वार्षिक प्रतिवेदन
ANNUAL REPORT
2022-23

केन्द्रीय रेशम जननद्रव्य संसाधन केन्द्र

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

Central Sericultural Germplasm Resources Centre

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

CBT-STEP Training Programme held on 9-10 January 2023

Release of training manual by dignitaries

Visit of Smt. Prajakta Verma, Joint Secretary (Textiles) to CSGRC, Hosur on 05.06.2022

43rd RAC meeting of CSGRC, Hosur held on 2nd September 2022

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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 2022-23 के दौरान केंद्र की महत्वपूर्ण उपलब्धियों को दर्शाती है। वार्षिक रिपोर्ट में सुधार के लिए किसी भी सुझाव का स्वागत है।

वी. निशिता नाइक

[डा. वि. निशिता नाईक]

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 2022-23. Any suggestions for improvement of the annual report are welcome.

[DR. V. NISHITHA NAIK]
DIRECTOR

CONTENTS

1. अनुसंधान की रूपरेखा

वर्ष 2022-23 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 489 रेशमकीट जर्मप्लाज्म स्टॉक का संरक्षण और इनब्रीडिंग डिप्रेशन के लिए उनका मूल्यांकन किया। 1317 शहतूत आनुवंशिक संसाधनों का संरक्षण किया गया।रिपोर्टाधीन अवधि के दौरान शहतूत और रेशमकीट प्रभाग की उपलब्धियों का सार निम्नानुसार है:

शहतूत विभाग:

- परियोजना **"पीआईई 06008 एसआई: अन्वेषण-संग्रह, लक्षण वर्णन, मूल्यांकन, पुन: स्थापना, संरक्षण और शहतूत आनुवंशिक संसाधनों (एमजीआर) चरण-X की आपूर्ति"** के अंतर्गत सर्वेक्षण क्षेत्र में उत्तर-पूर्वी भारत में अरुणाचल प्रदेश के कुरुंग कुमेय और कारा दादी जिले के कोलोरियांग (3 सं), संग्राम (2 सं.), न्यू पॉलिन (2 सं.), याज़ुली-पुतिन (1 सं.) और उत्तर प्रदेश के वाराणसी शामिल हैं जिसे रिपोर्ट अवधि के दौरान पूरा किया गया। एनएजीएस केंद्र की पूर्व-स्थिति स्थितियों के तहत विदेशी शहतूत जननद्रव्य के कुल 115 अभिगमों को सफलतापूर्वक प्रत्यारोपित किया गया और पुनः स्थापित किया गया।

- परियोजना **"पीआईजी06004एसआई: शहतूत आनुवंशिक संसाधनों की साइटोलॉजिकल स्थिति पर अध्ययन"** के अंतर्गत**,** पूरे जननद्रव्य संग्रह से आनुवंशिक स्पेक्ट्रम का प्रतिनिधित्व करने के लिए शहतूत से संबंधित 200 जननद्रव्य अभिगमों के लिए जीनोम आकार/प्लोइडी का अनुमान लगाने के लिए फ्लो साइटोमेट्री (एफसीएम) विश्लेषण के साथ मेटाफ़ेज़ गुणसूत्र गणना की गई। प्लोइडी भिन्नता अर्थात डिप्लोइड,, (2n=2x=28), ट्रिपलोइड (2n=3x=42), टेट्राप्लोइड (2n=4x=56) हेक्साप्लोइडी (2n=6x=84) तथा डेकासोप्लोइडी (2n=22x=308) की पहचान की गई।200 अभिगमों में से 154 अभिगम डिप्लोइड (77.00%), 23 अभिगम ट्रिपलोइड (11.50%), 16 अभिगम टेट्राप्लोइड (8.00%), 02 अभिगम हेक्साप्लोइड (1%) और 01 अभिगम डेकासोप्लोइडी (0.05%) हैं।

- **परियोजना "पीआईजी06005 एसआई: डुप्लीकेट की पहचान और उनके प्रभावी उपयोग के लिए शहतूत आनुवंशिक संसाधनों का आणविक लक्षण वर्णन"** के अंतर्गत, क्लस्टर विश्लेषण और पीसीए के माध्यम से रूपात्मक विवरणकों के आधार पर 84 शहतूत अभिगमों को संदिग्ध डुप्लिकेट के रूप में पहचाना गया। संदिग्ध डुप्लिकेट को आगे एसएसआर विश्लेषण के अधीन किया गया और 14 अभिगमों की वास्तविक डुप्लिकेट के रूप में पुष्टि की गई। कुल 86 एसएसआर मार्करों की जांच की गई और 12 बहुरूपी पाए गए जिनका उपयोग शहतूत जननद्रव्य की जांच के लिए किया जा सकता है।

- परियोजना **"पीआईटी-08004 एमआई: शहतूत में अगुणित सूक्ष्मबीजाणु भ्रूणजनन के प्रवेश पर एपिजेनेटिक और ऑटोफैगी संशोधक पर अध्ययन"** के अंतर्गत, पीजीआर की विभिन्न सांद्रता और संयोजन का उपयोग करके भ्रूणजनन और ऑर्गोजेनेसिस जैसी प्रतिक्रियाएं देखी गईं। सूक्ष्मबीजाणु से भ्रूण प्रेरण पर मौसमी प्रभाव की पहचान की गई है। मूल रूप से एकल और बहुकोशिकीय भ्रूण की पहचान की गई। द्विध्रुवी अगुणित पौधों के साथ-साथ प्राक्भ्रूण, ग्लोबुलर, हार्ट, टारपीडो, कोटिलेडोनरी चरणों को कम आवृत्ति के साथ हासिल किया गया था।

- विभिन्न पीजी अनुसंधान, सीएस-नेटवर्क परियोजना और फल मूल्यांकन आदि के लिए विभिन्न केरेबो संस्थानों / विश्वविद्यालयों / संगठनों के 6 मांगकर्ताओं को कतरन एवं कलमों के पौधों के रूप में 29 विदेशी और 33 स्वदेशी सहित कुल 62 शहतूत की आपूर्ति की गई थी।

रेशमकीट विभाग:

- परियोजना **"एआईई:06003एसआई: अन्तःप्रजनन अवसाद और उनके संरक्षण के संदर्भ में बॉम्बेक्स मोरी एल के रेशमकीट आनुवंशिक संसाधनों का मूल्यांकन"** के अंतर्गत, द्विप्रज से बीबीई-0179, बीबीई-0262, बीबीई-0221, बीबीआई-0172 और बीबीई-0188 रेशमकीट अभिगम तथा बीएमआई-0084, बीएमआई-0083, बीएमआई-0085, बीएमआई-0081 और बीएमआई-0076 से बहुप्रज जननद्रव्य के सभी मूल्यांकित किए गए आर्थिक पात्रों के लिए महत्वपूर्ण सर्वोत्तम प्रदर्शन के साथ शीर्ष प्रदर्शनकर्ताओं के रूप में पाया गया।

- परियोजना **"एआईटी:06006एमआई: बीएमएनपीवी और बीएमबीडीवी के प्रति सहिष्णु रेशमकीट आनुवंशिक संसाधनों की पहचान करने के लिए मार्कर सहायता प्राप्त स्क्रीनिंग**" के अंतर्गत, बायोएसे अध्ययनों से 2 मार्कर-पहचाने गए बीएमबीडीवी-सहिष्णु बहुप्रज अभिगम तथा 17 द्विप्रज अभिगमों का पता चला, जिसमें 7-87%कोशित उत्तरजीविता को दर्ज किया गया। बीएमएनपीवी के मामले में, 16 मार्कर- सहिष्णु अभिगम के रूप में पहचाने गए, डीम्भकीय उत्तरजीविता का रेंज 16-67.67% के बीच था और कोशित उत्तरजीविता का रेंज 7.5-48.67% के बीच था।

- परियोजना के **"एआईजी:06007एमआई: रेशमकीट (बॉम्बिक्स मोरी एल) जननद्रव्य में आनुवंशिक विविधता का आणविक लक्षण वर्णन और मूल्यांकन**" के अंतर्गत, जीनोम अनुक्रमण, आरएनएसेक और डीडीआरएडीअनुक्रमण और विश्लेषण की आउटसोर्सिंग के लिए एम/एस बायोनिविड टेक्नोलॉजी, बेंगलुरु के साथ समझौता ज्ञापन पर हस्ताक्षर किए गए। चार रेशमकीट अभिगमों अर्थात पीएम, सीएसआर-2, निस्तारी और एसके-6 का जीनोम पुन: अनुक्रमण लघु रीड इलुमिना प्रौद्योगिकी के साथ किया गया और विश्लेषण किया गया। इसी तरह, पीएम और सीएसआर-2 से चार ऊतकों (सिल्कग्लैंड, टेस्टिस, ओवरी और मिडगट) में आरएनए अनुक्रम कर और विश्लेषण किया गया।

- परियोजना **"एआईई:06009एमआई: रेशमकीट आनुवंशिक संसाधनों का संग्रह, लक्षण वर्णन, मूल्यांकन, संरक्षण और उपयोग - X चरण"** के अंतर्गत, कुल 113 द्विप्रज 83 बहुप्रज अभिगमों और 23 उत्परिवर्तन को ब्रश किया गया, कीटपालन एवं बीजागार की गतिविधियाँ पूरी की गई। द्विप्रज के मामले में, उत्तरजीविता की दर 65.25 से 99.00% दर्ज की गई; एकल कोसा वजन - 0.998 से 1.780 ग्राम, एकल कवच वजन - 0.153 से 0.360 ग्राम और उत्परिवर्ती में 70-92% उत्तरजीविता की दर दर्ज की गई। बहुप्रज अभिगमों में 93.50-99.50% की उत्तरजीविता दर दर्ज की गई, एकल कोसे का वजन - 0.737-1.550 ग्राम; एकल कवच का वजन - 0.075-0.286 ग्राम। रेशमकीट डेटाबेस के डिजिटलीकरण के भंडारण के लिए क्लाउड स्पेस को बाह्यस्रोतीकरण पर लेने की कार्रवाई शुरू की गई।

- अनुसंधान कार्य/सहयोगात्मक अनुसंधान परियोजनाओं के लिए विभिन्न केरेबो संस्थानों/विश्वविद्यालयों/संगठनों के 12 मांगकर्ताओं को कुल 51 द्विप्रज (232 डीएफएलएस) और 33 बहुप्रज (101 डीएफएलएस) रेशमकीट अभिगमों की आपूर्ति की गई थी।

1. RESEARCH HIGHLIGHTS

During the year 2022-23, CSGRC, Hosur continued its scientific pursuit towards systematic management of the vast range of seri-genetic resources available at the centre and ensured its disease-free conservation and sustainable utilization. The centre carried out conservation and evaluation of its 489 silkworm germplasm stock for inbreeding depression. Conservation of 1317 mulberry genetic resources was carried out as per SOP. The gist of achievements of mulberry and silkworm division during the period under report is as follows:

MULBERRY DIVISION:

- Under the project "**PIE 06008 SI**: **Exploration-collection, Characterization, Evaluation, Re-establishment, Conservation and Supply of Mulberry Genetic Resources (MGRs) Phase-X"**, two explorations were carried out for the collection of new mulberry germplasm. The survey area included Koloriang (3 nos.), Sangram (2 nos.), New Palin (2 nos.), Yazhuli-Putin (1 no.) of Kurung Kumey and Kara Daadi district of Arunachal Pradesh in North-Eastern India and Varanasi of Uttar Pradesh (5 nos.) was completed during the report period. A total of 115 accessions of exotic mulberry germplasm was successfully transplanted and re-established under *ex-situ* conditions of NAGS centre declared by NBPGR, New Delhi.
- A total of 62 mulberry accessions comprising 29 exotic and 33 indigenous in the form of cuttings and grafted saplings were supplied to 6 indenters of different CSB Institutes / Universities/Organizations for different UG education and PG research, CSB-network project and fruit evaluation etc.
- Under the project "**PIG06004SI: Studies on cytological status of mulberry genetic resources"**, metaphase chromosome count coupled with flow cytometry (FCM) analysis to estimate genome size/ploidy were carried out for 200 germplasm accessions belonging to mulberry to represent the genetic spectrum from the whole germplasm collection. Ploidy variation *viz*. diploid, (2n=2x=28), triploids (2n=3x=42), tetraploids (2n=4x=56) hexaploids (2n=6x=84) and decasoploid (2n=22x=308) were identified. Out of 200 accessions, 154 accessions are diploid (77.00%), 23 accessions are triploid (11.50%), 16 accessions are tetraploid (8.00%), 02 accessions are hexaploid (1%) and 01 accession decasoploid (0.05%).
- Under the project "**PIG06005 SI: Molecular Characterization of Mulberry Genetic Resources for the Identification of Duplicates and their Effective Utilization**", 84 mulberry accessions were identified as suspected duplicates based on morphological descriptors through cluster analysis and PCA. The suspected duplicates were further subjected to SSR analysis and 14 accessions were confirmed as true duplicates. A total of 86 SSR markers were screened and 12 were found to be polymorphic which could be used to screen the mulberry germplasm.
- Under the project "**PIT-08004 MI**: **Study on epigenetic and autophagy modifiers on induction of haploid microspore embryogenesis in mulberry**", responses like embryogenesis, and organogenesis were observed using different concentration and combination of PGRs. Seasonal impact on embryo induction from microspore has been identified. Embryo from single and multi-cellular in origin was identified. Proembryo, globular, heart, torpedo, cotyledonary stages along with bipolar haploid plants were achieved with low frequency.

SILKWORM DIVISION:

- 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 BBE-0179, BBE-0262, BBE-0221, BBI-0172 & BBE-0188 -among bivoltine and BMI-0084, BMI-0083, BMI-0085, BMI-0081 & BMI-0076 from the multivoltine germplasm were found as top performers with significant best performance for all the evaluated economic characters.
- Under the project "**AIT:06006MI**: **Marker assisted screening to identify silkworm genetic resources tolerant to BmNPV and BmBDV"**, bioassay studies revealed 2 marker-identified BmBDV-tolerant multivoltine accessions and 17 bivoltine accessions which recorded 7-87% pupal survival. In case of BmNPV, 16 marker-identified tolerant accessions, the larval survival ranged from 16-67.67% and pupal survival ranged from 7.5-48.67%.
- Under the project **"AIG:06007MI: Molecular characterization and assessment of genetic diversity in silkworm (*Bombyx mori* L) germplasm**", MoU was signed with M/S BIONIVID Technology, Bengaluru for outsourcing of Genome sequencing, RNASeq and ddRADsequencing and analysis. Genome re-sequencing of four silkworm accessions viz., PM, CSR-2, Nistari & SK-6 was carried out with short read Illumina technology and analyzed. Similarly, RNAsequence in four tissues (Silkgland, Testes, Ovary and Midgut) from PM and CSR-2 was carried out and analyzed.
- Under the project "**AIE:06009MI: Collection, Characterization, Evaluation, Conservation and Utilization of silkworm genetic resources - X Phase",** a total of 113 bivoltine, 83 multivoltine accessions and 23 mutants were brushed, rearing and grainage activities are completed. In case of bivoltine, the survival recorded was 65.25 to 99.00%; the single cocoon wt. 0.998 to 1.780g, single shell wt. 0.153 to 0.360g and mutants recorded survival of 70-92%. Multivoltine accessions recorded survival of 93.50-99.50%, single cocoon weight - 0.737-1.550g; single shell weight - 0.075-0.286g. Action initiated for hiring of cloud space for storage of digitization of silkworm database.
- A total of 51 multivoltine (232 dfls) and 33 bivoltine (101 dfls) silkworm accessions were supplied to 12 indenters of different CSB Institutes / Universities/Organizations for research work / collaborative research projects.

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

1. रेशमउत्पादन जननद्रव्य संसाधनों की खोज, संग्रह, लक्षण वर्णन, मूल्यांकन, संरक्षण और दस्तावेज़ीकरण।
2. रेशमउत्पादन जननद्रव्य संसाधनों का व्यावसायीकरण एवं सतत उपयोग को बढ़ावा देना।
3. रेशमउत्पादन जननद्रव्य संसाधनों के संरक्षण, प्रबंधन तथा उपयोग पर जागरूकता पैदा करना और हितधारकों को प्रशिक्षण देना।

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]

<u>दृष्टिकोण</u>

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 and utilization of mulberry seri-genetic resources as well as to create awareness and train the personnel on the said aspects. The centre is authorized by CSB to incorporate new 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 seri-genetic resources aiming at identification of better performing parental stock that will aid breeders in crop improvement programme.

Mandate

1. Exploration, collection, characterization, evaluation, conservation, and documentation of sericultural germplasm resources
2. Commercialization and promoting sustainable utilization of sericultural germplasm resources
3. Creating awareness and training to stakeholders on conservation, management and utilization of sericultural germplasm resources.

Activities

- Exploration, collection, introduction and conservation of mulberry and silkworm germplasm.
- Characterisation, classification, preliminary evaluation, national accessioning and cataloguing of germplasm collection for promoting utilization of seri-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 resources.
- Co-ordinate import and export of genetic resources.
- Serve as the National database and herbarium / display of seri-genetic resources.
- Promote utilization of seri-genetic germplasm through their supply to needy organizations.
- Impart training in sericultural germplasm resource management and conservation.

Results framework document [RFD]

Vision: To act as the nodal agency for introduction, characterisation, evaluation and conservation of seri-genetic resources.

Mission: To evaluate the seri-genetic resources in India, research activity facilitating utilisation of seri-genetic resources for crop improvement programme, conservation of seri-genetic resources, national posterity and prevention of extinction.

Road map

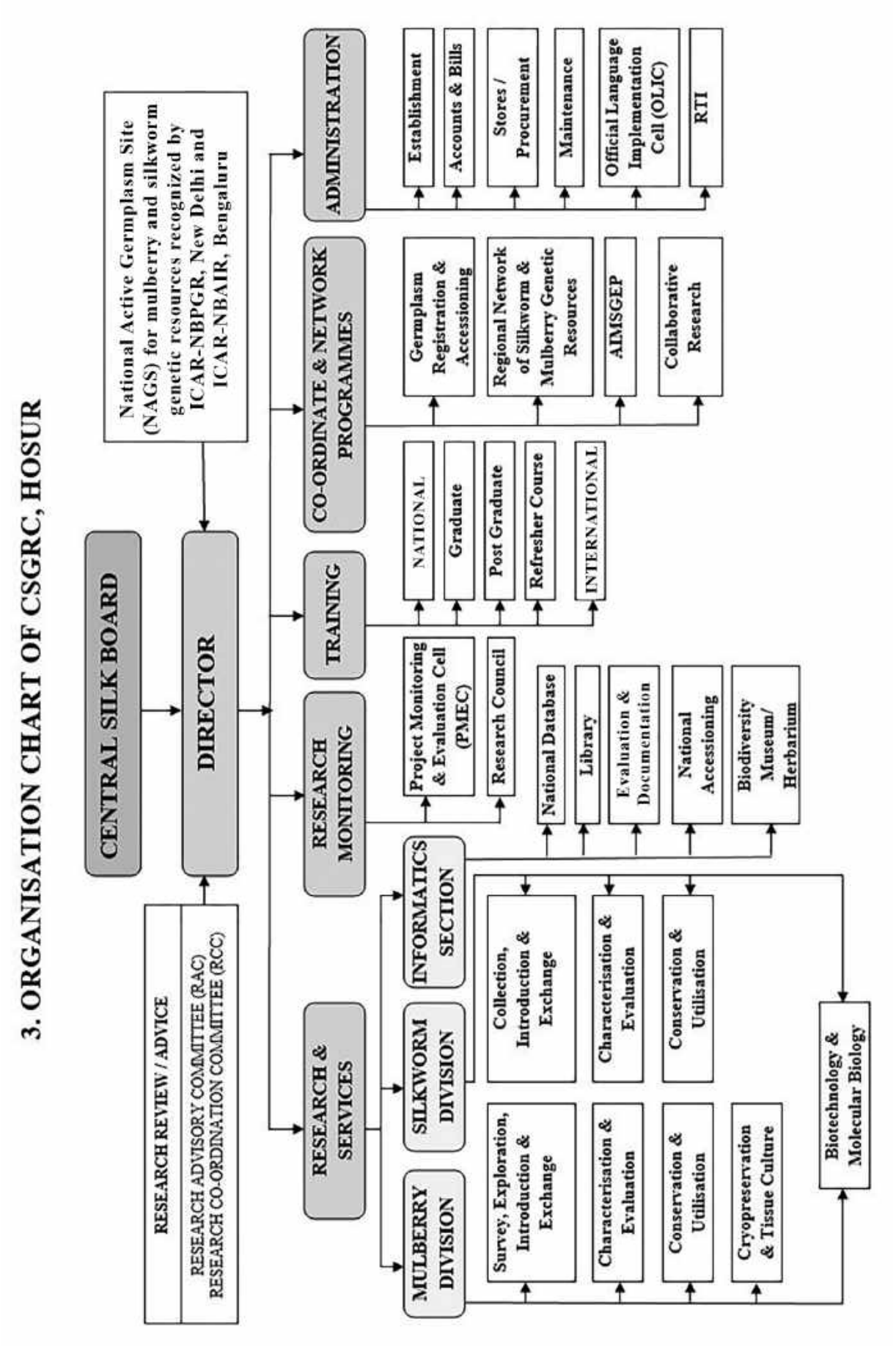
Short term plans

1. Survey of unexplored areas in different states and exploration of avenues from different countries for collection of new seri-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 seri-genetic resources tolerant to biotic and abiotic stress.
4. Adoption of climate resilient sericulture practices 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 strategies 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 genetic 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 database 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		
PIG-06004 SI	Studies on the cytological status of mulberry genetic resources.	Mar.20-Feb.23
PIG-06005 SI	Molecular characterization of mulberry genetic resources for the identification of duplicates and effective utilization.	Mar.20-Feb.23
PIE-06008 SI	Exploration-collection, Characterization, Evaluation,Re-establishment, Conservation and Supply of Mulberry Genetic Resources (MGRs)-Phase-X.	Jan.23-Dec.25
Multi-institutional		
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		
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		
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
AIE-06009 MI	Collection, Characterization, Evaluation, Conservation and Utilization of silkworm genetic resources - X Phase	Jan.23-Dec.25

5. OUTCOME OF CONCLUDED RESEARCH PROJECTS

PIG06004 SI: Studies on cytological status of mulberry genetic resources (March, 2020-March, 2023)

Raju Mondal (PI) & M.C. Thriveni (CI)

Objective

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

Materials and methods

Plant Material: Tree plants of 200 accessions maintained at CSGRC field gene bank were selected for metaphase chromosome count using apical shoot meristematic tips (the protocol is available in the Journal *Bio-protocol*, DOI: 10.21769/BioProtoc.4643).

A. Collections of samples and pre-treatment

Fresh apical shoot meristematic tips ~0.5-1.0 cm were collected between 9.00-10.00 am and immediately transferred to pre-fixative solutions, i.e., 1 mL saturated *para*-dichlorobenzene (PDB) with 20 µL of 0.002 M 8-hydroxyquinoline (HQ) in 1.5 mL eppendorf tube. Pre-treated samples were transferred to a 0°C mini cooler for 5 minutes followed by 4°C for 4 hours. Pre-fixative (PDB-HQ) solution was discarded and young leaf primordia was removed using pointed forceps and a needle. The trimmed apical shoot tips were transferred to a strainer and washed thoroughly under running tap water for 5 minutes and followed by 5 mL of ddH_2O for 10 minutes in a watch glass (**Figure 1**).

B. Fixation of meristems

The samples were transferred to 1 ml of ice-cold 3EtOH:1GAA in a 1.5 mL Eppendorf tube and incubated for 1 hour at room temperature (24±2°C). 3EtOH:1GAA solution was discarded and replaced with freshly prepared ice-cold 3EtOH:1GAA solution and incubated the samples at 4°C for a minimum of 2 days. Replaced with fresh 3EtOH:1GAA solution at an interval of 12 hours. Discarded the 3EtOH:1GAA solutions and washed thoroughly in 5 ml of ddH_2O for 10 minutes, then stored the samples in 1 ml of 70% ethanol in a 1.5 ml Eppendorf tube at 4°C for further use. Washed the samples in 5 ml of ddH_2O twice in a watch glass for 10 minutes each. Transferred the samples to 1 ml of 45% GAA in a 1.5 ml Eppendorf tube and incubated for 1 hour at room temperature. Washed thoroughly in 5 ml ddH_2O for 10 minutes in a watch glass and removed water from the sample with blotting paper.

Enzymatic digestion

The samples were treated with an enzyme cocktail comprising cellulase (2 %), pectinase (2.5 %), and pectolyase (1%) for 4 hours at 37°C in a dark using an incubator.

C. Staining

The enzyme-treated samples were transferred to 500 µl of 1% aceto-orcein in a 1.5 ml eppendorf tube covered with aluminum foil (for dark conditions) and incubated the sample-containing tubes for 12-14 hours at room temperature.

D. Squashing

Transferred one of the processed (stained) samples from the aceto-orcein stain to a glass slide. Added 2 drops of 45% GAA to the sample and gently dissolved the tissue with the back side of the needle. Gently mixed the sample with the addition of 1 drop of acetocarmine, and 3 drops of aceto-orcein stain; subsequently, removed the debris. Placed a cover slip over the slide. Gently tapped over the cover slip using the backside of the needle to obtain the optimum spread of cells as well as chromosomes. Applied flame heat on the bottom side of the mounted slide for 2-3 seconds and gently tapped for precise chromosome spreading. Sealed the mounted slide with wax. Placed the slide and visualized the chromosome under the microscope. Any compound microscope can be used having 40x or 100x objective with oil immersion. Microscopic images of representative accessions from each ploidy group are represented in **Figure 2**.

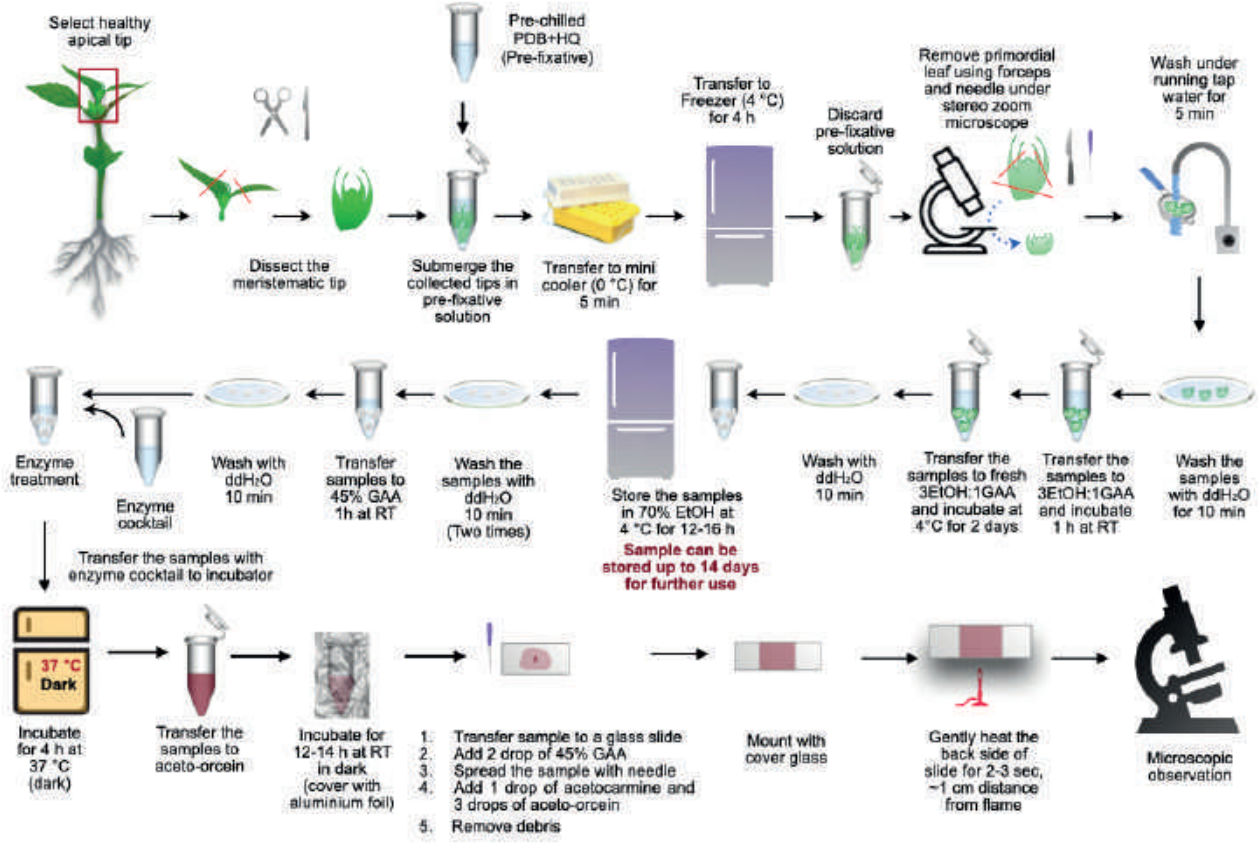


Figure 1: Step-by-step flow chart of sample collection, pre-treatments, fixation, staining and squash for microscopic observation.

Flow cytometry analysis

To confirm the ploidy level cytotypes, genome size was estimated by flow cytometry (FCM) of selected ploidy (2x, 3x, 4x, 6x, and 22x) accessions, which was identified through chromosome number count (**Figure 2**). A dual laser BD FACSCalibur™ (BD Biosciences, United States) was used to estimate genome size with the modification of the protocol described by Galbraith *et al.* (1983). In brief, young mulberry leaves (5–6 days old) of about 0.5 cm^2 were collected between 8:30 and 9:00 am. With a razor blade, the leaf sample was chopped in 2 mL of nuclear isolation buffer (hypotonic propidium iodide- 50 µg/ml, 3 g/l trisodium

citrate dihydride, 0.05% (v/v) of Nonidet P-40, 2 mg/mL RNase A), and filtered (30 µm nylon mesh) nucleus suspensions were collected in tubes. The tubes were capped and kept at 37 °C for 30 min. Then the samples were taken for analysis. Subsequently, the samples were subjected to FCM analysis. *Pisum sativum* was used as the standard reference, and measurements were made in triplicates **(Figure 3).**

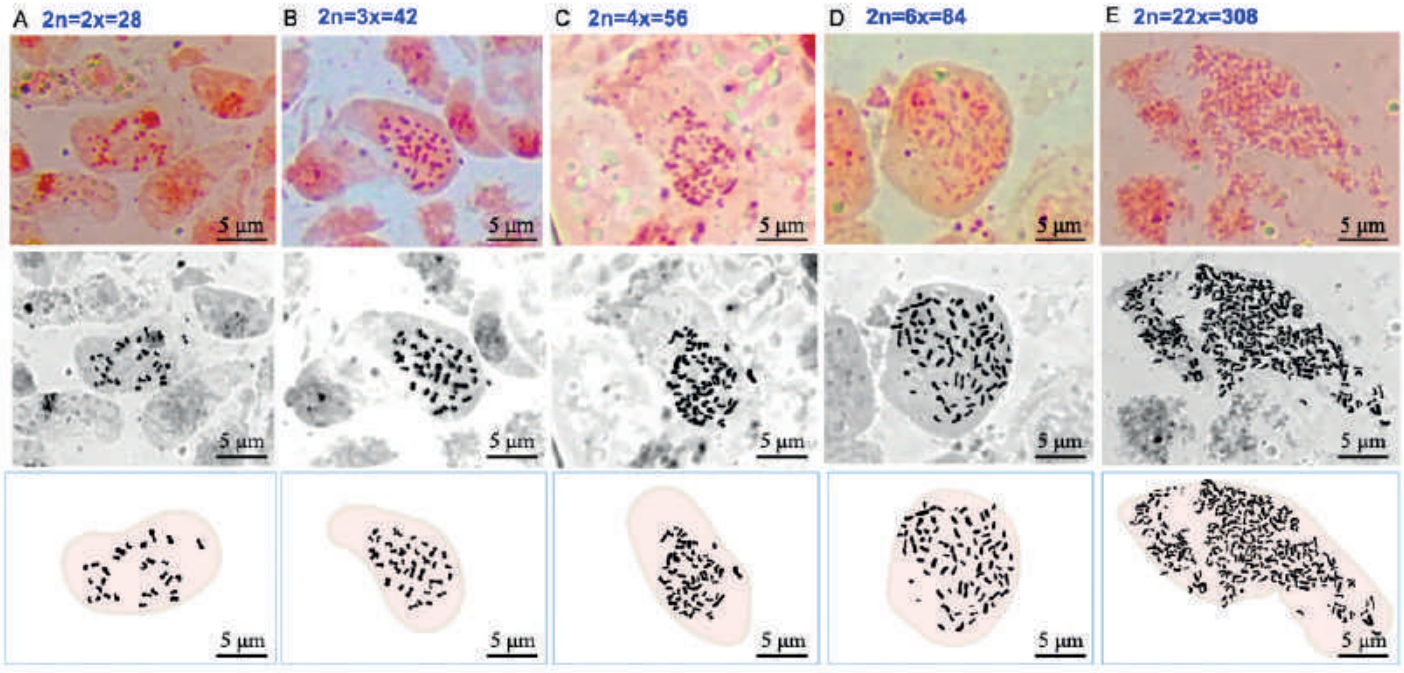


Figure 2. Metaphase plates and estimated chromosome number of different cytotypes of *Morus* spp. (A) diploids V1 (2n=2x=28), (B) triploid AR12 (2n=3x=42), (C) tetraploid *M. laevigata* L. (2n=4x=28), (D) hexaploid *M. Serrata* Roxb. (2n=6x=84), and (E) decosaploid *M. nigra* L. (2n=22x=308). Scale bar= 5µm.

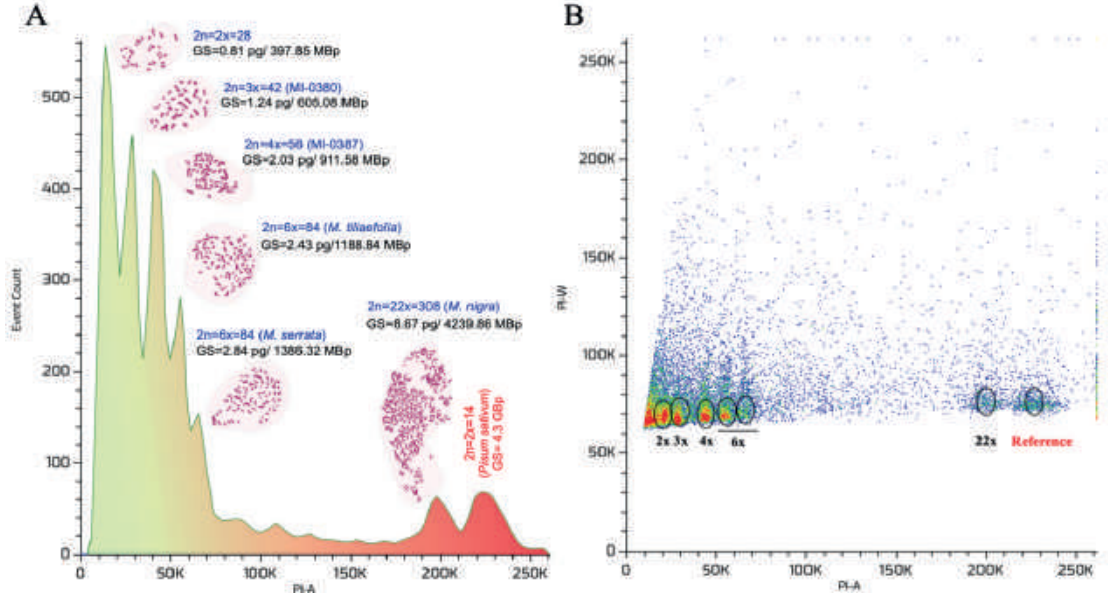


Figure 3. (A) Histogram of PI fluorescence intensity (count versus PI-A) of di- (2x), tri- (3x), tetra- (4x), hexa- (6x) and decosaploid (22x) with reference of *Pisum sativum*;
(B) Scatter plot show nuclei of different cytotype.

Results and discussion

In the present study, metaphase chromosome count coupled with flow cytometry (FCM) analysis to estimate genome size/ploidy were carried out for 200 germplasm accessions belonging to mulberry to represent the genetic spectrum from the whole germplasm collection. Ploidy variation *viz*. diploid, (2n=2x=28), triploids (2n=3x=42), tetraploids (2n=4x=56) hexaploidy (2n=6x=84) and decasoploidy (2n=22x=308) were identified. Out of 200 accessions, 154 accessions are diploid (77.00%), 23 accessions are triploid (11.50%), 16 accessions are tetraploid (8.00%), 02 accessions are hexaploid (1%) and 01 accession decasoploidy (0.05%) **(Figure 4)**.

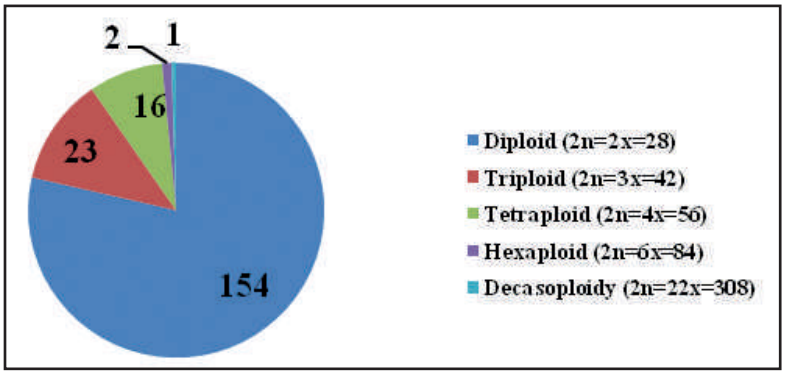


Figure 4: Pie chart represents individual indentified under different cytotypes.

PIG06005 SI: Molecular characterization of mulberry genetic resources for the identification of duplicates and effective utilization (March, 2020-February, 2023)

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

Objective:

- Identification of duplicates and their demarcation using morphological descriptors and molecular markers.

Methodology

Plant materials: Fresh and young leaf samples of mulberry field gene bank of CSGRC, Hosur were used for the study.

Morphological data: Morphological data of mulberry collections in the field gene bank were recorded as a part of routine characterization of germplasm at CSGRC, Hosur. In the present study, 17 morphological descriptors **(Table 1)** which are qualitative in nature and neutral to environmental influence are considered for duplicate identification. The morphological descriptors are coded using 0-9 scale numerically for each character state. The coded descriptors were subjected for the construction of UPGMA tree (Unweighted Pair Group Method with Arithmetic Mean). The dendrogram depicting the potential suspected duplicate accessions were subjected for further molecular characterization.

Table 1: Morphological descriptors used for identification of suspected duplicates

#	Morphological descriptors	#	Morphological descriptors
1	Branching nature	10	Leaf nature
2	Curve or straightness of the branch	11	Leaf color
3	Color of young shoot	12	Leaf surface
4	Color of mature shoot	13	Leaf texture
5	Stipule nature	14	Leaf apex
6	Stipule duration	15	Leaf base
7	Phyllotaxy	16	Leaf margin
8	Lobation type	17	Leaf shape
9	Lobation number		

Identification of suspected duplicates

A total of 312 mulberry accessions were subjected for cluster analysis. 17 qualitative morphological characters were considered for the identification of suspected duplicates. Out of 312 mulberry accessions, 84 were shortlisted as suspected duplicates based on the branch length which indicate the degree of similarity. These shortlisted accessions were used throughout the experiments. The fresh, young leaves samples were collected, surface sterilized with 70% ethanol and stored at -80°C until further use. List of suspected duplicates are given in **Table 2**.

Table 2: List of suspected duplicates

#	Acc. No.	#	Acc. No.	#	Acc. No.	#	Acc. No.
1	MI-0144	22	MI-0708	43	MI-0218	64	MI-0117
2	MI-0197	23	MI-0478	44	MI-0820	65	MI-0344
3	MI-0657	24	MI-0789	45	MI-0213	66	MI-0702
4	MI-0670	25	MI-0067	46	MI-0652	67	MI-0706
5	MI-0710	26	MI-0281	47	MI-0359	68	MI-0355
6	MI-0711	27	MI-0370	48	MI-0425	69	MI-0779
7	MI-0712	28	MI-0502	49	MI-0329	70	MI-0345
8	MI-0713	29	MI-0503	50	MI-0555	71	MI-0349
9	MI-0714	30	MI-0505	51	MI-0835	72	MI-0284
10	MI-0717	31	MI-0152	52	MI-0836	73	MI-0486
11	MI-0724	32	MI-0161	53	MI-0567	74	MI-0271
12	MI-0422	33	MI-0461	54	MI-0783	75	MI-0272
13	MI-0010	34	MI-0759	55	MI-0407	76	MI-0318
14	MI-0225	35	MI-0134	56	MI-0202	77	MI-0319
15	MI-0221	36	MI-0335	57	MI-0238	78	MI-0320
16	MI-0232	37	MI-0824	58	MI-0204	79	MI-0725
17	MI-0744	38	MI-0163	59	MI-0506	80	MI-0726
18	MI-0150	39	MI-0334	60	MI-0138	81	MI-0325
19	MI-0187	40	MI-0490	61	MI-0764	82	MI-0326
20	MI-0193	41	MI-0495	62	MI-0072	83	MI-0864
21	MI-0374	42	MI-0496	63	MI-0116	84	MI-0865

Results

Isolated genomic DNA from 84 suspected duplicate accessions. PCR was carried out using 86 SSR markers. The amplicons were resolved on 6% horizontal PAGE for better resolution. The clear and reproducible alleles amplified by each SSR among 84 accessions were scored according to their fragment size (bp) corresponding to 100 bp DNA marker. The data was transferred to binary matrix which is subjected to cluster analysis. The polymorphic information content (PIC) values were used to refer to the relative value of each marker with respect to the amount of polymorphism exhibited **(Table 3).** The PIC values were estimated for each marker using the formula given by Nei (1973). Out of 86 SSR markers screened, 12 markers gave polymorphism. Among 84 accessions, 14 were confirmed to be duplicates based on SSR markers **(Table 4).**

Table 3: SSR primers and their efficiency parameters

#	Marker	Allelic range	No. of alleles	Frequency of alleles	PIC value
1	MISSR15	200-250	2	0.53	0.12
2	MISSR20	170-300	4	0.27	0.29
3	MISSR35	200-250	2	0.93	0.12
4	MULSSR29	150-220	3	0.78	0.31
5	**MULSSR39**	190-260	3	0.40	**0.36**
6	MULSSR96B	280-300	4	0.62	0.33
7	**MULSSR258**	150-240	7	0.29	**0.37**
8	**M2SSR68**	190-210	3	0.42	**0.46**
9	**M2SSR87**	220-330	3	0.48	**0.43**
10	M2SSR89A	150-230	2	0.71	0.29
11	M2SSR36	180-220	2	0.58	0.18
12	**M2SSR112A**	180-250	4	0.59	**0.39**

*PIC > 0.5 (Highly informative); (Botstein *et al*., 1980)

Table 4: List of confirmed duplicates

#	Acc. No.
1.	MI-0713 (Gujarat) & MI-0712 (Gujarat)
2.	MI-0670 & MI-0657 (Himachal Pradesh)
3.	MI-0490 (Kerala) & MI-0334 (Tamil Nadu)
4.	MI-0325 & MI-0326 (ERRC, Kerala)
5.	MI-0725 & MI-0726 (Arunachal Pradesh)
6.	MI-0271 & MI-0272 (Kerala)
7.	MI-0318 & MI-0319 (Rajasthan)

Conclusion

In the present study, both morphological descriptors and SSR markers were considered for the identification of duplicates. The results of the study highlighted that out of 84 suspected duplicates, 14 accessions were confirmed as true duplicates. Among 86 SSR primers screened, 12 are found to be polymorphic. These polymorphic markers can be used to screen mulberry germplasm. Moreover, most of the accessions collected from Gujarat, Rajasthan, Assam, Arunachal Pradesh, Tamil Nadu, Karnataka and Kerala are found more duplicates.

Significance of the study

There are distinct advantages in identifying duplicate accessions and thereby conserving only unique genetic material. Collections of unique germplasm reflect the genetic variability in their wild relatives and may serve as potential parent material in breeding for improved varieties. The current study is of great importance to preserve the uniqueness among the mulberry germplasm and to provide the data to facilitate the selection in breeding and future research programs.

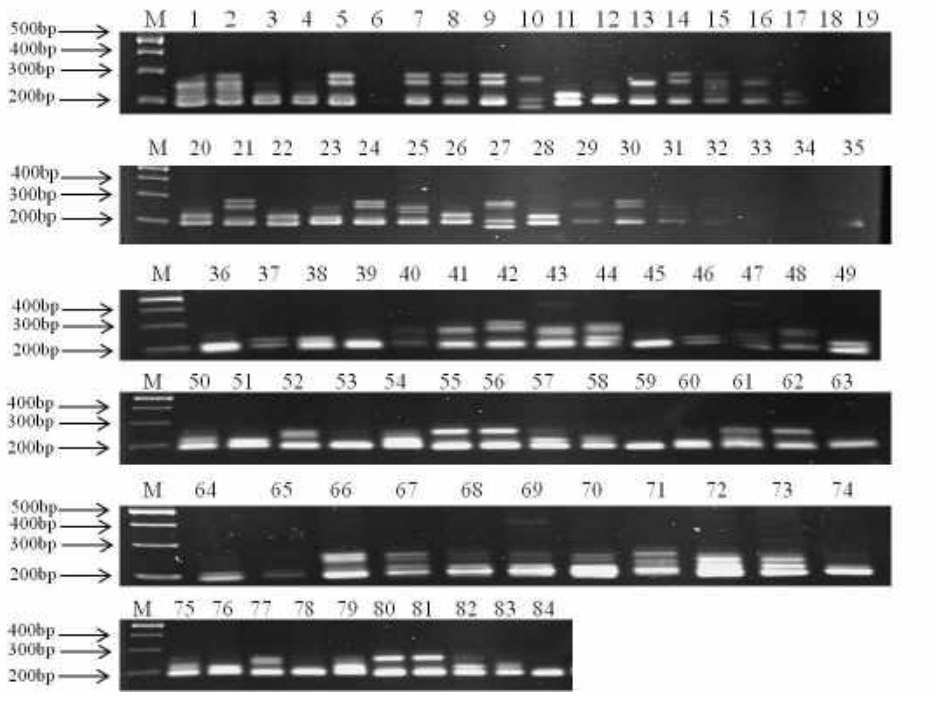


Figure 5: PCR profile of 84 mulberry accessions using SSR marker MULSSR39

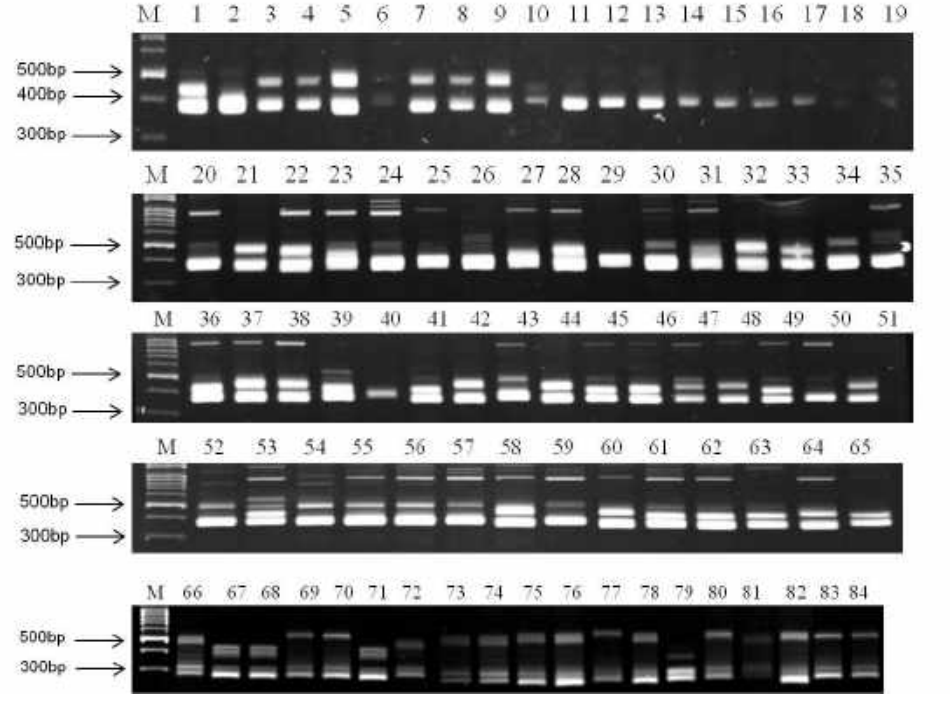


Figure 6: PCR profile of 84 mulberry accessions using SSR marker MULSSR29

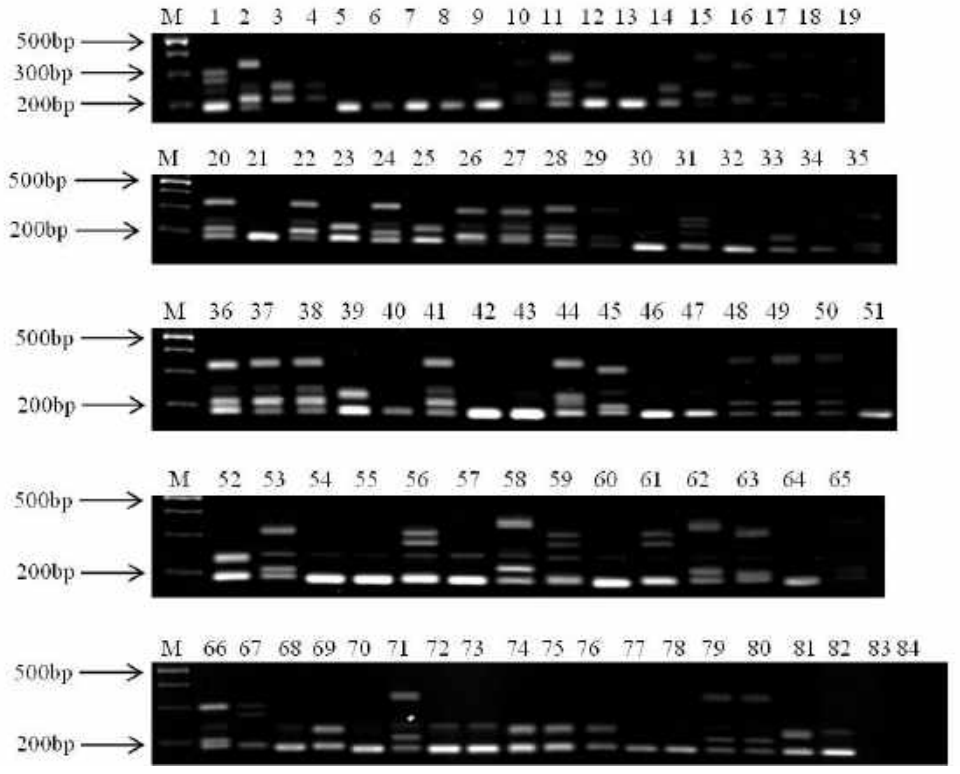


Figure 7: PCR profile of 84 mulberry accessions using SSR marker M2SSR68

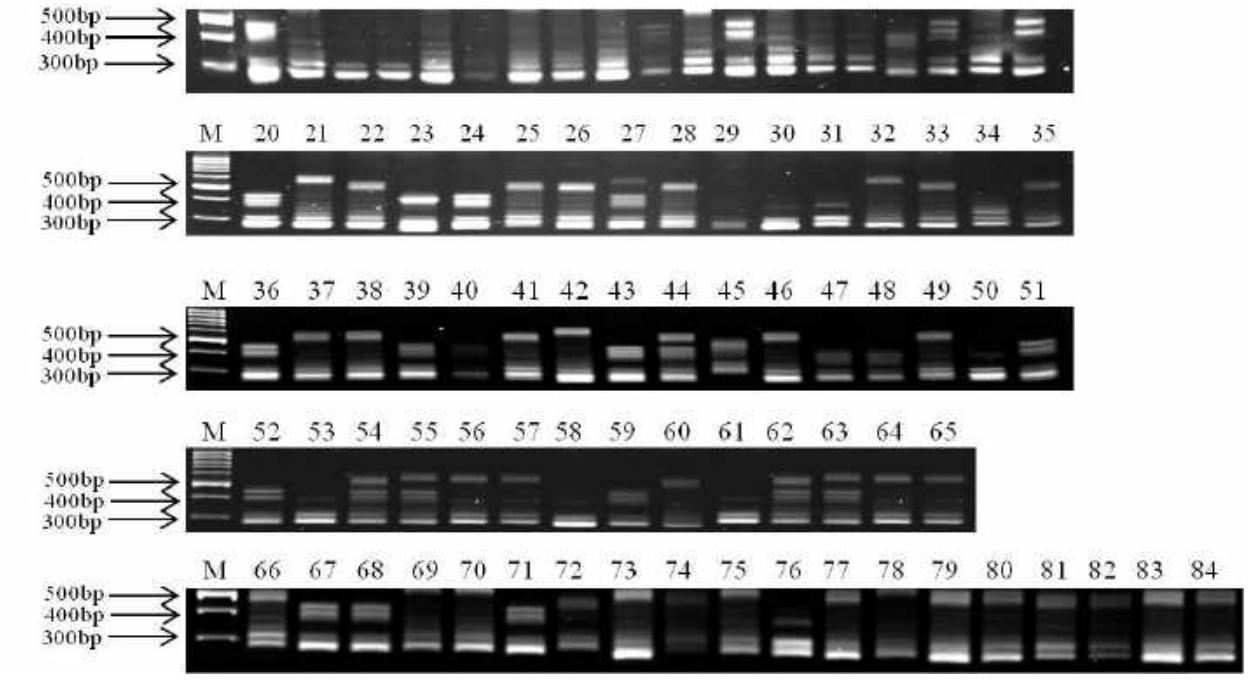


Figure 8: PCR profile of 84 mulberry accessions using SSR marker MULSSR96B

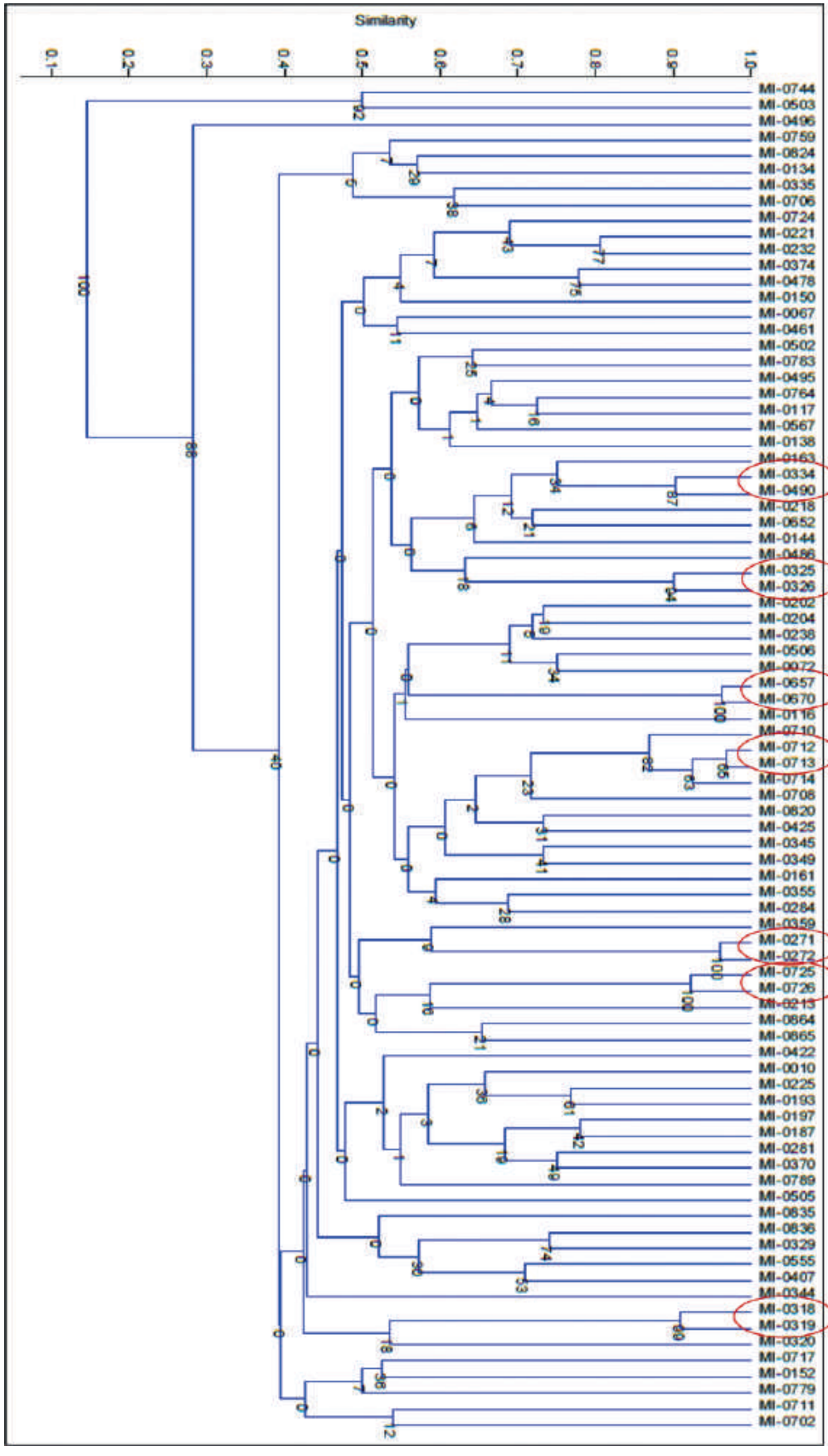


Figure 9: Dendrogram based on SSR markers (circled accessions are confirmed duplicates)

Utilization of output

After the identification of duplicates using molecular characterization of mulberry germplasm several utilities and benefits can be derived as bleow:

1. **Resource optimization:** By eliminating the duplicate accessions, resources such as land, labor and maintenance costs can be redirected towards the conservation and utilization of unique and diverse germplasm. This optimizes the efficiency of mulberry collections and ensures that resources are utilized effectively.

2. **Genetic diversity preservation:** The identification of duplicates allows more accurate assessment of the genetic diversity present in the mulberry germplasm collection. Preserving the diverse set of mulberry genetic resources is crucial for crop improvement. Also unique accessions can be prioritized for conservation and further research.

3. **Breeding and trait improvement:** Molecular characterization helps to identify unique accessions with desirable traits. These accessions can serve as valuable genetic resources for breeding programs aimed at developing improved mulberry cultivars with enhanced traits.

4. **Exchange and collaboration:** Accurate identification of duplicates using molecular markers facilitates effective exchange and collaboration between institutions, researchers and gene banks. This allows for sharing of unique accessions and the avoidance of redundant efforts, promoting greater collaboration and efficiency in mulberry research and breeding programs.

5. **Conservation and germplasm security:** Molecular characterization using SSR markers aids in maintaining the integrity of mulberry germplasm collections. By accurately identifying the duplicates, the risk of losing the valuable germplasm due to mislabeling or accidental loss is minimized. This ensures the long-term conservation of diverse mulberry germplasm for future generations.

Therefore, the utility of the mulberry germplasm lies in optimizing resource allocation, preserving genetic diversity, facilitating breeding and crop improvement, supporting research endeavors, and ensuring long-term conservation of valuable resources.

AIE-06003SI: Evaluation of silkworm genetic resources of *Bombyx mori* L. with reference to inbreeding depression and their conservation (December, 20 19 - November, 2022)

D.S. Somaprakash (PI) (upto-29.06.2020), C.M. Kishor Kumar (PI) (upto 31.07.2021), M. Maheswari (PI), G. Punithavathy, G. Lokesh, Jameela Khatoon (upto 31.05.2022), Ritwika Sur Chaudhuri and G.R.Manjunath (CO) - (CI)

Objectives:

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

Materials and Method:

- Rearing and grainage of 489 silkworm germplasm with Multivoltine and bivoltines races separately in different schedules. 1 crop Bivoltine (383) in 3 batches, 2 crop mutant races (23) and 5 crops multivoltine (83) silkworm races in a year.
- Evaluation of 489 SWGRs based on the Standard Operating Procedure (SOP) for conservation and maintenance of silkworm germplasm, recording data on set descriptors.
- Data analysis using Silkworm Germplasm Information System (SGIS) package, Mano's evaluation index, CSGRC evaluation index, and other available statistical packages.
- Evaluation for inbreeding depression and comparing observed data with available catalogue data for individual silkworm accessions for important economic characters.
- Calculation of Inbreeding depression (IBD) at different cycles as per following formula and the data will be analyzed to identify the levels of inbreeding in the silkworm germplasm resources:

$$IBD\ (\%) = [(g1 - g2)/g1] \times 100$$

Where g1: value of initial generation; g2: value of final generation

- Identification of silkworm accessions revealing inbreeding depression effects for important economic traits.
- Adoption of corrective measures by rejuvenating the accessions either by '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.

Result and Discussion:

The silkworm germplasm resources available at the centre include univoltine, bivoltine and multivoltine accessions. However due to continuous rearing, these strains have possibly undergone many evolutionary changes through mutations (natural as well as man-made selections), thereby creating a wide genetic diversity among the strains; but this diversity becomes more homogenous within the strain. This repeated inbreeding in each traditional strain results in the loss of valuable genes through a process called inbreeding depression. Therefore, it is imperative to prevent this genetic erosion due to excessive inbreeding to conserve the genetic resources of geographical strains for their use in divergent breeding programmes.

Evaluation of morphological characters of SWGRs:

The collection, characterization, evaluation and conservation of silkworm germplasm is a continuous programme as it is the main mandate of CSGRC Hosur. The centre has so far collected 489 silkworm germplasm accessions comprises 83 multivoltine, 383 bivoltine and 23 mutants. These accessions collected in phase wise manner, characterized by using set of morphological descriptors and evaluated for important economic parameters for growth and reproductive traits in each crop and conserved following different conservation crop cycles (**Table 5**).

The variability in the morphological features of different stages of all the silkworm accessions (SWGRs) for each descriptor was found 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 6**. The characterization on larval stage of multivoltine silkworm accessions revealed three types of larval patterns v*iz.,* plain, marked and mixed. The analysed data revealed that maximum accessions with plain larvae (46 accns, 55.4%) followed by marked (33 accns; 39.8%) and sex limited for larval marking (4 accns; 4.8%). In case of cocoon colour, maximum accessions revealed greenish yellow colour (35 accns; 42.2 %) followed by white (22 accns; 26.5%), chrome yellow (20 accns; 24.1%), yellow cocoons (4 accns; 4.8%) and creamy white (2 accns; 2.4%). Similarly the cocoon shape revealed maximum oval shaped cocoons (31 accns; 37.3%) followed by elongated with non constriction (24 accns; 28.9%), spindle shape (19 accns; 22.9%), spatulate (4 accns; 4.8%), dumbbell (3 accns; 3.6%) and elongated (2 accns; 2.4%).

In case of bivoltine accessions, majority of the accessions revealed plain (227 accns; 61.51%) followed by marked (136 accns; 36.85%), mixed (18 accns; 4.9%) and sex limited (2 accns; 0.5%). The cocoon colour revealed maximum accessions with white cocoons (349 accns; 91.12%) followed by creamish white (7 accns. 1.83%), Golden yellow (5 accns. 1.31%), Greenish yellow (4 accns 1.04%), Flesh yellow (4 accns 1.04%), Dull white (3 accns 0.78%), Flesh (2 accns 0.52%), Mixed (2 accns 0.52%), Off white (2 accns 0.52%), Chrome yellow (1 accn 0.26%). Similarly, the cocoon shape revealed that maximum accessions with oval (129 accns 34.96%), elongated faint constricted (61 accns 16.53%), elongated constricted cocoons (52 accns; 14.09%), elongated (41 accns 11.11%), Dumbbell (31 accns 8.40%), oval faint constriction (29 accns 7.86%), Elongated oval (19 accns 5.15%), Elongated faint constriction (15 accns 4.07%), spindle (6 accns 1.63%).

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% each). 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 5: Details on the phase wise collection of SWGRs

Year	Phase	Bivoltine	Multivoltine	Mutant	Total
1993-1997	I	169	57	-	**226**
1997-2000	II	103	-	-	**103**
2000-2003	III	40	8	19	**67**
2003-2006	IV	25	7	1	**33**
2006-2009	V	2	1	-	**3**
2009-2012	VI	11	1	-	**12**
2012-2015	VII	15	7	-	**22**
2015-2018	VIII	4	2	3	**9**
2018-2022	IX	14			**14**
Grand Total		**383**	**83**	**23**	**489**

Table 6: Morphological character variations in SWGRs

Parameters	Multivoltine		Bivoltine		Mutants	
	No.of accns.	(%)	No.of accns.	(%)	No.of accns.	(%)
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 13 growth and reproductive

traits is presented in **Table 7.** The coefficient of variation was highest for the characters like single shell weight (23.72%) followed by average filament length (19.96 %), Vth instar larval duration (13.84%), weight of 10 grown larvae (13.69 %), which indicate existence of the good amount of genetic variability among the accessions. The other phenotypic characters such as hatching %, yield per 10000 larvae by no., pupation rate and total larval duration did not show much variation in CV% indicating the adaptability of the inbred genotypes to the rearing environment.

Table 7. Overall performance of Multivoltine germplasm resources

Traits	Mean	Min	Max	SD	SE	CV%
Fecundity (No.)	396	326	486	32.76	3.60	8.28
Hatching (%)	96.11	86.75	97.45	1.45	0.16	1.51
Wt. of 10 Larvae (g)	23.20	18.55	35.04	3.18	0.35	13.69
Total larval duration (h)	537	519	587	16.92	1.86	3.15
V Larval duration (h)	120	100	171	16.56	1.82	13.84
ERR/No. (for 10000 larvae)	9479	9339	9736	78.48	8.61	0.83
ERR/wt. (in kg)	9.58	7.74	14.03	1.02	0.11	10.66
Pupation rate (%)	93.32	91.59	96.25	0.94	0.10	1.01
Single Cocoon wt (g)	1.045	0.816	1.489	0.12	0.01	11.59
Single Shell wt (g)	0.137	0.085	0.265	0.03	0.00	23.72
Shell Ratio (%)	13.07	10.49	18.00	1.60	0.18	12.23
Average filament length (m)	443	315	823	88.51	9.77	19.96
Filament size (d)	2.00	1.55	3.02	0.27	0.03	13.70

Further, individual trait-wise top performing 20 multivoltine SWGRs for various important traits along with the range values are presented in **Table 8**.

Table 8. Trait-wise top performing multivoltine SWGRs

Trait	Range	Accession No.
Fecundity (No.)	440-486	BMI-0084, BMI-0039, BMI-0070, BMI-0083, BMI-0045, BMI-0006, BMI-0038, BMI-0023, BMI-0085, BMI-0034
Hatching %	97.12-97.45	BME-0047, BMI-0077, BME-0030, BMI-0007,BMI-0025, BMI-0034, BMI-0039, BMI-0032, BME-0052, BMI-0023
Wt. of 10 grown larvae (g)	26.64-35.04	BMI-0083, BMI-0084, BMI-0085, BMI-0078, BMI-0080, BMI-0076, BMI-0066, BMI-0081, BMI-0074, BME-0048
ERR/No. (for 10000 larvae)	9579-9736	BMI-0084, BMI-0083, BMI-0081, BMI-0001, BMI-0006, BMI-0085, BMI-0068, BMI-0072, BMI-0053, BMI-0082
ERR/wt. (in kg)	10.45-14.03	BMI-0083, BMI-0084, BMI-0078, BMI-0025, BMI-0076, BMI-0080, BMI-0081, BMI-0024, BMI-0040, BMI-0085
Pupation rate (%)	94.57-96.25	BMI-0084, BMI-0083, BMI-0081, BMI-0068, BMI-0001, BMI-0085, BMI-0006, BMI-0046, BMI-0082, BMI-0072
Single cocoon wt. (g)	1.149-1.490	BMI-0083, BMI-0084, BMI-0085, BMI-0080, BMI-0078, BMI-0076, BMI-0081, BMI-0025, BMI-0066, BMI-0024
Single shell wt. (g)	0.162-0.26	BMI-0083, BMI-0084, BMI-0076, BMI-0085, BMI-0080, BMI-0081, BMI-0078, BMI-0066, BMI-0073, BMI-0065

Trait	Range	Accession No.
Shell ratio (%)	14.79-18.00	BMI-0083, BMI-0076, BMI-0084, BMI-0085, BMI-0080, BMI-0081, BMI-0073, BMI-0074, BMI-0060, BME-0052
Avg Filament Length (m)	546.33-823.33	BMI-0076, BMI-0081, BMI-0074, BMI-0078, BMI-0066, BMI-0083, BMI-0073, BMI-0025, BMI-0084, BMI-0024
Filament size (d)	1.55-1.74	BME-0015, BMI-0021, BMI-0055, BME-0049,BMI-0053, BMI-0022, BMI-0037, BMI-0027, BME-0047, BMI-0069

The multiple trait evaluation for the rearing and reeling traits (**Table 9**) revealed that, accession BMI-0084 ranked first with best performance for 8 traits followed by BMI-0083 and BMI-0085 and BMI-0081 with 8 traits, BMI-0076 with 6 traits, BMI-0080 for 5 traits and BMI-0078 with 4 traits.

Table 9. Top performing multivoltine SWGRs for multiple traits

Accession No.	No. of traits	Trait No. and Values
BMI-0084	8	1(486), 3(33.12), 6(9736), 7(13.05), 8(96.25), 9(1.457), 10(0.258), 11(17.82)
BMI-0083	8	1(450), 3(35.04), 6(9724), 7(14.03), 8(95.98), 9(1.489), 10(0.265), 11(18)
BMI-0085	8	1(442), 3(32.22),6(9600),7(10.45),8(95), 9(1.322), 10(0.216), 11(16.49)
BMI-0081	8	3(26.99), 6(9662), 7(11), 8(95.44), 9(1.224), 10(0.195), 11(16.08), 12 (618)
BMI-0076	6	3(29.31), 7(11.14), 9(1.267), 10(0.226), 11(17.96), 12 (823)
BMI-0080	5	3(29.56), 7(11.06), 9(1.304), 10(0.209), 11(16.21),
BMI-0078	4	3(31.37), 7(11.54), 9(1.292), 10(0.188),
BMI-0006	3	1(448), 6(9607), 8(94.71),
BME-0047	3	2(97.45), 4(520), 5(103),
BMI-0025	3	2(97.29), 7(11.3), 9(1.216),
BMI-0066	3	3(28.1), 9(1.182), 10(0.174),

Figures in parantheses indicates the actual value of the traits

1.Fecundity (Nos.), 2.Hatching (%), 3.Wt of 10 larvae (g), 4. Total Larval duration (hrs.) 5.Vth instar duration (hrs.) 6.ERR/No. 7.ERR/Wt. (kg) 8.Pupation Rate (%) 9.Single cocoon weight (g) 10. Single shell weight (g) 11. Shell ratio (%), 12. Average filament length (m), 13. Filament size (d)

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 13 important quantitative traits is presented in **Table 10.** 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 Vth instar larval duration (15.87%), followed by average filament length (15.31%), single shell weight (12.69%), filament size (11.17%). The other characters such as hatching (%), total larval duration, yield per 10000 larvae by no. did not show much variation in CV%.

Table 10. Overall performance of Bivoltine germplasm resources

Traits	Mean	Min	Max	SD	SE	CV%
Fecundity (No.)	476	276	684	51.72	2.66	10.88
Hatching (%)	97.04	86.87	99.29	1.34	0.07	1.38
Wt. of 10 Larvae (g)	34.23	17.62	44.50	3.60	0.19	10.53
Total larval duration (h)	521	480	576	40.20	2.06	7.72
V Larval duration (h)	121	96	144	19.13	0.98	15.87
ERR / No. (for 10000 larvae)	8470	5720	9900	716.48	36.80	8.46
ERR / wt. (in kg)	11.81	7.05	15.30	1.34	0.07	11.37
Pupation rate (%)	79.94	53.00	97.50	8.23	0.42	10.30
Single Cocoon Wt. (g)	1.481	0.998	1.791	0.11	0.01	7.61
Single Shell Wt. (g)	0.273	0.108	0.361	0.03	0.00	12.69
Shell Ratio (%)	18.52	10.13	22.84	1.58	0.08	8.51
Average filament length (m)	801	195	1153	122.72	6.87	15.31
Filament size (d)	2.48	1.67	3.34	0.28	0.02	11.17

The better performing bivoltine accessions shortlisted based on top performing as well as multiple trait analysis for individual and multiple important economic traits are presented along with the range values in **Tables 11 and 12** respectively.

Table 11. Top performing bivoltine germplasm accessions for individual traits

Trait	Range	Accession No.
Fecundity (No.)	602-684	BBI-0298, BBI-0401, BBI-0402, BBI-0274, BBI-0172, BBI-0400, BBE-0264, BBE-0270, BBI-0215, BBE-0262
Hatching (%)	98.71-99.29	BBI-0304, BBI-0273, BBI-0406, BBE-0262, BBE-0216, BBI-0113, BBI-0340, BBI-0401, BBE-0244, BBE-0192
Wt. of 10 grown larvae (g)	40.11-44.5	BBI-0172, BBI-0282, BBE-0179, BBE-0188, BBI-0285, BBE-0269, BBE-0171, BBE-0198, BBI-0286, BBI-0384
ERR / wt. (in kg)	14.35-15.30	BBE-0221, BBE-0226, BBE-0189, BBE-0238, BBE-0224, BBE-0179, BBE-0262, BBI-0135, BBE-0265, BBI-0383
Pupation rate (%)	96.5-97.5	BBE-0221, BBE-0238, BBI-0135, BBI-0383, BBI-0204, BBI-0257, BBI-0382, BBI-0372, BBI-0371, BBE-0260
Single cocoon wt. (g)	1.65-1.79	BBE-0039, BBE-0188, BBI-0302, BBI-0172, BBE-0182, BBE-0187, BBE-0174, BBE-0003, BBE-0179, BBI-0300
Single shell wt. (g)	0.33-0.36	BBE-0182, BBI-0388, BBE-0188, BBE-0179, BBI-0324, BBE-0187, BBI-0359, BBI-0344, BBI-0385, BBI-0351
Shell ratio (%)	21.34-22.84	BBI-0324, BBE-0197, BBI-0388, BBI-0359, BBE-0182, BBE-0220, BBE-0179, BBI-0284, BBE-0224, BBI-0325
Avg. Filament Length (m)	1000-1153	BBI-0364, BBI-0389, BBI-0368, BBI-0350, BBI-0358, BBI-0203, BBE-0179, BBI-0378, BBE-0214, BBI-0356
Filament size (d)	1.67-2.01	BBI-0093, BBI-0140, BBE-0195, BBE-0218, BBE-0189, BBI-0248, BBE-0169, BBE-0166, BBI-0085, BBI-0127

Data analysis indicated that, accession BBE-0179 performed best for 6 economic traits followed by BBE-0262, BBE-0221, BBI-0172, BBE-0188, BBE-0238 and BBE-0182 performed best for 3 traits.

Table 12. Top ranking bivoltine germplasm accessions identified for multiple traits

Accession No.	No. of traits	Trait No. and Values
BBE-0179	6	3(42.09), 7(14.55), 9(1.658), 10(0.354), 11(21.51),12 (1028)
BBE-0262	3	1(602), 2(98.92), 7(14.5)
BBE-0221	3	6(9900), 7(15.3), 8(97.5)
BBI-0172	3	1(618), 3(44.5), 9(1.694)
BBE-0188	3	3(41.8), 9(1.78), 10(0.357)
BBE-0238	3	6(9850), 7(14.65), 8(97.5)
BBE-0182	3	9(1.687), 10(0.361), 11(21.68)

Figures in parantheses indicates the actual value of the traits

1.Fecundity (Nos.), 2. Hatching (%), 3. Wt of 10 larvae (g), 4. Total Larval duration (h) 5. Vth instar larval duration (h) 6. ERR/No. 7.ERR/Wt. (kg) 8.Pupation Rate (%) 9. Single cocoon weight (g) 10. Single shell weight (g) 11. Shell ratio (%), 12. Average filament length (m), 13. Filament size (d)

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 13**. 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 wt.(15.9%), yield per 10000 larvae by wt. (15.6%), wt. 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 no., pupation rate, hatching (%) and total larval duration did not show much variation in CV% indicating the stabilized nature of genotypes to the rearing environment.

Table 13. Overall performance of Mutants germplasm resources

Traits	Mean	Min	Max	SD	SE	CV%
Fecundity (No.)	348	150	449	76.85	16.39	22.10
Hatching (%)	95.17	88.70	98.17	2.69	0.57	2.83
Wt. of 10 Larvae (g)	23.43	14.25	30.08	4.01	0.86	17.12
Total larval duration (h)	516	504	522	4.19	0.89	0.81
V Larval duration (h)	108	96	114	4.19	0.89	3.89
ERR / No. (10000 larvae)	7958	6770	9250	770.35	164.24	9.68
ERR / wt. (in kg)	8.74	6.08	11.90	1.59	0.34	18.22
Pupation rate (%)	74.87	60.50	90.10	9.07	1.93	12.11
Single Cocoon Wt (g)	1.036	0.688	1.308	0.15	0.03	14.94
Single Shell Wt (g)	0.142	0.083	0.226	0.03	0.01	23.60
Cocoon Shell Ratio (%)	13.68	11.06	17.55	1.55	0.33	11.37

III. Conservation of silkworm genetic resources:

a. Conservation of Multivoltine Silkworm genetic resources:

All the 83 multivoltine accessions were conserved by conducting rearing for five conservation crops (129th to 133rd generation) and the eggs were preserved at a temperature of 5º C for 35 days with backups for 45 and 60 days in the cold storages located at Hosur and Mysuru respectively. The multivoltine accessions were maintained true to type on par with catalogue data without any loss ensuring disease freeness.

b. Conservation of Bivoltine Silkworm genetic resources:

All the 383 bivoltine accessions were conserved by conducting rearing in three batches and the egg layings were preserved under 10 months hibernation schedule with one crop per year. As a backup, the egg layings of all the three batch accessions were also conserved under 12-month hibernation schedule in the cold storages located at Hosur and Mysuru. The accessions were maintained true to type on par with the catalogue data without any loss and ensuring disease freeness. So far, first batch accessions have completed 29 generations, second batch accessions 26 generations and third batch accessions 19 generations from the year 2004.

c. Conservation of Mutant SWGRs:

All the 23 bivoltine mutant genetic stocks were conserved following 6 months hibernation schedule @ 2 crops per year. These 23 mutant accessions have completed 42-43 generations. As a back-up, the accessions were conserved under 8 months hibernation schedule in the cold storages located at Hosur and Mysuru. The accessions were maintained true to type on par with the catalogue data without any loss and ensuring disease freeness.

IV. Estimation of Inbreeding Depression in SWGRs

Since, the silkworm accessions are conserved and maintained through inbreeding, populations of each accession become more homozygous that may lead to loss of unique and valuable genes through the process of inbreeding depression. As per the database of past five years, it was observed that the economic / quantitative characters of few germplasm accessions showed variations compared to the passport data which could be due to effects of inbreeding depression (IBD). Hence, it is proposed to estimate the IBD in the conserved silkworm accessions so as to take appropriate measures for efficient conservation. Based on the performance data of the accessions, which are showing high IBD% will be rejuvenated either by 'settling rearing' i.e. rearing the accessions at the original collection centre or by collecting dfls from the safety back up at the original collection station.

Under the study, data collected from 2020-2022 on the rearing and reeling performance of both 369 bivoltine and 83 multivoltine accessions were compiled and subjected to Inbreeding depression (IBD) analysis. Based on the analysis, it was grouped into three clusters viz. High performance with low IBD %, Medium performance with moderate IBD% and Low performance with high IBD%.

In case of bivoltine, the high performance cluster with low IBD % covers 55 exotic and 77 indigenous accessions. The medium performance cluster with moderate IBD % includes 103 exotic and 132 indigenous accessions whereas the low performance cluster with high IBD % includes 2 exotic accessions only (**Table-14**). Further, the year wise IBD performance of bivoltine silkworm germplasm are depicted in **Table-15**.

Table 14. Inbreeding depression analysis of bivoltine SWGRs

Year	Cluster	Exo./Ind.	Details of the Accns.
2020-22	High performance with Low IBD (%) (>+5)	Exotic (55)	BBE-0002-0003, 0008-0011, 0013-0015, 0018, 0020-0021, 0022, 0024-0027, 0029, 0035, 0038-0039, 0041, 0049, 0051, 0142, 0145-0149, 0152-0153, 0155-0156, 0158-0159, 0164, 0170, 0185, 0193, 0195-0197, 0213, 0216, 0230, 0231, 0240, 0244-0245, 0247, 0251, 0260, 0264, 0280
		Indigenous (77)	BBI-0045, 0048, 0055-0057, 0062-0063, 0069-0071, 0075, 0078, 0080, 0082, 0084-0085, 0091-0092, 0095, 0097, 0102-0110, 0112-0113, 0115-0116, 0119, 0122, 0124-0129, 0133, 0136, 0138-0139, 0205, 0255, 0257-0258, 0274-0275, 0277, 0281, 0283-0285, 0296, 0298, 0302, 0305, 0324, 0339, 0340, 0343, 0345, 0351, 0358, 0362-0364, 0366-0369, 0386
	Medium Performance with moderate IBD (%) (-5 to +5)	Exotic (103)	BBE-0001, 0004-0007, 0012, 0016-0017, 0019, 0023, 0028, 0030-0034, 0036-0037, 0040, 0042, 0043, 0050, 0143-0144, 0150-0151, 0154, 0157, 0160-0163, 0165-0169, 0171, 0173-0184, 0186- 0187-0192, 0194, 0198-0202, 0209-0212, 0214, 0217-0229,0232,0233,0236,0238,0241,0242, 0246, 0250, 0252, 0261-0263, 0265-0270,0272, 0288, 0329, 0332
		Indigenous (132)	BBI-0044, 0046-0047, 0052-0054, 0058-0061, 0064-0068, 0072-0074, 0076-0077, 0079, 0081, 0083, 0086-0089, 0093, 0096, 0098-0101, 0111, 0114, 0117-0118, 0120-0121, 0123, 0130-0132, 0135, 0137, 0140-0141, 0172, 0203-0204, 0207-0208, 0215, 0234-0235, 0237, 0239, 0243, 0248-0249, 0253-0254, 0256, 0259, 0271, 0273, 0276, 0278-0279, 0282, 0286-0287, 0289-0295, 0297, 0299-0301, 0303-0304, 0325-0328, 0330, 0334-338, 0341-0342, 0344, 0346-0350, 0352-0357, 0359-0361, 0365, 0370-0385, 0387-0389
	Low performance with high IBD (%) (<-5)	Exotic (2)	BBE-0189, 0201
		Indigenous(0)	--

Table 15. Year wise Clustering of bivoltine germplsam resources based on IBD % for 2020-22

IBD level	2020	2021	2022	2020-2022
High performance with Low IBD (>+5)	Exotic (51)	Exotic (88)	Exotic (69)	Exotic (55)
	Indigenous (111)	Indigenous (108)	Indigenous (48)	Indigenous (77)
Medium Performance with moderate IBD (%) (-5 to +5)	Exotic (87)	Exotic (71)	Exotic (88)	Exotic (103)
	Indigenous (93)	Indigenous (100)	Indigenous (156)	Indigenous (132)
Low performance with high IBD (%) (<-5)	Exotic (21)	Exotic (0)	Exotic (2)	Exotic (2)
	Indigenous (6)	Indigenous (2)	Indigenous (6)	Indigenous (0)

In case of multivoltine, the high performance cluster with low IBD % covers 6 exotic and 33 indigenous accessions. The medium performance cluster with moderate IBD % includes 4 exotic and 37 indigenous accessions. Whereas the low performance cluster with high IBD % includes 0 exotic and 3 indigenous accessions (**Table-16**) and the year wise IBD performance of silkworm germplasm resources are presented in **Table-17**.

Table 16. Clustering of Multivoltine SWGRs based on IBD% for 2020-22

Year	Cluster	Exo./Ind.	Details of the Accns.
2020-22	High performance with Low IBD (%) (>+5)	Exotic (6)	BME-0005, 0012-0013, 0030, 0050, 0052
		Indigenous (33)	BMI-0002, 0004, 0006, 0009-0011, 0017, 0020-0021, 0023-0027, 0029, BMI-0032-0035, 0039-0041, 0044, 0046, 0054-0056, 0060, 0062-0064, 0066, 0073
	Medium Performance with moderate IBD (%) (-5 to +5)	Exotic (4)	BME-0015, 0047-0049
		Indigenous (37)	BMI-0001, 0003, 0007-0008, 0014, 0016, 0018-0019, 0022, 0028, 0031, 0036-0038, 0042-0043, 0045, 0053, 0057-0059, BMI-0061, 0065, 0067-0072, 0074-0084
	Low performance with high IBD (%) (<-5)	Exotic (0)	-
		Indigenous (3)	BMI-0077, 0078, 0082

Table 17. Year wise clustering of Multivoltine SWGRs based on IBD%

IBD level	2020	2021	2022	2020-2022
High performance with Low IBD(%) (>+5)	Exotic (6)	Exotic (8)	Exotic (4)	Exotic (6)
	Indigenous (11)	Indigenous (50)	Indigenous (31)	Indigenous (33)
Medium Performance with moderate IBD (%) (-5 to +5)	Exotic (5)	Exotic (2)	Exotic (6)	Exotic (4)
	Indigenous (60)	Indigenous (21)	Indigenous (37)	Indigenous (37)
Low performance with high IBD (%) (<-5)	Exotic (0)	Exotic (0)	Exotic (0)	Exotic (0)
	Indigenous (2)	Indigenous (2)	Indigenous (5)	Indigenous (3)

When the data on rearing and reeling parameters of 369 bivoltine and 83 multivoltine accessions for the period from 2020-2022 analysed to assess IBD%, 37 bivoltine accessions and 12 multivoltine accessions were expressed moderate to high inbreeding depression (IBD%) (**Table 18 & 19**).

Table 18. Bivoltine accessions under medium and low cluster with (-) ve IBD% in 2020-2022

#	Accession	IBD%	#	Accession	IBD%	#	Accession	IBD%	#	Accession	IBD%
1	BBE-0201	-6.66	**11**	BBE-0019	-2.02	**21**	BBE-0222	-0.35	**29**	BBI-0207	-1.75
2	BBE-0189	-5.20	**12**	BBE-0143	-2.00	**22**	BBE-0261	-0.30	**30**	BBI-0093	-1.01
3	BBE-0177	-2.67	**13**	BBE-0173	-1.99	**23**	BBE-0160	-0.20	**31**	BBI-0355	-0.96
4	BBE-0232	-2.53	**14**	BBE-0168	-1.84	**24**	BBE-0252	-0.07	**32**	BBI-0377	-0.84
5	BBE-0167	-2.45	**15**	BBE-0176	-1.82	**25**	BBI-0141	-4.16	**33**	BBI-0254	-0.69
6	BBE-0288	-2.37	**16**	BBE-0036	-1.38	**26**	BBI-0235	-2.92	**34**	BBI-0353	-0.58
7	BBE-0175	-2.21	**17**	BBE-0192	-0.75	**27**	BBI-0208	-2.81	**35**	BBI-0286	-0.42
8	BBE-0190	-2.19	**18**	BBE-0042	-0.46	**28**	BBI-0303	-2.09	**36**	BBI-0249	-0.26
									37	BBI-0243	-0.04

Table 19. Multivoltine accessions under medium and low cluster with (-) ve IBD% in 2020-2022

#	Accession	IBD%
1	BMI-0082	-9.71
2	BMI-0077	-6.07
3	BMI-0078	-5.66
4	BMI-0079	-4.76
5	BME-0047	-3.87
6	BMI-0083	-2.28
7	BMI-0081	-1.26
8	BMI-0071	-1.14
9	BMI-0074	-1.09
10	BMI-0076	-1.09
11	BMI-0080	-0.41
12	BMI-0016	-0.40

In order to evaluate the performance of the silkworm germplasm resources, the rearing and reeling performance of the exotic as well indigenous bivoltine accessions were subjected for Principal Component Analysis (PCA) to assess the performance of SWGRs. Based on the PCA, the graphical representation of exotic bivoltine accessions and indigenous bivoltine accessions were depicted in **Figures 10** and **11** respectively.

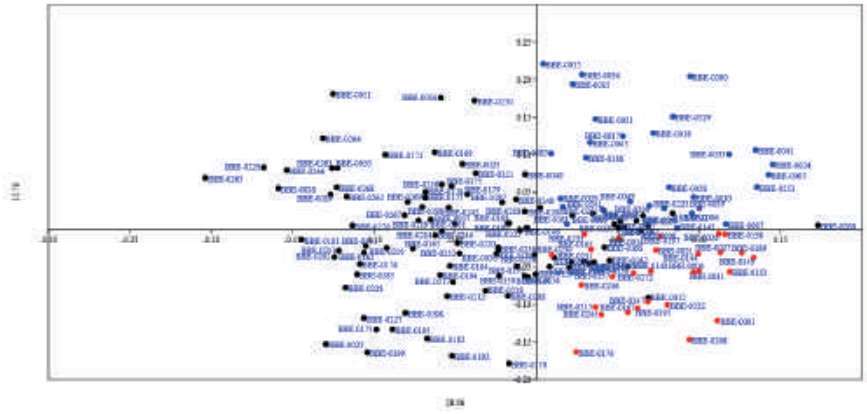


Fig.10 PCA graphical representation of Exotic bivoltine accessions for the period 2020-22

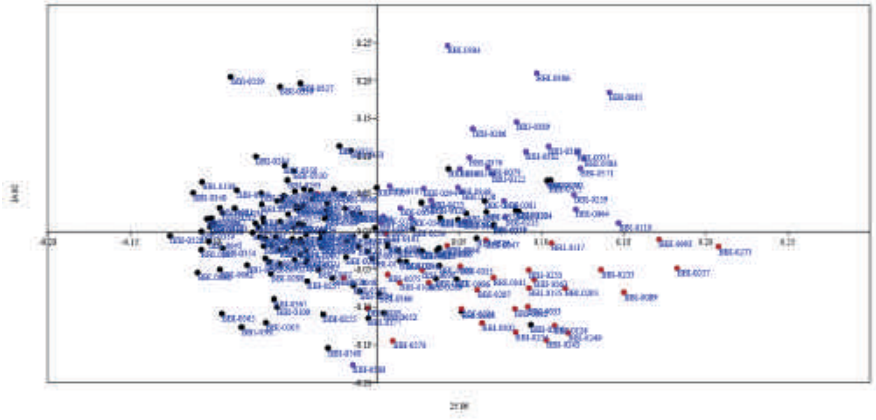


Fig. 11 PCA graphical representation of Indigenous bivoltine accessions for the period 2020-22

Similarly, the performance of the exotic as well as indigenous multivoltine accessions were compiled, analysed through principal co-ordinate analysis and presented in Fig.12 & 13 respectively.

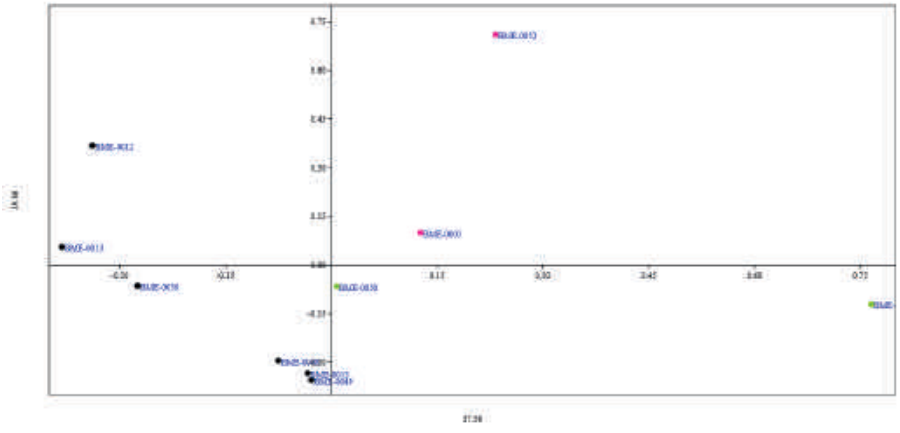


Fig.12 PCA graphical representation of Exotic Multivoltine accessions for the period 2020-22

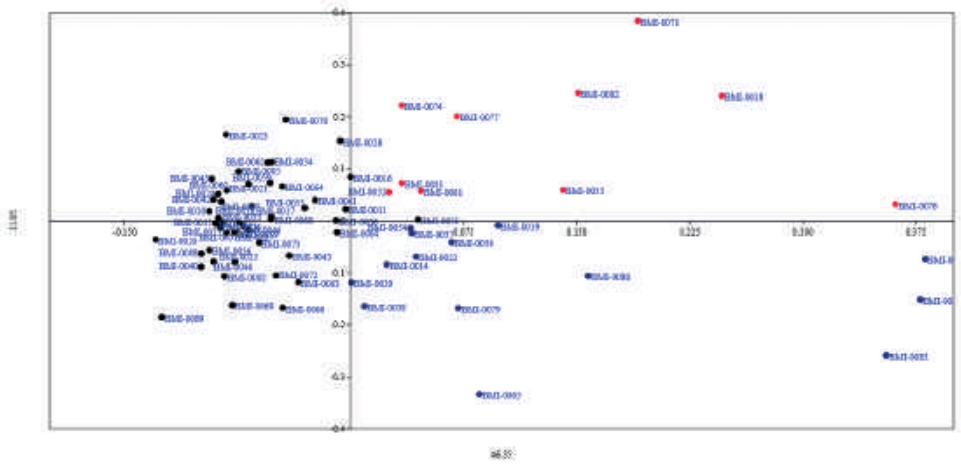


Fig.13 PCA graphical representation of Indigenous Multivoltine accessions for the period 2020-22

Objective 2: To promote utilization of sericultural germplasm for crop improvement programmes

During the year, under the project 232 dfls of bivoltine and 101 dfls of multivoltine silkworm accession was supplied for research and academic purpose (**Table 20**).

Table 20. Details on the dfls supply of silkworm germplasm resources from 2020-2022

#	Name and address of the Indenter	No. of the accession	Accession Nos.	Date of Supply	No. of DFLs supplied	
					MV	BV
1.	RSRS,Sahaspur	1BV	BBE-0148	14.05.20	-	7
2.	SSTL , Kodathi	9 MV 5 Dfls/ accn	BMI-0001, 2, 68,70, 71,74,78, 79, 80, 81	20.05.20	47	-
3.	Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, Maharastra	6 MV & 1BV 2Dfls/accn	BMI000 1,5,6,10, 59, 73 & BBE 0292	24.08.20	12	2
4.	SBRL , Kodathi	4 MV	BMI00017,18,19 (50 cocoons/accn.) BMI0001- 200 larva	10.09.20 19.08.20	4	-
5.	RSRS,Jammu	1BV	BHR2	09.03.21	-	5
6.	NM College of Agriculture, Narsari, Gujarat	5MV 10 Dfls/ accn	BMI-066,73,74,80,83	23.06.21	50	-
7.	CSR&TI , Berhampore	15MV	BMI-002,16,21,24,25, 27, 50, 66, 68, 69, 70, 72, 73, 79, 80	23.06.21	71	-
8.	VNMKV , Parbhani	6MV,7BV 5Dfls/accn	BMI-073, 59, 001, 006, 56, BME-005, BBI-292, 327, 328, 386,387, 384, 385	03.08.21	30	35
9.	University of Mysore	10BV 2 Dfls/accn	BBI-0336, 364,368, 374, 389, 347, 363, 387, 379, 382	09.12.21	-	20
10.	North eastern hill university	IBV	BBI-0293	16.4.22	-	02
11.	VNMKV, Parbhani	6MV, 6BV 3 Dfls/accn	BMI-001,6,10,59,73 & BME-005,BBI-0292, 327, 328,384,386 & 387	01.09.22	18	18
12.	Yuvaraj University, Mysuru	6BV	BBI-0330, 360, 366, 367, 377 & 389	29.09.22	-	12
Total					**232**	**101**
Grand Total					**333**	

Objective 3: To maintain National database on silkworm accessions and catalogue the data documentation

During the period, morphological characterization for 489 silkworm germplasm resources using 27 descriptors on various growth stages viz., egg, larva, cocoon, pupa and moth, to confirm its maintenance true to catalogue data was carried out. The data generated were updated in the Silkworm Germplasm Information System [SGIS] database. A total of 14 bivoltine accessions, 2 multivoltine accessions and 3 mutants were characterized obtained the national accessions numbers and included in the National database of the centre (**Table 21**).

Table 21. National Accession Numbers for SWGRs obtained from NBAIR, Bengaluru.

#	Acc. No.	National Acc. No.	Voltinism	Race Name
1	BBI-0393	NBAIR-BBI-0393	Bivoltine	BG(W)
2	BBI-0394	NBAIR-BBI-0394	Bivoltine	BHR-2
3	BBI-0395	NBAIR-BBI-0395	Bivoltine	SK3C
4	BBI-0396	NBAIR-BBI-0396	Bivoltine	SK4N
5	BBI-0397	NBAIR-BBI-0397	Bivoltine	MC4(E)
6	BBI-0398	NBAIR-BBI-0398	Bivoltine	D-5
7	BBI-0399	NBAIR-BBI-0399	Bivoltine	NBP4
8	BBI-0400	NBAIR-BBI-0400	Bivoltine	D-6(M)
9	BBI-0401	NBAIR-BBI-0401	Bivoltine	NBO-2
10	BBI-0402	NBAIR-BBI-0402	Bivoltine	MJ-2
11	BBI-0403	NBAIR-BBI-0403	Bivoltine	NBO-3
12	BBI-0404	NBAIR-BBI-0404	Bivoltine	MJ-1
13	BBI-0405	NBAIR-BBI-0405	Bivoltine	MC4(O)
14	BBI-0406	NBAIR-BBI-0406	Bivoltine	MC-2
15	BMI-0083	NBAIR-BMI-0083	Multivoltine	ND-7
16	BMI-0084	NBAIR-BMI-0084	Multivoltine	NDV-6
17	BBE-0390	NBAIR-BBE-0390	Mutant	TMS-4
18	BBE-0391	NBAIR-BBE-0391	Mutant	TMS-13
19	BBE-0392	NBAIR-BBE-0392	Mutant	TMS-18

Conclusion

It is essential to conserve and utilize the wild relatives of *Bombyx mori* to broaden the genetic base of the domesticated races apart from utilizing the geographically divergent races, mutants, sex-limited races, evolved breeds, breeder's genetic stocks, and exotic resources. Therefore, conservation of wild as well as domesticated seri-biodiversity resources is necessary for sustainable development of sericulture since loss of genetic resources of domesticated and wild relatives of *Bombyx* species along with their unique genes may be disadvantage for future generations (FAO Manual 2003). Hence understanding the effects of inbreeding for various traits can be very crucial points in the management of germplasm. Another important objective of silkworm genetic resource conservation is to protect the available seri-biodiversity from extinction. At present only few old Indian indigenous races survive, viz. Barapolu, Chotapolu, Nistari, Sarupat, and Moria; several indigenous races like Ichot, Nishmo, Itan, and the univoltine Kashmiri races are extinct w(FAO Manual 2003). So far, evidence of effects of inbreeding on inbreeding coefficients in silkworm populations is limited. Therefore, it is essential to develop appropriate strategies for the conservation of biodiversity not only for the vulnerable populations, but also for sustainable utilization of silkworm genetic resources.

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

PIT-08004 MI: Study on epigenetic and autophagy modifiers on induction of haploid microspore embryogenesis in mulberry

A. Ramesha (PI), Himanshu Dubey (SBRL, Kodathi), Prashanth Sangannavar (CO-CSB), Shri. Raju Mondal (CSGRC, Hosur)-CI & Ms. Sreya Antony (JRF)

Objective

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

Progress

Immature flower buds (1.5-2 mm) from male/female catkins were collected at morning 8 AM. After collection samples were subjected to surface sterilization following the steps- (1) wash 10 min in 0.1% $HgCl_2$, (2) wash with Tween-20 for 10 min (Step 2-5 processed under laminar air flow); (3) wash with 70% ethanol for 70 Sec; (4) wash 2 time in autoclaved ddH_2O; (5) carefully isolate anthers/ ovule from the inflorescence & placed in embryo induction media and response was recorded in percentage (%). Embryo induction medium comprising MS supplemented vitamins (Nicotinic acid, Pyridoxal 5P, Thymidine), sucrose (3%). The pH of the media was adjusted to 5.8 using 1 N KOH and 0.1 N HCl; 0.8% (*w*/*v*) agar was used for solid media. The plant growth regulators (PGRs) such as 2,4-dichlorophenoxy acetic acid (2,4-D), Indole acetic acid (IAA), kinetin (Kin), and 6-benzyladenine (BAP) were added to the media after filter sterilization. The cultured anthers/ovary were placed in the dark at 4 °C for the first 7 days and then cultured under a 16 h light-dark photoperiod at 25 ± 2 °C.

Effect of individual and combination of PGRs and mulberry accessions on the anther response at 30, 60 and 90 days of culture. Responses like embryogenesis, and organogenesis were observed using different concentration and combination of PGRs. Seasonal impact on embryo induction from microspore has been identified. Embryo from single and multi-cellular in origin was identified. Proembryo, globular, hart, torpedo, cotyledonary stages along with bipolar haploid plants were achieved with low frequency. Embryo developed from V1 anther was transferred to the full-strength MS for conversion to plantlets (0.2%). Optimum conversion and subsequent elongation were achieved in GA3 (0.5 mg 1-1). However, albinism plants were obtained from anther cultures **(Figure 14)**.

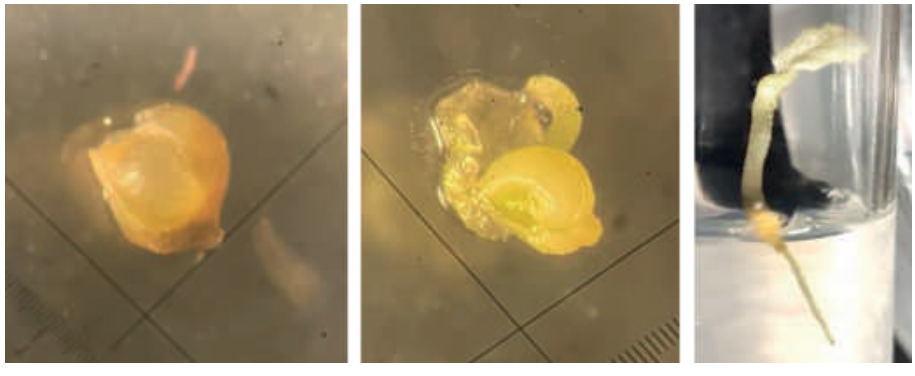


Figure 14: (A, B) Culture response of anther and ovary. (C) Albino plants generated from cultured anther of V1.

6. PROGRESS OF RESEARCH PROJECTS

MULBERRY DIVISION: [*Projects continued through 2022-23]*

1. PIE06008SI: Exploration-collection, Characterization, Evaluation, Re-establishment, conservation and Supply of Mulberry Genetic Resources (MGRs) - January, 2023 to December, 2025: Phase-10.

G.Thanavendan (PI), M.C. Thriveni, Raju Mondal, Halagunde Gowda, (CO-CSB), G. Ravikumar (upto February, 2023), N. Sakthivel

Objective1: Exploration and collection of new mulberry germplasm

Survey-1: A total of 8 new mulberry collections were collected from Koloriang (3 nos.), Sangram (2 nos), New Palin (2 nos) and Yazhuli-Putin (1 no.) of Kurung Kumey and Kara Daadidistrict of Arunachal Pradesh in North-Eastern India **(Figure 15)**. A total of 8 mulberry germplasm was collected from Arunachal Pradesh during September 2022 and are being maintained in raised nursery bed in conditions.

Figure 15: Mulberry germplasm collected from Kurung-Kumey and Kara-Daadi district of Arunachal Pradesh in North eastern regions of India

Survey-2: Five new mulberry germplasm were collected from Varanasi, UP during, January 2023 **(Figure 16).**

Figure 16: Mulberry germplasm collected from Varanasi, Uttar Pradesh

Objective 2:Re-establishment and Conservation of mulberry germplasm under ex-situ gene bank

The re-establishment of 115 exotic mulberry germplasm was completed in ex situ FGB and also maintained all exotic mulberry germplasm with proper labeling as per SOP (dual labeling of each accession as per SOP **(Figure 17,18 & 19).**

Figure 17: Uprooting of old exotic mulberry germplasm

Figure 18: Land preparation, pit making and transplantation activity

Figure 19:Uprooting of old mulberry exotic accessions, land preparation and Re-establishment activities and transplantation of 115 Exotic accessions under *ex-situ* conditions

- A total of 1317 mulberry accessions (Indigenous - 1032; Exotic – 285) were conserved under *ex-situ* gene bank and intercultural operations (FYM and fertilizer application and plant protection strategies etc.) were carried out as per the SOP **(Figure 20)**.
- A net area of 1.5 acres was prepared in well and pits were made with spacing 10 x 10 ft for re-establishment. As per the SOP drip irrigation facility was created @ 8.0lph for each accession.
- Visited ICAR-National Bureau of Plant Genetic Resources (NBPGR), New Delhi visited during 22 to 24.08.2022 for the discussion about the current status of cryopreserved mulberry germplasm accessions (338 nos.) and future work plan and institutional collaboration work.
- Museum plots were re-established and intercultural operations took as and when required for 14 *Morus spp*. and 10 morpho types of mulberry genetic resources were conserved as separately as part of conservation activities.
- Soil samples were Collected 15 plots of ex-situ FGB, General plots 10nos, other conservation plots were sent to CSRTI, Mysore for analysis. A total of 204 Indigenous accessions were established in nursery grow-bags (set-1) for safety back up and for further Re-establishment in FGB.

Figure 20: Intercultural operations, rain water draining and plant protection measures were taken into *ex-situ* field gene bank (FGB) for the management of economically important insect pests and diseases etc.,

Objective 3: Characterization and Evaluation of Mulberry Genetic Resources (MGRs) under *ex-situ* gene bank

A preliminary observation of mulberry accessions was done for the percent incidence of major pests viz., termites and stem borer for summer season.

Objective 4: Supply and collect feedback information on Mulberry Genetic Resources (MGRs)

A total of 62 mulberry accessions comprising 29 exotic and 33 indigenous accessions were supplied to 6 indenters (Table-22) for different purposes as mentioned below;

Table 22: Details of mulberry germplasm supplied from CSGRC, Hosur

#	Name and address of the indenter	No. of Accessions			Purpose
		Ind.	Exo.	Total	
1	The Director CSR&TI, Central Silk Board, Srirampura, Mysuru.	0	1	1	Evaluation of AICEM Trial for AGB-8
2	The Dean College of Sericulture Chindamani (UAS-B).	21	9	30	Post graduate, Research and academic purpose
3	The Director, KSSRDI, Thalaghattapura.	0	5	5	Evaluation of Mulberry germplasm resources against root rot diseases resistance in Karnataka
4	The Scientist-D and Head Seribiotech Research Laboratory, (SBRL) Kodathi, Bengaluru.	4	2	6	Utilized in the Project entitled "AIC08009CN: Profiling of lipid, protein and Carbohydrate of mulberry mealybug, *Maconellicoccus hirsutus* (Green)" for its control.
5	The professor and Head Dept. Of Sericulture GKVK, UAs- Bengaluru.	6	9	15	Post graduate and Demonstration cum Research purpose
6	The Scientist-D and Head REC-Research Extension Centre (RSRS-Salem) Krishnagiri.	2	3	5	Fruit saplings are requested for the demonstration to sericulture farmers and students of school & college
	Total	**33**	**29**	**62**	

The feedback information was received from 7 institutes out of 18 indenters for different purposes like project works of PG & Ph.D students, screening work of biotic and abiotic stress, evaluation and cultivation of minor fruits at small scale etc.

Objective 5: Updating of Mulberry Germplasm Information System (MGIS) E-indenting system and redesigning of MGIS database is under progress.

Other activities:

One project assistant was recruited during March, 2023 under the project. Besides, one more project assistant was also recruited for execution of routine activities of Seri-Germplasm Conservation.

Maintenance of mulberry leaf supply garden for silkworm conservation:

During the period a total of 6.0 acre mulberry gardens were maintained and leaf was supplied to 5 MV crops, 3 BV crops and 2 mutant crops of silkworm as per the conservation schedule **(Figure 21)**.

Figure 21 Tractor ploughing, application of FYM and mulching operations in mulberry leaf supply garden for silkworm rearing and conservation

Silkworm Division: [*Projects continued through 2022-23*]

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

Ritwika Sur Chaudhuri (PI), G.Punithavathy, G.Lokesh (CSGRC), R. Saravanakumar (SSTL, Kodathi) - CI

Objectives:

- To identify silkworm resources tolerant to BmNPV and BmBDV using molecular markers
- To validate disease tolerance of the accessions through bioassay studies.
- To quantify the level of resistance/tolerance among selected tolerant genotypes.

Progress:

Genomic DNA isolation of 9040 samples of 83 multivoltine and 369 bivoltine accessions collected from 3 batches of silkworm conservation rearing was completed.

PCR amplification of 323 BV silkworm accessions with primers specific to BmBDV, viz. aa-trans1 and aa-trans3, was carried out. Out of 323 accessions, 48 accessions were identified that carried the resistant allele (10-100%) in homozygous condition.

In case of screening for BmNPV tolerance, eight multi-viral tolerant markers were utilized for PCR amplification of 452 accessions. Out of them, 49 accessions showed amplification with atleast 6 out of 8 markers.

Bioassay studies were conducted at SSTL, Kodathi, for 2 marker-identified BmBDV tolerant MV accessions and 17 BV accession and recorded 6.5-84.2% pupal survival (**Table 23**). In case of BmNPV bioassay studies for 16 marker-identified tolerant accessions, the larval survival ranged from 16-67.67% and pupal survival ranged from 7.5-48.67% (**Table 24**). Procurement of 1 no. Real Time PCR machine, chemicals and consumables through bidding was carried out.

Table 23: BmBDV-tolerant silkworm accessions identified through markers and bioassay studies

Accession No.	nsd-2/nsd-2	+nsd-2/nsd-2	+nsd-2/+nsd-2	Pupae survival %
BMI-0076	100	0	0	70.00
BMI-0077	100	0	0	69.00
BBE-0008	70	0	30	20.33
BBE-0014	80	0	20	55.50
BBE-0027	100	0	0	84.17
BBE-0031	20	40	40	6.50
BBE-0035	70	0	30	30.33
BBE-0177	60	0	40	26.00
BBE-0190	80	0	20	42.00
BBE-0216	80	10	10	66.83
BBE-0225	30	20	50	11.00
BBE-0266	90	10	0	51.15

Accession No.	nsd-2/nsd-2	+nsd-2/nsd-2	+nsd-2/+nsd-2	Pupae survival %
BBE-0267	100	0	0	80.17
BBI-0325	20	50	30	9.50
BBI-0358	30	20	50	19.00
BBI-0378	30	0	70	14.50
BBI-0382	80	10	10	62.17

Table 24: BmNPV tolerant silkworm accessions identified through markers and bioassay studies

Accession No.	Larval survival %	Pupae survival %
BBE-0012	19.50	13.79
BBI-0018	58.67	57.27
BBI-0019	56.83	53.33
BBE-0029	28.00	9.83
BBI-0052	31.67	9.00
BBI-0078	46.67	29.33
BBI-0100	61.17	7.50
BBE-0182	20.50	18.00
BBI-0370	60.33	36.67
BBI-0371	67.67	48.67
BBE-0179	57.50	23.67
BBE-0185	53.67	10.67
BBE-0206	41.83	11.67
BBI-0237	16.00	13.26
BBI-0258	56.17	11.00
BBI-0276	28.00	13.00

AIG-06007 MI Molecular characterization and assessment of genetic diversity in silkworm (*Bombyx mori* L)

G. Lokesh (PI), G. Ravikumar (upto 28.02.2023),
Ritwika Sur Chaudhuri, Raju Mondal (from 01.03.2023) - CI, Deepak K V (JRF),
Himanshu Dubey, K M Ponnuvel (SBRL, Kodathi) - CI

Objectives:

- To characterize silkworm genetic resources based on SNP marker analysis through ddRADseq approach for identification of duplicates.
- Whole genome sequencing (WGS) of indigenous silkworm races/ breeds, Pure Mysore (PM), Nistari, CSR-2 and SK-6 for reference genome and identification of hypervariable SSRs.
- Genetic diversity analysis of silkworm germplasm using SNP/ SSR markers.
- To update and enrich the silkworm genetic resource database based on molecular characterization.

Progress:

- Maintenance of homozygous populations of four silkworm accessions through continuous rearing & egg production which are to be used for whole genome re-sequencing and RNA sequencing. The isozygous nature of the population was confirmed with SSR markers.
- DNA extraction and purification completed in 369 BV and 83 MV silkworm accessions.
- Tender document was prepared and processed through GeM portal for Genome re-sequencing in 04 silkworm accessions & ddRAD Sequencing of 350 silkworm accessions was processed through GeM, Received 05 participation and process is completed and awaiting Standing committee approval. MoU was signed with M/S BIONIVID Technology, Bengaluru for outsourcing of Genome sequencing, RNASeq and ddRADsequencing and analysis.
- Genome re-sequencing of four silkworm accessions viz., PM, CSR-2, Nistari & SK-6 was carried out with short read Illumina technology and analyzed. The raw sequence data (short read-Illumina) was subjected for quality check through FastQC & MultiQC bioinformatic tools and generated the files. It was found that, all the sequences and the reads are very good (>92%) which can be used for further downstream analysis like genome annotation and Structural variation studies.
- Similarly, RNAsequence in four tissues (Silkgland, Testes, Ovary and Midgut) from PM and CSR-2 was carried out and analyzed.
- Functional annotation of transcriptomes was carried out and differential expression of gene (DEGs) was studied between CSR-2 & PM. Gene Ontology & KEGGs pathway was used to study Up regulation and down regulated genes in four tissues and also for tissue specific genes.

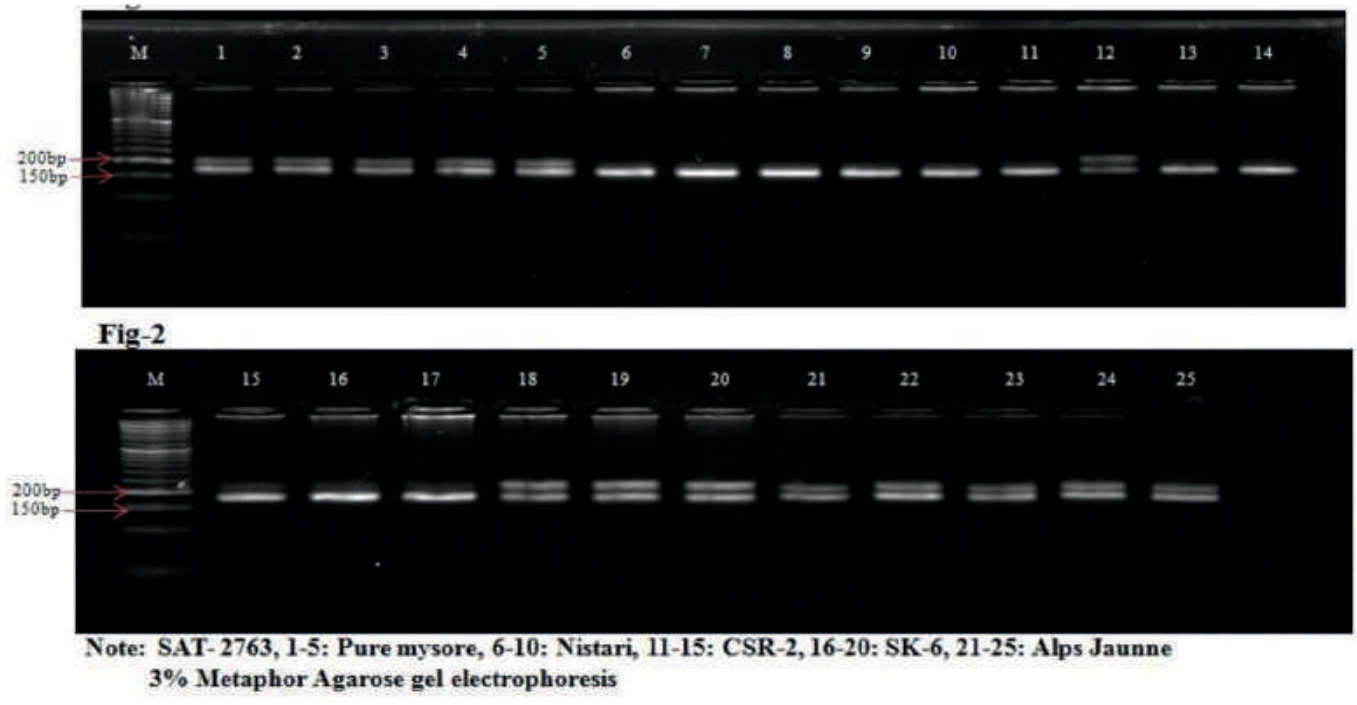


Fig.17: Microsatellite marker analysis of isozygous line in some representative accessions of Silkworm germplasm.

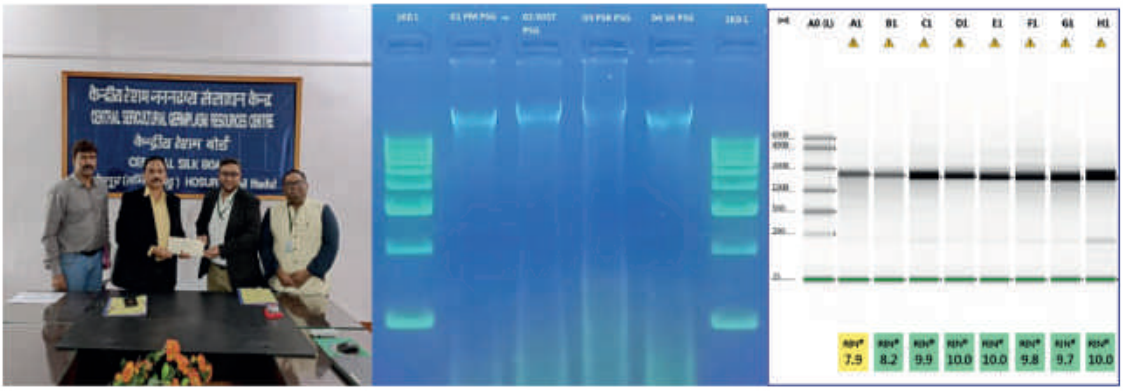
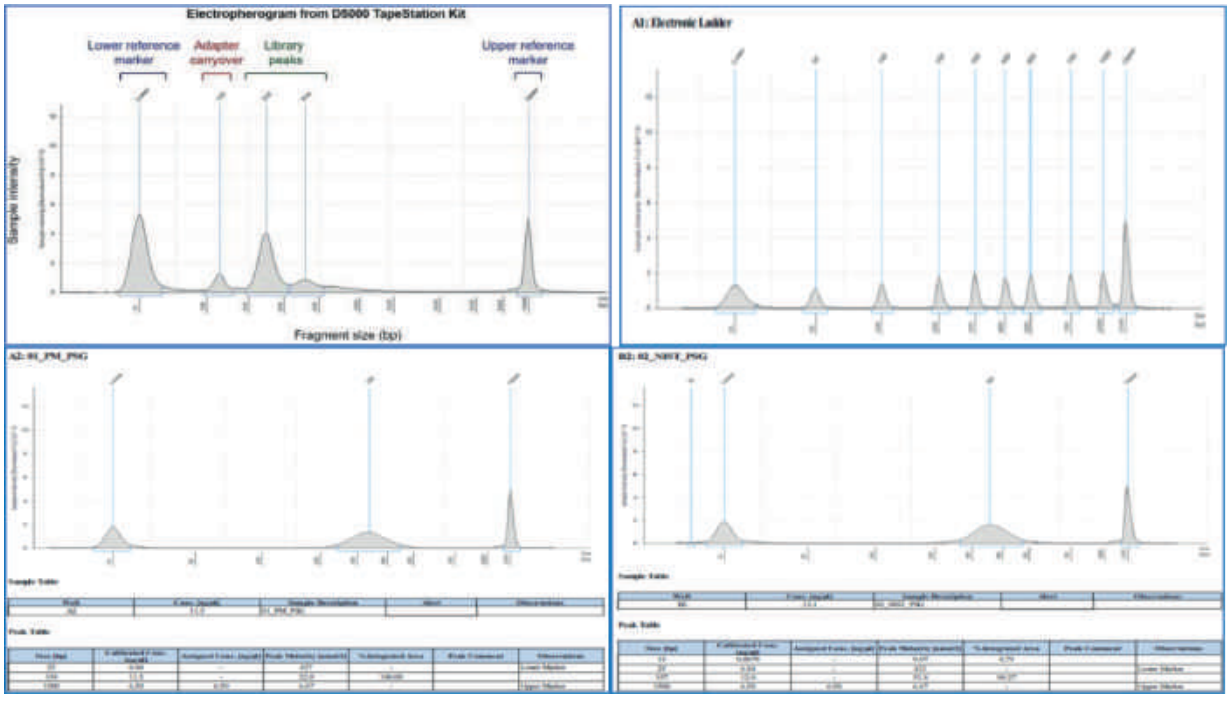


Fig. 18: **a**. Signing of MoU between CSGRC & BIONIVID for silkworm genome, transcriptome & ddRAD sequencing and analysis. **b**. Quality assessment of DNA, **c**. Quality assessment of RNA with RIN value.

#	Sample name	Qubit ng/ul	QC Status	Vol (µL)
1.	01 **PM** PSG	12.90	PASS	12
2.	02 **NIST** PSG	10.30	PASS	12
3.	03 **CSR** PSG	19.10	PASS	12
4.	04 **SK** PSG	17.90	PASS	12

#	Sample name	Qubit ng/ul	QC Status	Vol (µL)
1.	**PM**–MG	47.2	PASS	12
2.	**CSR**-MG	49.2	PASS	12
3.	**PM** -testes	50.2	PASS	12
4.	**CSR**-testes	48.6	PASS	12
5.	**PM** –Ovary	60.2	PASS	12
6.	**CSR**-Ovary	61.6	PASS	12
7.	**PM** –SG	44.6	PASS	12
8.	**CSR**-SG	43.0	PASS	12

Fig. 19 a&b: Quality assessment of DNA and RNA samples using Qubit 2.0 fluorometer



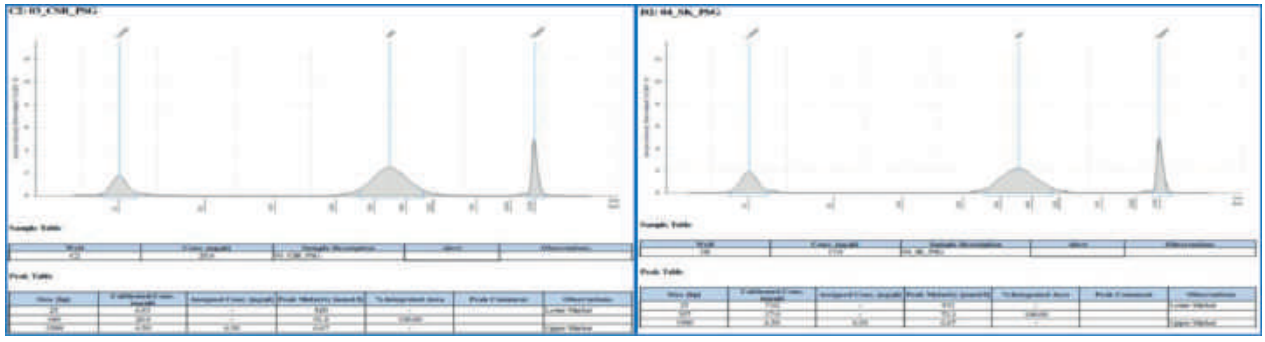


Fig. 20 a-d: Agilent Tapestation-2000 profile for the quality assessment of RNA and transcriptome library from four tissues samples

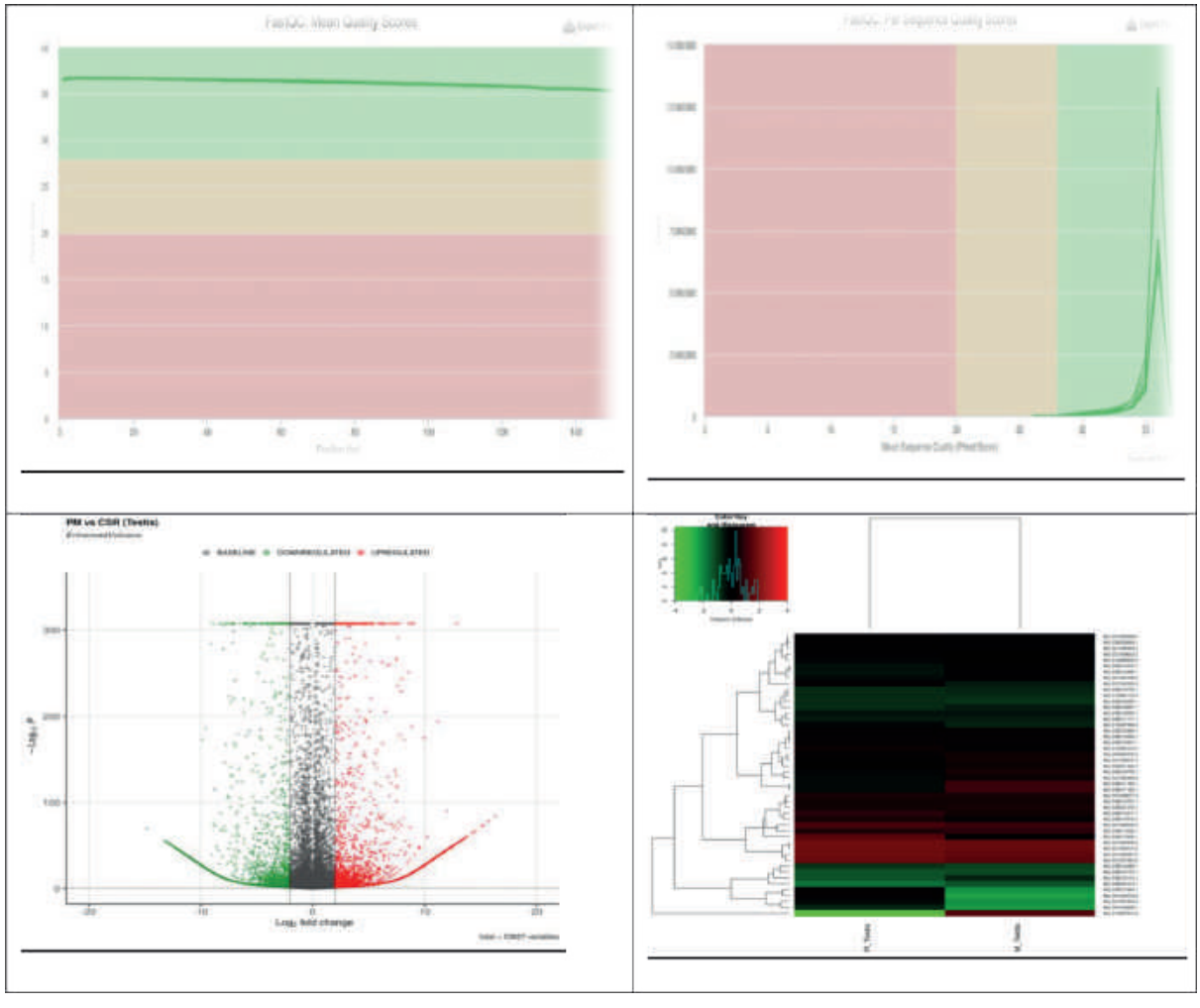


Fig.21: FastQC profile of quality parameters assessed for genome re-sequencing in four silkworm genomes, Volcanoplot and heatmap generated for differential gene expression in PM & CSR tissues.

AIE-06009MI - Collection, Characterization, Evaluation, Conservation and Utilization of silkworm genetic resources - X Phase

CSGRC, Hosur: M. Maheswari, Punithavathy, G. Lokesh, Ritwika Sur Chaudhuri
CSTRI, Bangalore: Mahadevaiah
CO, Bangalore: G.R.Manjunatha

Objectives:

- Collection, characterization evaluation and conservation of silkworm genetic resources.
- Maintenance and updation of SGIS database, cataloguing.
- Digitization of distinct morphological traits of silkworm accessions and creation of database.

Progress:

A total of 113 bivoltine, 83 multivoltine accessions and 23 mutants were brushed, rearing and grainage activities are completed. The morphological characters of the egg, larvae and cocoon silkworm germplasm resources were verified with catalogue. The layings prepared from bivoltine, mutants as well as multivoltine were tested for pebrine disease. The diseases free layings of SWGRs were consigned viz. Bivoltine-10M & 12 M, Mutants - 6 M & 8M, Multivoltine - 35, 45 & 60 days schedule. In case of bivoltine, the survival recorded was 65.25 to 99.00%; the single cocoon wt. 0.998 to 1.780g, single shell wt. 0.153 to 0.360g and mutants recorded survival of 70-92%. With regard to multivoltine, the survival recorded was 93.50-99.50%, single cocoon weight-0.737-1.550g; single shell weight - 0.075-0.286g.

Action initiated for hiring of cloud space for storage of Digitization of silkworm database – (40GB webserver space). The outsourcing agency (Siqell Inc Ltd.) for the development of digital database and hiring of webserver space was approached. Scope of work is under preparation.

7. SERVICES RENDERED

Trainings imparted:

- Smt. G. Punithavathy, Scientist-D and Dr. G.Thanavendan, Scientist-C, conducted theory sessions on the topics, viz., Silkworm Rearing and Diseases and Diseases of Mulberry for Department Staff at TNSTI, Hosur under SSEPERS-ATMA-SAMETI training programme on 08.06.2022.
- Dr. Ritwika Sur Chaudhuri, Scientist-Cand Shri. Raju Mondal, Scientist-C trained one IV Year B.Tech Biotechnology student of Arunai Engineering College, Thiruvannamalai, in carrying out their internship from 27th July to 12th August, 2022.
- Dr. Ritwika Sur Chaudhuri, Scientist-C and Shri. Raju Mondal, Scientist-C trained two II-year M.Sc. Microbiology student of MGR College, Hosur, in carrying out their internship from 21st July to 5th August 2022.
- Dr. Ritwika Sur Chaudhuri, Scientist-C supervised three M.Sc. Biotechnology students of Krishnagiri Arts and Science College, Periyar University Arunai Engineering College, Thiruvannamalai, in carrying out their dissertation work during October-December 2022.
- Dr. G. Lokesh, Scientist-D supervised four students (02 from Adhiyamaan college of Engineering and 02 from MGR College) for their short term project/ dissertation work during January-March, 2023.
- During the period, Smt. G. Punithavathy, Scientist-D and Dr. G. Thanavendan, Scientist-C imparted training to 802 sericulture farmers at TNSTI, Hosur in 22 batches on different subject areas of mulberry cultivation and silkworm rearing.
- The centre conducted a two-days STEP training programme under CBT on 'Conservation and maintenance of sericulture germplasm' for 24 participant including Scientists/ Technical Assistants/ Staff from different research institutes and State departments of South India during 9th & 10th January, 2023.
- Dr. Ritwika Sur Chaudhuri, Scientist-C, Dr. G. Thanavendan, Scientist-C and Shri. Raju Mondal, Scientist-C imparted one day training to 12 newly recruited CSB Scientists (Post-Cocoon) on mulberry crop protection, conservation and management of mulberry and silkworm germplasm on 04.03.2023.
- During the period, approximately 800 sericulture farmers were imparted training in different subject areas at TNSTI, Hosur in 22 batches. DOS field staff (163), Important dignitaries and VIP (07), farmers (256), and college students (307) visited CSGRC to see the activities of the centre. The institute activities were explained at TNSTI, DoS-Hosur under the scheme of State Extension Programme for Extension Reform Schemes (SSEPERS)-ATMA and Central Sector Schemes (Silk-SAMAGRA scheme).

Technical audit

Dr. G. Lokesh, Scientist-D, carried out the technical audit of SSPC, Bengaluru, NSSO during April 2022.

8. TRAINING PROGRAMMES

Trainings undergone:

Name of scientist	Period	Institute / Place	Training programme
Dr. G. Thanavendan, Scientist-C	21.05.2022 – 10.06.2022 (21 days)	Online - Agrimeet Foundation, Gwalior, Madhya Pradesh	21 days International Training cum Certificate course on Agriculture Drones "Revolutionizing the Future of Agriculture" organised by Agri Meet Foundation and Aviana in collaboration with ICAR-IISR, UPCAR, Lucknow, MPUAT, CAIE, NABARD, NAHEP & ITM University, MP.
Dr. G.Lokesh,Scientist-D	14th-23rd November, 2022 (10 days)	SBRL, Kodathi	Hands on Training in Molecular Techniques applied in the field of Sericulture
Dr. G. Thanavendan, Scientist-C	1st – 21st February, 2023 (21 days)	Online - ICAR - NBPGR, New Delhi	Virtual training on "Management and utilization of plant genetic resources (PGRs)"
Dr. M. Maheswari, Scientist-D, Smt. G. Punithavathy, Scientist-D, Dr. G. Lokesh, Scientist-D, Dr. Ritwika Sur Chaudhuri, Scientist-C, Dr. G. Thanavendan, Scientist-C, Dr. M.C. Thriveni, Scientist-C, Shri. Raju Mondal, Scientist-C	06/07th March, 2023	Central Office, Bangalore	Hands on Training programme on eSubMIS web portal of CSB

9. PUBLICATIONS

Research papers

1) Lokesh, G., M. Maheswari, Ritwika S Chaudhuri, S. Sekar, Halagunde Gowda and B. T. Sreenivasa (2022) Estimation of Genetic parameters and variability in the Bivoltine silkworm *Bombyx mori* L germplasm. *Uttar Pradesh Journal of Zoology* **NAAS rating: 4.21.**

2) Thriveni, M. C., Deepa, S., Thanavendan, G., Ravikumar, G., & Sreenivasa, B. T. (2023). Characterization and Evaluation of Mulberry Genetic Resources for the Identification of Promising Accessions. *Indian Journal of Plant Genetic Resources*, 36(01), 85-95. (Accepted) **NAAS rating-5.54.**

3) Maheswari, M., Lokesh, G., Chaudhuri, R. S., Chandrakanth, N., & Sreenivasa, B. T. (2022). Evaluation and Identification of Silkworm (*Bombyx mori* L.) Genetic Resources Tolerant to Temperature and Humidity. *Current Journal of Applied Science and Technology,* 41(31), 1-13. **NAAS rating 4.71.**

4) Mondal R., Antony S., B.N. Gnanesh, Thanavendan G., Ravikumar, G., Sreenivasa, B.T., Doss S.G. and Vijayan K. (2023). A protocol for mitotic metaphase chromosome count using shoot meristematic tissue of tree species of mulberry. *Bio-Protocol,* 1-10 **IF-5.78.**

5) Mondal, R., Antony, S., Thriveni, M. C., Thanavendan, G., Ravikumar, G., & Sreenivasa, B. T. (2022). Genetic architecture of morin (pentahydroxyflavone) biosynthetic pathway in mulberry *(Morus notabilis)*: an in silico approach. *Journal of Berry Research,* 12(4), 483-494**. IF: 2.156.**

6) Sur Chaudhuri, R., Srinivasan, S., Punithavathy, G., Lokesh, G., Maheswari, M. Sreenivasa, B.T. (2023) Characterization of mutant silkworm germplasm resources for tolerance to Bidensovirus. *Sericologia* (*Communicated).*

Popular articles

1. G. Ravikumar *et al*. (2022). Role of biotechnology in germplasm research: a CSGRC perspective. Indian Silk, CSB

2. M. C. Thriveni *et al*. (2022). Focused identification of germplasm strategy (FIGS). Indian Silk, CSB

3. Thanavendan *et al.* (2022) शहतूत के फल- एक नया रूप (Hindi) Resham Bharti, CSB

4. Thanavendan *et al.* (2022) Use of Mulberry germplasm for animal fodder: An introduction, Pattumalar, TNSTI, Hosur (in Tamil)

Abstracts:

1. Lokesh *et al.* (2022) Evaluation of Genetic variability, heritability and genetic parameters in the bivoltine silkworm (Bombyx mori L) germplasm accessions for productive traits in "26th ISC Congress", Cluj-Napoca, Romania, 7-11 Sept, 2022., pp.102 [Oral presentation].

2. Sur Chaudhuri *et al.* (2022) Conservation and characterization of silkworm germplasm in India for biodiversity and posterity in "26th ISC Congress", Cluj-Napoca, Romania, 7-11 Sept, 2022, pp.101. [Oral presentation].

3. Sur Chaudhuri *et al.* (2022) "Screening of germplasm for identification of silkworm genetic resources tolerance to biotic stress" in National Seminar on Climate Smart Sericulture-2022, Bengaluru, 6-7 Oct, 2022, pp.32[Poster presentation-3rd prize].

4. Lokesh *et al.* (2022) "Screening of silkworm germplasm and identification of promising region-specific silkworm resources for productivity and sustainable sericulture" in National Seminar on Climate Smart Sericulture-2022, Bengaluru, 6-7 Oct, 2022, pp.31. [Poster presentation]

5. Maheswari *et al.* (2022) "Evaluation and Identification of Silkworm (*Bombyx mori* L.) Genetic Resources for abiotic stress condition" in National Seminar on Climate Smart Sericulture-2022, Bengaluru, 6-7 Oct, 2022, pp. 23. [Oral presentation].

6. Mondal *et al.* (2022) Climate-smart mulberry through the implementation of trait-specific mulberry accessions; National Seminar on Climate Smart Sericulture – 2022, Bengaluru, 6-7 Oct, 2022, pp. 7 [Oral presentation; obtained 2nd prize].

7. Thanavendan, G *et al*. (2022) Screening of diverse mulberry genetic resources against stem borer (A*priona germari* Hope) resistance in *ex-situ* field genebank National Seminar on Climate Smart Sericulture – 2022, Bengaluru, 6-7 Oct, 2022, pp.108 [Oral presentation].

Book Chapter

1. G. Lokesh, M. Maheswari, Ritwika Sur Chaudhuri , G. Punithavathy, S. Sheeba and B.T. Sreenivasa (2023). उत्परिवर्ती रेशमकीट आनुवंशकि संसाधनों के महत्वपूर्ण आकारकिी एवं मात्रात्मक वर्णों का मूल्यांकन. Proceedings of Rajbhasha technical national seminar, "Samgra Resham Uthpadan: Challenges and future strategies" CTR&TI, Ranchi 28th January 2023. Pp: 131- 137 (ISBN: 978-81-958770-1-0).

Technical Report

Thanavendan et al.,(2022). Survey, exploration and collection of new mulberry germplasm in Koloriang, Kurung-Kumey River valley & Kara-Dadi district of Arunachal Pradesh from 07.09.2022 to 17.09.2022 in collaboration with ICAR-NBPGR, New Delhi.

Institute publications

1. Training Manual on Conservation and Maintenance of Sericulture Germplasm and Management, 2023, CSGRC

2. CSGRC *for biodiversity and posterity* (2023) CSGRC

3. Bilingual CSGRC Newsletter, Oct-Mar, 2022

4. Bilingual CSGRC Newsletter, Apr-Sep, 2022

10. PARTICIPATION IN CONFERENCE / SEMINAR / WORKSHOP

1. Attended one day lecture on Role of miRNA in plants at CO, Bangalore on 9th May, 2022 (Dr. G. Lokesh, Scientist-C; Dr. Ritwika Sur Chaudhuri, Scientist-C; Shri. Raju Mondal, Scientist-C)

2. Attended One day workshop on Intellectual Property Rights held on 23rd May, 2022 (Dr. G. Lokesh, Scientist-D & Dr. G. Thanavendan, Scientist-C)

3. Participated in National Conference on Sericulture based multidisciplinary approaches for climate resilience sustainability and livelihood security held on 26th & 27th August, 2022 (Dr. B.T.Sreenivasa, Director)

4. Participated in SERITECH-26th ISC conference, Romania (Online Participation) held during 7th-11th September, 2022 (Dr. G. Lokesh, Scientist-D & Dr. Ritwika Sur Chaudhuri, Scientist-C).

5. Paricipated in National Seminar on "Climate Smart Sericulture-2022: Approaches for sustainable Sericulture" at NIFT, Bengaluru organized by Central Silk Board held on 6-7 October, 2022 (Dr. M. Maheswari, Scientist-D; Dr. G. Lokesh, Scientist-C; Dr. Ritwika Sur Chaudhuri, Scientist-C; Dr. G. Thanavendan, Scientist-C; Shri. Raju Mondal, Scientist-C)

6. Participated in Virtual Workshop on "World Soil Day, 2022" by VAIAL, Vellore on 6th December, 2022 (Dr. G. Thanavendan, Scientist-C)

11. VISITORS

#	Date	Name & Address of the Institutes	Purpose	Nos.
1	05.06.2022	Smt. Prajakta L. Verma, Joint Secretary (Textiles), MOT, GOI	To see the activities of the centre.	01
2	31.12.2022	Shri. Julian Tobias, Joint Director (Admin), Central Silk Board	To witness the activities of the centre.	01
3	08.03.2023	Dr. C. Meenakshi, IFS Director (Finance) & Member Secretary In-Charge	To review the activities of the centre.	01
4	18.04.2022	Dr. S. Nandagopal, Asst. Professor & Head, Govt Arts & Science College, Hosur	To acquire knowledge of mulberry plantation	01
5	27.04.2022	Shri. A. Viveganandhan, Inspector DOS, TN (alongwith farmers)	Farmer's Exposure Visit	29
6	11.05.2022	Smt. S. Jeyalakshmi, Asst Inspector, DOS, TN (alongwith farmers)	Farmer's Exposure Visit	28
7	18.05.2022	Shri. A. Viveganandhan, Inspector DOS, TN (alongwith farmers)	Farmer's Exposure Visit	25
8	24.05.2022	Shri. A. Viveganandhan, Inspector DOS, TN (alongwith farmers)	Farmer's Exposure Visit	31
9	25.05.2022	Smt. S. Jeyalakshmi, Asst Inspector, DOS, TN (alongwith farmers)	Farmer's Exposure Visit	24
10	26.05.2022	Shri. A. Viveganandhan, Inspector DOS, TN (alongwith farmers)	Farmer's Exposure Visit	35
11	27.05.2022	Smt. S. Jeyalakshmi, Asst Inspector, DOS, TN (alongwith farmers)	Departmental Staff Exposure Visit	31
12	31.05.2022	Dr. Jyoti Biradar, Asst Professor, COS, Chintamani, UAS Bangalore (along with University Staff)	To collect mulberry germplasm	04
13	01.06.2022	Shri. A. Viveganandhan, Inspector DOS, TN (alongwith farmers)	Farmer's Exposure Visit	34
14	07.06.2022	Smt. S. Jeyalakshmi, Asst Inspector, DOS, TN (alongwith farmers)	Farmer's Exposure Visit	31
15	08.06.2022	Shri. A. Viveganandhan, Inspector DOS, TN (alongwith farmers)	Farmer's Exposure Visit	33

#	Date	Name & Address of the Institutes	Purpose	Nos.
16	05.07.2022	Dr. R.M.Shivaprakash, Scientist-E, KSSR&DI, Bengaluru	To collect mulberry germplasm	02
17	05.07.2022	Dr. A. Mahadeva, Scientist-C, KSSR&DI, Bengaluru		01
18	07.07.2022	Dr. L.H. Shivashankar & Dr. A.C. Manjula, Associate Professors, DOS, MSCW, Bengaluru	Students exposure visit	50
19	12.07.2022	Dr. P. Lakshminarayan Reddy, DOS, Sri Krishnadevaraya University, Anantpur, AP	M.Sc. Students exposure visit	15
20	15.07.2022	Smt.R.Sasikala, Asst Inspector, Dharmapuri, TNSTI, Hosur	Farmer's Exposure Visit	07
21	28.07.2022	Dr. Divya S.H., Lecturer DOS, Yuvaraja's College, Mysore	Students exposure visit	15
22	29.07.2022	Shri.S. Arumugam, Inspector of Sericulture, DOS, TN (alongwith farmers)	Farmer's Field visit	10
23	18.08.2022	Smt. C. Gayathri, Teacher, Advaith International Academy, Hosur	Farmer Field exposure visit	83
24	11.10.2022	Smt. S. Jeyalakshmi, Asst Inspector, DOS, Hosur, TN (alongwith farmers)	Department staff exposure visit	31
25	14.10.2022	Dr. V. Ulaganathan, Teaching Asst, FC&RI, TNAU, Mettupalayam	PG Students Field exposure visit	26
26	29.100.2022	Smt. Sudha Praveen Kumar, Principal, Narayana-e Techno School, Hosur	School students study tour	232
27	30.01.2023	Dr. A. Thangamalar, Teaching Asst. (Seri), FC&RI, TNAU, Mettupalayam	Students exposure visit	53
28	28.02.2023	Dr. Chikkalingaiah & Dr. Fatima S, UAS Bengaluru	PhD students visit	06
			Total Visitors	**840**

12. 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 Research Station, Rajendranagar, Hyderabad - 500 030.	**Member**
Dr. Modhumita G Dasgupta, Scientist F, Institute of Forest Genetics and Tree Breeding (IFGTV-ICFRE), Coimbatore - 641 002.	**Member**
Dr. Rajasekharan, P.E, Professor, ICAR-lndian lnstitute of Horticulture Research (ICAR-IIHR), No. 1 41, A6, Janapriya Greenwood, Somashetti Halli, Chikkabanavara Post, Bengaluru -560 090	**Member**
Dr. Manjunatha Gowda, Professor and Head Dept. of Sericulture, University of Agricultural sciences, GKVK, Bengaluru - 560 065.	**Member**
Dr. Ravindra Singh, Scientist-D (Rtd.), Central Silk Board, Bengaluru.	**Member**
Director (Tech), Central Silk Board, CSB Complex, Bengaluru - 560 068.	**Member**
SCIENTIST-D & Head, Research Coordination Section, Central Silk Board, Bengaluru - 560068.	**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

13. राजभाषा कार्यान्वयन / OFFICIAL LANGUAGE IMPLEMENTATION:

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

#	दिनांक	विषय	वक्ता
1.	28.06.2022	राजभाषा कार्यान्वयन की नीति	श्री. पी. दामोधरन, सहायक निदेशक (रा.भा.) एवं प्रभारी, हिंदी शिक्षण योजना, बैंगलोर।
2.	27.09.2022	हिंदी व्याकरण, हिंदी भाषा, शब्द और वाक्य लेखन का अभ्यास	डॉ. ऋत्विका सूर चौधरी, वैज्ञानिक-सी (हिन्दी प्रभारी) श्री बैरवा नरेंद्रकुमार मोहरीलाल, पुस्तकालय और सूचना सहायक, केरेजसंके, होसूर
3.	27.12.2022	पत्र लेखन	श्री. कोमल सिंह, उप निदेशक (राजभाषा), हिंदी शिक्षण योजना, गुवाहाटी
4.	18.03.2023	सरल हिन्दी भाषा का उपयोग, पत्र लेखन, टिप्पण और मसौदा लेखन, बोल चाल की हिन्दी, गूगल अनुवाद एवं स्वयं अभ्यास, राजभाषा अधिनियम एवं इसके विभिन्न पहलुएं।	डॉ. एस. राजनटेशन, हिन्दी अधिकारी, भारतीय ताराभौतिकी संस्थान, बैंगलूर

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

#	Date	Topic	Speaker
1.	28.06.2022	OLIC policy	Shri. M. P Damodharan, Assistant Director (OL) / Incharge, Hindi Teaching Scheme, Bangalore
2.	27.09.2022	hindi grammar, words and sentence writing practice	Dr. Ritwika Sur Chaudhuri, Sc-C & Hindi I/C & Shri. B. Narendra kumar Mhorilal, Lib. & Info Asst.
3.	27.12.2022	Hindi words and sentence writing	Shri. Komal Singh, Deputy Director (Official Language), Hindi Teaching Scheme, Guwahati.
4.	18.03.2023	Hindi pronunciation and grammar	Dr. S. Rajnatesan, Hindi Officer, Indian Institute of Astrophysics, 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 चार बैठकें(100-103 वी) 28 जून 2022, 27 सितंबर 2022, 27 दिसंबर 2022 एवं 18 मार्च 2023 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 (100th-103rd) were organized on 28 June 2022, 27 September 2022, 27 December 2022 and 18 March 2023. 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.

हिंदी कार्यशाला में प्रतिभागी गण

प्रतिभागियों द्वारा स्वयं अभ्यास

दिनांक 14.09.2022 को भारतीय भाषाओं के सौहार्द दिवस के रूप में हिंदी दिवस मनाया गया। केरेजसंके, ईएसएसपीसी व एसएसपीसी के वैज्ञानिकों / अधिकारियों / कर्मचारियों एवं कुशल श्रमिकों के सहयोग के साथ इस केन्द्र में 14 सितम्बर से 20 सितम्बर तक हिन्दी सप्ताह मनाया गया। हिन्दी सप्ताह के दौरान तीन प्रतियोगिताओं अर्थात शब्दावली, स्मृति परीक्षण, एवं गायन का आयोजन किया गया। हिन्दी सप्ताह के समापन दिवस पर सांस्कृतिक कार्यक्रम का आयोजन किया गया और निदेशक, सीएसजीआरसी द्वारा प्रतियोगिताओं के विजेताओं को पुरस्कार और प्रमाण पत्र वितरित किए गए।

सीएसजीआरसी, होसूर में मनाया जा रहा हिंदी सप्ताह, सितंबर, 2022

Hindi Day was celebrated on 14.09.2022 as a cordial day of Indian languages. The Hindi Week was organized from 14th September to 20th September 2022 with the support of scientists, officials, employees and field workers of ESSPC and SSPC, Hosur. During the week, 3 competitions viz. Glossary, Memory test & Singing competitions were organized. On the concluding day of the week, cultural programme was organized and prizes and certificates were distributed to the winners of the competitions by Director-in-Charge, CSGRC.

14. OTHER ACTIVITIES

Research Council Meeting

The 67th, 68th, 69th & 70th meeting of the Research Council was convened on 6th June, 2022, 11th August, 2022, 28th December, 2022 and 9th March, 2023 respectively 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 43rd and 44th meeting of the RAC of the Centre was organized on 2nd September 2022 and 21st March, 2023 respectively. 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.

Pebrine Monitoring

The Pebrine Monitoring Team consisting of nominated scientists from SSTL and RSRS, Kodathi, SSPC, Dharmapuri and REC, Krishnagiri carried out the mandated microscopic testing during different stages of rearing for incidence of Pebrine. Approximately 13000 moth samples from Bivoltine (3 batches) and 15,000 samples of Multivoltine from four crops were screened.

Celebration of National and International Official Events

1. INTERNATIONAL YOGA DAY

As per instructions from Ministry of Textiles, Govt of India, International Yoga Day was celebrated at the centre on 11th April, 2022 and 21st June, 2022. Yoga instructor, Smt. Preethi, was invited on both days to deliver lectures on the importance and benefits of yoga and to also demonstrate basic yoga techniques to the officers, officials and staff of CSGRC. She highlighted the health benefits of yoga and encouraged all to include yoga in their day to day life.

2. WORLD ENVIRONMENT DAY

World Environment Day was celebrated on 5th June 2022 at CSGRC, Hosur. During the celebration, Smt. Prajakta L. Verma, IAS, Joint Secretary, Ministry of Textiles, Government of India, visited the centre and joined the celebration in plantation of mulberry and other ornamental plants in the campus. The Director addressed the gathering and emphasized on the rising levels of pollution which is causing a threat to the environment and the climate change. He requested all the participants to grow trees to restore our ecosystem.

3. INDEPENDENCE DAY

On 15th August 2022, the Independence Day was celebrated at the Centre and the National flag was hoisted by the Director. The Scientists, Officers, Staff members, Skilled Farm Workers and their families participated in the celebration.

4. NATIONAL SILK DAY CELEBRATION

Silk Day was celebrated in the centre on 20th September, 2022 to commemorate the establishment of Central Silk Board. A floral tribute was paid to Late Shri. Shyama Prasad Mookerjee, the first Minister of Commerce and Industry of free India, and also the ex-officio first Chairman of the Central Silk Board by all officers and staff of the centre. A pledge on Silk Day was taken by all the employees of CSGRC.

5. NATIONAL UNITY DAY

The National Unity Day of India was celebrated on 31st October, 2022 to mark the 147th birth anniversary of Sardar Vallabhbhai Patel. The reason behind the celebration of this day is to make people aware of the ideas of staying together and uplifting society. A pledge was taken and an event 'Run for Unity' was organized where all the officers and staff of CSGRC participated in a road march.

6. VIGILANCE AWARENESS WEEK

The Vigilance Awareness Week-2022 was observed at the Centre on the theme "Corruption free India for a developed Nation" from 26-10- 2022 to 01-11-2022. Integrity pledge for the Organization was administered by the Director to all the Officers /Staff /SFW of the Centre. A Lecture on "Anti-Corruption" was delivered by the Principal, Krishnagiri Arts and Science College at the centre.

7. REPUBLIC DAY

Republic Day was celebrated on 26th January, 2023 by all the officers and staff at CSGRC, Campus. In his speech, Director, CSGRC explained the importance of the day for the citizens of India and the historical events that led up to the making of the country's constitution.

15. ADMINISTRATIVE AND FINANCIAL REPORT

a. Staff strength as on 31.03.2023

Category	Nos.
Director	1
Scientific	
Scientist-D	4
Scientist-C	4
Sub-total	**9**
Technical	
Senior Technical Assistant	1
Technical Assistant [R & S]	1
Sub-total	**2**
Administrative	
Asst. Director (Computer)	1
Junior Engineer (Electrical)	1
Library & Information Assistant	1
Senior Translator (Hindi)	1
Staff Car Driver - (Grade 1)	1
Assistant Technician	1
Sub-total	**6**
Total	**17**
Skilled Farm workers (TS)	28

b. Research Fellows/Project Assistants

Junior Research Fellow (JRF)	1
Project Assistant	4
Sub-total	**5**

c. Superannuation/Voluntary Retirement from Service/Transfers

#	Name & Designation	Remarks
1	Dr. G. Ravikumar, Scientist-D	Superannuation on 28.02.2023
2	Dr. Jameela Khatoon, Scientist-D	Superannuation on 31.05.2022
3	Shri. V. Gopala	Superannuation on 31.05.2022
4.	Shri. M. Muniraju	Superannuation on 31.05.2022
5.	Smt. P. Elizabeth Rani	Superannuation on 31.01.2023

d. Personnel posting position as on 31.03.2023

Division / Section	Name	Designation
	Dr. B.T. Sreenivasa	Director
Mulberry	Dr. Jameela Khatoon (till 31/05/2022)	Scientist-D (R&S)
	Dr. G. Ravikumar (till 28/02/2023)	Scientist-D
	Dr. N. Sakthivel (from 20/03/2023)	Scientist-D
	Dr. G. Thanavendan	Scientist-C
	Dr. M.C. Thriveni	Scientist-C
	Shri. Raju Mondal	Scientist-C
	Shri. A. Sathyamurthy	S.T.A.
Silkworm	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 (till 31/05/2022)	Scientist-D
	Shri. R. Pugalendi	T.A. (R&S)
Administration & Computer Section	Shri. S. Sekar	Assistant Director (Comp.)
	Smt. P. Elizabeth Rani (till 31/01/2023)	Upper Division Clerk
	Smt. Poonam R. (from 20/03/2023)	Steno Grade-I
	Shri. P. Nagadurai	Staff Car Driver (Grade-I)
	Shri. A. Subramani	Asst. Technician
	Shri. V. Gopala (till 31/05/2022)	MTS
	Shri. M. Muniraju (till 31/05/2022)	MTS
Hindi	Smt. Sheeba V.S.	Senior Translator (Hindi)
Library	Shri. Bairwa Narendra Kumar M	Lib. & Information Asst.
Electrical Maintenance	Shri. M. Vijayakumar	Junior Engineer

e. Abstract of receipts and expenditure statement for the year 2022-23

Fund Head	Amount Received [in Rs.]	Expenditure [in Rs.]	Balance surrendered [in Rs.]
Contingent Amount	11,72,723.00	11,72,723.00	0.00

16. METEOROLOGICAL DATA (AWS) OF CSGRC HOSUR FOR THE PERIOD

FROM APRIL 2022 TO MARCH 2023

SUMMARY OF METEOROLOGICAL DATA FROM APRIL 2022 TO MARCH 2023											
Month	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.					
Apr. 2022	20.75	33.55	26.90	42.13	79.63	60.88	2.50	2	1.44	ESE	352
May 2022	20.87	29.83	25.90	79.12	93.80	86.46	163.50	18	1.82	WSW	321
Jun. 2022	20.59	29.47	23.80	53.40	88.83	71.11	114.00	10	1.90	WSW	345
Jul. 2022	20.06	27.77	23.10	76.64	94.06	85.35	73.00	15	2.06	WSW	320
Aug. 2022	20.43	27.86	22.80	35.51	36.12	35.81	385.00	16	1.90	WSW	323
Sep. 2022	20.25	28.27	23.10	55.20	65.50	60.35	105.00	9	1.70	WSW	323
Oct. 2022	18.80	27.40	22.50	82.08	98.74	90.41	264.00	15	1.26	S	316
Nov. 2022	18.52	26.22	21.30	51.76	100	75.88	53.00	9	1.40	ESE	292
Dec. 2022	17.26	25.00	20.30	80.56	99.43	90.00	9.00	5	1.70	SE	290
Jan. 2023	14.90	27.80	20.80	30.93	99.80	65.36	10.25	2	1.61	ESE	286
Feb. 2023	16.20	29.60	22.90	22.17	93.82	58.00	17.62	4	1.55	SE	284
Mar. 2023	18.80	32.20	25.60	24.41	91.80	58.10	27.50	5	1.63	SSE	304

Minimum Temperature (January 2023)	**14.90 °C**
Maximum Temperature (April 2022)	**33.55 °C**
Minimum Relative Humidity (February 2023)	**22.17%**
Maximum Relative Humidity (November 2022)	**100%**

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100th OLIC meeting of CSGRC, Hosur on 28.06.2022

Celebration of international women's day, 2023

Health camp organised at CSGRC, Hosur on 09.03.2023

Swachhata Pakhwada at CSGRC, Hosur (October 2022)

For further details please contact

Director

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