक और अजैविक तनाव के लिए रेशमकीट जननद्रव्य संसाधनों की पहचान पर केंद्रित, रेशमकीट में आणविक लक्षण वर्णन और आनुवंशिक विविधता का आकलन आदि पर इन-हाउस और सहयोगी नेटवर्किंग अनुसंधान परियोजनाएं शुरू कर रहा है।

मैं इस अवसर पर सदस्य-सचिव, केंद्रीय रेशम बोर्ड और केंद्र की अनुसंधान सलाहकार समिति के साथ-साथ अन्य संस्थानों/संगठनों को अनिवार्य गतिविधियों के सफल निष्पादन में उनके समर्थन और प्रोत्साहन हेतु अपनी हार्दिक कृतज्ञता व्यक्त करना चाहता हूँ। मैं केंद्र के वैज्ञानिकों और कर्मचारियों को उनके बहुमूल्य योगदान और संघ-भावना के लिए ऋणी हूँ जो केंद्र की महत्वपूर्ण उपलब्धियों के लिए प्रेरक शक्ति रही है। यह वार्षिक रिपोर्ट वर्ष 2020-21 के दौरान केंद्र की महत्वपूर्ण उपलब्धियों को दर्शाती है। वार्षिक रिपोर्ट में सुधार के लिए किसी भी सुझाव का स्वागत है।

बी.टी. श्रीनिवास

दिनांक: 10.11.2021

निदेशक

PREFACE

Central Sericultural Germplasm Resources Centre, Hosur was established in 1991, and the centre has systematically and strategically addressed conservation of mulberry and silkworm genetic resources against its mandate of collection, characterization, evaluation, conservation and utilization. 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 National Bureau of Agricultural Insect Resources (NBAIR), ICAR, Bengaluru for silkworm germplasm. Accordingly, the mulberry germplasm varieties/ silkworm germplasm accessions are assigned unique National Accession numbers.

The centre manages the vast collection of 1317 mulberry and 489 silkworm genetic resources ensuring maximum diversity and laying emphasis on systematic analysis of genetic diversity, genetic integrity, population structure, species relationships, identification of trait specific promising accessions etc. by employing conventional methods, biochemical and molecular markers as well as other techniques like cryopreservation. CSGRC Hosur is taking up in-house and collaborative networking research projects that focusses on cytological status of mulberry genetic resources, molecular characterization of mulberry genetic resources for the identification of duplicates and their effective utilization, identification of silkworm germplasm resources for biotic and abiotic stress, molecular characterization and assessment of genetic diversity in silkworm etc. to aid crop improvement and crop protection of both mulberry and silkworm germplasm resources.

I wish to take this opportunity to extend my deepest gratitude to the Member-Secretary, Central Silk Board, and the Research Advisory Committee of the Centre as well as other institutes/organizations for their support and encouragement in the successful execution of mandated activities. I am indebted to the scientists and staff of the centre for their valuable contributions and team spirit that has been the driving force for the significant achievements of the centre. This annual report depicts the significant achievements of the centre during the year 2020-21. Any suggestions for improvement of the annual report are welcome.

Date: 10.11.2021 Director

CONTENTS

1. अनुसंधान की रूपरेखा

वर्ष 2020-21 के दौरान, केरेजसंके, होसुर ने केंद्र में उपलब्ध विशाल मात्रा में सेरी-आनुवंशिक संसाधनों के व्यवस्थित प्रबंधन की दिशा में अपनी वैज्ञानिक खोज जारी रखी और इसके रोग मुक्त संरक्षण और उपयोग को सुनिश्चित किया। केंद्र ने अपने रेशमकीट जननद्रव्य स्टॉक को केरेउएवंएप्रसं, बेरहमपुर से चौदह पैतृक द्विप्रज बॉम्बिक्स मोरी रेशमकीट नस्लों को जोड़कर समृद्ध किया, जिससे रेशमकीट की कुल स्टॉक 489 तक बढ़ गयी। इन आनुवंशिक संसाधनों का संरक्षण भी किया गया। रिपोर्टाधीन अवधि के दौरान शहतूत और रेशमकीट प्रभाग की उपलब्धियों का सार निम्नानुसार है:

<u>शहतूत विभाग:</u>

- परियोजना **पीआईई-06001 एसआई** के तहत: संग्रह, लक्षण वर्णन, मूल्यांकन, संरक्षण और शहतूत आनुवंशिक संसाधनों की आपूर्ति, प्रर्वधन विशेषक हेतु आशाजनक अभिगमों की पहचान निम्नानुसार की गई: एमआई -1002, एमआई -0988, एमआई -0841, एमआई -0985, एमआई -1003, एमआई -0996, एमआई -1006, एमआई -1004, एमआई -0989 एवं एमआई -0992 तथा विकास और उपज पैरामीटर के लिए अर्थात, एमआई-0992, एमआई-0988, एम आई-0997, एमआई-0991, एमआई-1004, एमआई -1006, एमआई -1000, एमआई -0986, एमआई -1002, एमआई -0985 एवं एमआई -0990.
- परियोजना **पीआईजी-06004 एसआई** के तहत: शहतूत आनुवंशिक संसाधनों की साइटोलॉजिकल स्थिति के अध्ययन में, यूपीजीएमए पदानुक्रमित क्लस्टरिंग के परिणाम में यह इंगित करता है कि 200 कोर-सेट शहतूत अभिगमों को 2 प्रमुख समूहों, 4 उप समूहों और 14 समूहों में बांटा गया है। डेंड्रोग्राम और प्रिंसिपल कंपोनेंट विश्लेषण (पीसीए) से यह पता चला कि किए गए अध्ययन के आबादी के अंतर्गत कोई संभावित डुप्लिकेट नहीं है। 200 शहतूत अभिगमों में से, मेटाफ़ेज़ तैयारी के लिए 53 अभिगमों का अध्ययन किया गया, जिनमें से 15 अभिगमों में मध्यम स्तर का मेटाफ़ेज़ देखा गया है। कैरियोटाइप विश्लेषण के आधार पर, 9 अभिगमों में गुणसूत्र 2n=28 थे।
- परियोजना "**पीआईजी-06005 एसआई** के तहत: डुप्लिकेट की पहचान और उनके प्रभावी उपयोग हेतु शहतूत आनुवंशिक संसाधनों का आणविक लक्षण वर्णन", क्लस्टर विश्लेषण तथा पीसीए के माध्यम से अकारिकी डिस्क्रिप्टर के आधार पर 60 शहतूत अभिगमों को संदिग्ध डुप्लिकेट के रूप में पहचाना गया।
- सहयोगी अनुसंधान परियोजनाओं, डीबीटी-सीएसबी नेटवर्क परियोजना और फल मूल्यांकन आदि के लिए विभिन्न सीएसबी संस्थानों/विश्वविद्यालयों/संगठनों के 8 मांगकर्ताओं को कटिंग/ग्राफ्टेड पौधे के रूप में 75 विदेशी और 358 स्वदेशी सहित कुल 433 शहतूत परिग्रहण की आपूर्ति की गई।

<u>रेशमकीट विभाग:</u>

- केरेजसंके 489 रेशमकीट जननद्रव्य संसाधनों (एसडब्ल्यूजीआर), जिसमें 83 बहुप्रज (स्वदेशी-73 व विदेशी-10), 383 द्विप्रज (स्वदेशी-223 व विदेशी-160) और 23 विदेशी उत्परिवर्ती रेशमकीट आनुवंशिक स्टॉक उनके उपयोग हेतु उचित लक्षण वर्णन, मूल्यांकन और संवर्धन के साथ संरक्षण कर रहा है।
- परियोजना **एआईई:06003 एसआई**: के तहत: बॉम्बिक्स मोरी एल. के रेशमकीट आनुवंशिक संसाधनों का मूल्यांकन आंतरिक प्रजनन न्यूनता और उनके संरक्षण के संदर्भ में, द्विप्रज रेशमकीट परिग्रहण में से बीबीआई-0389, बीबीआई-0379, बीबीआई-0374, बीबीआई-0378 और बीबीई-0154 और बहुप्रज जर्मप्लाज्म में से बीएमआई-0083, बीएमआई-0076, बीएमआई-0081, बीएमआई-0078 और बीएमआई-0074 सभी मूल्यांकन किए गए आर्थिक लक्षणों के लिए अभिप्रायपूर्ण सर्वश्रेष्ठ निष्पादन हेतु शीर्ष प्रदर्शनकर्ता के रूप में पाए गए।
- परियोजना **एआईई: 06002 एमआई** के तहत: चयनित हॉट स्पॉट में अजैविक तनाव के प्रति सहयता के लिए द्विप्रज रेशमकीट आनुवंशिक संसाधनों का मूल्यांकन, गर्मी और शरद ऋतु में विभिन्न परीक्षण केंद्रों पर दस बाइवोल्टाइन परिग्रहणों का मूल्यांकन किया गया। गर्मी के मौसम के दौरान, बीबीआई-0301 (97.07%), बीबीआई-0334 (96.93%), बीबीआई-0343 (96.80%) और बीबीआई-0358 (96.80%) ने केरेजसंके, होसुर में उच्च उत्तरजीविता दर्ज की। आरईसी, चित्रदुर्ग में द्विप्रज अभिगम बीबीआई -0044 (95.33%) बीबीआई -0338 (95%) एवं बीबीई -0184 (94%) ने उच्च उत्तरजीविता दर्ज की। शरद ऋतु के दौरान, बीबीआई-0336 (93.60%), बीबीआई-0339 (93.47%) और बीबीआई-0086 (92.13%) ने केरेजसंके, होसुर में उच्च उत्तरजीविता दर्ज की। केरेउएवप्रसं, बेरहामपुर में बीबीआई-0301 (68.67%) और बीबीआई-0338 (67.87%) ने उच्च उत्तरजीविता दिखाई।
- परियोजना एआईटी:06006 एमआई के तहत: बीएमएनपीवी और बीएमबीडीवी के प्रति सहिष्णु रेशमकीट आनुवंशिक संसाधनों की पहचान करने के लिए मार्कर-सहायता प्राप्त स्क्रीनिंग, 12 बहुप्रज और 60 द्विप्रज अभिगमों के जीनोमिक डीएनए पृथक्करण किया गया। बीएमबीडीवी के लिए विशिष्ट प्राइमरों के साथ 12 बहुप्रज अभिगमों का पीसीआर प्रवर्धन, अर्थात, एए-ट्रांस1 तथा एए-ट्रांस3 से पता चला कि 2 अभिगमों ने प्रतिरोधी एलील (~1200 बीपी) की उपस्थिति दिखाई और 10 अभिगमों ने प्रतिरोधी और अतिसंवेदनशील एलील दोनों की अनुपस्थिति दिखाई।
- एआईजी:06007 एमआई नामक परियोजना: रेशमकीट (बॉम्बिक्स मोरी एल) जननद्रव्य में आनुवंशिक विविधता के आणविक लक्षण वर्णन और मूल्यांकन को मार्च, 2021 के महीने में परियोजना कोड के साथ अनुमोदित किया गया।
- अनुसंधान गतिविधियों के लिए 7 विभिन्न अनुसंधान संस्थानों को कुल 19 बहुप्रज (59 डीएफएल) और 23 द्विप्रज (134 डीएफएल) रेशमकीट अभिगमों की आपूर्ति की गई।

1. RESEARCH HIGHLIGHTS

During the year 2020-21, CSGRC, Hosur continued its scientific pursuit towards systematic management of the vast quantum of seri-genetic resources available at the centre and ensured its disease-free conservation and utilization. The centre enriched its silkworm germplasm stock adding fourteen parental bivoltine *Bombyx mori* silkworm breeds from CSR&TI Berhampore enhancing the total silkworm stock to 489 accessions. Conservation of these genetic resources was carried out. The gist of achievements of mulberry and silkworm division during the period under report is as follows:

MULBERRY DIVISION:

- Under the project PIE 06001S SI: Collection, characterization, evaluation, conservation and supply of mulberry genetic resources, promising accessions were identified for propagation traits as follows: MI-1002, MI-0988, MI-0841, MI-0985, MI-1003, MI-0996, MI-1006, MI-1004, MI-0989, and MI-0992 and for growth and yield parameters viz., MI-0992, MI-0988, MI-0997, MI-0991, MI-1004, MI-1006, MI-1000, MI-0986, MI-1002, MI-0985 and MI-0990.

- Under the project **PIG-06004SI:** Studies on cytological status of mulberry genetic resources, UPGMA hierarchical clustering result indicates that the 200 core-set mulberry accessions grouped into 2 Major clusters, 4 Sub clusters & 14 clades. Dendrogram and Principal Component Analysis (PCA) revealed that there are no probable duplicates within the studied population.

- Out of 200 mulberry accessions, 53 accessions were studied for metaphase preparation, out of which 15 accessions have shown moderate level of metaphase. Based on karyotype analysis, 9 accessions consisted of chromosome 2n=28.

- Under the project "**PIG-06005 SI:** Molecular Characterization of Mulberry Genetic Resources for the Identification of Duplicates and their Effective Utilization", 60 mulberry accessions were identified as suspected duplicates based on morphological descriptors through cluster analysis and PCA.

- A total of 433 mulberry accessions comprising 75 exotic and 358 indigenous in the form of cuttings /grafted saplings were supplied to 8 indenters of different CSB Institutes / Universities/Organizations for collaborative research projects, DBT-CSB network project and fruit evaluation, etc.

SILKWORM DIVISION:

- CSGRC is conserving 489 Silkworm germplasm resources (SWGRs) includes 83 multivoltine (indigenous-73 & exotic-10), 383 bivoltine (indigenous-223 & exotic-160) and 23 exotic mutant silkworm genetic stocks with due characterization, evaluation and promotion for their utilization.

- Under the project **AIE:06003SI**: Evaluation of silkworm genetic resources of *Bombyx mori* L. with reference to inbreeding depression and their conservation, the silkworm accessions BBI-0389, BBI-0379, BBI-0374, BBI-0378 & BBE-0154 among bivoltine and BMI-0083, BMI-0076, BMI-0081, BMI-0078 & BMI-0074 from the multivoltine germplasm were found as top performers with significant best performance for all the evaluated economic characters.
- Under the project **AIE:06002MI:** Evaluation of bivoltine silkworm genetic resources for tolerance to abiotic stress in selected hot spots, ten bivoltine accessions were evaluated at different test centres for summer and autumn seasons. During summer season, BBI-0301 (97.07%), BBI-0334 (96.93%), BBI-0343 (96.80%) and BBI-0358 (96.80%) recorded higher survival at CSGRC, Hosur. The bivolitne accns. BBI-0044 recorded higher survival (95.33%) followed by BBI-0338 (95%), BBE-0184 (94%) at REC Chitradurga. During autumn, BBI-0336 (93.60%), BBI-0339 (93.47%) and BBI-0086 (92.13%) recorded higher survival at CSGRC, Hosur. In case of CSR&TI, Berhampore, BBI-0301 showed higher survival (68.67%) followed by BBI-0338 (67.87%).
- Under the project **AIT:06006MI**: Marker-assisted screening to identify silkworm genetic resources tolerant to BmNPV and BmBDV, genomic DNA isolation of 12 multivoltine and 60 bivoltine accessions was carried out. PCR amplification of 12 multivoltine accessions with primers specific to BmBDV, viz. aa-trans1 and aa-trans3, revealed 2 accessions showed presence of resistant allele (~1200 bp) and 10 accessions showed absence of both resistant and susceptible alleles.
- One project entitled, **AIG:06007MI:** Molecular characterization and assessment of genetic diversity in silkworm (*Bombyx mori* L) germplasm was approved with project code in the month of March, 2021.
- A total of 19 multivoltine (59 dfls) and 23 bivoltine (134 dfls) silkworm accessions were supplied to 7 different research institutes for research activities.

2. परिचय

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 परियोजनायेँ 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 और रेशमकीट जननद्रव्य की खोज, संग्रह और परिचय।*
- *आनुवांशिक संसाधनों के उपयोग को बढ़ावा देने के लिए लक्षण वर्णन, वर्गीकरण, प्रारंभिक मूल्यांकन, राष्ट्रीय अभिगमन और जननद्रव्य संग्रह की सूची बनाना।*
- *रेशम उत्पादन विषयक आनुवांशिक संसाधनों के दीर्घकालिक राष्ट्रीय भंडार के रूप में सेवा करना।*
- *जननद्रव्य संसाधनों के पंजीकरण और संदर्भ केंद्र के लिए नोडल एजेंसी के रूप में कार्य करना।*
- *जननद्रव्य के परीक्षण / मूल्यांकन के लिए अंतर-संस्थागत सहयोग में प्रमुख भूमिका।*
- *आनुवंशिक संसाधनों के आयात और निर्यात का समन्वय।*
- *राष्ट्रीय डेटाबेस और हर्बेरियम/रेशम आनुवंशिक संसाधनों के प्रदर्शन के रूप में सेवा करें।*
- *जरूरतमंद संगठनों को उनकी आपूर्ति के माध्यम से जननद्रव्य के उपयोग को बढ़ावा देना।*
- *रेशम उत्पादन विषयक जननद्रव्य संसाधन प्रबंधन में प्रशिक्षण देना।*

रेसल्ट्स फ्रेमवर्क डोकुमेंट [आर एफ डी]

दृष्टिकोण

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

मिशन

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।

रोड मैप

लघु अवधि योजनाएं

1. विभिन्न राज्यों में अस्पष्टीकृत क्षेत्रों का सर्वेक्षण करें और आनुवंशिक स्टॉक को समृद्ध करने के लिए नए शहतूत आनुवंशिक संसाधनों के संग्रह के लिए अलग-अलग देशों से मार्ग का पता लगाएं।
2. विविधता और जीन समृद्धि के केंद्रों में शहतूत आनुवंशिक संसाधनों के सीटू संरक्षण में संवर्धन।
3. तनाव के प्रति सहिष्णु संसाधनों की पहचान के लिए हॉटस्पॉट क्षेत्रों में आनुवंशिक संसाधनों का मूल्यांकन।
4. शहतूत आनुवांशिक संसाधनों की सुरक्षा के लिए जलवायु लचीला रेशम उत्पादन को अपनाना।
5. आनुवंशिक वृद्धि के लिए पूर्व प्रजनन कार्यक्रमों का कार्यान्वयन।
6. अजैविक और जैविक तनाव के लिए रेशमकीट आनुवंशिक संसाधनों का मूल्यांकन।
7. मार्करों के माध्यम से सेरी-आनुवंशिक संसाधनों का आणविक लक्षण वर्णन।

दीर्घकालिक योजनाएं

1. एनबीपीजीआर, नई दिल्ली / आईएससी, सीएसबी कॉम्प्लेक्स, बैंगलोर के माध्यम से विदेशी शहतूत (मॉरस) प्रजातियों का परिचय।
2. इको फ्रेंडली और जैविक कृषि तकनीकों को अपनाना।
3. शहतूत प्रजनकों द्वारा नवीन जीनों / एलील्स के उपयोग और बेस चौड़ीकरण के साथ-साथ हेटेरोसिस के दोहन के लिए जंगली जीनों के अंतःक्षेपण के लिए प्रीब्रीडिंग कार्यक्रमों का कार्यान्वयन।
4. संरचित और टिकाऊ ऑन-फार्म का कार्यान्वयन और अपने मूल कृषि-पारिस्थितिक वातावरण में भूमि के संरक्षण का इन सीटू संरक्षण।

5. शहतूत और रेशमकीट जीन बैंकों के लिए एक्स सीटू संरक्षण रणनीतियों का उन्नयन, लागत प्रभावी संरक्षण के लिए उन्नत जैव प्रौद्योगिकी के साधनों को अपनाना।
6. आनुवंशिक वृद्धि के लिए पूर्व प्रजनन कार्यक्रम में उपयोग हेतु आणविक उपकरणों का उपयोग करके जंगली और भूमि जाति में होनहार जीन की पहचान।
7. केंद्र के एक आवश्यक अधिदेश के रूप में जीनोमिक्स को शामिल करके विभिन्न अजैविक तनावों / कार्यात्मक लक्षणों के प्रति सहिष्णुता के लिए आणविक साधनों की जांच हेतु आणविक उपकरणों का उपयोग।
8. कठिन श्रम कमी के लिए मेजबान संयंत्र की खेती और रेशम कीट पालन में मशीनीकरण।
9. जलवायु परिवर्तन के लिए लचीलापन हेतु विशिष्ट कार्यात्मक लक्षणों के साथ शहतूत जननद्रव्य की पहचान।
10. लक्षण और मूल्यांकन डेटा के साथ-साथ आणविक आईडी के साथ सेरी-आनुवंशिक संसाधनों के राष्ट्रीय डेटा बेस का विकास।

2. INTRODUCTION

Central Sericultural Germplasm Resources Centre (CSGRC), Hosur is an exclusive institute established by 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 CSB to register seri-genetic resources developed by various institutes through Germplasm Registration Committee to protect authorship rights of the breeders. The centre is recognized as "National Active Germplasm Sites (NAGS)" for mulberry and silkworm germplasm by National Bureau of Plant Genetic Resources (NBPGR), New Delhi and National Bureau of Agricultural Insect Resources (NBAIR), Bengaluru, respectively. The germplasm conserved at this centre are assigned national accession numbers by the aforesaid institutes. CSGRC Hosur has been implementing several in-house 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 sericultural germplasm resources for research.*
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

- Exploration, collection and introduction of mulberry and silkworm germplasm.
- Characterisation, classification, preliminary evaluation, national accessioning and cataloguing of germplasm collection for promoting utilization of genetic resources.
- Serve as long-term national repository of sericultural genetic resources.
- Act as nodal agency for registration and reference centre for germplasm resources.
- Play lead role in inter-institutional collaboration for testing / evaluation of germplasm.
- Co-ordinate import and export of genetic resources.
- Serve as the national database and herbarium / display of sericultural genetic resources.
- Promote utilization of germplasm through their supply to needy organizations.
- 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: To register the seri-genetic 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

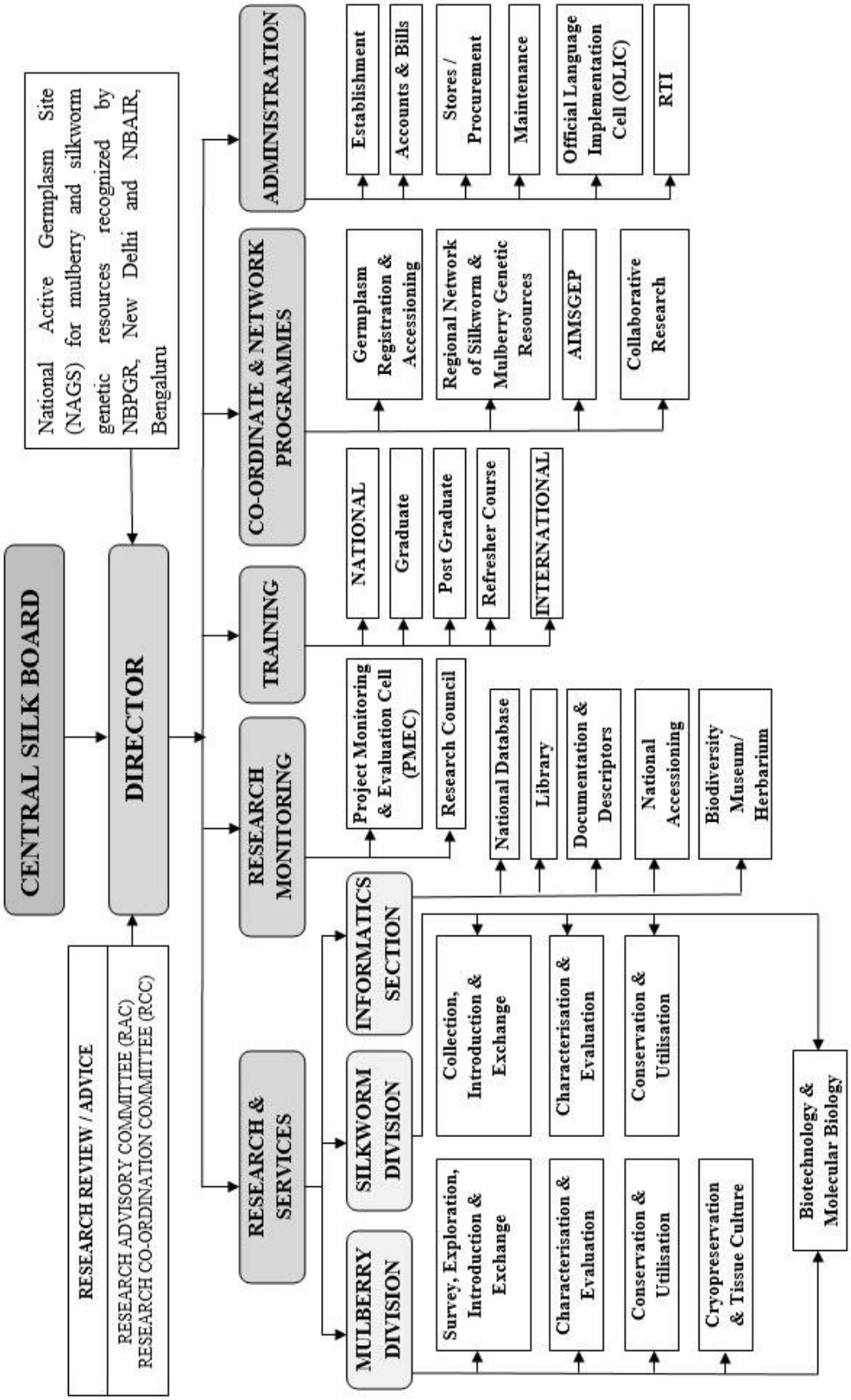
Short term plans

1. Survey of unexplored areas in different states and exploration of 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 at the centers of diversity and gene richness.
3. Evaluation of seri-genetic resources in hotspot areas to identify resources tolerant to biotic and abiotic stress.
4. Adoption of climate resilient sericulture to protect seri-genetic resources.
5. Implementation of pre-breeding programmes for genetic enhancement.
6. Molecular characterization of seri-genetic resources through markers.

Long term plans

1. Introduction of exotic mulberry (*Morus*) species through NBPGR, New Delhi / ISC, CSB Complex, Bangalore.
2. Adoption of eco friendly and organic farming techniques.
3. 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.
4. Implementation of structured and sustainable on-farm and *in situ* conservation of landraces in their native agro-ecological environments.
5. Upgradation of *ex situ* conservation strategies for mulberry and silkworm gene banks adopting advanced biotechnological tools with back up for cost effective conservation.
6. Identification of promising genes in wild and land races using molecular tools for utilization in pre-breeding programme for genetic enhancement.
7. 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.
8. Mechanization in host plant cultivation and silkworm rearing for drudgery reduction.
9. Identification of mulberry germplasm with specific functional traits for resilience to climate change.
10. Development of National Data Base of Seri-genetic Resources with molecular IDs along with characterization and evaluation data.

3. ORGANISATION CHART OF CSGRC, HOSUR



4. LIST OF RESEARCH PROJECTS

CODE	TITLE OF PROJECT	DURATION
Mulberry Division		
Single Institutional projects		
PIE-06001SI	Collection, characterization, evaluation, conservation and supply of mulberry genetic resources.	Nov.18-Oct.21
PIG-06004SI	Studies on the cytological status of mulberry genetic resources.	Mar.20-Feb.23
PIG-06005SI	Molecular characterization of mulberry genetic resources for the identification of duplicates and effective utilization.	Mar.20-Feb.23
Multi-institutional projects		
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-Jun. 21
PIB - 3629	Development of Mulberry Genotypes Suitable for Rainfed Hill Farming in North - West India (RSRS, Jammu with CSGRC, Hosur)	Jan.18-Dec. 21
PIB – 3586	Development of superior mulberry varieties through controlled hybridization for North-West Indian states (CSR&TI Pampore with CSGRC Hosur)	Mar.17-Feb.22
PIT – 08004MI	Studies on epigenetic and autophagy modifiers on induction of haploid microspore embryogenesis in mulberry (SBRL Kodathi with CSGRC Hosur)	Mar.20-Feb.23
Silkworm Division		
Single Institutional projects		
AIE-06003 SI	Evaluation of silkworm genetic resources of *Bombyx mori*. L, with reference to inbreeding depression and their conservation.	Dec.19-Nov.22
Multi Institutional projects		
AIE-06002 MI	Evaluation of bivoltine silkworm genetic resources for tolerance to abiotic stress in selected hotspots *(CSGRC Hosur with CSR&TI Mysuru, CSR&TI Berhampore & CSR&TI Pampore)*	Apr.19-Mar.22
AIT-06006 MI	Marker assisted screening to identify silkworm genetic resources tolerant to BmNPV and BmBDV	Nov.20-Oct.23
AIG-06007 MI	Molecular characterization and assessment of genetic diversity in silkworm (*Bombyx mori L*)	Mar.21-Feb.24

5. PROGRESS OF RESEARCH PROJECTS

MULBERRY DIVISION

Projects continued through 2020-21

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

G. Thanavendan (PI), M.C. Thriveni, Raju Mondal

Objectives

- To collect new mulberry germplasm
- To characterize and evaluate mulberry genetic resources
- To conserve mulberry genetic resources in the *ex situ* field gene bank
- To update Mulberry Germplasm Information System (MGIS)
- To supply mulberry genetic resources for utilization

Progress

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

Survey was not conducted due to travel restrictions and prevailing situations of COVID-19 pandemic nationwide.

S-02: Characterization of Mulberry Genetic Resources

E01: Morphological characterization of mulberry genetic resources

A total new set of 24 accessions were characterized as per prescribed descriptors viz., morphological (17 descriptors), anatomical (15 descriptors) and preliminary growth & yield components (20 descriptors), reproductive (17), and propagation traits (25 descriptors) parameters. The data documented were updated in the Mulberry Germplasm Information System (MGIS) database. Details of characterization and evaluation of the 24 new mulberry accessions are given in Table-1.

Table 1: Details of mulberry genetic resources (MGRs) under characterization and evaluation

#	Institute Acc-No.	Accession Name	Date of Collection	Sex	Donor Name/ ID	Survival (%)	State
1	MI-0980	Madathanthope	13/03/2013	ML	SSR-DMR 2013/4	50	Pondicherry
2	MI-0981	Melakundalapadi	13/03/2013	MLFL	SSR-DMR 2013/5	45	Pondicherry
3	MI-0985	Thalaghattapura-38	03/08/2011	ML	KSSRDI-38	85	Karnataka
4	MI-0986	Thalaghattapura-39	03/08/2011	FL	KSSRDI-39	75	Karnataka
5	MI-0987	Thalaghattapura-40	03/08/2011	MLBI	KSSRDI-40	55	Karnataka
6	MI-0988	Thalaghattapura-41	03/08/2011	ML	KSSRDI-41	70	Karnataka
7	MI-0989	Thalaghattapura-42	03/08/2011	FL	KSSRDI-42	90	Karnataka
8	MI-0990	Thalaghattapura-43	03/08/2011	ML	KSSRDI-43	70	Karnataka
9	MI-0991	Thalaghattapura-44	03/08/2011	MLFL	KSSRDI-44	75	Karnataka
10	MI-0992	Thalaghattapura-45	03/08/2011	FL	KSSRDI-45	55	Karnataka
11	MI-0993	Thalaghattapura-46	03/08/2011	ML	KSSRDI-46	70	Karnataka
12	MI-0994	Thalaghattapura-47	03/08/2011	ML	KSSRDI-(303)	70	Karnataka
13	MI-0995	Thalaghattapura-48	03/08/2011	FL	KSSRDI-(310)	75	Karnataka
14	MI-0996	Thalaghattapura-49	09/09/2011	FL	KSSRDI-(311)	95	Karnataka
15	MI-0997	Thalaghattapura-50	09/09/2011	FL	KSSRDI- (325)	85	Karnataka
16	MI-0999	Thalaghattapura-52	09/09/2011	FL	KSSRDI-(326)	70	Karnataka
17	MI-1000	Suvarna-1	28/12/2015	MFBI	KSSRDI, TGP	85	Karnataka
18	MI-1001	Suvarna-2	28/12/2015	ML	KSSRDI, TGP	75	Karnataka
19	MI-1002	Suvarna-3	28/12/2015	FL	KSSRDI,TGP	95	Karnataka
20	MI-1003	S 41 (4x)	28/12/2015	MLFL	KSSRDI-(317)	90	Karnataka
21	MI-1004	K 2 (3x)	28/12/2015	MLFL	KSSRDI-(319)	70	Karnataka
22	MI-1005	RFS 135 (4x)	28/12/2015	FL	KSSRDI-(329)	80	Karnataka
23	MI-1006	S 35 (4x)	28/12/2015	FL	KSSRDI-(330)	80	Karnataka
24	MI-1007	Ziro valley-1	28/07/2016	FL	Wild collection	70	Arunachal Pradesh
#	**Standard check used for Evaluation of MGRs in ex-situ FGB**						**Purpose**
1	MI-0308	Victory -1	NA	MLBI	NA	95	Irrigated
2	MI-0012	S-13	NA	ML	NA	90	Rainfed
3	MI-0014	Kanva-2	NA	MLFL	NA	80	Rooting
4	ME-0066	Kosen	NA	MFBI	NA	75	Temperate
MGRs flowers code	ML- Male; FL- Female; MLFL- Male and Female Flower; MLBI- Male Bisexual; FLBI- Female Bisexual and MFBI- Male -Female Bisexual						

Table 2: Morphological characterization of mulberry accessions in Field Gene Bank

Parameter	Frequency	Percentage
Branching Nature		
Erect	22	91.66
Staight	2	8.33
Total	**24**	**100.00**
Curve or Straightness of the branch		
Curved	2	8.33
Slightly curved	20	83.33
Staight	2	8.33
Total	**24**	**100.00**
Colour of young shoot		
Green	1	4.16
Greyish green	2	8.33
Pale green	8	33.33
Light Green	13	54.16
Total	**24**	**100.00**
Colour of mature shoot		
Blue green	1	4.16
Dark green	1	4.16
Grey	1	4.16
Greyish green	18	75.00
Light green	2	8.33
Blue green	1	4.16
Total	**24**	**100.00**
Stipule nature		
Foliaceous	2	8.33
Free lateral	22	91.66
Total	**24**	**100.00**
Stipule duration		
Caducous	22	91.66
Persistant	2	8.33
Total	**24**	**100.00**
Phyllotaxy		
Distichous	24	100.00
Total	**24**	**100.00**

Lenticels shape		
Elliptical	5	20.83
Oval	6	25.00
Round	13	54.16
Total	**24**	**100.00**
Leaf lobation type		
Unlobed	24	100.00
Total	**24**	**100.00**
Leaf nature		
Homophyllous	24	100.00
Total	**24**	**100.00**
Leaf colour		
Dark green	14	58.33
Green	2	8.33
Greyish green	2	8.33
Light green	6	25.00
Total	**24**	**100.00**
Leaf surface		
Rough	8	33.33
Slightly rough	9	37.50
Smooth	7	29.16
Total	**24**	**100.00**
Leaf texture		
Chartaceous	10	41.66
Coriaceous	7	29.16
Herbaceous	7	29.16
Total	**24**	**100.00**
Leaf apex		
Acuminate	20	83.33
Acute	4	16.66
Total	**24**	**100.00**
Leaf margin		
Crenate	8	33.33
Dentate	6	25.00
Serrate	10	41.66
Total	**24**	**100.00**
Leaf base		
Cordate	11	45.83
Lobate	1	4.166
Truncate	12	50.00
Total	**24**	**100.00**
Leaf shape		
Ovate	24	100.00
Total	**24**	**100.00**

Among the mulberry accessions evaluated for morphological characterization, most of the accessions consisted of erect branching nature (91.66%), distichous phyllotaxy (100%), unlobed

(100%), homophyllous leaves (100%), with chartaceous leaf texture (41.66%), acuminate leaf apex (83.33%), truncate leaf base (50.00%), serrate leaf margin (41.66%) and ovate leaf shape (100%) (Table-2).

E02: Reproductive characterization of mulberry genetic resources

The data on variability for different reproductive characters are presented in the Table-3. Among the different characters, highest coefficient of variation was observed in fruit weight (52.90%), followed by style length (33.06%), and number of flowers/ female catkin (29.29%). The number of flowers / catkins ranged between 22 to 63 in male and 24 to 67 in female. Out of 24 accessions characterized, MI-1000 recorded longest inflorescence length of 3.53 cm and highest single fruit weight of 1.82 (g).

Table 3: Variability statistics for different reproductive traits of mulberry accessions

Parameters	Mean	Min	Max	SD	SE	CV%
Inflorescence length (Male) (cm)	2.64	1.88	3.53	0.61	0.20	23.17
Inflorescence length (Female) (cm)	1.66	1.11	2.66	0.39	0.10	23.53
Inflorescence length (Bisexual) (cm)	1.22	1.13	1.30	0.12	0.12	9.71
Inflorescence diameter (Male) (cm)	0.67	0.50	0.81	0.12	0.04	18.32
Inflorescence diameter (Female) (cm)	0.65	0.42	0.88	0.12	0.03	18.89
Inflorescence diameter (Bisexual) (cm)	0.55	0.50	0.60	0.07	0.07	12.86
No. of flowers (Male) (Nos.)	37.54	22.98	63.00	10.07	3.04	26.83
No. of flowers (Female) (Nos.)	42.42	24.00	67.10	12.43	3.21	29.29
No. of flowers (Bisexual) (Nos.)	28.97	28.33	29.60	0.90	0.90	3.09
Style length (mm)	0.81	0.38	1.28	0.27	0.07	33.06
Stigma length (mm)	4.57	3.05	6.42	1.11	0.28	24.37
Stamen length (mm)	3.69	2.68	4.75	0.53	0.18	14.46
Anther length (mm)	1.13	0.80	1.62	0.23	0.08	20.77
Fruit length (cm)	2.05	1.14	2.86	0.49	0.12	23.67
Fruit diameter (cm)	0.83	0.50	1.29	0.24	0.06	28.49
Fruit weight (g)	0.99	0.13	1.82	0.52	0.13	52.90

E03: Leaf anatomical characterization of mulberry genetic resources

Twenty-four new accessions were studied for eight anatomical parameters *viz*. stomatal size, stomatal frequency, upper cuticular thickness, lower cuticular thickness, upper epidermal thick, lower epidermal thick, leaf thickness, no. of chloroplast/stomata. The data was collected in three seasons (summer, rainy, and winter) for all 24 accessions and pooled data was subjected to statistical analysis and principal component analysis (PCA). Stomatal size varied from 223.38 to 345.77 sq.µm with CV 11.90 %, stomatal frequency varied from 581.77 to 871.98 no./sq.mm with 12.70 % CV. Higher CV% was observed about 25.64% for the lower cuticular thickness, and for other remaining parameters it ranged from 9.60 (leaf thickness) to 16.89 (upper epidermal thick) indicating moderate level of variation among the parameters (Table-4). PCA analysis suggests that total variation (%) ~ 75.34 is the contribution of component 1 (PC1-36.52%), component 2 (PC2-20.57) and component 3 (PC3-18.23%). Additionally, PCA revealed that MI-0989, MI-1005, MI-1001 and MI-0994 positively correlates with stomatal frequency (SF), upper epidermal thick (UET), and leaf thickness (LT) whereas MI-0988, MI-0996 and MI-0993 positively correlates with lower cuticular thickness (LCT).

MI-1006 and MI-0987 showed positive correlation with stomatal size (SS) and chloroplast/stomata (C/S) and better performing accessions for different anatomical traits and the range of variation of these accessions are presented in Figures 1 & 2.

Table 4: Variability statistics for different anatomical traits of mulberry accessions

Parameters	Min.	Max.	Mean	SE	SD	CV%
Stomatal size (sq.µm)	223.38	345.77	279.85	7.10	33.29	11.90
Stomatal frequency (no./sq.mm)	581.77	871.98	718.19	19.44	91.19	12.70
Upper cuticular thickness (µm)	4.55	8.79	6.48	0.19	0.89	13.73
Lower cuticular thickness(µm)	2.36	5.96	3.77	0.21	0.97	25.64
Upper epidermal thick (µm)	18.07	35.25	23.94	0.86	4.04	16.89
Lower epidermal thick (µm)	6.80	11.56	8.88	0.30	1.41	15.82
Leaf thickness (µm)	132.26	196.64	162.65	3.33	15.61	9.60
No. of chloroplast /stomata	8.87	14.52	10.78	0.29	1.35	12.49

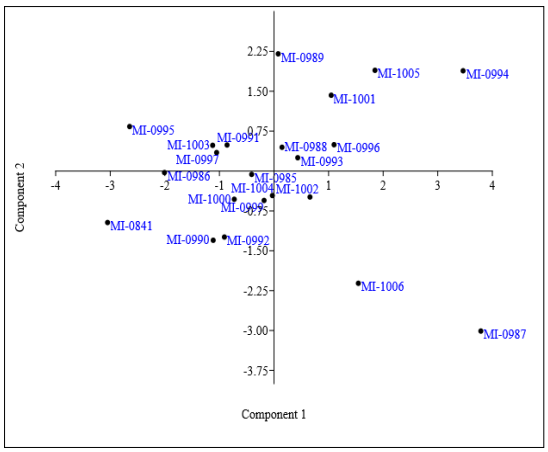


Fig.1. PCA scattered plot indicates distribution of studied accessions

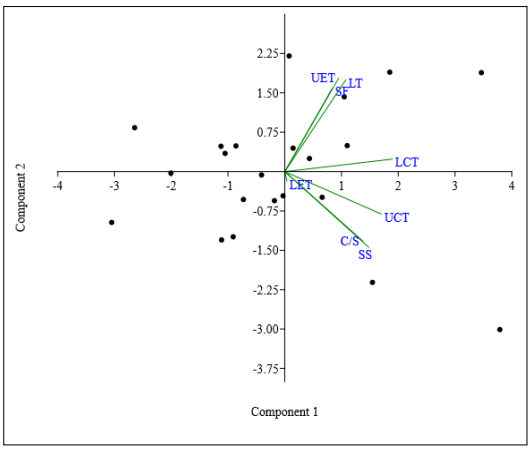


Fig.2. Correlation of studied parameters with the accessions

S03: Evaluation of Mulberry Genetic Resources

Evaluation of mulberry genetic resources was carried out for preliminary growth and yield (70 DAP) (24 descriptors) as well as propagation (16 descriptors) parameters recorded after 90 days of plantation. The data on characterization and evaluation was documented in Mulberry Germplasm Information System (MGIS) database.

E01: Evaluation of mulberry genetic resources for propagation traits

Wide variations observed among the 24 accessions were evaluated for propagation traits and presented in Table-5. The survival percentage varied from 45.00-92.50%. The highest coefficient of variation was recorded for root dry weight (98.10%), followed by leaf fresh weight (74.87%). The highest length of longest root was recorded for MI-1001 (32.45 cm) and highest root volume was recorded for MI-1004 (16.0 ml). The top performing mulberry accessions are presented in Table-6.

Table 5: Details on propagation traits of mulberry accessions

Parameters	Mean	Min	Max	SD	SE	CV%
Survival %	71.82	45.00	92.50	12.75	2.78	17.76
Shoot length (cm)	59.36	26.60	123.00	21.36	4.66	35.98
Shoot wt. Fr (g)	26.15	4.41	65.47	17.83	3.89	68.19
Leaf length (cm)	12.11	9.05	15.35	1.58	0.34	13.03
Leaf width (cm)	8.47	6.15	10.95	1.24	0.27	14.60
Stem diameter (cm)	0.75	0.53	1.00	0.13	0.03	17.04
Stem Fr. wt. (g)	11.72	1.34	26.28	7.90	1.72	67.46
Leaf wt. Fr. (g)	14.61	2.94	39.20	10.94	2.39	74.87
Leaf dry wt. (g)	3.84	0.65	11.30	2.65	0.58	68.89
Shoot wt. dry (g)	8.73	1.48	19.23	5.34	1.17	61.23
No. of roots (Nos.)	18.69	3.83	37.50	9.48	2.07	50.70
Longest root length (cm)	23.53	14.67	32.45	4.37	0.95	18.58
Root fresh wt. (g)	5.11	0.98	14.89	4.19	0.91	82.03
Root dry wt. (g)	2.00	0.30	7.94	1.97	0.43	98.10
Root volume (ml)	8.66	2.00	16.00	4.54	0.99	52.45
Root shoot ratio / fresh wt.	0.20	0.11	0.36	0.07	0.02	35.42
Root shoot ratio / dry wt.	0.22	0.07	0.48	0.12	0.03	53.30
Leaf shoot ratio / fresh wt.	0.58	0.41	0.78	0.10	0.02	16.56
Leaf shoot ratio dry wt.	0.46	0.27	0.71	0.10	0.02	22.49
Leaf moisture content (%)	73.13	52.18	108.94	10.68	2.33	14.61
Root moisture content (%)	63.46	25.06	76.61	11.72	2.56	18.47
Stem moisture content (%)	52.48	9.80	69.95	14.16	3.09	26.98
Root shoot ratio	0.45	0.24	0.76	0.14	0.03	30.52
Leaf area (sq. cm)	105.68	59.85	168.58	28.88	6.30	27.33
Stem dry wt. (g)	4.89	0.68	9.74	2.95	0.64	60.40

Table 6: List of top performing mulberry accessions for propagation traits based on multiple trait analysis

Acc. No.	No. of traits	Trait No. (value)
MI-0996	19	1(92.5), 2(68.3), 3(40.16), 4(12.65), 6(0.85), 7(21.25), 8(18.91), 10(11.46), 11(33.5), 13(5.675), 14(2.24), 15(14.5), 16(0.13), 18(0.481), 19(0.428), 20(74.045), 21(61.265), 23(0.323), 24(108.165)
MI-1001	18	1(75), 2(84.4), 3(50.585), 4(15.35), 6(0.95), 7(21.25), 8(29.335), 10(14.43), 11(20), 12(32.45), 13(12.675), 14(4.94), 15(9.5), 19(0.427), 20(79.961), 21(61.017), 23(0.386), 24(168.575)
MI-1005	16	1(80), 2(65.7), 3(44.32), 4(13.05), 6(0.8), 7(22.61), 8(21.71), 10(16.92), 12(29.05), 13(9.305), 14(3.36), 18(0.505), 19(0.439), 21(64.345), 22(46.288), 24(119.63)
MI-1000	16	1(85), 2(65.9), 3(51.375), 4(13.6), 6(1), 7(13.315), 8(38.06), 10(13.065), 11(26), 12(26.8), 13(13.375), 14(5.705), 15(13), 20(80.964), 22(49.442), 24(122.86)
MI-1004	14	2(62.65), 3(65.47), 4(13.8), 6(0.9), 7(26.275), 8(39.195), 10(19.225), 11(27), 12(27.3), 13(14.89), 14(7.94), 15(16), 21(46.96), 24(151.26)

MI-1003	14	1(87.5), 3(36.399), 4(14.7), 6(0.85), 7(18.28), 8(18.118), 10(13.96), 13(6.77), 14(1.945), 17(0.139), 18(0.509), 19(0.446), 23(0.36), 24(163.87)
MI-1006	14	1(77.5), 2(71.317), 4(12.644), 6(0.783), 9(1.3), 12(24.55), 16(0.16), 17(0.177), 18(0.519), 19(0.313), 20(81.301), 23(0.355), 24(116.042), 25(2.83)
MI-0992	14	3(33.575), 4(13.5), 8(23.89), 10(10.11), 11(37.5), 13(5.81), 14(2.86), 15(11.5), 16(0.183), 20(77.238), 21(47.877), 22(48.262), 23(0.375), 24(133.8)
MI-0994	13	2(63.4), 3(27.965), 7(12.585), 8(15.38), 10(10.345), 11(32), 12(23.15), 13(4.86), 15(16), 16(0.163), 17(0.115), 23(0.362), 24(106.11)
MI-0990	13	2(92.902), 5(7.711), 7(13.653), 9(1.377), 12(30.317), 16(0.125), 17(0.164), 18(0.417), 19(0.274), 20(108.937), 21(52.058), 23(0.338), 25(4.003)
MI-0989	12	1(85), 2(60.617), 5(7.867), 9(1.52), 16(0.115), 17(0.069), 19(0.305), 20(73.501), 21(65.982), 22(9.801), 23(0.33), 25(3.988)
MI-0991	12	2(123), 4(12.439), 6(0.85), 9(3.003), 12(25.067), 16(0.107), 17(0.106), 18(0.485), 19(0.386), 20(72.841), 23(0.235), 24(105.009)
MI-0993	12	3(43.09), 4(12.35), 6(0.805), 7(22.06), 8(21.03), 10(13.805), 11(29), 13(5.415), 15(14.5), 16(0.128), 17(0.09), 18(0.513)
MI-1002	12	1(85), 3(31.984), 7(18.253), 10(13.327), 11(19), 12(24.5), 13(8.07), 14(2.598), 15(11.5), 18(0.414), 19(0.347), 22(52.669)

1) Survival %, 2) Shoot length (cm), 3) Shoot wt. Fr (g), 4) Leaf length (cm), 5) Leaf width (cm), 6) Stem diameter (cm), 7) Stem Fr. Wt. (g), 8) Leaf wt. Fr. (g), 9) Leaf dry wt. (g), 10) Shoot wt. dry (g), 11) No. of roots (Nos.), 12) Longest root length (cm), 13) Root fresh wt. (g), 14) Root dry wt. (g), 15) Root volume (ml), 16) Root shoot ratio / fresh wt., 17) Root shoot ratio / dry wt., 18) Leaf shoot ratio /fresh wt., 19) Leaf shoot ratio dry wt., 20) Leaf moisture content (%), 21) Root moisture content (%), 22) Stem moisture content (%), 23) Root shoot ratio, 24) Leaf area (sq. cm) , 25) Stem dry wt. (g).

E-02: Evaluation of mulberry genetic resources for growth and yield parameters

During the period of report, high variability was observed for growth and yield parameters among the mulberry accessions (Table-7). Evaluation of 24 mulberry accessions for growth and yield parameters in the field gene bank revealed maximum variability in total stem yield (72.71%) followed L:P ratio by length (58.33%), whereas it was lowest for total moisture content (6.01%). The highest leaf yield / plant was recorded for MI-1000 (2073 g) followed by MI-0995 (1327 g). The top performing accessions for different growth and yield parameters are presented in Table-8.

Table 7: Details on growth and yield characters of mulberry accessions

Parameters	Mean	Min	Max	SD	SE	CV%
No. of branches (no.)	12.59	8.33	19.67	3.31	0.72	26.31
Length of the longest shoot (cm)	142.58	83.17	216.67	39.52	8.62	27.72
Inter nodal distance(cm)	4.31	2.49	9.38	1.26	0.27	29.12
Lamina length (cm)	21.57	14.58	30.72	3.50	0.76	16.24
Lamina width(cm)	14.78	8.87	17.52	2.33	0.51	15.79
Petiole length (cm)	4.47	1.48	6.08	1.00	0.22	22.35
Petiole width (cm)	0.45	0.23	0.93	0.13	0.03	29.28
Wt. of single leaf (g)	6.49	1.17	15.63	3.29	0.72	50.69
Total shoot length (cm)	1177.33	614.33	2340.83	507.75	110.80	43.13
Total leaf yield (g)	841.18	243.93	2073.02	417.87	91.19	49.68
Total stem yield (kg)	799.00	285.48	2745.45	580.97	126.78	72.71
L:P ratio by length	6.83	4.31	23.67	3.98	0.87	58.33
L:P ratio by wt.	1.05	1.00	2.15	0.25	0.05	23.30
Petiole wt. (g)	6.47	0.70	15.63	3.33	0.73	51.46
Total moisture content (%)	65.85	58.08	73.76	3.96	0.86	6.01
Moisture content % after 6 hours	48.55	35.95	59.19	4.33	0.94	8.92
Moisture Retention Capacity (%)	50.02	36.60	60.32	6.29	1.37	12.59
Moisture loss (%)	32.68	22.19	42.99	4.02	0.88	12.30
Biomass (kg)	1640.18	529.42	4818.46	917.25	200.16	55.92
Leaf shoot ratio	1.54	0.57	3.68	0.85	0.19	55.40

Table 8. Top performing mulberry accessions for growth and yield traits based on multiple trait analysis

Acc. No.	No. of traits	Trait No. (value)
MI-0997	14	1(19.667), 2(154.166), 3(3.55), 6(3.117), 7(0.226), 8(1.373), 9(1955.333), 11(892.4), 14(1.37), 15(71), 16(54.25), 18(34.9), 19(1636.92), 20(0.85)
MI-1000	14	1(19), 2(212.5), 3(4.2), 7(0.416), 9(2340.833), 10(2073.015), 11(2745.45), 12(5.21), 15(67.71), 16(51.24), 17(51), 18(34.51), 19(4818.46), 20(0.73)
MI-0988	14	1(13.666), 2(194.166), 6(4.134), 7(0.39), 8(5.102), 9(1837.834), 10(921.984), 11(1717.184), 13(1), 14(5.1), 17(52.39), 18(33.71), 19(2639.17), 20(0.57)
MI-1004	13	1(13), 2(147.5), 3(3.98), 5(15.734), 8(3.736), 9(1150.5), 11(724.084), 12(4.98), 14(3.74), 16(49.33), 17(52.1), 18(33.92), 20(0.96)
MI-0985	12	1(15.7), 2(195.333), 7(0.306), 8(2.245), 9(1638.167), 11(895.583), 12(4.63), 13(1), 14(2.24), 15(69.48), 16(49.4), 19(1710.45)
MI-1006	12	1(17.167), 2(185.834), 4(24.284), 5(17.516), 9(1714.334), 10(1158.584), 11(1295.067), 12(5.62), 15(73.76), 16(50.13), 19(2453.65), 20(1.04)
MI-0992	11	1(12.5), 2(216.666), 5(15.533), 6(3.966), 9(1710.167), 10(878.752), 11(1576.066), 13(1), 17(58.53), 18(34.19), 19(2454.82)

MI-0989	10	3(2.49), 4(23.716), 5(16.7), 6(4.233), 7(0.396), 10(1180.925), 13(1), 17(57.2), 18(35.71), 19(1685.08)
MI-0990	9	3(4), 4(22.433), 6(4.483), 7(0.387), 10(1225), 13(1), 15(67.5), 16(49.52), 19(1719.78)
MI-0987	9	1(13.5), 2(151.667), 4(30.717), 5(16.717), 6(3.839), 9(1298.834), 10(958.03), 13(1), 17(51.77)
MI-1003	9	1(14.416), 3(3.8), 4(23.534), 5(15.634), 8(4.74), 9(1325.334), 12(5.62), 14(4.74), 20(1.08)

1) No. of branches (No.), 2) Length of longest shoot (cm), 3) Inter nodal distance (cm), 4) Lamina length (cm), 5) Lamina width (cm), 6) Petiole length (cm), 7) Petiole width (cm), 8) Single leaf wt. (g), 9)Total shoot length (cm), 10) Total leaf yield (kg), 11) Total stem yield (kg), 12) L:P ratio by length, 13) L:P ratio by wt., 14) Petiole wt. (g), 15) Total moisture content (%), 16) Moisture content after 6 hrs, 17) Moisture retention capacity, 18) Moisture loss, 19) Biomass, 20) Leaf shoot ratio.

E03: Evaluation of mulberry genetic resources for natural incidence of pests and diseases

Natural Incidence of pests:

A] Chewing insect pests

The incidences of Bihar hairy caterpillar (BHC), stem borer, leaf roller and termites were observed in the *ex-situ* Field Gene Bank (FGB). Based on the pooled data analysis, among the 24 accessions evaluated in the three seasons, it was observed that, MI-0997; MI-1000; MI-0988; MI-0985; MI-1006; MI-0992; MI-0989; MI-0990; MI-0987; MI-1003; MI-1001 and MI-1007 revealed least infestation (Table-9).

The following management practices were adopted:

- Clipping off of infested apical shoots manually.
- Application of Azadirachtin 1% EC (10000 ppm) during monsoon period to manage the young caterpillar stages of lepidopteran insects.
- Crude extract (10%) of *Agave Americana* was poured into the hole followed by closing with wet soil to reduce the infestation of stem borer.
- Application of a solution of Chlorpyriphos (20% EC) @ 3ml/litre of water for termite management.
- In *ex situ* plantation, soil drenching with 0.1% Chlorpyriphos 20% EC or Imidacloprid @ 3ml per litre of water was used to reduce the level of infestation of termite colonies.

Table 9: Incidence of chewing insect pests in mulberry field gene bank-pooled value of summer, rainy and winter seasons

Name of the insect pests		Summer				Rainy					Winter		
		Level of infestations (%) or Nos. per accession/ plant											
		Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Hairy caterpillar, (*Spilosoma obliqua)*		Nil	11.0	Nil	23.0	10.45	6.40	Nil	Nil	Nil	Nil	Nil	Nil
Leaf roller (*Diaphania pulverulentalis)*		Nil	1.24	6.78	24.58	38.56	8.56	Nil	Nil	Nil	Nil	Nil	Nil
Stem borer (*Apriona* spp.)		Nil	2.00	2.00	4.00	8.00	12.00	8.00	Nil	Nil	Nil	Nil	Nil
Termites *(Odontotermes* spp.)		Nil	Most of the accessions were suffered moderate infestation from termite attack during these month								Nil	Nil	Nil

Grade: 1= (1-10%); 3= (11-30%); 5= (31-50%); 7= (51-70%); 9= (71-100%)

B] Sucking insect pests

Among the sucking insects, minor incidences of tukra mealybug, papaya mealybug, thrips, white fly and *Clovia* spp. were observed. Among the 24 accessions evaluated, the least infestation was recorded in MI-0980; MI-0985; MI-1006; MI-0992; MI-0989; MI-0990; MI-1003; MI-1001 and MI-1007 based on the preliminary observation in all seasons (Table-10).

The following management practices were adopted:

- Clipping off of infested apical shoots.
- Removal of infested portions with secature and buried.
- Spraying Dimethoate (36%EC) 2ml / L of water at one-month interval for thrips management during summer season.
- Release of lady bird beetles, *Scymnus coccivora* @ 500 beetles or *Cryptolaemus montrouzieri* @250 beetles/ac/year in two splits at an interval of 6 months for management of sucking pests.
- Inoculative release of exotic nymphal parasitoid, *Acerophagus papayae* @ 100 adults (one vial)/acre/ year in papaya mealybug infested gardens.

Table 10: Incidence of sucking insect pests in mulberry genetic resources-pooled value of summer, rainy and winter seasons

Name of the insect pests	Summer season				Rainy season					Winter season		
	% Level of infestations (or) Nos. per accession/ plant											
	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Mealybug (*Maconellicoccus hirsutus*)	All accessions suffered moderate infestation from Mealybugs attack during these months							Nil	Nil	Nil	Nil	Nil
Thrips (*Pseudodendrothrips mori)*	Nil	23.54	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
Whitefly (*Tetraleurodes mori)*	Nil	27.54	Nil	Nil	Nil	Nil	22.54	18.57	Nil	Nil	Nil	Nil

Grade: 1= (1-10%); 3= (11-30%); 5= (31-50%); 7= (51-70%); 9= (71-100%)

Natural incidence of diseases (foliar fungal diseases):

The natural incidence of diseases was observed with major fungal diseases viz., powdery mildew, leaf spot and leaf rust, which were monitored and necessary measures were taken to control the disease. Among the 24 accessions, the accessions MI-0988; MI-0985; MI-1006; MI-0992; MI-0989; MI-0990; MI-0987; MI-1000; MI-1002; MI-1003; MI-1001 and MI-1007 were recorded least infestations based on the preliminary observation in all the seasons (Table 11).

Table 11: Incidence of foliar fungal diseases in mulberry genetic resources

Level of resistance (PDI)	Summer			Rainy			Winter		
	Foliar fungal diseases								
	A	B	C	A	B	C	A	B	C
No incidence / Immune (0.00)	6	18	13	4	10	9	9	8	7
Resistant (0.1-5.0)	9	2	4	9	5	6	7	7	3
Moderate resistant (5.1-20.0)	5	-	3	2	3	3	6	2	4
Suceptible (20.1-50.0)	2	2	-	5	3	-	-	2	4
Highly Suceptible (>50.00)	2	2	2	4	3	4	6	5	6

Note: A-Leaf spot; **B**- Leaf rust; **C**- Powdery mildew

E03: Supply of mulberry genetic resources

During the project period, a total of 433 mulberry accessions (includes recurrent supply) comprising 79 exotic and 357 indigenous accessions were supplied to 8 indenters (Table-12) for different purposes viz., DUS project, screening for root rot resistance, identification of QTLs, Sheep and Goat fodder purpose, evaluation of arid fruit, UG, PG education and Ph.D. project works of universities and other R & D institutes.

Table 12: Details of mulberry germplasm supplied from CSGRC, Hosur

SN	Name of indentor	No. of Accessions			Purpose
		Indigenous	Exotic	Total	
1	The Director, CSR&TI, Central Silk Board, Srirampura, Mysuru.	232	35	267	DBT Multi component Net work Project and DUS Project
2	The Professor and Head Dept. of TIGR, Dr.YS Parmer UH&F, Nauni, Solan-173 230	9	9	18	Mulberry germplasm used for Fodder quality Evaluation
3	Dr. A.K. Goyal, Scientist, APSSR&DI, Hindupuram.	4	2	6	Fruit Yielding Accessions – Plantation Purpose.
4	The Dean, Dept. Of Sericulture, FC&RI, TNAU, Mettupalayam.	58	22	80	PG -Education and Ph.D. Research purpose
5	Shri. Taranath G.T. International, GT House, #48, Layout, B.S.K 3rd Stage, Bangalore - 560 085.	3	1	4	Fruit Yielding Accessions - Plantation Purpose
6	Dr. Jyothi Birador, Asst.Professor ,	19	6	25	UG and PG Education purpose.

	College of Sericulture, Chinthamani,Chickballapur Dt. UAS- Bangalore.				
7	Dr. Aparna Saraf, Asssociate professor University of Mumbai, Mumbai -400098.	2	1	3	For PhD work and analysis of chemical compounds.
8	Dr. K.P. Mohapatra, Principal Scientist, NBPGR, New Delhi	30	0	30	For fruit plantations and research work at NBPGR, New Delhi.
	TOTAL	**357**	**76**	**433**	

2. PIG06004 SI: Studies on cytological status of mulberry genetic resources (Mar.20 – Feb.23)

Raju Mondal (PI) and Dr. M.C. Thriveni

Objective

1. Identification of chromosome number and ploidy level of mulberry genetic resources

Progress

Cluster analysis of 200 core-set accessions using 17 morphological parameters was carried out. UPGMA hierarchical clustering result indicated that accessions grouped into 2 major clusters, 4 sub clusters & 14 clades. Dendrogram and principle component analysis (PCA) revealed that no probable duplicates within the studied population (Figure 3).

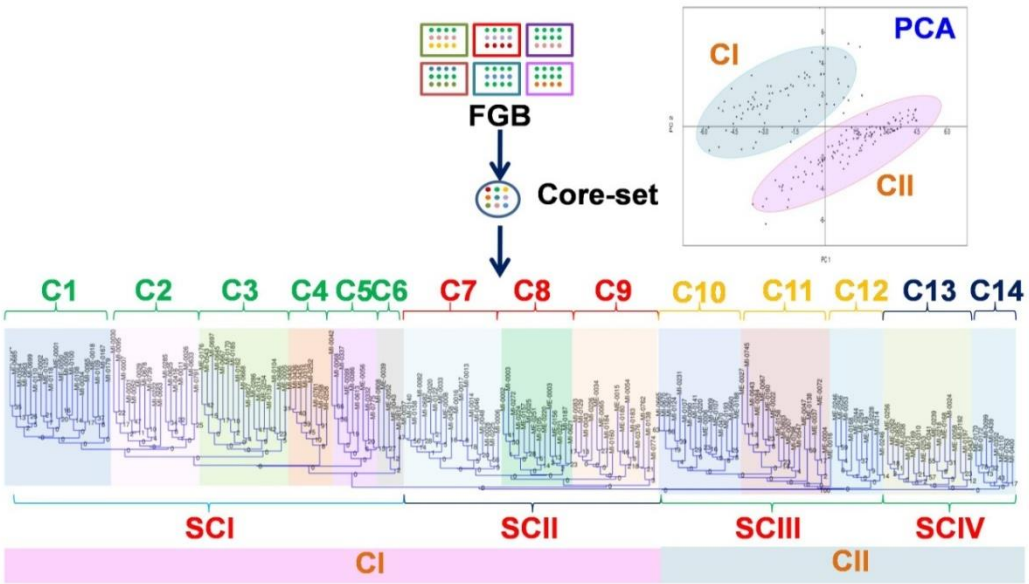


Fig. 3: PCA and Dendrogram analysis. Accessions are grouped in to 2 major clusters (CI and CII), 4 sub clusters (SCI to SCIV) & 14 clades (C1 to C14)

Out of 200 accessions, 53 accessions were studied for metaphase preparation (sample size = 1908, 3 replication*2 time point*2 tissue type*3 different treatment*53 accessions). Out of 53 accessions, only 15 accessions have shown moderate level of metaphase. Out of 15 accessions, 9 accessions consist of chromosome 2n=28. Karyotype analysis was done for 09 accessions. High vicinity cytoplasmic material creates hindrance to observe chromosomes. Hence, further protocol optimization with different enzyme and chemical treatment will be done for high quality metaphase plate (Fig.4).

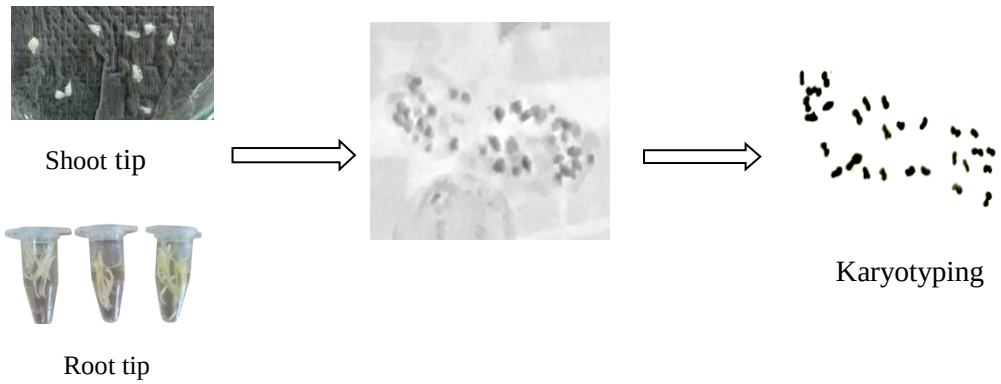


Fig. 4: Metaphase stage.

2. PIG06005 SI: Molecular characterization of mulberry genetic resources for the identification of duplicates and effective utilization (Mar.20-Feb.23)

M.C. Thriveni (PI) and Mr. Raju Mondal

Objectives

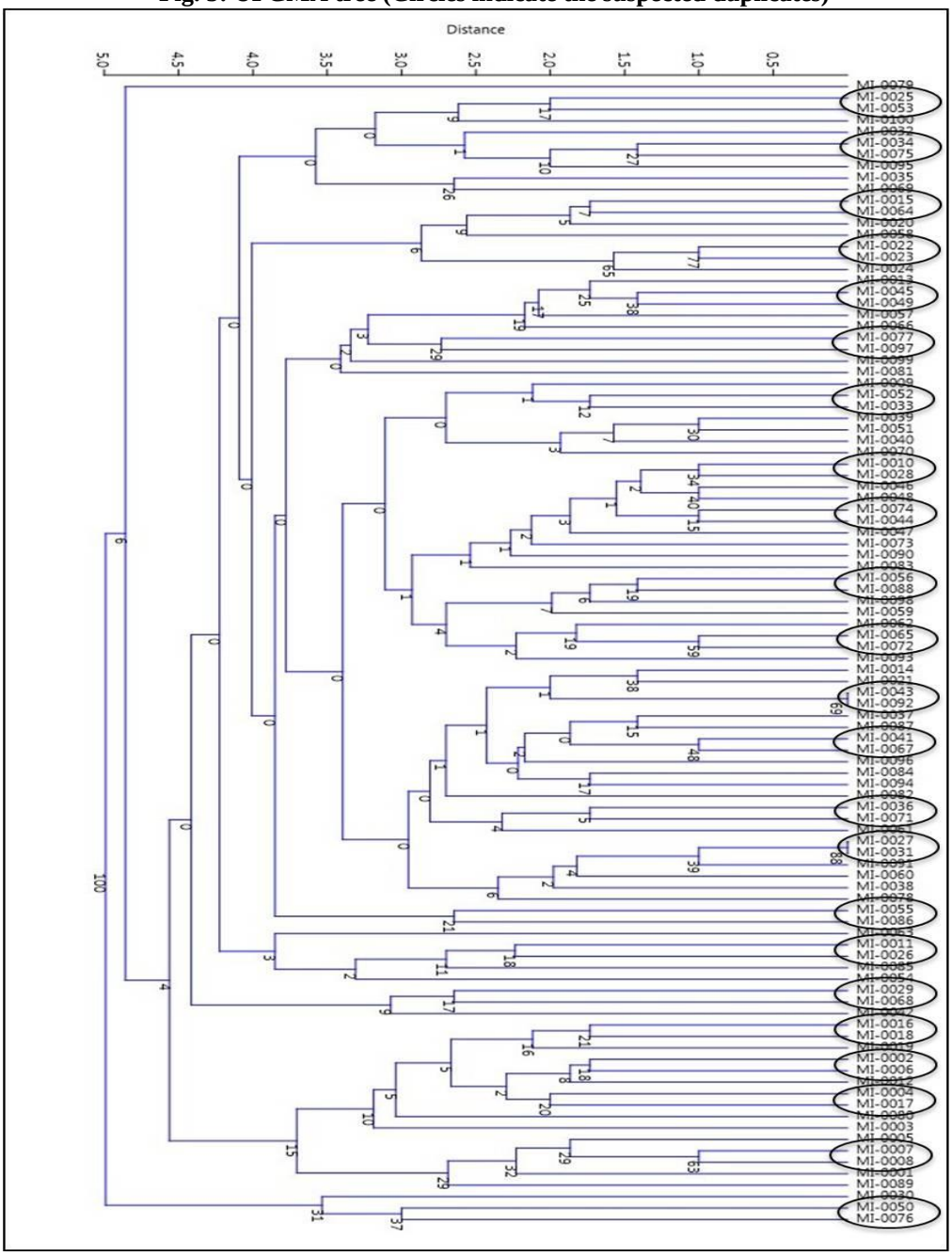
1. Whole Genome Sequencing of *Morus indica* and mining of genome-wide SSR markers
2. Identification of duplicates and their demarcation using morphological descriptors and molecular markers.

Progress

Whole genome sequencing of *Morus indica* has been done by CSB-DBT network project. To mine the SSR from the available database, SSRMMD (Simple Sequence Repeat Molecular Marker Developer) tool was used. It is an algorithm-based tool that uses Perl programming language. This tool helps in assessing the conservativeness of SSR flanking sequences and mines the perfect SSR loci from any size of assembled sequence. The genome sequences were retrieved from NCBI database for both *Morus alba* and *M. notabilis*. Both the sequences were analyzed for the identification of SSRs regions. A total of 2,85,791 SSR regions were identified in *M. notabilis* and 3,65,445 SSR regions in *M. alba*. A comparative analysis of the sequences was done to know the polymorphic SSRs. Using Primer 3, a total of 981 pairs of polymorphic primers were designed. These primers are having a product size ranging from 100-300 bp. Selection of primers, synthesis and validation is under progress.

To identify duplicates, 100 accessions were selected and the morphological data was collected from the available MGIS database. Each morphological descriptor was coded using 0-9 scale. The coded accessions were subjected for cluster analysis using past software. The UPGMA tree was generated (Fig. 5). Those accessions in the single clade are considered as suspected duplicates. A total of 60 accessions were identified as suspected duplicates. Alternatively, principal component analysis (Fig. 6) was carried out to check the suspected duplicates. The results showed the grouping 36, 16, 23 and 24 accessions. The accessions grouped in a particular component are considered as closely related, which share most of the similar characters analyzed.

Fig. 5: UPGMA tree (Circles indicate the suspected duplicates)



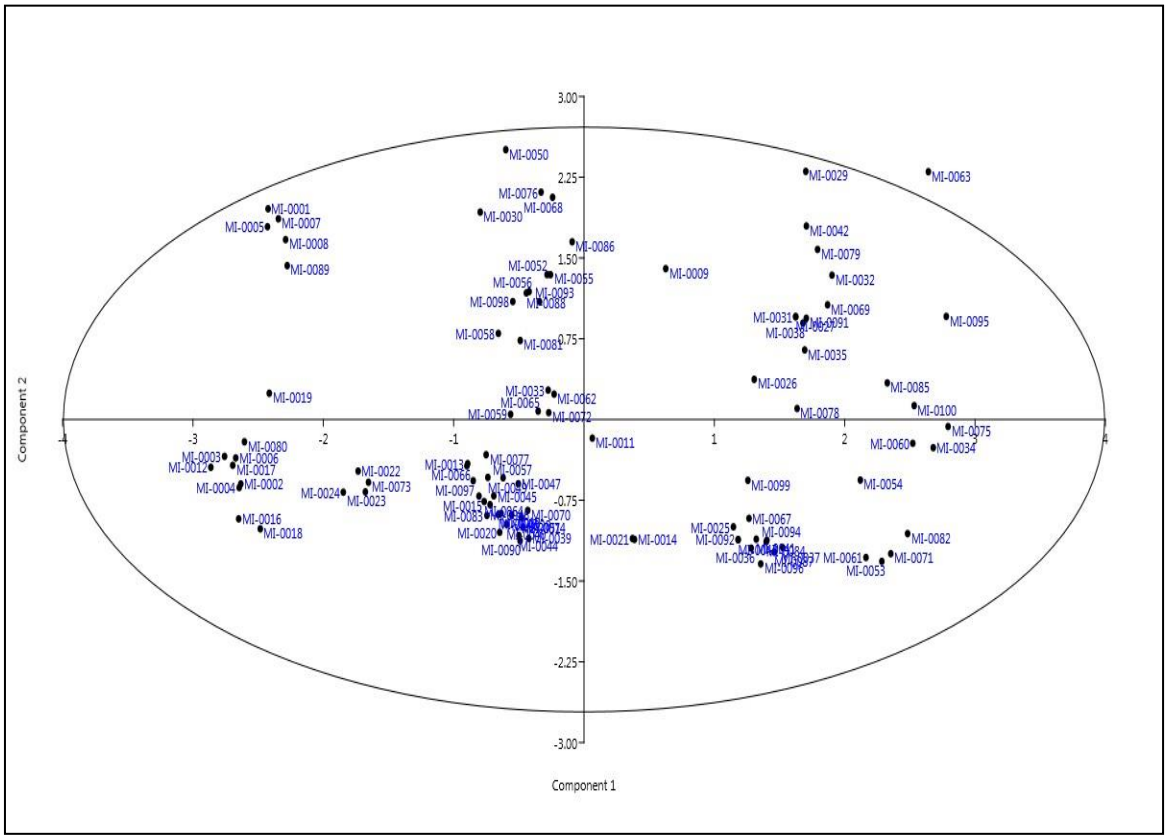


Fig. 6: Principal component analysis

Inter-Institutional [Other institute projects with CSGRC Hosur as collaborator]

1. **PIB 3586**: **Development of superior mulberry varieties through controlled hybridization for North-West Indian states** (Mar.17 – Feb.22)

CSR&TI, Pampore: *Rajesh Kumar (PI), Pawan Saini, Aftab A. Shabnam,*
CSGRC, Hosur: *G. Thanavendan*
RCS-CO, Bangalore: *K. Vijayan*

Objective

Project was implemented by CSR&TI, Pampore in collaboration with CSGRC, Hosur aiming to develop high yielding mulberry variety with early sprouting and cold tolerance for North West India.

Progress

During the year, Principal Investigator recorded morphological growth parameters viz., plant height, growth nature, branching nature, young shoot colour, matured shoot colour, phyllotaxy, Internodal distance, lenticles / sq cm, lenticles shape, no of branches, branch thickness, bud shape, leaf apex, leaf shape, leaf margin, leaf base, leaf surface leaf texture, leaf nature, leaf colour leaf

glossiness, leaf area and petiole length for selected 40 plants in Progeny Row Trial (PRT) at CSR&TI, Pampore.

2. PIB-3629: Development of drought tolerant mulberry genotype suitable for rainfed hill farming in North-west India (Jan.18 to Dec.21)

RSRS Jammu: *Chhattar Pal (PI), Jadhav Ashok Limbaji (till Nov.18), Murali S.*
CSGRC, Hosur: *G. Thanavendan*

Objective

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

Progress

During the report period, hybrid progenies of 12 different crosses were visually observed for desirable morphological traits such as plant vigour, phyllotaxy, leaf lobation, leaf texture, leaf base, leaf margin, leaf shape, leaf colour, leaf texture and leaf angle under moisture stress condition in nursery beds at RSRS, Jammu. On the basis of visual observations out of 971 progenies; 236 progenies belong to different crosses were found desirable for further evaluations of Progeny Row Trials (PRT) at RSRS, Jammu.

3. PIC-01003CN – NW4b: Sugar-mimic alkaloids in mulberry and their role in modulating host plant-insect interactions (Jun.18 – May 21)

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

Objective

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 levels of resistance for foliar insect pests that are able to overcome mulberry plant's defenses.

Progress

CSGRC, Hosur is one of the collaborators in the project with a work plan that involves maintenance of mulberry genetic resources shortlisted for the study and supply of samples of leaf and latex for further biochemical and other studies to the other collaborating institutes. As a collaborator of the project, the concerned scientist of this centre participated in the project related meetings and supplies the materials as per milestone of the project.

As per the milestone the following work was carried by Crop Physiology and School of Ecology and Conservation, University of Agricultural Sciences, GKVK, Bengaluru. RNA isolated from silkworm was converted into cDNA and amplified and sequenced using specific primers of beta-fructofuranosidase gene from silkworm *Bombyx mori*. According to our hypothesis the insect pest of

mulberry might have evolved a strategy similar to that of silkworms to overcome inhibition imposed by the sugar mimic alkaloids and hence, *Spilosoma obliqua* and Spodoptera litura were collected and reared in the laboratory. Total RNA was isolated from both *Spilosoma obliqua* and *Spodoptera litura* converted into cDNA and amplified with specific primers of beta-fructofuranosidase gene from silkworm *Bombyx mori*. However, both *Spilosoma obliqua* and *Spodoptera litura* cDNA failed to amplify. Further, the gene expression in insect pest of mulberry is in progress. Comparative growth analysis of *Spodoptera litura* was done by feeding on both mulberry and castor leaves and it was show feeding on mulberry was less compared to larvae feeding on castor leaves, but there was no significant difference in growth and development of larvae. DNJ (sugar mimic alkaloid from mulberry latex) inhibition assay was done with different concentration of DNJ on mulberry leaves. Compared to control, growth of *Spodoptera larvae* was reduced or inhibited in different concentration of DNJ, but there was no significant difference in inhibition rate with different concentration of sugar mimic alkaloid.

4. PIT08004 MI: Study on epigenetic and autophagy modifiers on induction of haploid microspore embryogenesis in mulberry

SBRL, Kodathi: *A. Ramesha (PI), Himanshu Dubey*
RCS-CO, Bangalore: *Prashanth Sangannavar*
CSGRC-Hosur: *Raju Mondal*

Objective

The project aims to develop a protocol for haploid microspore embryogenesis in mulberry.

Progress

For Anther culture, mulberry variety V1 was selected as donor and planted in net-house. Size and shape of bud explant and optimal stage of pollen mother cell (PMC) were optimized. Standardization of sterilization process, culture media and growth condition are under progress as indicated in Figure **7**.

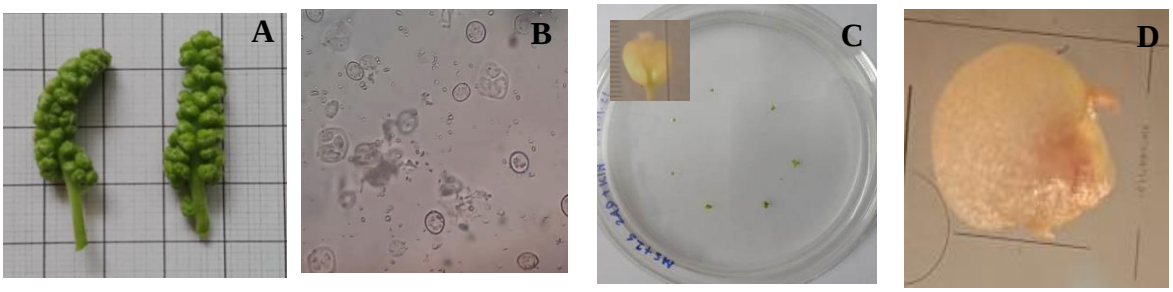


Fig 7: (A) Immature anther used as explant. (B) Identification of pollen mother cell size for standardization. (C) Individual anthers are separated and culture in embryo induction medium. (D) Response of cultured anther after 15 days of incubation.

SILKWORM DIVISION

1. AIE-06003SI: Evaluation of silkworm genetic resources of *Bombyx mori* L. with reference to inbreeding depression and their conservation (Dec, 19 - Nov, 22)

D. S. Somaprakash (PI) (upto-29.06.2020), C.M. Kishor Kumar (PI) (upto 31.07.2021), M. Maheswari, G. Punithavathy, G. Lokesh, Jameela Khatoon, and Ritwika Sur Chaudhuri

Objectives

1. To evaluate silkworm genetic resources and estimate the level of inbreeding depression.
2. To promote utilization of sericultural germplasm for crop improvement programmes.
3. To maintain national database on silkworm accessions and catalogue the data generated.

Progress

CSGRC Hosur is an exclusive centre for collection, characterization, evaluation and conservation of seri-genetic resources for the purpose of utilization of germplasm by CSB and other R&D institutes. As per mandate, the centre is conserving 489 Silkworm germplasm resources (SWGRs) with characterization, evaluation, updating of database and promotion of their utilization. The gene bank comprises collection of SWGRs from India and 14 other countries across the world. It includes 83 multivoltine (indigenous-73 & exotic-10), 383 bivoltine (indigenous-223 & exotic-160) and 23 mutant genetic stocks (exotic) (Table-13).

The morphological characterization for 27 descriptors and evaluation of 24 growth & reproductive traits has been carried out on various growth stages *viz.*, egg, larva, cocoon, pupa and moth for all the silkworm accessions. Out of 489 SWGRs, CSGRC, Hosur has already documented the characterization and evaluation data of 431 SWGRs (72 multivoltine, 339 bivoltine and 20 mutants) in 3 volumes of catalogues published for the benefit of researchers. The characterization and evaluation for remaining 58 accessions (11 MV, 44 BV & 3 Mut) has been completed during the year for cataloguing. The data generated has been updated in the Silkworm Germplasm Information System [SGIS] database.

Table 13. Phase-wise collection of silkworm germplasm resources (SWGRs)

Year	Phase	Multivoltine	Bivoltine	Mutant	TOTAL
1993-1997	I	57	169	-	**226**
1997-2000	II	-	103	-	**103**
2000-2003	III	8	40	19	**67**
2003-2006	IV	7	25	1	**33**
2006-2009	V	1*	2	-	**3**
2009-2012	VI	1*	11*	-	**12**
2012-2015	VII	7*	15*	-	**22**
2015-2018	VIII	2*	4*	3*	**9**
2018-2021	IX	-	14*	-	**14**
Grand Total		**83**	**383**	**23**	**489**

* Catalogue to be published

I. Morphological characterization of Silkworm Genetic Resources (SWGRs)

During the year, the morphological characterization was carried out for all the 489 silkworm accessions to confirm maintenance of traits true to catalogue data. The data on the major important morphological parameters of 83 multivoltine, 383 bivoltine and 23 mutant silkworm accessions is presented in Table 14. Multivoltine silkworm accessions revealed three types of larval patterns *i.e.,* plain larvae (46 accns; 55.4%), marked larvae (33 accns; 39.8%) and Sex-limited for larval markings (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 (4 accns; 4.8%) and creamish 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%), dumb-bell (3 accns; 3.6%) and elongated (2 accns; 2.4%).

Morphological characterisation among the 383 bivoltine silkworm accessions recorded four types of larval patterns with majority accessions revealing plain type (228 accns-59.3%) followed by marked pattern (133 accns-34.7%), sex-limited for larval markings (16 accns-4.2%) and mixed (6 accns-1.6%). The cocoon colour revealed maximum accessions with white colour (357 accns-93.2%) followed by chrome yellow (9 accns-2.3%), flesh (6 accns-1.6%), creamish white (5 accns-1.3%), greenish yellow (4 accns-1.0%) and sex-limited for cocoon colour (2 accns-0.5%). The cocoon shape data revealed that maximum accessions are with elongated constriction type (164 accns-42.8%) followed by oval shape (132 accns-34.5%), elongated non-constriction (37 accns-9.7%), dumb-bell shape (34 accns-8.9%), elongated faint constriction (9 accns-2.4%), spindle (6 accns-1.6%) and elliptical shape (1 accn-0.3 %).

Mutant silkworm accessions revealed only two types of larval patterns i.e, plain larvae (9 accns-39.1%) and marked larvae (14 accns-60.9%). In case of cocoon colour, maximum accessions revealed white colour (14 accns-60.9%) followed by chrome yellow (3 accns-13.0%). The other colours being yellow, greenish yellow and flesh in 2 accessions each (8.7%). Similarly, the cocoon shape revealed maximum dumb-bell shaped cocoons (16 accns-69.6%) followed by elongated faint constriction (5 accns-21.7%) and elongated non-constricted (2 accns-8.7%).

Table 14. Morphological characters variations in SWGRs

Parameters	Multivoltine		Bivoltine		Mutants	
	Frequency	(%)	Frequency	(%)	Frequency	(%)
Larval Pattern						
Plain (P)	46	55.40	228	59.33	9	39.13
Marked (M)	33	39.80	133	34.73	14	60.87
Mixed (both P & M)	-	-	6	1.57	-	-
Sex limited for Larval Marking (Plain-♂♂ & Marked-♀♀)	4	4.80	16	4.18	-	-
Total	**83**	**-**	**383**	**-**	**23**	**-**
Cocoon colour						
White	22	26.50	357	93.21	14	60.87
Yellow	4	4.80	-	-	2	8.70
Greenish yellow	35	42.20	4	1.04	2	8.70
Chrome yellow	20	24.10	9	2.35	3	13.04
Creamish white	2	2.40	5	1.31	-	-
Flesh	-	-	6	1.57	2	8.70
Sex Limited for Cocoon colour (White -♂♂ & Yellow-♀♀)	-	-	2	0.52	-	-
Total	**83**	**-**	**383**	**-**	**23**	**-**
Cocoon shape						
Oval	31	37.30	132	34.46	-	-
Dumb-bell	3	3.60	34	8.88	16	69.57
Spindle	19	22.90	6	1.57	-	-
Elongated non-constricted	24	28.90	37	9.66	2	8.70
Elongated constricted	-	-	164	42.82	-	-
Elongated faint constricted	-	-	9	2.35	5	21.74
Elliptical	-	-	1	0.26	-	-
Spatulate	4	4.80	-	-	-	-
Elongated	2	2.40	-	-	-	-
Total	**83**	**-**	**383**	**-**	**23**	**-**

II. Evaluation of SWGRs for growth and reproductive traits

a) Evaluation of multivoltine SWGRs

During the year, 5 successive conservation rearings have been carried out for the 83 multivoltine SWGRs evaluation. The statistically analysed data on the trait-wise variability observed for 14 growth and reproductive traits is presented in Table 15. The coefficient of variation was highest for the characters like non-breakable filament length (28.5%) followed by shell weight (27.2%), average filament length (20.8%), wt. of 10 grown larvae (15.4%), filament size (13.3), shell ratio (13.1%), single cocoon wt. (12.8%) and yield per 10000 larvae by wt. (11.9%) which indicate

existence of good amount of genetic variability among the accessions. The other phenotypic characters such as hatching percentage, yield per 10000 larvae by number, pupation rate and total larval duration did not show much variation in CV% indicating the adaptability of the inbred genotypes to the rearing environment. The analysed data for the economically important traits like highest pupation rate recorded in BMI-0008 (96.4%), higher single cocoon wt. & shell wt. in BMI-0083 ((1.479 g & 0.277 g), highest shell ratio, average filament length and non-breakable filament length in BMI-0076 (19.3%; 783 m & 673 m).

Table 15. Economic trait-wise range of variability in multivoltine SWGRs (Mean of 5 trials)

Parameters	Avg	Min.	Max.	SD	SE	CV %
Fecundity (no.)	395.8	356.0	456.0	21.23	2.34	5.36
Hatching (%)	96.6	95.4	97.5	0.35	0.04	0.37
Wt. of 10 grown larvae (g)	23.1	18.8	38.1	3.56	0.39	15.42
Total larval duration (h)	518.8	495.0	631.0	25.57	2.82	4.93
V age larval duration (h)	116.7	99.0	189.0	14.00	1.55	11.99
Yield/10,000 larvae by no.	9468	8808	9768	183.45	20.26	1.94
Yield/10,000 larvae by wt. (kg)	9.3	7.3	14.5	1.11	0.12	11.85
Pupation rate (%)	92.8	85.0	96.4	2.08	0.23	2.24
Single cocoon wt (g)	0.976	0.781	1.479	0.12	0.01	12.80
Single shell wt (g)	0.129	0.085	0.277	0.04	0.004	27.23
Single shell ratio (%)	13.3	11.1	19.3	1.74	0.19	13.14
Average filament length (m)	425.1	298.3	783.0	88.48	9.77	20.82
Non-breakable filament length (m)	310.8	156.7	673.0	88.64	9.79	28.52
Filament size (d)	2.11	1.59	3.18	0.28	0.03	13.34

Further, individual trait-wise top performing 20 multivoltine SWGRs for various important traits along with the range values are presented in Table 16. Similarly based on the evaluation indices (EI) and multiple trait analysis the top ranking 20 multivoltine SWGRs have been selected and it can be seen that accession BMI-0083 ranked first with best performance for eight economic traits and a highest evaluation index value (EI) of 71.6 (Table 17).

Table 16. Trait-wise top performing 20 multivoltine SWGRs

Trait	Range	Accession No.
Fecundity(no.)	456-404	BMI-0082, BMI-0080, BMI-0079, BMI-0081, BMI-0078, BMI-0084, BMI-0077, BMI-0083, BMI-0076, BMI-0074, BMI-0023, BMI-0071, BMI-0067, BMI-0075, BMI-0007, BMI-0066, BMI-0039, BMI-0024, BME-0052, BMI-0018
Hatching (%)	97.54-96.88	BMI-0079, BMI-0083, BMI-0041, BMI-0078, BMI-0021, BMI-0080, BMI-0065, BMI-0057, BMI-0082, BMI-0024,

		BME-0052, BMI-0074, BMI-0076, BMI-0027, BMI-0081, BMI-0069, BMI-0056, BMI-0062, BMI-0066, BMI-0075
Wt. of 10 grown larvae(g)	38.08-23.81	BMI-0083, BMI-0084, BMI-0078, BMI-0080, BMI-0074, BMI-0081, BMI-0076, BMI-0082, BME-0048, BMI-0066, BMI-0054, BMI-0067, BMI-0007, BMI-0073, BMI-0077, BMI-0079, BMI-0034, BMI-0009, BMI-0024, BMI-0044
Yield/10,000 larvae by no.	9768-9612	BMI-0007, BMI-0008, BMI-0006, BMI-0063, BMI-0009, BMI-0022, BMI-0011, BMI-0068, BMI-0002, BMI-0004, BMI-0037, BMI-0033, BMI-0072, BMI-0034, BME-0050, BMI-0028, BME-0048, BME-0015, BMI-0029, BME-0049
Yield/10,000 larvae by wt.(kg)	14.45-9.7	BMI-0083, BMI-0084, BMI-0078, BMI-0081, BMI-0080, BMI-0076, BMI-0074, BMI-0067, BMI-0066, BMI-0024, BME-0048, BMI-0009, BME-0005, BMI-0025, BMI-0007, BMI-0054, BMI-0073, BMI-0001, BMI-0041, BMI-0006
Pupation rate (%)	96.4-94.28	BMI-0008, BMI-0022, BMI-0007, BMI-0009, BMI-0063, BMI-0028, BMI-0034, BMI-0037, BMI-0006, BME-0049, BMI-0072, BMI-0068, BME-0050, BMI-0033, BMI-0002, BMI-0029, BMI-0011, BMI-0024, BMI-0016, BMI-0018
Single cocoon wt.(g)	1.48-1.018	BMI-0083, BMI-0084, BMI-0080, BMI-0076, BMI-0081, BMI-0078, BMI-0074, BMI-0067, BMI-0066, BMI-0001, BME-0048, BMI-0024, BMI-0073, BMI-0025, BMI-0075, BMI-0054, BMI-0009, BMI-0027, BMI-0079, BMI-0007
Single shell wt. (g)	0.28-0.139	BMI-0083, BMI-0084, BMI-0076, BMI-0080, BMI-0081, BMI-0078, BMI-0074, BMI-0073, BMI-0001, BMI-0067, BMI-0066, BMI-0079, BMI-0075, BME-0012, BME-0048, BME-0052, BMI-0065, BMI-0024, BMI-0023, BME-0030
Shell ratio (%)	19.34-14.46	BMI-0076, BMI-0083, BMI-0084, BMI-0081, BMI-0080, BMI-0074, BMI-0078, BMI-0079, BMI-0073, BME-0012, BMI-0001, BME-0052, BMI-0067, BMI-0020, BMI-0075, BMI-0068, BMI-0069, BMI-0023, BMI-0066, BMI-0065
Average Filament length (m)	783-457.33	BMI-0076, BMI-0074, BMI-0081, BMI-0083, BMI-0078, BMI-0080, BMI-0084, BMI-0073, BMI-0067, BMI-0066, BMI-0025, BMI-0007, BMI-0024, BMI-0020, BMI-0044, BMI-0079, BMI-0009, BMI-0065, BMI-0077, BMI-0023
Non breakable filament length (m)	673-360	BMI-0076, BMI-0081, BMI-0007, BMI-0074, BMI-0044, BMI-0043, BMI-0078, BMI-0066, BMI-0079, BMI-0068, BMI-0023, BMI-0025, BMI-0020, BMI-0004, BME-0005, BMI-0027, BMI-0009, BMI-0077, BME-0048, BMI-0024

Table 17. Top ranking 20 multivoltine SWGRs identified based on evaluation indices

Rank No.	Acc-No.	Fec (no.)	Hat (%)	LW (g)	Yield/10,000 larvae		PR (%)	SCW (g)	SSW (g)	SR %	AFL (m)	NBFL (m)	Mean E.I	No. of qualified traits
					By No.	By Wt (kg)								
1	BMI-0083	429	97.5	38.1	9312	14.45	91.0	1.479	0.277	18.9	619.7	229.0	**71.6**	8
2	BMI-0076	424	97.0	28.8	9388	11.32	92.0	1.238	0.238	19.3	783.0	673.0	**69.7**	9
3	BMI-0081	446	96.9	30.3	9456	11.39	92.4	1.234	0.206	17.1	648.7	533.3	**66.6**	9
4	BMI-0078	445	97.2	33.6	9420	11.65	91.7	1.233	0.193	15.9	618.3	428.0	**65.5**	9
5	BMI-0074	418	97.0	30.3	9512	11.27	92.6	1.166	0.182	16.0	658.7	482.0	**63.7**	10
6	BMI-0084	442	96.2	36.4	8976	12.95	88.2	1.434	0.268	18.9	580.3	248.0	**63.5**	7
7	BMI-0080	456	97.1	30.3	9304	11.33	90.6	1.244	0.207	16.8	586.0	343.3	**63.4**	9
8	BMI-0079	449	97.5	25.1	9520	9.69	93.3	1.026	0.159	15.7	472.3	414.7	**59.8**	11
9	BMI-0067	410	96.8	26.2	9500	10.68	93.9	1.135	0.164	14.7	531.7	352.7	**57.8**	11
10	BMI-0007	408	96.5	25.5	9768	10.18	95.6	1.018	0.134	13.3	508.7	495.3	**57.3**	10
11	BMI-0066	407	96.9	26.4	9368	10.36	91.6	1.124	0.161	14.5	528.3	424.7	**56.6**	9
12	BMI-0024	406	97.0	24.4	9560	10.34	94.5	1.083	0.139	13.0	492.3	360.0	**55.8**	10
13	BMI-0073	396	96.6	25.5	9456	9.90	92.8	1.080	0.168	15.7	579.0	290.7	**55.4**	8
14	BME-0048	386	96.8	26.4	9624	10.25	94.1	1.089	0.147	13.7	437.0	366.7	**55.2**	10
15	BMI-0082	456	97.0	26.5	9472	9.28	92.8	1.015	0.129	12.9	446.7	318.0	**54.8**	8
16	BMI-0025	404	96.6	23.6	9552	10.18	93.9	1.065	0.133	12.6	514.7	399.7	**54.3**	9
17	BMI-0065	402	97.1	23.7	9528	9.37	94.0	1.012	0.144	14.5	468.3	285.3	**53.9**	10
18	BMI-0009	392	96.0	24.5	9692	10.25	95.5	1.032	0.138	13.6	468.7	383.3	**53.6**	9
19	BMI-0077	438	96.6	25.1	9464	9.18	93.2	0.966	0.129	13.5	463.0	369.3	**53.2**	6
20	BMI-0023	413	96.7	20.4	9516	9.29	93.1	0.971	0.139	14.6	457.3	404.7	**52.8**	8

b) Evaluation of bivoltine SWGRs

The 383 bivoltine silkworm genetic resources were evaluated in three conservation batches during the year. Variability statistics analysis of the data generated for 14 important quantitative traits is presented in Table 18**.** The data indicates that there is wide genetic diversity among the bivoltine accessions by exhibiting highest coefficient of variation (CV%) for most of the traits like non-breakable filament length (23.1%) followed by shell weight (15.6%), fecundity (15.5%), average filament length (15.3%), yield per 10000 larvae by weight (13.3%), weight of 10 grown larvae (12.2%), V age larval duration (11.7), single cocoon weight (11.4%), filament size (11.3%) and shell ratio (8.8%). The other characters such as hatching (%), total larval duration, yield per 10000 larvae by number and pupation rate did not show much variation in CV% indicating the stabilized nature of genotypes to the rearing environment. The analysed data for the economically important traits like highest pupation rate recorded in BBI-0405 (99.4 %), single cocoon weight in BB-0133 (1.985 g),

single shell weight in BBI-0389 (0.392 g), shell ratio in BBI-0358 (22.7%), average filament length in BBI-0389 (1310 m) and non-breakable filament length in BBI-0368 (1209 m).

Table 18. Economic trait-wise range of variability in bivoltine SWGRs

Parameters	Avg	Min.	Max.	SD	SE	CV %
Fecundity (no.)	365.0	171.0	493.0	56.72	2.92	15.54
Haching (%)	95.4	78.7	98.9	2.39	0.12	2.50
Wt. of 10 grown larvae (g)	38.6	20.1	50.8	4.71	0.24	12.20
Total larval duration (h)	568.4	540.0	606.0	17.34	0.89	3.05
V age larval duration (h)	149.0	113.0	196.0	17.50	0.90	11.74
Yield/10,000 larvae by no.	9456	7000	9960	365.7	18.81	3.87
Yield/10,000 larvae by wt. (kg)	15.4	9.4	20.0	2.05	0.11	13.32
Pupation rate (%)	94.0	70.0	99.4	3.42	0.18	3.63
Single cocoon wt (g)	1.538	0.896	1.985	0.18	0.01	11.44
Single shell wt (g)	0.279	0.116	0.392	0.04	0.00	15.60
Single shell ratio (%)	18.3	10.9	22.7	1.61	0.08	8.84
Average filament length (m)	869.9	276	1310	132.8	6.83	15.26
Non-breakable filament length (m)	747.4	63	1209	172.4	8.87	23.07
Filament size (d)	2.53	1.77	3.62	0.29	0.01	11.30

Further, the details of individual trait-wise top performing 20 bivoltine SWGRs for various important traits along with the range values are presented in Table 19. Similarly, based on the evaluation indices (EI) and multiple trait analysis, the top ranking 20 bivoltine SWGRs have been selected and it can be seen that accession BBI-0389 ranked first with best performance for ten economic traits and a highest evaluation index value (EI) of 65.0 (Table 20).

Table 19. Top performing 20 bivoltine SWGRs for individual traits

Trait	Range	Accession No.
Fecundity (no.)	493-451	BBI-0095, BBI-0114, BBI-0357, BBI-0098, BBI-0116, BBI-0361, BBE-0169, BBI-0107, BBI-0337, BBI-0330, BBE-0155, BBE-0163, BBI-0134, BBI-0258, BBE-0156, BBI-0341, BBI-0097, BBE-0153, BBI-0139, BBE-0171
Haching (%)	98.92-97.92	BBI-0275, BBE-0231, BBE-0201, BBI-0358, BBI-0352, BBI-0290, BBE-0265, BBI-0302, BBE-0238, BBE-0232, BBE-0280, BBI-0379, BBI-0357, BBE-0197, BBI-0370, BBI-0373, BBE-0242, BBI-0235, BBE-0164, BBE-0166
Wt. of 10 grown larvae (g)	50.78-45.62	BBI-0350, BBI-0389, BBI-0344, BBI-0129, BBI-0349, BBE-0162, BBE-0154, BBI-0360, BBI-0127, BBI-0343, BBI-0121, BBE-0159, BBI-0381, BBI-0376, BBI-0382, BBI-0301, BBI-0367, BBE-0164, BBI-0348, BBI-0386
Yield/10,000 larvae by no.	9960-9860	BBE-0238, BBE-0260, BBI-0401, BBI-0254, BBI-0296, BBI-0405, BBI-0403, BBI-0394, BBI-0274, BBI-0374, BBI-0371, BBI-0271, BBE-0181, BBI-0347, BBE-0169, BBE-0261, BBE-0242, BBI-0095, BBI-0092, BBI-0123

Yield/10,000 larvae by wt. (kg)	20-18.5	BBI-0330, BBI-0116, BBE-0162, BBE-0154, BBI-0303, BBE-0164, BBE-0149, BBI-0301, BBI-0101, BBI-0100, BBI-0334, BBI-0290, BBI-0348, BBE-0150, BBI-0385, BBI-0371, BBI-0335, BBE-0332, BBI-0374, BBI-0121
Pupation rate (%)	99.4-97.8	BBI-0405, BBI-0374, BBI-0296, BBI-0371, BBI-0347, BBE-0169, BBI-0095, BBI-0092, BBI-0297, BBE-0238, BBI-0385, BBI-0123, BBE-0154, BBE-0150, BBE-0209, BBI-0099, BBE-0163, BBE-0149, BBE-0260, BBI-0125
Single cocoon wt (g)	1.98-1.85	BBI-0133, BBI-0344, BBI-0389, BBI-0382, BBE-0159, BBI-0341, BBE-0169, BBI-0138, BBI-0385, BBE-0154, BBI-0378, BBI-0383, BBI-0137, BBI-0338, BBI-0345, BBI-0376, BBI-0377, BBI-0347, BBI-0360, BBI-0299
Single shell wt (g)	0.39-0.354	BBI-0389, BBI-0366, BBI-0386, BBI-0344, BBI-0378, BBI-0385, BBI-0137, BBI-0364, BBI-0379, BBI-0338, BBI-0381, BBI-0324, BBI-0349, BBI-0374, BBI-0299, BBE-0244, BBI-0339, BBI-0343, BBI-0345, BBI-0368
Shell ratio (%)	22.67-20.748	BBI-0358, BBI-0359, BBE-0197, BBI-0388, BBI-0368, BBI-0324, BBE-0332, BBE-0244, BBI-0386, BBI-0327, BBI-0366, BBE-0262, BBI-0374, BBI-0325, BBI-0284, BBI-0081, BBE-0179, BBE-0264, BBI-0290, BBE-0182
Average Filament length (m)	1310-1083	BBI-0389, BBI-0378, BBI-0364, BBE-0153, BBI-0368, BBI-0138, BBI-0362, BBI-0379, BBI-0125, BBI-0127, BBE-0147, BBI-0388, BBI-0132, BBI-0324, BBE-0332, BBE-0150, BBI-0375, BBI-0085, BBI-0380, BBI-0172
Non-breakable filament length (m)	1209-991	BBI-0368, BBI-0389, BBI-0085, BBI-0362, BBI-0172, BBE-0186, BBI-0379, BBI-0342, BBI-0125, BBE-0038, BBI-0364, BBI-0135, BBI-0324, BBE-0332, BBE-0150, BBE-0164, BBI-0325, BBI-0350, BBE-0241, BBE-0231

Table 20. Top ranking 20 bivoltine SWGRs identified based on evaluation indices

Rank No.	Acc-No.	Fec (no.)	Hat (%)	LW (g)	Yield/10,000 larvae		PR (%)	SCW (g)	SSW (g)	SR (%)	AFL (m)	NBFL (m)	Mean EI	No. of qualified traits
					By No.	By Wt. (Kg)								
1	BBI-0389	378.5	95.1	49.0	9560	18.15	95.6	1.898	0.392	20.7	1310	1191	**65.0**	10
2	BBI-0379	433.5	98.1	45.2	9780	17.70	97.8	1.811	0.372	20.7	1177	1070	**64.8**	11
3	BBI-0374	421.0	96.3	43.2	9920	18.55	99.2	1.704	0.358	21.1	1077	828	**62.0**	11
4	BBI-0378	402.5	95.4	44.4	9480	17.55	94.8	1.866	0.378	20.4	1247	959	**61.6**	10
5	BBE-0154	379.0	96.3	47.1	9840	19.70	98.4	1.867	0.342	18.6	971	971	**61.3**	11
6	BBI-0364	367.0	95.5	43.6	9580	17.30	95.8	1.843	0.374	20.4	1224	1020	**61.3**	11
7	BBI-0368	403.5	93.8	42.7	9480	18.20	94.8	1.625	0.354	22.0	1209	1209	**61.2**	10
8	BBI-0382	427.0	97.6	46.1	9640	18.10	96.4	1.892	0.353	18.7	1055	811	**60.8**	11
9	BBI-0349	422.5	97.1	48.3	9700	17.55	97.0	1.848	0.365	19.9	865	865	**60.7**	10
10	BBI-0366	368.5	96.8	43.7	9640	16.85	96.4	1.822	0.384	21.2	1051	876	**60.6**	11
11	BBI-0347	369.5	97.4	44.7	9900	18.40	99.0	1.852	0.340	18.5	1038	865	**60.6**	11
12	BBI-0363	388.5	97.8	45.6	9640	18.00	96.4	1.729	0.346	20.3	1035	941	**60.5**	11
13	BBI-0129	393.5	97.2	48.7	9680	17.20	96.8	1.774	0.338	19.1	1060	964	**60.5**	11
14	BBI-0344	346.5	96.7	48.7	9680	17.40	96.8	1.923	0.380	19.8	960	800	**60.2**	10
15	BBI-0362	369.5	92.8	44.2	9680	17.40	96.8	1.753	0.352	20.3	1192	1084	**60.1**	10
16	BBE-0153	454.5	96.3	43.2	9600	17.75	96.0	1.701	0.322	19.0	1209	930	**60.0**	11
17	BBE-0169	475.5	95.2	45.1	9900	17.90	99.0	1.873	0.353	19.0	882	678	**59.9**	9
18	BBI-0360	421.0	97.2	47.0	9700	18.10	97.0	1.850	0.334	18.2	992	827	**59.8**	10
19	BBI-0375	349.5	96.7	43.5	9780	17.00	97.8	1.780	0.350	19.9	1107	851	**59.5**	10
20	BBE-0149	417.5	95.4	43.2	9840	19.30	98.4	1.694	0.324	19.4	1041	801	**59.4**	10

c). Evaluation of mutant SWGRs

Two evaluation rearings were conducted for 23 mutant SWGRs and the variability statistics on the important growth and reproductive traits is presented in Table 21. Statistical analysis of data revealed higher co-efficient of variation for single shell weight (26.6%), average filament length (25.8%), non-breakable filament length (25.2%), single cocoon weight (15.9%), yield per 10000 larvae by weight (15.6%), weight of 10 grown larvae (15.5%), filament size (14.8%), shell ratio (11.9%), fecundity (11.6%) and V age larval duration (11.1%). The other characters such as yield per 10000 larvae by number, pupation rate, hatching percentage and total larval duration did not show much variation in CV% indicating the stabilized nature of genotypes to the rearing environment. The analysed data for the economically important traits like highest pupation rate and shell ratio recorded in BBE-0391 (97.8% & 16.3%), highest single cocoon weight, average & non-breakable filament length in BBE-0392 (1.408 g; 790 m & 790 m) and highest single shell weight in BBE-0390 (0.223 g).

Table 21. Economic trait-wise variability in 23 mutant genetic stocks (Mean of 2 trials)

Parameters	Avg.	Min.	Max.	SD	SE	CV %
Fecundity (no.)	305.8	212.0	389.0	35.31	7.53	11.55
Hatching (%)	94.88	88.19	97.84	2.41	0.51	2.54
Wt. of 10 grown larvae (g)	25.61	16.99	34.86	3.96	0.84	15.46
Total larval duration (h)	550.1	531.0	570.0	12.27	2.62	2.23
V age larval duration (h)	110.1	91.0	130.0	12.27	2.62	11.14
Yield/10,000 larvae by no.	9339	8852	9780	197.5	42.11	2.12
Yield/10,000 larvae by wt.(kg)	10.79	7.68	13.82	1.69	0.36	15.64
Pupation rate (%)	93.39	88.52	97.80	1.98	0.42	2.12
Single cocoon wt.(g)	1.077	0.748	1.408	0.171	0.04	15.91
Single shell wt. (g)	0.140	0.085	0.223	0.037	0.01	26.56
Shell Ratio (%)	13.0	10.2	16.3	1.54	0.33	11.89
Average filament length (m)	459.2	300	790	118.4	25.24	25.78
Non-breakable filament length (m)	438.9	273	790	110.8	23.62	25.24
Filament size (d)	1.99	1.19	2.55	0.30	0.06	14.84

Further, based on the evaluation indices (EI) and multiple trait analysis, the ranking of 23 mutant SWGRs have been prepared and it can be seen that accession BBE-0392 ranked first with best performance for seven economic traits and a highest evaluation index value (EI) of 62.8 (Table 22).

Table 22. Ranking mutant SWGRs based on evaluation indices

Rank No.	Acc-No.	Fec (no.)	Hat (%)	LW (g)	Yield/10,000 larvae		PR (%)	SCW (g)	SSW (g)	SR (%)	AFL (m)	NBFL (m)	Mean E.I	No. of qualified traits
					By No.	By Wt. (Kg)								
1	BBE-0392	303	93.5	34.9	9220	13.8	92.2	1.408	0.220	15.8	790	790	**62.8**	7
2	BBE-0391	340	96.1	29.0	9780	13.2	97.8	1.260	0.203	16.3	447	447	**61.9**	10
3	BBE-0390	360	97.8	33.2	9010	13.6	90.1	1.402	0.223	16.1	676	563	**61.0**	9
4	BBE-0306	389	96.5	27.9	9280	12.9	92.8	1.292	0.177	13.9	598	543	**58.4**	9
5	BBE-0307	331	95.6	26.0	9430	11.7	94.3	1.166	0.152	13.2	518	518	**54.3**	11
6	BBE-0323	328	95.7	27.1	9370	12.1	93.7	1.212	0.156	13.1	505	505	**54.3**	11
7	BBE-0333	308	93.0	26.1	9490	10.7	94.9	1.126	0.160	14.4	568	516	**53.8**	9
8	BBE-0309	330	95.4	25.4	9650	10.0	96.5	1.012	0.124	12.5	474	474	**52.6**	6
9	BBE-0319	314	95.9	28.2	9410	11.5	94.1	1.138	0.143	12.6	442	340	**51.5**	8
10	BBE-0308	292	95.7	26.1	9460	10.0	94.6	1.055	0.127	12.2	436	436	**49.7**	4
11	BBE-0317	301	97.5	20.9	9508	8.5	95.1	0.848	0.100	11.8	578	526	**48.9**	5
12	BBE-0311	312	94.7	26.0	9300	10.3	93.0	1.077	0.133	12.4	410	410	**48.4**	2
13	BBE-0331	278	96.0	22.0	9490	9.2	94.9	0.926	0.126	13.7	415	415	**48.1**	4
14	BBE-0315	324	97.0	25.4	9340	10.3	93.4	1.012	0.113	11.3	371	371	**47.7**	4
15	BBE-0310	303	90.1	25.8	9430	12.2	94.3	1.083	0.132	12.2	323	323	**47.2**	5
16	BBE-0314	272	95.6	23.8	9390	10.0	93.9	0.986	0.124	12.7	385	350	**46.7**	3
17	BBE-0321	281	97.6	25.1	9120	10.4	91.2	0.985	0.120	12.4	420	420	**46.3**	1
18	BBE-0322	310	96.4	22.3	9250	8.8	92.5	0.932	0.124	13.4	388	388	**46.1**	3
19	BBE-0320	292	92.4	27.9	8852	11.0	88.5	1.157	0.155	13.5	405	405	**45.3**	5
20	BBE-0313	268	88.2	26.1	9238	11.9	92.4	1.129	0.129	11.6	430	430	**45.1**	3
21	BBE-0316	312	92.7	24.1	9240	10.4	92.4	1.015	0.102	10.2	300	273	**42.3**	1
21	BBE-0318	274	92.9	17.0	9310	8.6	93.1	0.748	0.085	11.5	341	310	**39.0**	0
23	BBE-0312	212	96.0	19.0	9230	7.7	92.3	0.802	0.093	11.7	341	341	**38.7**	1

III. Estimation of inbreeding depression in SWGRs

The data compilation of all the SWGRs since introduction to gene bank i.e, MV - 123 generations (1995-2021); BV – 27 generations (1995-2021) and mutants 27 generations (2002-2021 is under progress for phase-wise estimation of inbreeding depression (5 year time period) as per the suggestion of Research Advisory Committee. Upon data completion, a biometrician will be consulted for suitable analysis for estimation/calculation of inbreeding depression. Based on the Inbreeding depression, if any, adoption of corrective measures will be taken up by rejuvenating the respective accessions either through 'settling rearing' i.e. rearing the accessions at the original collection centre or by collecting dfls of same set of accessions from the safety back up at the original

collection centre and rearing. The selection breeding methods will also be employed if found necessary for improving the modified traits.

IV. Conservation of SWGRs

As per the SOP established for the silkworm germplasm conservation, the bivoltine accessions were conserved by rearing once, the mutant accessions by rearing twice and multivoltine silkworm accessions by rearing five times during the year. From each crop, after cocoon harvesting, de-flossing and assessment, accession-wise seed cocoons were selected for progeny layings preparation based on the cocoon shape, uniformity and conforming of racial characters. During the year, a total of 46,345 dfls comprising 20,878 dfls of multivoltine, 22,230 dfls of bivoltine and 3,227 dfls of mutants were produced and conserved. The details of seed cocoon generation, dfls production and conservation are given in Table 23. The multivoltine dfls 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 bivoltine egg layings were preserved under 10 months hibernation schedule with backup under 12 month hibernation schedule. The mutant genetic stocks were conserved under 6 months hibernation schedule with a back-up under 8 months hibernation schedule. All the 489 SWGRs were maintained true to type on par with the catalogue data without any genetic loss and ensuring disease freeness.

Table 23. Seed cocoon generation, egg production and conservation during 2020-21

Crop No.	Germplasm	Season	No. of good cocoon produced	No. dfls production and conservation
1	Multivoltine	Apr-May 2020	19222	3986
2		Jun-Jul 2020	38769	4370
3		Sep-Oct 2020	37510	4224
4		Nov-Dec 2020	37324	4192
5		Feb-Mar 2021	36955	4106
Total			**1,69,780**	**20,878**
1	Bivoltine	June July 2020	50275	7007
2		Sep-Oct 2020	62533	7986
3		Jan-Feb 2021	57916	7237
Total			**1,70,724**	**22,230**
1	Mutant	June July 2020	10297	1682
2		Jan-Feb 2021	9925	1555
Total			**20,222**	**3,237**
Grand Total			**3,60,726**	**46,345**

V. Supply and Utilization of SWGRs

During the year, 16 multivoltine (59 dfls) and 3 bivoltine (14 dfls) silkworm germplasm resources have been supplied to 4 different research institutes as per their indents for research activities. Besides, under a collaborative research project-AIE-06002MI, 10 bivoltine silkworm germplasm resources (90 dfls) were supplied to 3 research institutes in order to conduct evaluation trials. (Table 24).

Table 24. Supply of silkworm genetic resources

Sl.No.	Name of the Indenter	No. of SWGRs	Type of SWGRs (MV/BV/Mut)	No. of Dfls	Purpose
1	SSTL, CSB, Kodathi, Bengaluru, Karnataka	10	MV	47	Research & stock maintenance
2	RSRS, CSB, Sahaspur, Dehradun, Uttarakhand	1	BV	7	,,
3	VNMKV, Parbhani, Maharashtra	6	MV	12	,,
		1	BV	2	,,
4	RSRS, Jammu, CSB Jammu & Kashmir	1	BV	5	,,
		10	BV	30	Collab. research project-AIE-06002MI
5	REC, CSB, Chitradurga, Karnataka	10	BV	30	,,
6	CSRTI, CSB, Berhampore, West Bengal	10	BV	30	,,
	Total			**163**	

2. 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, Ritwika Sur Chaudhuri & Jameela Khatoon*
SBRL, Kodathi: *K.S. Tulsi Naik;* **REC, Chitradurga (CSRTI, Mysuru):***Y. Srinivasulu*
CSRTI, Berhampore: *N. Chandrakanth & Raviraj*
RSRS, Jammu-CSRTI, Pampore: *Sardar Singh & S. Murali*

Objectives:

1) To screen and select bivoltine germplasm resources with presence of markers linked to thermo-tolerance.
2) To evaluate selected bivoltine germplasm resources against abiotic stress and identify suitable bivoltine breeds to target selected hot spots.

Progress:

Central Sericultural Germplasm Resources Centre (CSGRC), Hosur has screened 40 bivoltine silkworm germplasm resources for presence of markers linked to thermo-tolerance. Among the screened genetic resources, 10 bivoltine silkworm accessions with markers linked to thermo-tolerance and better economic traits viz., BBI-0086, BBE-0184, BBI-0301 and BBI-0339 (Oval accessions) and BBI-0044, BBI-0334, BBI-0336, BBI-0338, BBI-0343 & BBI-0358 (Dumbbell accessions) were selected. These accessions were utilized for hotspot evaluation at CSGRC, Hosur, REC Chitradurga

& RSRS Jammu (summer trials) and at CSGRC, Hosur, CSR&TI, Berhampore and RSRS Jammu (autumn trials). The centre-wise performance of the genetic resources during summer and autumn seasons are as follows:

Summer season:

A. CSGRC, Hosur:

The rearing of 10 bivoltine accessions was conducted during May-June'2020. Among the bivoltine accessions tested, the oval accessions BBI-0301 (97.07%) and BBI-339 (95.73%) recorded higher survival rate (Table-25).

In case of dumbbell accessions, BBI-0334, BBI-0343 and BBI-0358 recorded 96.93%, 96.80% & 96.80% survival rate respectively (Table-26).

When the data was evaluated for multiple trait evaluation index, BBI-339 [oval] recorded higher value of E.I. 55.82 with high single cocoon wt. (1.798g), single shell wt. (0.345g), average filament length (961.56 m.) with less filament size (1.93d). Similarly, BBI-0338 [dumbbell] recorded high EI (55.55) and performed better by recording high single cocoon wt. (1.755g) high single shell wt.(0.357g), average filament length (919.5 m), reelability (94.72%), raw silk (15.85%) and less renditta (6.35 kg). Based on the 1st trial performance, BBI-0339 followed by BBI-0338 were found to be promising accessions.

B. REC, Chitradurga:

Ten bivoltine accessions were evaluated during summer season and the rearing performance results are depicted in Table 27 and 28.

Among the oval bivoltine accessions, though BBI-0290 (control) recorded high survival rate (96.50%), the overall performance of the accession BBE-0184 was found better with 94.00% survival rate and higher single shell wt. (0.338g), reelability (85.36%), raw silk percentage (17.15%) and lesser renditta (7.29kg) with high evaluation index value (57.53).

Among dumbbell accessions, though BBI-0291 (control) recorded higher survival rate of 97.17 %, the accessions BBI-0343 recorded high EI value of 51.38 with high single cocoon wt. (1.760g), single shell wt. (0.365g) and reelability (81.22%). This evaluation trial conducted at Chitradurga, the accession BBE-0184 [oval] followed by BBI-0343 [dumbbell] are found to be promising.

C. RSRS, Jammu:

One summer crop during June-July'2020 and one autumn crop during Aug-Sept'2020 were taken up at RSRS, Jammu. But the centre lost both the crops due to fluctuations in temperature, humidity and disease incidence.

Autumn Trial:

A. CSGRC, Hosur:

The trial was taken up during Oct-Nov'2020 with the shortlisted 10 bivoltine accessions along with two controls. Among the oval accessions tested, control BBI-0290 (94.53%), BBI-0339 (93.47%) and BBI-0086 (92.13%) recorded higher survival rate. The rearing and reeling data analysed with multiple trait evaluation index revealed that, the accession BBI-0339 [oval] recorded higher EI value (57.63) with better performance for economic parameters, viz. single cocoon weight (1.718 g), single shell weight (0.348 g) and average filament length (861.50 m) (Table-29).

Among the dumbbell accessions, though BBI-0336 recorded higher survival rate of 93.60%, the accession BBI-0358 recorded high E.I. value (55.61) along with better performance for economic parameters viz. single shell weight (0.366g), average filament length (880.52 m.), reelability (78.78%), raw silk percentage (15.92%) with lesser renditta (6.32 kg) (Table-30).

B. CSR&TI, Berhampore:

One trial rearing was conducted during Nov-Dec, 2020 with 8 bivoltine accessions along with 2 local control breeds BBI-0371 and BBI-0372. Selected silkworm breeds were reared at suitable temperatures and humidity along with the control breeds. The data on important rearing and reeling parameters were collected and analysed. The selected bivoltine breeds performed better than the controls in terms of survival rate as well as cocoon traits. Among the breeds, BBI-301 (68.67%) exhibited highest survival followed by BBI-338 (67.87%) and BBI-343 (65%). Higher cocoon weight (1.407 g) and shell weight (0.248 g) were also recorded by BBI-301. The data analysed with multiple trait E.I recorded the BBI-301 with high E.I of 58.20 followed by BBI-0338 (56.60) and BBI-0343 (55.63). Based on the first trial conducted, BBI-0301 and BBI-0338 were found to be better performing accessions (Table-31).

Table: 25 Rearing performance of oval bivoltine accessions during summer (May-June'2020) at CSGRC, Hosur

Temp (°C): 22.00 – 36.00; RH (%): 53.00-85.00

Sl. No	BV Accns	Rearing parameters							Reeling parameters					Avg EI
		LW_10 (g)	ERR/10,000 larvae		Pupation rate (%)	SCW (g)	SSW (g)	SR (%)	AFL (m)	Fil. Size (d)	Reelability (%)	Renditta (kg)	Raw silk (%)	
			By no.	By wt. (kg)										
1	BBI-0086	35.30	9373	13.10	93.73	1.587	0.289	18.28	792.8	2.32	93.04	7.70	13.08	48.85
2	BBE-0184	40.01	9133	12.57	91.33	1.430	0.240	17.12	795.2	3.08	89.54	5.80	17.34	46.18
3	BBI-0301	40.72	9707	13.80	97.07	1.596	0.285	18.07	759.7	2.67	84.04	7.36	13.67	51.75
4	BBI-0339	35.26	9573	13.47	95.73	1.798	0.345	19.32	961.5	1.93	90.69	7.97	12.63	55.82
5	BBI-0290 (c)	41.50	9240	12.90	92.40	1.536	0.298	19.58	747.1	2.70	81.49	7.48	13.38	47.41
Average		38.56	9405	13.17	94.05	1.589	0.291	18.47	811	2.54	87.76	7.26	14.02	
SD		3.04	235.4	0.48	2.35	0.13	0.04	1.00	86.52	0.43	4.82	0.85	1.90	
CV %		7.88	2.50	3.65	2.50	8.43	12.85	5.39	10.66	17.10	5.49	11.7	13.52	

Table: 26 Rearing performance of dumbbell bivoltine accessions during summer (May-June'2020) at CSGRC, Hosur

Temp (°C): 22.00 – 36.00; RH (%): 53.00-85.00

Sl. No	BV Accns	Rearing parameters							Reeling parameters					Avg EI
		LW_10 (g)	ERR/10,000 larvae		Pupation rate (%)	SCW (g)	SSW (g)	SR (%)	AFL (m)	Fil. Size (d)	Reelability (%)	Renditta (kg)	Raw silk (%)	
			By no.	By wt. (kg)										
1	BBI-0044	37.39	8840	12.77	88.40	1.015	0.173	17.09	886.5	2.37	93.75	7.09	14.21	41.72
2	BBI-0334	33.52	9693	13.33	96.93	1.722	0.330	19.38	847.1	2.52	92.98	6.80	14.80	51.17
3	BBI-0336	35.27	9587	13.23	95.87	1.868	0.331	17.74	885.1	2.67	90.38	6.37	15.81	50.80
4	BBI-0338	41.16	9560	13.37	95.60	1.755	0.357	20.43	919.5	2.69	94.72	6.35	15.85	55.55
5	BBI-0343	35.36	9680	13.70	96.80	1.789	0.333	18.69	844.8	2.44	92.51	7.93	12.69	50.03
6	BBI-0358	32.49	9680	13.90	96.80	1.841	0.345	18.86	921.4	2.34	94.34	6.72	14.96	55.40
7	BBI-0291 (c)	41.36	9693	13.57	96.93	1.516	0.274	18.22	837.4	2.60	66.62	8.30	12.05	45.33
Average		*36.65*	*9533*	*13.41*	*95.33*	*1.644*	*0.306*	*18.63*	*877*	*2.52*	*89.33*	*7.08*	*14.34*	
SD		*3.506*	*310.4*	*0.365*	*3.105*	*0.300*	*0.064*	*1.095*	*35.19*	*0.14*	*10.12*	*0.76*	*1.47*	
CV %		*9.566*	*3.257*	*2.723*	*3.257*	*18.25*	*20.985*	*5.876*	*4.011*	*5.59*	*11.32*	*10.7*	*10.27*	

Table: 27 Rearing performance of oval bivoltine accessions during summer (May-June'2020) at REC Chitradurga

Temp (°C): 24.00 –36.00 ; RH (%): 45.00-61.00

Sl. No	BV Accns	Rearing parameters							Reeling parameters					Avg EI
		LW_10 (g)	ERR/10,000 larvae		Pupation rate (%)	SCW (g)	SSW (g)	SR (%)	AFL (m)	Fil. size (d)	Reelability (%)	Ren-ditta (kg)	Raw silk (%)	
			By no.	By wt. (kg)										
1	BBI-0086	34.78	9200	14.47	92.00	1.198	0.196	16.39	740.3	2.59	83.21	7.63	15.60	42.56
2	BBE-0184	37.23	9400	18.10	94.00	1.685	0.338	20.03	749.2	2.62	85.36	7.29	17.15	57.53
3	BBI-0301	39.13	9167	17.00	91.67	1.750	0.294	16.84	740.2	2.59	83.54	7.42	15.47	49.31
4	BBI-0339	32.26	9200	16.10	92.00	1.610	0.309	19.21	756.8	2.53	83.49	7.77	14.38	48.31
5	BBI-290(c)	43.55	9650	15.25	96.50	1.630	0.331	20.28	762.1	2.72	81.98	7.55	14.38	52.29
Average		*37.39*	*9323*	*16.18*	*92.73*	*1.575*	*0.294*	*18.55*	*749.7*	*2.61*	*83.51*	*7.53*	*15.39*	
SD		*4.30*	*204.6*	*1.43*	*1.16*	*0.22*	*0.06*	*1.82*	*9.79*	*0.07*	*1.21*	*0.19*	*1.14*	
CV %		*11.51*	*2.20*	*8.82*	*1.25*	*13.81*	*19.52*	*9.79*	*1.31*	*2.67*	*1.45*	*2.48*	*7.40*	

Table: 28 Rearing performance of dumbbell bivoltine accessions during summer (May-June'2020) at REC, Chitradurga

Temp (°C): 24.00 –36.00 ; RH (%): 45.00-61.00

Sl. No	BV Accns	Rearing parameters							Reeling parameters					Avg El
		LW_10 (g)	ERR/10,000 larvae		Pupation rate (%)	SCW (g)	SSW (g)	SR (%)	AFL (m)	Fil. size (d)	Reelability (%)	Renditta (kg)	Raw silk (%)	
			By no.	By wt. (kg)										
1	BBI-0044	33.46	9533	13.05	95.33	1.290	0.240	18.63	773.0	2.63	82.46	7.49	16.18	49.74
2	BBI-0334	36.09	9400	15.83	94.00	1.583	0.282	17.81	740.5	2.60	82.92	7.42	13.81	50.78
3	BBI-0336	33.70	9167	14.60	91.67	1.460	0.276	18.93	751.4	2.54	82.32	7.69	14.09	48.76
4	BBI-0338	33.40	9500	15.00	95.00	1.500	0.317	21.16	719.1	2.69	81.33	7.48	14.12	50.81
5	BBI-0343	35.58	9100	17.63	91.00	1.760	0.365	20.72	726.2	2.65	81.22	8.30	14.50	51.38
Average		*35.291*	*9360*	*15.116*	*93.26*	*1.526*	*0.297*	*19.44*	*752*	*2.62*	*80.32*	*7.82*	*14.27*	
SD		*3.24*	*241.9*	*1.470*	*1.961*	*0.163*	*0.042*	*1.165*	*29.39*	*0.049*	*4.766*	*0.42*	*1.179*	
CV %		*9.197*	*2.585*	*9.725*	*2.102*	*10.66*	*14.028*	*5.993*	*3.909*	*1.862*	*5.934*	*5.45*	*8.259*	

Table: 29 Rearing performance of oval bivoltine accessions during Oct-Nov'2020 at CSGRC, Hosur

Temp (°C): 20.00-36.00; RH (%): 54.00-85.00

Sl. No	BV Accns	Rearing parameters								Reeling parameters				Avg El
		LW_10 (g)	ERR/10,000 larvae		Pupation rate (%)	SCW (g)	SSW (g)	SR (%)	AFL (m)	Fil. Size (d)	Reelability (%)	Renditta (kg)	Raw silk (%)	
			By no.	By wt. (kg)										
1	BBI-0086	40.96	9213	13.37	92.13	1.533	0.292	19.05	788.6	2.34	61.53	7.88	12.81	47.68
2	BBE-0184	40.01	8077	11.43	80.77	1.580	0.288	18.23	865.0	2.62	78.67	6.38	15.80	46.63
3	BBI-0301	41.65	8773	12.77	87.73	1.800	0.317	17.61	652.9	4.35	45.77	6.35	15.88	47.31
4	BBI-0339	43.75	9347	14.03	93.47	1.718	0.348	20.26	861.5	2.76	66.8	6.78	14.86	57.63
5	BBI-0290(c)	41.77	9453	13.10	94.53	1.540	0.297	19.50	768.2	2.85	85.65	7.39	13.42	50.76
Average		*41.63*	*8973*	*12.94*	*89.73*	*1.634*	*0.308*	*18.93*	*787*	*2.98*	*67.68*	*6.96*	*14.55*	
SD		*1.377*	*563.6*	*0.963*	*5.636*	*0.119*	*0.025*	*1.042*	*86.54*	*0.79*	*15.51*	*0.67*	*1.39*	
CV %		*3.309*	*6.282*	*7.440*	*6.282*	*7.277*	*8.037*	*5.503*	*10.99*	*26.39*	*22.92*	*9.57*	*9.55*	

Table: 30 Rearing performance of dumbbell bivoltine accessions during Oct-Nov'2020 at CSGRC, Hosur

Temp (°C): 20.00-36.00; RH (%): 54.00-85.00

Sl. No	BV Accns	Rearing parameters							Reeling parameters					Avg El
		LW_10 (g)	ERR/10,000 larvae		Pupation rate (%)	SCW (g)	SSW (g)	SR (%)	AFL (m)	Fil. Size (d)	Reelability (%)	Renditta (kg)	Raw silk (%)	
			By no.	By wt. (kg)										
1	BBI-0044	39.68	7860	11.40	78.60	1.534	0.291	18.97	841.8	2.52	75.60	6.57	15.31	44.24
2	BBI-0334	37.74	9227	13.07	92.27	1.511	0.308	20.38	747.1	2.85	77.64	6.57	15.33	49.11
3	BBI-0336	44.43	9360	14.27	93.60	1.716	0.333	19.41	730.3	2.99	51.64	7.78	12.95	49.05
4	BBI-0338	42.49	9213	13.73	92.13	1.890	0.368	19.47	893.5	1.93	76.82	10.10	9.98	53.32
5	BBI-0343	45.48	9000	13.47	90.00	1.906	0.351	18.42	840.9	2.63	60.46	8.28	12.17	50.36
6	BBI-0358	40.68	9196	13.57	91.96	1.743	0.366	21.00	880.5	2.86	78.78	6.32	15.92	55.61
7	BBI-0291(c)	42.47	9453	13.07	94.53	1.506	0.279	18.81	855.6	2.63	70.35	8.26	12.45	48.33
Average		*41.853*	*9044*	*13.226*	*90.44*	*1.687*	*0.328*	*19.49*	*827.0*	*2.630*	*70.184*	*7.697*	*13.44*	
SD		*2.696*	*541.0*	*0.904*	*5.410*	*0.173*	*0.036*	*0.909*	*63.56*	*0.350*	*10.339*	*1.346*	*2.161*	
CV %		*6.441*	*5.982*	*6.836*	*5.982*	*10.27*	*10.970*	*4.662*	*7.684*	*13.29*	*14.731*	*17.49*	*16.07*	

Table: 31 Rearing performance of Bivoltine accessions during autumn

(Oct-Nov'2020**) at CSR&TI, Berhampore** Temp: (°C) 22.00-29.00; RH (%):57.00-92.00

Sl. No	BV Accns	Rearing parameters							Reeling parameters					Avg El
		LW_10 (g)	ERR/10,000 larvae		Pupation rate (%)	SCW (g)	SSW (g)	SR (%)	AFL (m)	Fil. Size (d)	Reelability (%)	Ren-ditta (kg)	Raw silk (%)	
			By no.	By wt. (kg)										
1	BBI-0086	26.14	5347	6.37	53.47	1.234	0.204	16.75	662	2.34	72.54	7.84	12.76	52.26
2	BBE-0184	22.74	1533	1.83	15.33	1.251	0.212	17.19	645	2.41	73.12	7.25	11.13	45.14
3	BBI-0301	30.04	6867	8.43	68.67	1.407	0.248	17.67	596	2.29	75.56	8.28	12.08	58.20
4	BBI-0334	27.36	5040	6.35	50.40	1.242	0.233	18.93	678	2.44	68.44	7.88	12.68	52.52
5	BBI-0336	27.30	4467	5.87	44.67	1.191	0.229	19.40	581	2.47	67.95	9.47	10.56	44.88
6	BBI-0338	31.51	6787	8.93	67.87	1.266	0.234	18.66	627	2.37	79.55	8.48	11.80	56.60
7	BBI-0339	16.61	1293	1.37	12.93	1.247	0.238	19.16	572	2.39	69.12	7.21	11.21	44.30
8	BBI-0343	28.96	6500	7.53	60.93	1.317	0.219	16.93	736	2.36	77.66	8.50	11.77	55.63
9	BBI-0371(c)	25.39	4467	5.17	44.67	1.242	0.196	15.75	636	2.33	75.51	8.81	11.35	47.65
10	BBI-0372(c)	20.32	4300	5.15	43.00	1.120	0.180	16.07	594	2.40	74.98	8.77	11.25	42.82
Average		*25.64*	*4660*	*5.70*	*46.19*	*1.25*	*0.22*	*17.65*	*632.7*	*2.38*	*73.44*	*8.25*	*11.66*	
SD		*4.58*	*1964*	*2.50*	*19.25*	*0.07*	*0.02*	*1.32*	*50.53*	*0.05*	*3.96*	*0.71*	*0.70*	
CV%		*17.88*	*42.15*	*43.94*	*41.68*	*5.96*	*9.67*	*7.47*	*7.99*	*2.25*	*5.39*	*8.64*	*6.01*	

New Projects initiated during 2020-21

AIT 06006 MI: Marker assisted screening to identify silkworm genetic resources tolerant to BmNPV and BmBDV (November, 2020 to October, 2023)

Objectives:

To identify silkworm resources tolerant to BmNPV and BmBDV using molecular markers

2. To quantify the level of resistance/tolerance among selected tolerant genotypes.

3. To validate disease tolerance of the accessions through bioassay studies.

Progress:

Genomic DNA isolation of 1,440 samples of 12 multivoltine and 60 bivoltine accessions collected from III batch was carried out. PCR amplification of 12 multivoltine silkworm accessions with primers specific to BmBDV, viz. aa-trans1 and aa-trans3, was carried out. Out of 12 accessions, 2 accessions were identified that showed presence of resistant allele (~1200 bp), and remaining 10 accessions showed presence of only the susceptible allele (~800 bp).

AIG-06007 MI Molecular characterization and assessment of genetic diversity in silkworm (*Bombyx mori* L) (March, 2021 to February, 2024)

Objectives:

1. To characterize silkworm genetic resources based on SNP marker analysis through ddRADseq approach for identification of duplicates.
2. Whole genome sequencing (WGS) of indigenous multivoltine silkworm races, Pure Mysore (PM) and Nistari for reference genome and identification of hypervariable SSRs.
3. Genetic diversity analysis of silkworm germplasm using SNP/ SSR markers
4. To update and enrich the silkworm genetic resource database based on molecular characterization.

Progress:

The project was initiated in March, 2021. Pupal samples of multivoltine accessions selected from ddRAD sequencing were collected.

6. TRAINING PROGRAMMES

Training attended by the scientists:

Name of scientist	Date	Place	Training programme
Dr. Lokesh, G, Sci- D	21-25th September 2020	Centre for Organization Development (COD), Hyderabad.	On-line Training Program on "Emotional Intelligence at Workplace for Scientists/ Technologists"

Technical audit

Sl No.	Scientist deputed for audit	Date	CSB Centre
1	Dr. G. Lokesh, Sc-D	09.11.2020-13.11.2020	SSPC, Bengaluru
2	-do-	16.11.2020-20.11.2020	SSPC, Vijaypura
3	-do-	23.11.2020-27.11.2020	SSPC, Ramanagaram

7. PUBLICATIONS

Research papers

1. G. Lokesh, M. Maheswari, Ritwika Sur Chaudhuri, D.S. Somaprakash, S. Sekar and R.K. Mishra (2020) Evaluation of Mutant Silkworm Genetic Resources for Important Morphological and Quantitative Characters, *Asian Journal of Applied Sciences*, 13(2), 84-93. ISSN 1996-3343.

2. G. Thanavendan, G. Lokesh and Geetha N. Murthy (2020). Explorative Survey of Wild Mulberry Silkworm Genetic Resources. *Singapore Journal of Scientific Research* 10:28-34. **ISSN**: 1205-2421.

3. Jameela Khatoon, Subhas V. Naik, Jagannathan and Benkappa Hubballi (2020) Silk Union (backed) fabrics – A promising product for the silk apparel sector, Part I: Fabric hand of silk union (backed) fabrics, *Sericologia*,60 (1 & 2):29-37, ISSN 0250-3980.

4. Mondal R, Das P. (2020) Data-mining Bioinformatics: Suggesting Arabidopsis thaliana L-type lectin receptor kinase IX.2 (LecRK-IX.2) modulates metabolites and abiotic stress responses. *Plant Signaling & Behavior*. ISSN: 1559-2316.

5. Mondal R, Das P. (2020) Novel aspects of Cell Division Cycle and Apoptosis Regulator 1 (CCAR1) protein in *Morus notabilis*: an *in silico* approach. *Plant Signaling & Behavior*. 23:1795396. ISSN: 1559-2316.

6. Kumar A, Medhi K, Fagodiya RK, Subrahmanyam G, Mondal R, Raja P, Malyan SK, Gupta DK, Gupta CK, Pathak H. (2020) Molecular and ecological perspectives of nitrous oxide producing microbial communities in agro-ecosystems. *Reviews in Environmental Science and Bio/Technology*. 16:1-34. ISSN: 1569-1705.

7. Kumar A, MMS CP, Chaturvedi AK, Shabnam AA, Subrahmanyam G, Mondal R, Gupta DK, Malyan SK, S Kumar S, A Khan S, Yadav KK. (2020) Lead Toxicity: Health Hazards, Influence on Food Chain, and Sustainable Remediation Approaches. *International Journal of Environmental Research and Public Health*. 17(7):2179. ISSN: 1660-4601.

8. Ritwika Sur Chaudhuri, Subramanya Gopal, B. T. Sreenivasa and C. M. Kishor Kumar (2021) Adult lifespan variation in silkworm, *Bombyx mori* L. and its effect on silk productivity. *Munis Entomology & Zoology* 16 (2): 1027-1032. ISSN: 1306-3022.

8. PARTICIPATION IN CONFERENCE / WEBINAR / WORKSHOP

1. Webinar on '**DNA-protein interactions: tools of the trade**' held on 23rd September, 2020 conducted by Genespy Research Services, Mysuru. (Dr. M.C. Thriveni, Sc-B, Sri. Raju Mondal, Sc-B)

2. E- Conference on "**Multidisciplinary approaches for plant disease management in achieving sustainability in agriculture**" held during 6 to 9th October 2020 organized by Department of Plant Pathology, College of Horticulture, Bengaluru. (Dr. G. Thanavendan, Sc-C)

3. Webinar on "**Enterprise Opportunities in Mulberry Silkworm Seed Sector**" held on 12th November, 2020 conducted by DOS in Sericultural Sciences, University of Mysore, Mysuru. (Dr. Ritwika Sur Chuadhuri, Sc-C)

4. International webinar on "**Seri-startups for sustainable development**" held on 20th -21st November, 2020 conducted by Department of Biosciences & Sericulture, Sri Padmavati Mahila Visvavidyalayam, Tirupati (Dr. G. Lokesh, Sc-D)

5. Brainstorming workshop on "**Seri-Biotechnology research in CSB**" held on 22nd December 2020 conducted by CSB, Bengaluru. (Dr. G. Ravikumar, Sc-D, Dr. M. Maheswari, Sc-D, Dr.G. Lokesh, Sc-D, Dr. Ritwika Sur Chaudhuri, Sc-C, Dr. M.C. Thriveni, Sc-B)

6. Brainstorming workshop on "**Host Plant Improvement"** held on 5th January, 2021 conducted by CSR&TI, Berhampore. (Dr. G. Ravikumar, Sc-D, Dr. G. Thanavendan, Sc-C, Dr. M.C. Thriveni, Sc-B, Sri. Raju Mondal, Sc-B)

7. Brainstorming workshop on "**Post Cocoon Technology**" held on 19th January, 2021 conducted by CSTRI, Bengaluru. (Dr. Jameela Khaoon, Sc-D)

8. International webinar on "**Insect Systematics: Importance, Challenges and Way Forward**" held on 29 January, 2021 organised by ICAR-NBAIR, Bengaluru (Dr. G. Thanavendan, Sc-C)

9. Virtual Workshop on "**Technologies to enhance bivoltine silk production in India**" on 21st February, 2021 organised by CSR&TI, Mysuru. (Dr. G. Lokesh, Sc-D & Dr. Ritwika Sur Chaudhuri, Sc-C)

Technical reports

1. Thanavendan, G. (2021). Status report on Mulberry Field Gene bank (FGB) under *ex-situ* Conservation.

2. Thanavendan, G. & Kishor Kumar, C.M. (2021) Revision of sale price of mulberry and silkworm germplasm resources.

9. VISITORS

S.N	Date of visit	Name / Institution	Purpose	Nos.
1	24/09/2020	Shri. Shambhu Kailolikar, IAS, Principal Secretary, Handlooms, Handicrafts, Textiles & Khadi Department, Govt. of Tamil Nadu, Chennai.	To initiate the Sericulture Training Farmers meeting and Giving the Subsidy Materials to sericulture Farmers of Tamil Nadu.	1
2	24/09/2020	Smt. P. Srivenkatapriya, IAS-Director, Dept. of Sericulture, Govt. of Tamil Nadu Salem, Tamilnadu.	To Visit the Eri-SSPC and Sericultural Germplasm Centre	1
3	01/10/2020	Shri. T. Krishna, National Awardee, Palamaner- Sricuture Enterprenure, Chittoor District, Andhra Pradesh.	Sericulture Germplasm Institute visit	1
4	23/11/2020	Shri. N.H.Venkatesh Manager (Retd) Canara Bank, Bengaluru	To acquire knowledge of mulberry and silkworm germplasm	1
5	28/11/2020	Smt. M. Umashalini, Assitant Director, Agricultural Technology Management Agency (ATMA), Tiruppur, Tamil Nadu	Sericulture exposure visit for Sericulture Farmers of Tiruppur DOS, Tamil Nadu	42
6	19/01/2020	Shri.S. Yogesha and Shri. R. Muddegowda Central silk Board-Members, Bengaluru.	To visit the Germplasm of the Institute	2
7	03/02/2021	Dr.S. Manimegalai Assistant professor, FC&RI, TNAU, Mettupalayam.	Germplasm collections and Institute exposure visit	4
8	19/02/2021	Dr. T.G. Vinay, IAS-Director, Dept. of Sericulture, Govt. of Tamil Nadu, Salem, Tamilnadu.	To inaugurate the krishi mela functions and visit of Sericultural germplasm centre.	1
9	09/03/2021	Dr. K.P. Mohapatra, ARS, Principal Scientist, NBPGR-ICAR, PUSA, New Delhi.	To visit of NAGS-Mulberry and other crops of South India.	1
10	18/03/2021	Shri. K. Narayanan, Social activist, Babuji memorial Ashram, SRCM Rd, Manapakkam, Chennai, Tamil Nadu	Institute Visit and getting information about the Mulberry fruit plants.	1
11	22/03/2021	Smt. A. Vennila Mary, Asst. Professor, Agricultural Extension and Rural Sociology, Palar Agricultural College (TNAU), Tamil Nadu	RAWE - Sericultural Programme and Institute Exposure visit.	41
			TOTAL	**96**

10. COMPOSITION OF COMMITTEES

Research Advisory Committee

Dr. Chandish R. Ballal, Former Director & Chairperson, RAC ICAR-NBAIR (erst while PDBC) (ICAR) &\ Former Project Co-ordinator, AICRP on Biocontrol, House no.460, 2nd cross, 9th main, HAL II stage, Bengaluru-560 008	**Chairperson**
Dr. B.T. Sreenivasa, Director, Central Sericultural Germplasm Resources Centre, Hosur	**Member - Convener**
Dr. Anitha Kodaru, Principal Scientist, NBPGR, Regional Station, Rajendranagar, Hyderabad-500 030 (Telangana)	**Member**
Dr. Modhumita Dasgupta, Scientist F, Institute of Forest Genetics and Tree Breeding (ICFRE), Coimbatore- 641 002.	**Member**
Dr. Rajasekharan, P.E, Professor, ICAR-lndian lnstitute of Horticulture Research(llHR), No. 1 41, A6, Janapriya Greenwood, Somashetti Halli, Chikkabanavara Post, Bengaluru -560 090	**Member**
Dr. Manjunatha Gowda, Professor of Sericulture, University of Agricultural sciences, GKVK, Bengaluru- 560 065 (Karnataka)	**Member**
Dr. Ravindra Singh, Scientist-D (Rtd.), Central Silk Board	**Member**
Director (Tech), Central Silk Board, CSB Complex, Bengaluru-560 068	**Member**
SCIENTIST-D & Head, Research Coordination Section, Central Silk Board, Bengaluru-560 068	**Member**

Research Council

Director, Central Sericultural Germplasm Resources Centre, Hosur - 635 109	**Chairman**
Scientist-D, PMCE, Central Sericultural Germplasm Resources Centre, Hosur - 635 109	**Member – Convener**

Germplasm Registration Committee

Director (Tech.), Central Silk Board, Bangalore - 560 068	**Chairman**
Director, Central Sericultural Germplasm Resources Centre, Hosur	**Member – Convener**
Director, Central Sericultural Research and Training Institute, Mysuru	Member
Director, Central Tasar Research and Training Institute, Ranchi	Member
Director, Central Muga and Eri Research and Training Institute, Jorhat, Lahdoigarh, Assam.	Member

Germplasm Supply & Exchange Committee

Director (Tech.), Central Silk Board, Bangalore – 560 068	**Chairman**
Director, Central Sericultural Germplasm Resources Centre, Hosur	**Member – Convener**
Scientist-D&Head, Mulberry Division, CSGRC, Hosur	Member
Scientist-D & Head, Silkworm Division, CSGRC, Hosur	Member

11. राजभाषा कार्यान्वयन / Official language implementation:

राजभाषा कार्यान्वयन के तहत एरीएसएसपीसी ,एससएपीसी एवं शीतागार भंडार ,होसूर के साथ चार कार्यशालाओं का आयोजन किया गया। विवरण निम्नानुसार है:

क्रम सं.	दिनांक	विषय	वक्ता
1.	29.06.2020	बोल चाल की हिन्दी, अनुच्छेद का पाठन, हिन्दी प्ररणात्मक दस्तावेज को दिखते हुए प्रतिभागीयों से उक्त को दख कर अपने विचारों को व्यक्त करवाना।	श्रीमती. शीबा वी. एस., क. अनु. (हिन्दी)
2.	26.09.2020	राजभाषा संबंधी अधिनियमों, नियमों एवं आदेशों के मुख्य बिंदुओं पर प्रकाश व उक्त पर सरकार द्वारा अनुपालन, शब्दावली, ई – टूल्स एवं अनुवाद।	डॉ. जी. आर. चौधरी, वरिष्ठ अनुवाद अधिकारी, डीआरडीओ, बैंगलूर।

3.	19.12.2020	राजभाषा नीति, नियम, ई टूल्स, अनुवाद, शब्दावली।	डॉ .जी .आर .चौधरी, वरिष्ठ अनुवाद अधिकारी, डीआरडीओ, बैंगलूर।
4.	20.03.2021	संगणक पर हिन्दी टंकण, गूगल वॉयस टाइपिंगं, गूगल ट्रांसलिटरेशन, डिजिटल टूल्स, हिन्दी वेबसाइट जैसे www.learning-hindi.com, shabdakosh.com आदि का उपयोग।	श्री. एम. पी. दामोदरन, सहायक निदेशक (रा. भा) / प्रभारी, हिंदी शिक्षण योजना, बैंगलोर।

Four workshops were organized under Official language implementation, jointly with Eri SSPC, SSPC and Cold Storage Hosur. The details are as follows:

Sl.No.	Date	Topic	Speaker
1.	29.06.2020	Spoken Hindi, Paragraph Reading, Showing Hindi motivational document, asking the participants to see the above and express their views.	Smt. Sheeba. V. S, Jr. Transl. (Hindi)
2.	26.09.2020	Official Language Acts, Highlighting the main points of rules and orders and compliance by the Government on the above, Glossary, E-tools and translation.	Dr. G. R. Chowdhary, Sr. Translation Officer, DRDO, Bangalore.
3.	19.12.2020	Official Language policy, Rules, e - Tools, Translation and Glossary.	Dr. G. R. Chowdhary, Sr. Translation Officer, DRDO, Bangalore.
4.	20.03.2021	Hindi typing on computer, Google voice typing, Google Transliteration, Digital Tools, Hindi websites like www.learning-hindi.com, shabdakosh.com etc. and its usage.	Shri. M. P Damodharan, Assistant Director (OL) / Incharge, Hindi Teaching Scheme, Bangalore.

चारों कार्यशालाएं बहुत ही उपयोगी एवं उदेश्यपूर्ण रही तथा केन्द्र के पदधारिगण टिप्पण ,आलेखन एव पत्राचार को तैयार करने हेतु प्रेरित हुए।

राजभाषा कार्यान्वयन समिति की दो बैठकें 27 जून 2020, 30 सितंबर 2020, 31 दिसंबर 2020 एवं 25 मार्च 2021 को आयोजित की गई। उक्त रिपोर्टाधीन अवधि के दौरान प्रगति की समीक्षा की गई। सभी पदधारियों से अनुरोध किया कि वे अपने दैनिक सरकारी कामकाज में हिन्दी को बढावा दे ,जो अधिदिष्टित है।

All the four workshops were very effective and staff of the Centre was inspired and motivated to use Hindi in the preparation of noting, drafting and letters.

Four meetings of the Official Language Implementation Committee were organized on 27 June 2020, 30 September 2020, 31st of December 2020 and 25th March 2021. The progress of work carried out during the period under report was reviewed. The staff was requested to put their best efforts in increasing the usage of Hindi in routine official work as mandated.

दिनांक 14.09.2020 से 28.09.2020 तक हिंदी दिवस तथा हिंदी पखवाड़े को भारतीय भाषाओं के सौहार्द दिवस के रूप में केरेजसंके, ईएसएसपीसी व एसएसपीसी के वैज्ञानिकों / अधिकारियों / कर्मचारियों एवं कुशल श्रमिकों के सहयोग के साथ इस केन्द्र में मनाया गया। पखवाड़े के दौरान चार प्रतियोगिताओं अर्थात स्मृति परीक्षण, टिप्पण / आलेखन एवं श्रुत लेखन, वाद – विवाद एवं गायन का आयोजन किया गया। हिन्दी प्रभारी व हिन्दी शिक्षण योजना, बैंगलूर से पधारे मुख्य अतिथि श्री. एम. पी. दामोदरन, सहायक निदेशक राजभाषा एवं प्रभारी की अध्यक्षता में समापन सह पुरस्कार वितरण समारोह मानाया गया।

Hindi Day was celebrated from 14.09.2020 to 28.09.2020 as a cordial day of Indian languages. The Hindi Fortnight was organized from 14th September to 28th September 2020 with the support of scientists, officials, employees and field workers of ESSPC and SSPC, Hosur. During the fortnight, four competitions viz. Memory test, Noting & Drafting, Debate & Singing were organized. On the concluding day of the fortnight Shri. M. P. Damodharan, Assistant Director (OL), In-charge, Hindi Teaching Scheme, Bangalore was invited as the Chief Guest and prizes were distributed to the winners of the competitions.

12. OTHER ACTIVITIES

Research Council Meeting

The 63rd meeting of the Research Council was convened on December 2020, chaired by Dr.B.T. Sreenivasa, Director, CSGRC, Hosur. the Committee and participants deliberated upon the research work undertaken at the Centre and provided suggestions for improvement.

Research Advisory Committee Meeting

The 39th and 40th meeting of the RAC of the Centre was organized on 23rd October'2020 and 15th January'2021. 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.

Germplasm Registration Committee Meeting

The Germplasm Registration Committee meeting of CSGRC, CSB Hosur was convened on 5th February'2021.

Pebrine Monitoring Committee Meeting

The 20th Pebrine Monitoring Committee Meeting was held on 30th December, 2020 through webinar hosted by CSR&TI, Mysuru. All scientists of silkworm division participated in the meeting.

Pebrine Monitoring

The Pebrine Monitoring Team consisting of nominated scientists from CSR & TI, Mysuru, SSTL and SBRL, Kodahi carried out the mandated microscopic testing during different stages of rearing for incidence of Pebrine. A total of 8,570 moth samples from Bivoltine 2nd and 3rd batch and about 15,000 samples of Multivoltine from three crops were screened.

Celebration of National and International Official Events

1) Constitution day

Central Sericultural Germplasm Resources Centre, Hosur has celebrated Constitution Day (Samvidhan Diwas) on 26.11.2020 to commemorate the adoption of the Constitution of India. All Officers, staff and TSFWs of the centre participated in online reading of the Preamble of The Constitution of India by Hon. President of India, Shri. Ramnath Kovind to promote constitution values among citizens.

2) Swachh Bharat

Under "SWACCH BHARAT" activities a "Clean and Green Drive" was organised at CSGRC, Hosur Campus. All the vacant areas around the Rearing, Reeling and Grainage blocks were cleaned and the seasonal weeds were removed. In addition to this collected, segregated and auctioned the unserviceable articles and also recycled the waste systematically.

A meeting regarding the maintenance of hygiene and disposal of waste was organised and conducted for the residents of the staff quarters.

In order to provide a clean and hygienic environment to the residents in the campus the Children's park was renovated. The passages of the road, rain water channels were cleaned and the weeds / bushes and thorny plants behind staff quarters, LTE room and Guest house were also removed.

3) Vigilance Awareness Week

The Vigilance awareness week was observed at the Centre from 27th October 2020 to 2nd of November 2020 as per the theme "Satark Bharat, Samriddh Bharat (Vigilant India, Prosperous India)", chosen by the Central vigilance Commission (CVC), Ministry of Personnel, Public Grievance & Pension, Government of India. The Integrity pledge was administered by the Director to all the officers and staff of the Centre.

4) World Environment Day

The World Environment Day was celebrated on 5th June, 2020 at CSGRC, Hosur. The Director addressed all the officers and staff of the Centre and reiterated the importance of a healthy and greener environment. Saplings were planted at the office campus.

5) Independence Day

On 15th August 2020 the Independence day was celebrated at the Centre and the National flag was hoisted. The Scientists, Officers, Staff members, Skilled Farm Workers and their families participated in the celebration**.**

6) Republic Day

Republic Day was celebrated on 26th of January 2021 by the officers, staff and their families in the office campus. The Director hoisted the National flag.

Visit of Director and team to IIHR, Bengaluru

Director along with his team from CSGRC, visited IIHR, Bengaluru on 9th March, 2021 in order to see the facilities existing at their campus and to study the possibility of taking up collaborative research work with them.

Director along with CSGRC scientists at IIHR –ICAR; Director planting a tree in Ashoka Vana at IIHR, Bengaluru

Visit of Scientists to other institutes:

The scientists of CSGRC, Hosur, Dr. Lokesh & Dr. Ravikumar visited University of Agricultural Sciences, GKVK on 3rd December, 2020 to discuss the modalities of thecollaborative project proposal on molecular characterization of Silkworm genetic resources.

Closure of partially collapsed dried open well in front of Cold Storage Plant/ Post Cocoon Evaluation Section

A partially collapsed, dried open well located in front of Cold Storage Plant/Post Cocoon Evaluation Section was posing threat to the safety of the staff and visitors. It had become a home for venomous snakes and was creating panic during rainy season. Therefore, efforts were made to close the collapsed dried well after seeking the approval from Central Office, CSB, by hiring a JCB and Tipper Tractor during December 2020. An aesthetic circle has been created with lighting arrangements to facilitate the staff/Residents/Visitors to the campus.



Establishment of Rain water harvesting pond

A rainwater harvesting pond, covering an approximate area of 1500 sq.ft., was established near mulberry field gene bank in CSGRC campus to mitigate water shortage problems during summer seasons.



13. ADMINISTRATIVE AND FINANCIAL REPORT

Dr. B.T. Sreenivasa assumed charge as the Director of this center on promotion on 30th of June 2020. The officers and staff extended a warm welcome to the Director. An interactive meet was also held by the Director with all the Scientists, officers, staff and farm workers and the activities of the centre were discussed.

a. Staff strength as on 31.03.2021

Category	No.
Director	1
Scientific	
Scientist-D	6
Scientist-C	2
Scientist-B	2
Sub-total	**11**
Technical	
Technical Assistant	3
Sub-total	**3**
Administrative	
Asst. Director (Administration & Accounts)	1
Asst. Director (Computer)	1
Assistant Superintendent	1
Upper Division Clerk	1
Stenographer (Grade I)	1
Junior Engineer (Electrical)	1
Library & Information Assistant	1
Junior Translator (Hindi)	1
Assistant Technician	1
Multi-tasking Staff	2
Driver	2
Sub-total	**13**
Total	**28**
Supporting (Skilled Farm workers)	35

b. Research Fellows/Project Assistants

Junior Research Fellow (JRF)	1
Project Assistant	2
Sub-total	**3**

b. Personnel posting position as on 31.03.2021

Division / Section	Name	Designation
	Dr.R.K.Mishra	Director (upto 29.06.2020)
	Dr.B.T.Sreenivasa	Director (from 30.06.2020)
Mulberry	Dr.G.Ravi Kumar	Scientist-D
	Dr.G.Thanavendhan	Scientist-C
	Dr.M.C.Thriveni	Scientist-B
	Mr.Raju Mondal	Scientist-B
Silkworm	Dr.C.M.Kishor Kumar	Scientist-D
	Dr.M.Maheswari	Scientist-D
	Smt.G.Punithavathy	Scientist-D
	Dr.G.Lokesh	Scientist-D
	Dr.Ritwika Sur Chaudhuri	Scientist-C
Post Cocoon Technology	Dr.Jameela Khatoon	Scientist-D
PMCE	Dr.Geetha N Murthy-upto 30.9.2020 Dr.M.Maheswari-from 01.10.2020	Scientist-D Scientist-D
Computer Section	Shri.S.Sekar	Assistant Director (Comp.)
Administration	Smt.K.Gayathri	Assistant Director(A&A)
Hindi	Smt.V.S.Sheeba	Junior Hindi Translator
Linbrary	Shri Bairawa Narendra Kumar M	Lib. & Information Asst.
Electricity supply	Shri. Vijayakumar	Junior Engineer (Elec.)

c. Superannuation/Voluntary Retirement from Service/Transfers

Sl. No.	Name & Designation	Remarks
1	Shri. A. Jagajeevan, Assistant Director (A&A)	Superannuation on 30.06.2020
2	Dr. Geetha N. Murthy, Scientist-D	Superannuation on 31.08.2020
3	Shri. Chinnavenkatappa, STA	Superannuation on 30.09.2020
4.	Smt. Jothi. UDC	Voluntary Retirement on 18.10.2020
5.	Dr. D.S. Somaprakash, Scientist-D	Transferred to RSRS, Chamarajanagar on 30.06.2020

d. Abstract of receipts and expenditure statement for the year 2020-21 [Rs. In lakhs]

Fund Head	GIA received [Rs.]	Expenditure [Rs.]	Balance surrendered [Rs.]
Plan General	75,00,729.00	75,00,729.00	0.00
Plan Capital	20,27,077.00	20,27,077.00	0.00
Total (PL)	**95,27,806.00**	**95,27,806.00**	**0.00**
Plan Salary **(PLS)**	3,59,57,406.00	3,59,57,406.00	0.00
SCSP	1,67,59,151.00	1,67,59,151.00	0.00
TSP	28,35,993.00	28,35,993.00	0.00
Total (PLS)	**5,55,52,550.00**	**5,55,52,550.00**	**0.00**
Grand total (PL+PLS)	**6,50,80,356.00**	**6,50,80,356.00**	**0.00**

14. METEOROLOGICAL DATA

METEOROLOGICAL DATA OF CSGRC, HOSUR FOR THE PERIOD APRIL, 2020 TO MARCH, 2021

Month/ Year	Temperature (°C)			Humidity (%)			Total Rain fall (mm)	No. of rainy days	Avg. Wind Speed (m/sec)	Wind Direction	Sun Duration (mins)
	Min.	Max	Avg.	Min.	Max.	Avg.					
April 2020	19.69	33.37	26.53	39.36	77.90	58.63	73	6	1.45	S	337
May 2020	24.41	33.39	16.69	47.83	86.38	67.10	62	5	1.51	SW	330
June 2020	21.21	29.94	25.57	62.96	93.10	78.03	110	6	2.20	WSW	337
July 2020	20.58	28.69	24.63	58.38	74.48	66.20	124	10	1.90	WSW	329
Aug 2020	28.65	27.63	28.14	67.77	80.87	74.32	25	3	2.25	WSW	329
Sept 2020	20.39	27.24	23.81	52.30	52.70	52.50	108	7	2.01	WSW	324
Oct 2020	19.08	28.05	23.56	64.74	80.10	72.42	238	10	1.56	SW	323
Nov 2020	16.26	25.53	20.89	56.76	65.53	61.14	49	6	1.67	ESE	301
Dec 2020	16.66	25.8	21.23	22.19	24.25	23.22	10	2	1.76	E	280
Jan 2021	16.53	26.05	21.29	27.87	37.83	32.85	0	0	1.71	ESE	295
Feb 2021	14.77	29.06	21.91	36.07	78.60	57.33	0	0	1.71	ESE	321
Mar 2021	14.97	32.64	23.80	22.80	64.90	43.85	0	0	1.66	SSE	349
						Total	**799**	**55**			

Minimum Temperature (February 2021)	**14.77°C**
Maximum Temperature (April 2020)	**33.37°C**
Minimum Relative Humidity (December 2020)	**22.19%**
Maximum Relative Humidity (June 2020)	**100%**

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Hindi Day / Workshop

Research Advisory Committee Meeting

Director planting a tree in Ashoka Vana at IIHR. Benaaluru

Republic Day celebration

Lecture on Integrated Pest Management in Mulberry imparted to Tamil Nadu Sericulture Farmers

For further details please contact
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