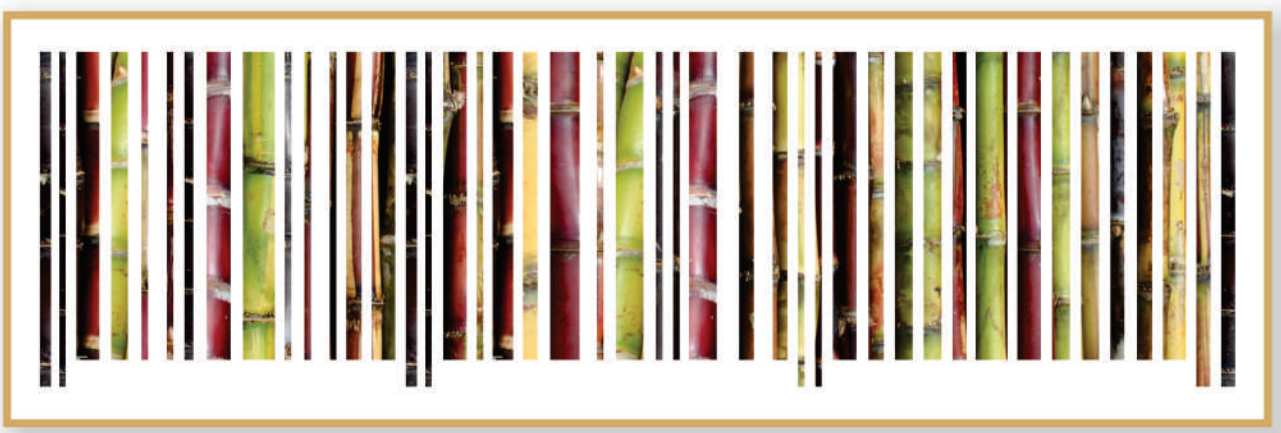
ISSN 0973-8177

# वार्षिक प्रतिवेदन
# Annual Report
# 2023



भा. कृ. अ. प. - गन्ना प्रजनन संस्थान
कोयंबत्तूर – 641 007
ICAR- SUGARCANE BREEDING INSTITUTE
Coimbatore - 641 007

# वार्षिक प्रतिवेदन
# Annual Report
## 2023

भा. कृ. अ. प. - गन्ना प्रजनन संस्थान
कोयंबत्तूर – 641 007
ICAR- SUGARCANE BREEDING INSTITUTE
Coimbatore - 641 007

ICAR-Sugarcane Breeding Institute
Coimbatore - 641 007, Tamil Nadu, India
Tel. No. : 0422 - 2472621
E-mail : director.sbi@icar.gov.in
Website : http://sugarcane.icar.gov.in

**For updates**
Visit: CaneInfo (http://caneinfo.icar.gov.in)
Facebook (https://www.facebook.com/icar.sbi )
YouTube (http://www.youtube.com/@icar-sugarcanebreedinginst1942 ;
http://www.youtube.com/caneinfo)
X - Twitter (@BreedingIcar)



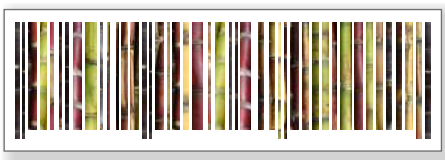
ISSN 0973-8177

**ICAR – Sugarcane Breeding Institute Annual Report - 2023**

**Suggested Citation**
ICAR – Sugarcane Breeding Institute. (2024). 2023 annual report. Coimbatore: ICAR-SBI. p224

**Editorial Committee**
Dr. G. Hemaprabha
Dr. D. Puthira Prathap
Dr. A. Ramesh Sundar
Dr. K. Kannan
Dr. P. Govindaraj
Dr. R. Gopi
Dr. M. Alagupalamuthirsolai
Dr. H.K. Mahadeva Swamy

**Published by**
Dr. G. Hemaprabha
Director



*Cover page: Diversity in sugarcane germplasm at SBI-RC, Kannur*

**Printed at**
Thannambikkai Printers
No. 15, Sastri Street No. 1
P.N. Pudur, Coimbatore - 641 041.
Mobile : 98650 10414

# Contents

# Preface

Sugarcane is a widely grown crop in India, except in Kashmir, Arunachal Pradesh and Himachal Pradesh. As the crop has also evolved as a bioenergy crop in the recent years, the almost stagnant area under the crop has been reported to be increasing to 5.7 MHa (though the final figures are yet to come). Although sugarcane is mainly an industrial crop and sugarcane farmers are largely connected with the sugar industry, the use of sugarcane for diverse purposes of food, fuel, fertilizer, feed and many other applications including pharmaceuticals and biopharming is increasing and entrepreneurship development is now booming across the country for producing varied commodities for internal use and export. The favorable start-up ecosystem in the country as well as the increasing agritech innovation capability are catalysts that further give scope of opportunities for the crop. At the same time, the changing climate and mounting scarcity of inputs to enable a good sugarcane agriculture pose serious challenges.

Considering all these growing opportunities as well as the expertise studded with the glorious history of ICAR Sugarcane Breeding Institute, we could extend our collaborations with the sugar industry, other private R&D industries as well as with FPOs, and startups for developing and demonstrating viable and eco-friendly technologies. More such collaborations for product diversification and input use- efficiency with the goal of increasing productivity and profitability, while focusing more on sustainability to save natural resources and to improve the soil properties with integrated approaches are on the anvil.

During 2023, research programmes have been oriented to achieve these goals. Collaborations with the sugar industry on a pan-India basis have been established, along with more technologies commercialized through ITMU and ABI. More focus was given to the state-of the art technologies like genome editing and management of biotic and abiotic stresses including large scale field testing, use of nanoformulations, drone based survey, surveillance and remediation, natural / organic farming and integration of the best technologies for optimizing benefits and these experiments yielded creditable success and as well as more lessons learnt for moving forward with confidence.

I proudly present this Annual Report with the hope that this would be beneficial to researchers, all stakeholders and all interested in sugarcane agriculture and sugarcane agroindustry. I am sure that the way research is progressing in the Institute with about 70 scientists along with a dedicated team of technical and administrate staff & students and other contractual services reflects passion, commitment and dedication, so that the Institute can continue to deliver big, like the priceless technology in the form of Co 0238. I am grateful to Dr. Himanshu Pathak, DG ICAR & Secretary DARE, Dr. T.R. Sharma, DDG (Crop Sciences) and Dr. R.K. Singh & Dr. D.K. Yadava, ADG CC for the kind guidance, relentless support & co-operation as well as for being magnanimous in facilitating more fund-flow to this 112- year old Institute to upgrade our research facilities. I join our staff to reiterate that ICAR- SBI is always committed to nation building and work with renewed passion and dedication in the years to come for the glory of this great nation Bharat.

**G. HEMAPRABHA**
Director
ICAR-SBI

# 02
# Overview

## Background

ICAR- Sugarcane Breeding Institute (SBI), Coimbatore has been conducting research on various aspects of sugarcane agriculture and varietal improvement since its inception in 1912. The Institute has developed nearly 4000 'Co' selections, many of them becoming popular as commercial varieties in different parts of the country. 'Co' canes bred at SBI along with the varieties identified from the crosses made at the institute by the State Sugarcane Research Stations occupy nearly 95% of the cane area in the country. Thus, the sugarcane varieties cultivated in the country today are directly or indirectly derived from this institute. 'Co' canes were successful as commercial varieties in over 28 countries at one time and are being extensively used as parents in breeding programmes even today. The Institute maintains one of the largest collections of sugarcane genetic resources in the world.

## Location

The Institute is located 8 km from the Coimbatore railway station and 19 km from the Coimbatore airport. Geographically it is located at 770 E longitude and 110 N latitude at an altitude of 427 m above mean sea level.

## Centres

The Institute has one Regional Centre at Karnal (Haryana) and two Research Centres at Kannur and Agali (Kerala).

## Mandate

- To breed superior sugarcane varieties/ genotypes having high sugar productivity as well as sustainability and to assist State sugarcane breeding programmes.
- To collect, maintain, evaluate, document and conserve sugarcane genetic resources.
- To conduct basic and strategic research on crop improvement, production and protection aspects of sugarcane cultivation.
- To effect technology transfer, consultancy and human resource development in the area of sugarcane agricultural research.

## Staff Position

**Staff position as on 31 December 2023**

| Post | Sanctioned | Filled | Vacant |
|---|---|---|---|
| Director | 1 | 1 | - |
| Scientific | 77 | 70 | 7 |
| Technical | 73 | 41 | 32 |
| Administration | 43 | 21 | 22 |
| Supporting | 56 | 36 | 20 |
| **TOTAL** | **250** | **169** | **81** |

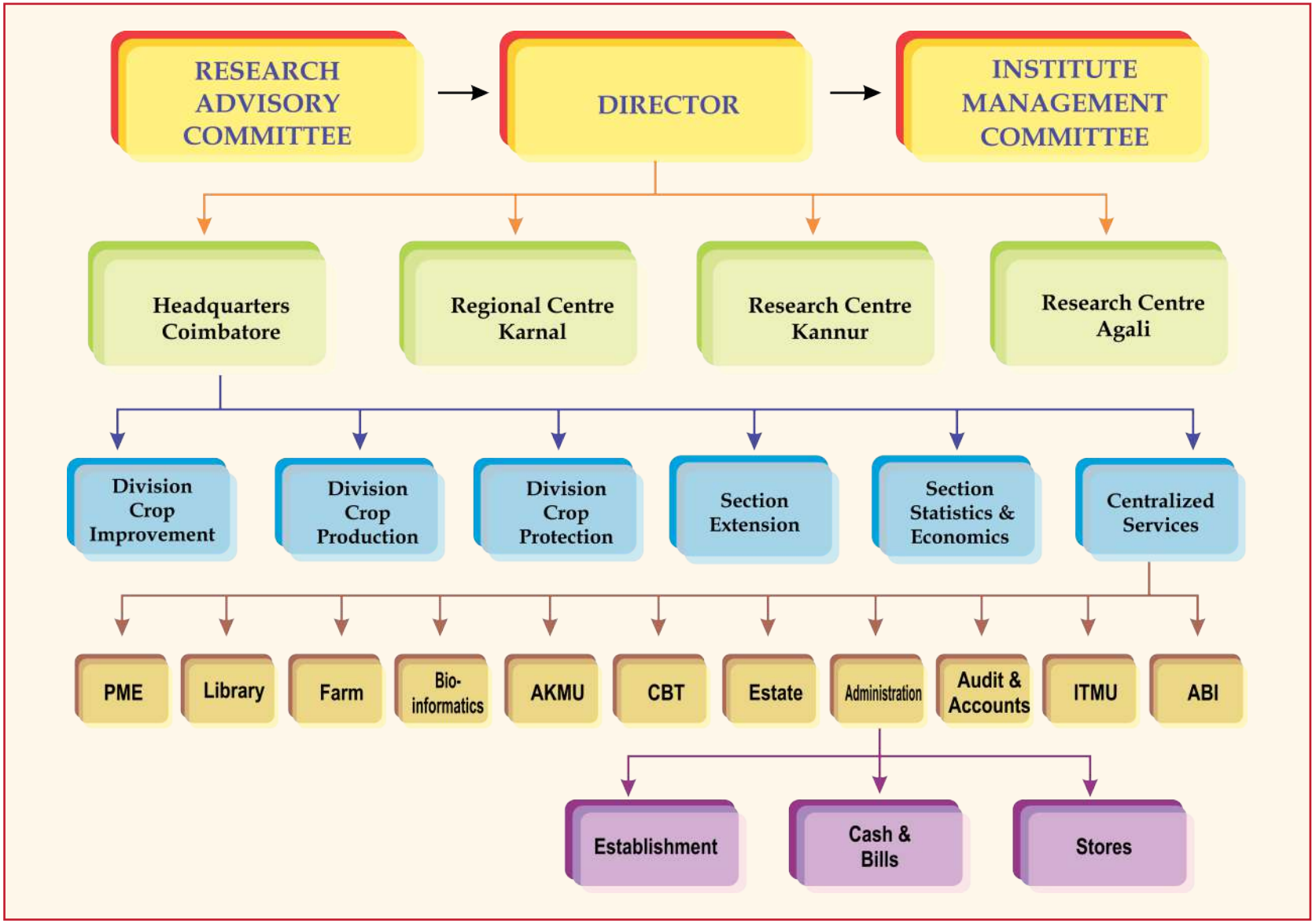
## Financial Statement

**Abstract of expenditure during 2022-23**

| Head | Amount in Lakhs (Rs.) |
|---|---|
| Government Grant | 5074.79 |
| Government Grant Schemes | 41.09 |
| Externally Funded Schemes | 332.70 |
| Contract Research Projects | 14.38 |
| Total | 5462.96 |

## Organizational Set-up

The research activities of the Institute are being carried out in three divisions and two sections at the main Institute and its Regional / Research Centres under the administrative control of the Director. The Prioritization, Monitoring and Evaluation Unit supports the research management functions like prioritization, coordination, planning and review of research programs to ensure that the system functions with the requisite accountability in terms of efficiency and optimal utilization of resources. An administrative wing comprising Establishment, Audit and Accounts, Cash and Bills, and Stores effectively provides the required administrative support. The Estate section, besides maintenance of buildings, takes care of the vehicle management and security arrangements.




*Organizational Setup of ICAR-SBI*

## Organizational Setup of ICAR-SBI Farm

The main Institute in Coimbatore has a total area of 89.09 ha including farm, laboratory and office buildings. The farm area is 54.98 ha and is situated in four campuses *viz.*, Main (7.28 ha), ECC (28.50 ha), Additional land (17.20 ha) and VPT (2.00 ha). ICAR-SBI Regional Centre, Karnal has 22 ha, ICAR-SBI Research Centre, Kannur has 8.33 ha and ICAR-SBI Research Centre, Agali has 12 ha.

## Library & Documentation

The Library provides information support to the Research and Development activities of the institute. It has a collection of around 14253 books including bound volumes of journals. The Library continues to provide IP based online access to the e-journals and e-books through CeRA. Library has facilities *viz.*, internet terminals, scanning and digital access to holdings through KOHA software for the users. It has got ISBN and ISSN assigning facility for the publications of the institute. Academic research support is provided to the students and scholars in the form of access to dissertations, thesis and reports of other ICAR institutes. The library also provides vital information on the sugar industry activities through sugar industry publications. The priced publications of the institute (70 nos.) were sold for an amount of Rs.18860/- during the period.

## Weather Data

### Weather data for January – December 2023

| Month | Temperature ($^{O}$C) | | RH (%) | | Wind velocity (km per hour) | Open pan evaporation (mm/day) | Rainfall (mm) | No. of rainy days |
|---|---|---|---|---|---|---|---|---|
| | Maximum | Minimum | Fore noon | After noon | | | | |
| January | 26.68 | 18.94 | 84.26 | 56.48 | 1.45 | 3.89 | - | - |
| February | 30.70 | 18.00 | 78.20 | 39.00 | 1.40 | 4.38 | 2.00 | - |
| March | 34.26 | 23.97 | 84.52 | 44.39 | 1.94 | 4.73 | 4.2 | 1.00 |
| April | 34.90 | 22.70 | 83.90 | 44.00 | 1.40 | 5.30 | 36.3 | 3.00 |
| May | 35.91 | 24.03 | 85.52 | 56.06 | 1.01 | 4.12 | 145.8 | 11.00 |
| June | 36.11 | 22.93 | 89.20 | 58.03 | 2.27 | 4.69 | 67.5 | 3.00 |
| July | __ | __ | 85.06 | 66.45 | 3.75 | 3.78 | 72.6 | 6.00 |
| August | 34.47 | 22.44 | 86.26 | 54.45 | 2.62 | 5.28 | __ | __ |
| September | 32.48 | 23.70 | 82.70 | 63.23 | 3.15 | 4.45 | 12.00 | 2.00 |
| October | 33.28 | 24.55 | 87.27 | 54.60 | 1.45 | 4.04 | 31.7 | 4.00 |
| November | 30.68 | 26.02 | 91.13 | 66.33 | 1.06 | 2.70 | 298.8 | 11.00 |
| December | 29.88 | 26.49 | 90.39 | 67.23 | 1.13 | 2.21 | 97.8 | 3.00 |
| Mean/Total | 32.67 | 23.07 | 85.70 | 55.86 | 1.89 | 4.13 | 768.70 | 44.00 |

*Total rainfall received during 2023 was **768.70** mm which is 94.5 mm higher than the 60 years (1930-1990) average rainfall of 674.2 mm. The rainfall received during 2023 is normal.*

# 03
# कार्यकारी सारांश

अनुसंधान गतिविधियाँ संस्थान के अधिदेश के अनुसार मुख्य स्टेशन कोयंबटूर में, इसके क्षेत्रीय केंद्र करनाल और अनुसंधान केन्द्रों कन्नूर और अगली में अच्छी तरह से आगे बढ़ीं। वर्ष 2023 के दौरान कृषि फसलों के लिए फसल मानकों, अधिसूचना और किस्मों की जारी पर केंद्रीय उप-समिति की 90 वीं बैठक में चार नई गन्ना किस्मों को जारी और अधिसूचित किया गया। ये किस्में है को. 11015 (अतुल्य), एक उच्च उपज देने वाली और जल्दी पकने वाली किस्म एवं को. 14005 (मध्यवर्ती), दोनों प्रायद्वीपीय क्षेत्र के लिए; को. 18009 (पुन्नगई), तमिलनाडु राज्य के लिए जारी की गई एक मध्यम देर वाली जलवायु प्रतिमान किस्म है और को. 16030 (करन 16), उत्तर पश्चिम क्षेत्र में खेती के लिए मध्य देर से पकने वाली किस्म है। कोयंबटूर से, को. 2023 श्रृंखला के 21 'को.' गन्ने (केन्स) की पहचान की गई, जिनमें से तीन को. केन्स नए और विविध आनुवंशिक आधार से विकसित किये गये। दस को. केन्स को एआईसीआरपी परीक्षण के लिए आगे बढ़ाया गया। करनाल केंद्र से पांच को. केन्स (को. 23021 से को. 23025) की पहचान की गई। कुल 420 द्विपैत्रक संकरण किए गए जिनमें जंगली आनुवंशिक स्रोतों से युक्त नए संकरों से युक्त 20 संकरण शामिल थे। कन्नूर केंद्र में विकसित दो जल-भराव सहिष्णु क्लोंस को. 22017 (WL 15-1177) कोयंबटूर से तथा को. 22020 (WL 10-85) क्षेत्रीय केंद्र, करनाल से को-केन्स के रूप में चुने गये।

कोयंबटूर और करनाल में नियमित चरणवार चयन परीक्षणों के साथ किस्म विकास कार्यक्रम आगे बढ़े। कोयंबटूर में, ग्राउंड नर्सरी प्लांट और रैटून फसल में 47000 से अधिक पौधों का मूल्यांकन किया गया। विभिन्न क्लोनल परीक्षणों में, सर्वश्रेष्ठ क्लोनों का चयन किया गया और उच्च प्रजनन मूल्य के साथ लाल सड़न प्रतिरोध एवं अधिक चीनी संयोजन युक्त क्लोन उत्पन्न करने वाले नए क्रॉस कॉम्बिनेशनस को भविष्य के प्रजनन कार्यक्रमों में तैनात करने के लिए भी पहचाना गया। उच्च उपज, गुणवत्ता, लाल सड़न प्रतिरोध और फील्ड स्टैंड के संयोजन वाले कुल 263 क्लोनों का चयन किया गया, जिन्हें को. केन्स की पहचान के लिए PZVT 2023 परीक्षण के लिए प्रमोट किया गया। उल्लेखनीय है कि क्रॉस को.वीसी 14062 x को. 11015 से विकसित क्लोन 2018-185 में फसल की 11वें माह की अवस्था में 24.20% सुक्रोज दर्ज किया गया, जो एक महत्वपूर्ण उपलब्धि है। चूँकि लाल सड़न प्रतिरोध को प्रतिरोधी किस्मों की तैनाती के माध्यम से प्रभावी तरीके से प्रबंध किया जा सकता है, इस वर्ष भी दूसरे क्लोनल परीक्षण में प्रविष्टियों के लाल सड़न परीक्षण का मूल्यांकन लाल सड़न प्रतिरोध के लिए किया गया था, जिसमें लगभग 37 प्रतिशत प्रविष्टियाँ ने बीमारी के प्रति आर / एमआर प्रतिक्रिया दिखाई, जो एक बहुत उत्साहजनक संकेत है।

2022 श्रृंखला के सभी को. केन्स का DUS दिशानिर्देशों के आधार पर वानस्पतिक रूप से वर्णन किया गया और आणविक प्रोफाइल के ग्राफिकल प्रतिनिधित्व ने प्रत्येक क्लोन के लिए अलग-अलग पैटर्न दिखाए। महाराष्ट्र में 23 विशिष्ट क्लोनों के स्थान परीक्षण में को. 18001, को. 19008, को. 20005, को. 20006 और को. 21003 का प्रदर्शन अच्छा पाया गया। कर्नाटक में, 28 विशिष्ट क्लोनों में से 2018-14, 2018-123, 2018-161, 2019-3 और 2019-12 क्लोनों का मूल्यांकन सीसीएस उपज के लिए मानकों से बेहतर था। तमिलनाडु कृषि विश्वविद्यालय के सहयोग से किए गए अनुकूली परीक्षणों में, मल्टी-लोकेशन परीक्षण में को. 17001, बहु स्थान परिक्षण में; को. 15020, अनुकूली अनुसंधान परीक्षण प्रथम पौध फसल में; को.14004 अनुकूली अनुसंधान परीक्षण रेटून परीक्षण में ने विभिन्न चीनी कारखानों में बेहतर प्रदर्शन किया।

कन्नूर में, गन्ना जर्मप्लाज्म के विश्व संग्रह को जिसमें 3379 क्लोन्स शामिल है का रख-रखाव फील्ड जीन बैंक में किया गया। कोयंबटूर में 2239 जंगली गन्ना जर्मप्लाज्म परिग्रहण (accessions), 2049 वाणिज्यिक क्लोन और आनुवंशिक स्टॉक, 229 राष्ट्रीय सक्रिय जर्मप्लाज्म का रखरखाव किया गया तथा वेलिंग्टन में अरुणाचल प्रदेश के 47 परिग्रहण का रखरखाव किया गया। इस अवधि के दौरान *सैकरम* और संबद्ध जेनेरा में कोशिकाई अध्ययन जारी रहे और *सै. स्पोंटेनियम* क्लोन मे गुणसूत्र संख्या की रेंज IND 09-1520 और IND 09-1544 में 2n=40 से IND 01-1157 में 112 तक थी और वाणिज्यिक संकरों में, को. 09010 में सबसे कम संख्या 2n = 102 दर्ज की गई। जंगली जर्मप्लाज्म की स्क्रीनिंग से पता चला कि सूखे के तनाव के तहत, जीनोटाइपस जैसे IND 04-1372, IND 99-847, IND 99-850, IND 11-1620 और SES 600 में उच्च बायोमास उत्पादन देखा गया तथा H 60-4-5 और SES 600 में ताजा बायोमास में 3% से कम की कमी देखी गई। करनाल में, अंतरविशिष्ट और अंतरजेनेरिक संकर जैसे 14-90, 14-58, 14-67, 14-474, 14-195, 14-124, आईएसएच 524 और आईएसएच-588 में कटाई के समय गन्ने की उपज में कम कमी देखी गई। कन्नूर में, 119 संभावित जल-जमाव सहिष्णु क्लोनों की स्क्रीनिंग से 12 क्लोंस मानक से अधिक उच्च सीसीएस उपज वाले पहचाने जा सके। पांच लाल गूदे वाले *एस. रोबस्टम* व्युत्पन्न बैक क्रॉस में 7वें महीने में 21% से अधिक ब्रिक्स की मात्रा थी। ये दुर्लभ संकर हैं, जो अब तक कहीं और रिपोर्ट नहीं किए गए हैं।

एरिंथस क्लोन एसईएस 3, एसईएस 7, एसईएस 27 और एसईएस 181 ने लवण तनाव के विरुद्ध उच्च स्तर की सहनशीलता क्रियाविधि दिखाई। बारागुआ और लालकाडी में इंटरनोड शारीरिक चरित्रों ने बड़े बंडल शीथ दिखाए। 'सैकरम कॉम्प्लेक्स' के इंटरनोड्स के सूक्ष्मरूपात्मक लक्षण तैयार किए गए। एक गुण विशिष्ट आनुवंशिक स्टॉक टीएसजीएस 20-74, लाल सड़न रोगज़नक़ के सीएफ 06 और सीएफ 12 दोनों आइसोलेट्स के लिए प्रतिरोधी पाया गया और टीएसजीएस 20-125, स्मट और लाल सड़न रोगज़नक़ दोनों के लिए मध्यम प्रतिरोधी था। इसके अलावा, जलवायु परिवर्तन को ध्यान में रखते हुए बहुगुणीय जेनेटिक स्टॉक के विकास पर ध्यान दिया गया और *सै. बारबेरी*, इम्प्रूव्ड *सै. ऑफिसिनारम* और *सै. रोबस्टम* को शामिल करके चार विशिष्ट क्लोन जैसे 12-127, 003-14, 07-520, 13-457 विकसित किए गए जो प्री जोनल वैराइटल ट्रायल में प्रवेश

कर गए हैं। *सै. स्पोंटेनियम* साइटोटाइप 2n=72 से प्राप्त जलभराव और ठंड सहनशीलता वाला एक आनुवंशिक स्टॉक (एएस 04-635) आईसीएआर-एनबीपीजीआर को पंजीकरण के लिए प्रस्तुत किया गया। अजैविक तनाव सहिष्णु *सै. स्पोंटेनियम* क्लोन का मातृ अभिभावक के रूप में उपयोग आगे बढ़ा, हालांकि ऐसे पांच क्रॉस से प्राप्त वास्तविक एफ$_1$ ($F_1$) संकर का प्रतिशत केवल 58% था। बयालीस अलग-अलग आईएसएच और आईजीएच संकरों की बहु-रैटूनिंग क्षमता पहली रैटून फसल की ओर बढ़ी। *सै. स्पोंटेनियम* व्युत्पन्न संकर गन्ना संख्या और गन्ने की उपज के लिए बेहतर थे, जबकि कटाई के समय सबसे अधिक सुक्रोज % *सै. ऑफिसिनेरम* समूह में पाया गया था। रूपात्मक लक्षणों और आणविक विविधता के पैटर्न का अध्ययन करके जंगली सैकरम प्रजातियों का एक मुख्य संग्रह विकसित किया जा रहा है। शीतसंरक्षण के लिए आज़माए गए विभिन्न तरीकों में से, पुनर्जनन केवल मेरिस्टेम-व्युत्पन्न एक्सिलरी कलियों में और अलग-अलग समय अंतराल में क्रायोजेनिक उपचार के बाद निष्क्रिय नोडल कलियों में देखा गया था।

गन्ना जीनोमिक्स और आणविक मार्करों के अध्ययन में अच्छी प्रगति हुई। सूखा और लाल सड़न प्रतिरोध के लिए मार्कर असिस्टेड चयन जारी रखा गया और सूखा सहनशीलता से जुड़े मार्कर एसएनएसी1, डीआरईबी1ए और पीओएम1 तथा लाल सड़न प्रतिरोध के लिए आरजीए 184 को आगे के सत्यापन के लिए आशाजनक पाया गया। सूखा सहिष्णु और अतिसंवेदनशील किस्म को. 06022 और को. 8021 के प्रतिलेख अनुक्रमों से क्रमशः कुल 56646 SSR और 49974 SSR की पहचान की गई। सूखा प्रतिलेख के डीईजी से एसएनपी के लिए खनन के परिणामस्वरूप 995 unigenes से कुल 968 एसएनपी प्राप्त हुए। सूखा transcriptome से पहचाने गए सात उम्मीदवार जीनों जैसे, डिहाइड्रिन (754 बीपी), टीपीएस (2.5 केबी), टीपीपी (1.1 केबी) एबीआरई (1.1 केबी), ग्लाइऑक्सिल ट्रांसफरेज (1.5 केबी), साइटोक्रोम पी450 (2.6 केबी) और एनएसी 4 (1.2 केबी) को क्लोन और अनुक्रमित किया गया।विभेदित रूप से व्यक्त जीन/ट्रांसक्रिप्शनल फैक्टर की खोज के लिए, सूखे के तनाव के दौरान प्रेरित होमियो डोमेन ल्यूसीन जिपर (एचडीएलजेड) का एक पूर्ण लंबाई ट्रांसक्रिप्शनल फैक्टर क्लोन किया गया। दो सूखा सहिष्णु क्लोनों का सप्रेस्सन सबट्रेकटिव हाइब्रिडाइजेशन का उत्पाद एम्प्लिकॉन अनुक्रमण के लिए भेजा गया है। कल्लों की संख्या की द्रष्टि से दो विपरीत जीनोटाइप (को. 86032 और को. 99004) में टिलर नोड्स की प्रोटीन प्रोफाइलिंग की गई। अनुक्रम के परिणामस्वरूप प्रत्येक जीनोटाइप में एफडीआर ≥ 0.001 पर 1500 महत्वपूर्ण प्रोटीन की पहचान हुई। करनाल में, गन्ने में ट्रांस्क्रिप्टोम विश्लेषण द्वारा शीघ्र परिपक्व होने के लिए उत्तरदायी जीन की खोज के अध्ययन ने 165 डीईजी की पहचान की जो विशेष रूप से फसल के 8 महीने के चरण में पाए गए। विभेदक जीन अभिव्यक्ति विश्लेषण, स्टेम ऊतक में भिन्न रूप से व्यक्त 204 जीनों की पहचान कर सका, जिनमें से 19 जीनों ने एक ही उम्र में विभेदक अभिव्यक्ति दिखाई।

सुक्रोज संचय में शामिल स्वीट (SWEET) जीन स्वीट 3, 4 और 13 सी की विशेषता बताई गई व इनका जीन संपादन (gene editing) कार्य प्रगति पर है। कम ग्लाइसेमिक शर्करा जैसे डी-एल्यूलोज़ एपिमेरेज़ और आइसोमाल्टोज़ के जीन को सूक्ष्मजीवों से क्लोन और अनुक्रमित किया गया है। WUE जीन जैसे Angustifolia (AN3) ERECTA, CER9 और WIN1 को उच्च और निम्न WUE गन्ना क्लोनों से सफलतापूर्वक अलग किया गया और क्लोन किया गया। सूखे, बाढ़, गर्मी और ठंड के तनाव वाले वातावरण में गन्ना क्लोनों से तनाव प्रतिक्रियाशील जीआरएएस प्रतिलेखन कारक (GRAS transcription factor) की आरटी-पीसीआर मात्रा का निर्धारण किया जा रहा है। पीडीएफ जीन के जीन एडिटिंग के परिणामस्वरूप 74 अनुमानित एडिटेड पौधे प्राप्त हुए जिन्हें दृढ़ किया गया और पत्तियों में क्लोरोफिल सामग्री के लिए फिनोटीपिक भिन्नता देखी गई। उत्परिवर्ती (mutant) आवृत्ति कम थी। इसी प्रकार, बेहतर बायोमास रूपांतरण की दिशा में गन्ने में लिग्निन संशोधन के लिए दो CRISPR constructs को एग्रोबैक्टीरियम होस्ट में संगठित किया गया है और एक construct (pGREB31::F5H::sg1439) का उपयोग तंबाकू और गन्ना आनुवंशिक परिवर्तन के लिए किया गया है।

लाल सड़न प्रतिरोध के लिए, 540 जीनोटाइप के पैनल में 12 क्यूटीएल की पहचान की गई। बीओ 91 पैत्रक वाली पापुलेशन में कॉमन मार्करों की संख्या अधिक थी और उन एसएनपी को आस-पास के आश्रय देने वाले जीनों के लिए खोजा गया था, साथ ही लाल सड़न से जुड़ी उच्च आनुवंशिकता वाले कारकों की भी पहचान की गई थी।

एआईसीआरपी (एस) में, सभी परीक्षण कोयंबटूर और करनाल में कार्यक्रम के अनुसार आयोजित किए गए। कोयंबटूर में, एवीटी में दो पौधे और एक पेड़ी की फसल के आधार पर, दो प्रविष्टियाँ को. 16006 और को. 16018 बेहतर थीं। आईवीटी में, मूल्यांकन की गई 23 प्रविष्टियों में से, दो प्रविष्टियाँ को. 19004 और को. 19008 गन्ना उपज और चीनी उपज के लिए बेहतर थीं और AVT I प्लांट में छह प्रविष्टियाँ बेहतर थीं। करनाल में एवीटी 1 प्लांट फसल में सीओ 18022 सर्वश्रेष्ठ प्रविष्टि थी। जलवायु प्रतिमान क्लोन जैसे आईएसएच 567 (94.58 टन हेक्टेयर$^{-1}$), आईएसएच 502 (88.12 टन हेक्टेयर$^{-1}$) और आईएसएच 545 (86.38 टन हेक्टेयर$^{-1}$) करनाल की परिस्थितियों में परिपक्वता के समय सूखे के तनाव में बेहतर थे।

राष्ट्रीय फ्लफ आपूर्ति कार्यक्रम के तहत, 2022 के पुष्पन सीजन के दौरान कोयंबटूर में बनाए गए 24.30 किलोग्राम वजन वाले फ्लफ की 23 फ्लफ प्राप्त केंद्रों को आपूर्ति की गई। राष्ट्रीय संकरण उद्यान 447 अभिभावकों (पेरेंट्स) के साथ लगाया गया। पुष्पन काल के दौरान, जिसमें दो सप्ताह की देरी हुई, भा.कृ.अनु.प.-ग.प्र.सं. ने 21 भाग लेने वाले केंद्रों को 487 द्विपैत्रक क्रॉस की सुविधा प्रदान की। डीयूएस (DUS) कार्यक्रम नई किस्मों के परीक्षण के साथ आगे बढ़ा, जो उष्णकटिबंधीय किस्मों के लिए कोयंबटूर और अगली में और उपोष्णकटिबंधीय किस्म को. 13035 के लिए करनाल में संदर्भ किस्मों से अलग थे। डीयूएस संदर्भ लाइनों का पुनः लक्षण वर्णन करनाल में किया गया और सत्यापित डीयूएस संदर्भ किस्मों का डेटाबेस पीपीवी और एफआर प्राधिकरण को सारणीबद्ध प्रारूप में प्रस्तुत किया गया। अगली केंद्र में, दूरस्थ संकरण कार्यक्रम में उपयोग के लिए 1394 परिग्रहणों का एक सक्रिय जर्मप्लाज्म संग्रह बनाए रखा गया। पुष्पन काल के दौरान 18 एआईसीआरपी (एस) केंद्रों के लिए

226 क्रॉस किए गए। प्रजनन परियोजनाओं और डीयूएस परीक्षणों के क्लोनल परीक्षण आयोजित किए गए; डीयूएस परीक्षणों में, परीक्षण के तहत पांच उम्मीदवार किस्मों को अलग पाया गया। केंद्र (अगली केंद्र) ने आईसीएआर-एनआरसी त्रिची को केले की ऑफ सीजन नर्सरी के लिए सुविधाएं भी प्रदान कीं।

संस्थान में बीज कार्यक्रम एक बड़ी सफलता है, जो वर्ष 2015-16 में 163 टन के बहुत कम उत्पादन से, बीज उत्पादन न केवल 2022-23 में 959.985 टन तक पहुंच गया, बल्कि उच्च गुणवत्ता वाले बीज भी सुनिश्चित हुए, जिससे लाभार्थी किसान और चीनी कारखानों की उपज बढ़ सकी। तीन नई रिलीज किस्मों जैसे सीओ 11015, सीओ 18009 और सीओ 14012 के लिए बीज मांगपत्र तमिलनाडु सरकार के शर्करा निदेशक से प्राप्त हुए। सहभागी बीज उत्पादन कार्यक्रम के तहत जून-जुलाई 2023 के दौरान नया लक्ष्य 1100 टन उत्पादन का है। सूक्ष्मप्रवर्धन के माध्यम से गन्ना किस्मों को. 86032, को. 11015, को. 0118, को. 0238 के कुल 1,23,500 गुणवत्ता वाले टिशू कल्चर पौधे उत्पादन किये गये तमिलनाडु, कर्नाटक, केरल, महाराष्ट्र, उत्तर प्रदेश और उत्तराखंड की चीनी मिलों/किसानों को आपूर्ति की गई, इसके अलावा किस्मों को. 86032, को. 11015, को. 0238, को. 0118, को. 15023 के 118 मदर कल्चर फ्लास्क छह राज्यों की 10 टिशू कल्चर प्रयोगशालाओं को वितरित किये गए। करनाल में, कुल 24398.64 क्विंटल प्रजनक बीज, मुख्य रूप से को. 15023 (12135.6 क्विंटल) और को. 0118 (11767.1 क्विंटल) का उत्पादन किया गया और विभिन्न हितधारकों को आपूर्ति की गई। पहली बार आरकेवीवाई फंड से स्थापित सेटलिंग उत्पादन सुविधा, प्लांट ग्रोथ चैम्बर के उपयोग से चरम सर्दियों के दौरान लगभग 50,000 सेटलिंग का उत्पादन किया गया और प्रत्यारोपण के लिए तैयार सेटलिंग को शीतकालीन द्रढ़ीकरण के उद्देश्य से डिज़ाइन किए गए बहु-स्तरित रैक में स्थानांतरित कर दिया गया।

संस्थान-उद्योग भागीदारी दृष्टिकोण के माध्यम से तमिलनाडु में गन्ना उत्पादकता और चीनी रिकवरी को बढ़ाने के उद्देश्य से स्वीट ब्लूम 2.0 परियोजना को SISMA-SBI सहयोग से लागू किया गया। परीक्षण 16 आशाजनक प्रविष्टियों के साथ 10 चीनी मिलों में प्रगति पर थे। प्रारंभिक अवलोकन के आधार पर दो प्रविष्टियाँ को. 15017 और को. 20010 बेहतर थीं।

पादप रोगविज्ञान की प्रमुख गतिविधियों के अंतर्गत लाल सड़न रोग प्रतिरोधक क्षमता का मूल्यांकन कोयंबटूर में विभिन्न प्रजनन परीक्षणों से 4791 क्रन्तकों को नियंत्रित स्थिति परीक्षण (सीसीटी) के तहत देखा गया जिसमें 1381 को मध्यम प्रतिरोधी और 314 को प्रतिरोधी के रूप में पाया गया। सोलह नए लाल सड़न आइसोलेट्स को एकत्र कर रोगजनक भिन्नता के लिए उनका मूल्यांकन किया गया जिसमे तीन आइसोलेट्स अत्यधिक उग्र थे और गन्ने की किस्मों में को. 2001-13, को. 99004 और को. 09004 लाल सड़न आइसोलेट्स के प्रति प्रतिरोधी थे। करनाल में समग्र रोग प्रतिक्रियाओं ने परीक्षण मेजबान अंतर पर स्पष्ट रोगजनक भिन्नता का संकेत दिया, पैथोटाइप सीएफ13 सर्वाधिक उग्र पाया गया व बाद में उग्रता क्रमशः सीएफ 11, सीएफ 01, सीएफ 02, सीएफ 08, सीएफ 09, सीएफ 03 और सीएफ 07 में थी। क्षेत्र में एक अन्य पैथोटाइप के संभावित उद्भव का उल्लेख किया गया है जिसके लिए अधिक अध्ययन की आवश्यकता है। क्षेत्र की कई चीनी मिलों में प्रचलित किस्म को. 0238 में लाल सड़न रोग के सामान्य से अधिक प्रकोप के कारण क्षेत्रफल मे कमी हुई है। पोकहा बोईंग, कंडुआ (पोधा फसल में 10 प्रतिशत तक) और उखेड़ा जैसी अन्य बीमारियों का सामान्य प्रकोप देखा गया। एनएचजी में 225 पैतृक क्लोनों मे से नौ क्लोनों को उखेड़ा रोग के प्रति प्रतिरोधी के रूप में और 116 क्लोनों को संवेदनशील अंतर्गत समूहीकृत किया गया। नौ पैतृक क्लोन कंडुआ रोग के प्रति प्रतिरोधी थे। लाल सड़न के परिरोधिता के लिए क्षेत्रीय किस्मों का कोयंबटूर और करनाल में मूल्यांकन किया गया, जिसमें प्रतिरोधी और मध्यम प्रतिरोधी लाइनों की प्रबलता देखी गई। दो नैनो फॉर्मूलेशन का खेत मे कृत्रिम रूप से रोगज़नक़ टीकाकरण के तहत लाल सड़न रोग के प्रति उनकी प्रभावकारिता के लिए परीक्षण से पता चला है कि बीटीएच और एसए नैनो फॉर्मूलेशन के अनुप्रयोग से लाल सड़न रोग के प्रभाव को रोगज़नक़ टीका नियंत्रण की घटनाओं से क्रमशः 80.4% और 74.0% तक कम किया जा सकता है।

प्ररोही कायिक प्रवर्धन फसलों जैसे गन्ना, टैपिओका, केला, ग्लेडियोलस, गुलदाउदी, रजनीगंधा और क्रॉसेंड्रा की स्वस्थ बीज नर्सरी रोपण सामग्री के यंत्रीकृत प्राइमिंग को पूरा करने के लिए अन्य संस्थानों के सहयोग से परीक्षण किया गया। गन्ना बीज को गर्म पानी से उपचारित करने के बाद पोषक तत्वों से उपचार करने से अंकुरण व उपज गुणों में काफी सुधार पाया गया तथा परिपक्वता तक पीली पती रोग और घसेला रोग मे भी कमी अभिव्यक्त की गई। मशीनीकृत बीज प्राइमिंग तकनीक को लोकप्रिय बनाने का काम दस चीनी मिलों में किया गया जहां स्वस्थ पोध का उत्पादन आरंभ किया गया। घसेला रोग से संक्रमित गन्ने के पौधों में कायिकी मापदंड जैसे स्वस्थ पौधों की तुलना में पत्ती क्षेत्र माप (सेमी$^2$) में 52-80% की कमी, क्लोरोफिल सामग्री में 39-78% की कमी और कुल मुक्त अमीनो एसिड सामग्री में 4-71% की वृद्धि देखी गई। करनाल में अतिसंवेदनशील किस्म को. 0238 के बीज उपचार के लिए थियोफैनेट मिथाइल (टीपीएम) और 'अमिस्टार' का प्रयोग उत्साहजनक परिणामों के साथ किया गया।

गन्ने के पौधे से एंडोफाइटिक बैक्टीरिया को अलग करने के लिए सतह विसंक्रमण प्रोटोकॉल को मानकीकृत किया और गन्ने की किस्म को. 86032 की जड़, तने और पत्तियों से 239 एंडोफाइटिक बैक्टीरिया को अलग किया गया। यीस्ट एक्सप्रेशन वेक्टर *पिचिया पास्टोरिस* की सक्षम कोशिकाओं और इलेक्ट्रोपोरेशन विधियों द्वारा प्रपांतरण प्रोटोकॉल को SCYLV कोट प्रोटीन जीन अभिव्यक्ति के लिए मानकीकृत किया गया। तम्बाकू में GFP की नियंत्रित क्षणिक अभिव्यक्ति के लिए एक डेक्सामेथासोन (DEX)-इंड्यूसिबल वेक्टर, pC1302DEX को विकसित और पुष्टि किया गया इस नवीन अभिव्यक्ति प्रणाली ने एक रासायनिक-प्रेरक प्रमोटर के तहत ट्रांसजीन की विनियमित अभिव्यक्ति को दिखाया।

कीट विज्ञान में, कृषि-औद्योगिक उप-उत्पादों और गन्ना और इसके उप-उत्पादों का उपयोग करके बीटी-62 के बड़े पैमाने पर उत्पादन के लिए एक कम लागत वाली तकनीक विकसित की गई फॉर्मूलेशन 300 दिनों से अधिक जीवन क्षमता है और *होलोट्रिचिया सेराटा* के खिलाफ फील्ड परीक्षणों में बड़े पैमाने पर उत्पादन का वर्णन किया

गया और इसका उपयोग *होलोट्रिचिया सेराटा*, *एच. कंसांगुइनिया* और *एच. लोंगिपेनिस* के नियंत्रण के लिए किया गया। अभिव्यक्ति अध्ययनों से इंटरनोड बेधक *चिलो सैकरीफैगस* इंडिकस में *cry9Eb* जीन की विषाक्तता का पता चला और इसे गन्ने को संक्रमित करने वाले विभिन्न चिलो एसपीपी बेधक के खिलाफ ट्रांसजेनिक विकसित करने के लिए एक उम्मीदवार जीन के रूप में उपयोग किया जा सकता है। चिमनी और बॉक्स विधियों का उपयोग करके *टेलीनोमस डिम्नस* उत्पादन को बढ़ाने के लिए बड़े पैमाने पर गुणन विधि विकसित की गई । *टी. डिम्नस* की फील्ड प्रभावकारिता इंटरनोड बोरर के खिलाफ संवर्द्धक परीक्षणों में स्थापित की गई थी। परजीव्याभ बढ़ी हुई परजीविता दर जारी करता है और इंटर्नोड बेधक घटना को कम करता है।

विशिष्ट प्राइमरों के साथ क्यू-आर.टी.पी.सी.आर. विश्लेषण से पता चला कि क्रैम्बिड बोरर्स के विभिन्न इंस्टार में काईटिन सिंथेज़ ए (सीएचएसए), काईटिन सिंथेज़ 1बी (सीएचएस1बी), जुवेनाइल हार्मोन मिथाइल ट्रांसफ़ेज़ (जेएचएमटी) और साइटोक्रोम पी450 जैसे महत्वपूर्ण जीनों की अभिव्यक्ति के स्तर की पुष्टि हुई । RNAi के माध्यम से प्राप्त ट्रांस्क्रिप्टोम डेटा का उपयोग गन्ने में क्रैम्बिड बोरर्स के आरएनएआई-मध्यस्थता नियंत्रण के लिए किया जा सकता है । मिलीबग, *फेनाकोकस सैकरिफोली* और कीटनाशकों के बीच पहली बार कीटनाशकों के लिए बेसलाइन विषाक्तता डेटा (एलसी $_{50}$) तैयार किया गया, एक पीपीएम से कम के सबसे कम एलसी $_{50}$ के साथ थियामेथोक्सम को अधिक जहरीला पाया। प्रारंभिक प्ररोह बेधक और पोरी बेधक के खिलाफ जांचे गए *एरियनथस अरुंडिनेशस* से जुड़े अंतरजेनेरिक गन्ना संकरों में से क्रमशः चार और सात संकर सहनशील थे। करनाल में AICRP(S) परीक्षणों में दो जीनोटाइप; को. 17018 और को. 05011 प्रमुख कीटों के प्रति सबसे कम संवेदनशील (<15%) थे।

नेमाटोलॉजी संकाय में, आठ ईपीएन आइसोलेट्स की आणविक पहचान आंतरिक ट्रांसक्राइब्ड स्पेसर (आईटीएस) विशिष्ट प्राइमरों के साथ जीनोमिक डीएनए अनुक्रमों के विश्लेषण द्वारा की गई । उपोष्णकटिबंधीय गन्ना क्षेत्रों से अलग किए गए आठ ईपीएन (*हेटेरॉर्बडाइटिस* और *स्टीनरनेमा स्पीसीज*) के आईटीएस अनुक्रम ओपी 985087 से ओपी 985094 तक परिग्रहण संख्या के साथ एन.सी.बी.आई. डेटाबेस को प्रस्तुत किए गए। उपसतह ड्रिप सिंचाई प्रणाली के माध्यम से ईपीएन *स्टीनरनेमा ग्लैसरी* का नवीन सूत्रीकरण किया गया। ईपीएन *हेटेरोर्हेब्डाइटिस इंडिका* की ड्रिप सिंचाई डिलीवरी से *जी. मेलोनेला* लार्वा की 95% से अधिक मृत्यु और सफेद ग्रब की 75% मृत्यु हुई । तरल संवर्धन में सफल नेमाटोड बड़े पैमाने पर उत्पादन दो ईपीएन आइसोलेट्स (*एस. सुरखेटेन्स* एसबीआईपी3 और *एस. सियामकायई* एसबीआईटीएनटी1) में देखा गया । *फोटोरैबडस स्पीसीज* तथा *ज़ेनोरहैबडस स्पीसीज* से संबंधित 78 ईपीएन उपभेद और 45 सहजीवी बैक्टीरिया का नियमित रूप से उप-संवर्धित तथा भंडारण किया गया। आईसीएआर-एसबीआई ईपीएन बायोपेस्टीसाइड फॉर्मूलेशन तकनीक को दो कंपनियों (एग्रीनोवेट इंडिया, नई दिल्ली द्वारा समन्वित) के लिए 4 लाख.रुपये के लाइसेंस शुल्क के साथ व्यावसायीकृत किया गया *एच. इंडिका* की विभिन्न खुराकों के साथ किए गए क्षेत्रीय अध्ययनों से पता चला कि *एच. इंडिका* 3000 आईजे/एमएल के साथ 2% ग्लिसरॉल + 1% ट्वीन 20 के पर्णीय छिड़काव से फॉल आर्मी वोर्म की 55% मृत्यु हुई । गन्ने के राइजोस्फीयर से पौधे परजीवी नेमाटोड निकाले गए, गन्ने के नेमाटोड कीटों की वास्तविक समय की निगरानी के लिए कृत्रिम बुद्धिमत्ता (आर्टिफीसियल इन्टेलिजेंस) संचालित डायग्नोस्टिक किट के विकास के लिए नेमाटोड छवियों को कैप्चर किया गया और संसाधित किया गया।

प्रारंभिक अंकुर बेधक, शीर्ष बेधक, जड़ बेधक, तना बेधक; पाइरिला, ब्लैक बग और दीमक को हरियाणा में गन्ने के प्रमुख कीटों के रूप में सूचीबद्ध किया गया, जबकि गुरदासपुर बोरर, गुलाबी बोरर और ब्लिस्टर माइट और सफेद ग्रब उत्तर पश्चिमी क्षेत्र में गन्ने के गौण कीट थे।

नए शाकनाशी अणुओं पर अध्ययन से पता चलता है कि केवल अनुशंसित खुराक पर एमेट्रिन और 2, 4-डी अमाइन के उपयोग से न्यूनतम क्षति हुई, जबकि अनुशंसित खुराक से दोगुनी मात्रा में उनके संयोजन के परिणामस्वरूप गन्ने में, विशेष रूप से को.0212 में पत्तियां झुलस गईं। इस क्षति के बावजूद, गन्ने की अंतिम उपज अप्रभावित रही । शाकनाशी हेलोसल्फ्यूरॉन के अवशेष 9.12 से 9.71 दिनों के हाफ लाइफ के साथ 75 दिनों के भीतर लगभग 95% के स्तर तक नष्ट हो गए।

दो उर्वरक स्तरों यानी 100 और 125% अनुसंसित उर्वरक मात्रा (आर.डी.एफ.) के तहत तीन मानकों की तुलना में चार विशिष्ट गन्ना जीनोटाइपों में से, प्रविष्टि को. 16018 और को. 16006 ने मानक की तुलना में काफी अधिक गन्ना उपज प्रदर्शित की । रस की गुणवत्ता के मानदंड जीनोटाइप के बीच काफी भिन्न थे, तथा उर्वरक के स्तर से कोई महत्वपूर्ण प्रभाव नहीं देखा गया।

गन्ना आधारित खेती प्रणाली (गन्ना, पशुधन, मुर्गी पालन और मत्स्य पालन) ने पारंपरिक एकमात्र फसल गन्ना प्रणाली की तुलना में बेहतर उत्पादकता, शुद्ध रिटर्न और ऊर्जा दक्षता पैदा की। यह प्रणाली 4,11,604/- की अतिरिक्त आय के साथ, मासिक आय उत्पन्न करने वाले एक संसाधन मॉडल के रूप में कार्य करती है।

सक्रिय फास्फोरस का पोटेशियम लवण (PSAP) आधारित पोषक तत्व प्रबंधन (बीज टुकड़े 0.8% PSAP के घोल में + अनुसंसित नत्रजन मात्रा, 50% फॉस्फोरस व 50% पोटाश + सक्रिय फास्फोरस के पोटेशियम लवण (PSAP) का 0.4, 0.65, 1.10 और 1.10 की दर से बिजाई के 60, 80, 100 और 120 दिन बाद पर्णीय छिडकाव) से उल्लेखनीय रूप से अधिक गन्ना उपज (123 टन/हेक्टेयर) प्राप्त हुई ।

फार्म मशीनीकरणः गन्ने में सफेद लट (white grub)नियंत्रण के लिए बायो फॉर्मूलेशन एप्लिकेटर ने के देरी के सीजन में और उन्नत प्यूपा चरण में सफेद लट की कम उपस्थिति के कारण सीमित प्रभावशीलता दिखाई। ट्रैक्टर चालित संपूर्ण गन्ना हार्वेस्टर, नव विकसित मिनी ट्रैक्टर चालित गन्ना सेट कटर प्लांटर, मिनी ट्रैक्टर चालित गन्ना सेटलिंग ट्रांसप्लांटर को CAD drawings के साथ डिजाइन किया गया और तैयार किए गए प्रोटोटाइप का फील्ड परीक्षण किया गया।

खोई से 2जी इथेनॉल उत्पादन में उनकी दक्षता का अध्ययन करने के लिए लिग्नोसेल्यूलोज खाने वाले कीड़ों की आंत से कुल 40 बैक्टीरियल आइसोलेट्स, एक कवक और पांच यीस्ट आइसोलेट्स प्राप्त किए गए। इसी प्रकार, सड़ती हुई लकड़ी के नमूनों से 10 जीवाणु, 11 कवक और 7 एक्टिनोमाइसेट्स आइसोलेट्स प्राप्त किए गए।

गन्ने के दस हाइब्रीड्स की शारीरिक दक्षता का मूल्यांकन पूर्ण सिंचाई और कम सिंचाई के तहत उनकी जल उपयोग दक्षता के लिए किया गया और को. 85019, को. 14002, को. 15021 और को. 14025 ने पानी की कमी की स्थिति के तहत उच्च सिंचाई जल उपयोग दक्षता दर्ज की थी।

उष्णकटिबंधीय और उपोष्णकटिबंधीय परिस्थितियों में गन्ने की उष्णकटिबंधीय और उपोष्णकटिबंधीय किस्मों की तुलनात्मक शारीरिक दक्षता का अध्ययन किया गया । को.14012 और को. 98014 ने दोनों स्थितियों में बेहतर उपज और शारीरिक दक्षता दिखाई । पूर्ण और कम सिंचाई के तहत आशाजनक गन्ना जीनोटाइप की विकिरण उपयोग दक्षता से पता चला है कि को. 85019, को. 14002, को. 15021 और को. 14025 ने सीमित पानी स्थिति के तहत बेहतर प्रकाश अवरोधन और RUE दर्ज किया । कार्यकी के आधार पर पोषक तत्व उपयोग दक्षता के लिए अध्ययन से पता चला कि पत्ती क्षेत्र, क्लोरोफिल सामग्री, क्लोरोफिल ए प्रतिदीप्ति, केनौपी तापमान अवसाद (कैनोपी टेम्परेचर डिप्रेशन), पत्ती मेटाबोलाइट सामग्री (प्रोटीन, फिनोल, मुक्त अमीनो एसिड, शर्करा और स्टार्च), लिपिड पेरोक्सीडेशन और जड़ प्रणाली लक्षण, परीक्षण की गई गन्ने की किस्मों के बीच विभेदक प्रतिक्रिया के साथ, बायोमास संचय और पोषक तत्व ग्रहण से संबंधित थे । इडियोटाइप अवधारणा विकसित करने के लिए 70 जीनोटाइप के पादप वास्तुशिल्प लक्षणों का मूल्यांकन किया गया।

गन्ने के क्लोनों में निर्माणात्मक एवं भव्य विकास काल में फसल वृद्धि और शुष्क पदार्थ विभाजन का अध्ययन किया गया, जिसमें को. केन्स में स्रोत-सिंक संबंध का बेहतर सबंध सामने आया। नियंत्रित स्थिति में अजैविक तनाव के जवाब में गन्ने की किस्म के मूल्यांकन के लिए हाइड्रोपोनिक स्क्रीनिंग पद्धति विकसित की गई । करनाल में, आरकेवीवाई फंडिंग से लवणता सहनशीलता की जांच की सुविधाएं स्थापित की गई। को. केन्स की स्क्रीनिंग से पता चला कि जीनोटाइप को. 17018, को. 18022, को. 21016, को. 21012 और को.21013 ने 6 और 8 dS/m $EC_{iw}$ लवणता तनाव के तहत बेहतर प्रदर्शन किया।

गन्ना सेटलिंग रोपाई तकनीक जिसमें नौ अलग-अलग गन्ना खेती प्रथाओं (अधिक उपज देने वाली बेहतर गुणवत्ता वाली किस्म (को. 11015) के एकल कली सेटों से प्राप्त रोपाई सेटलिंग (25-30 दिन पुरानी) को चौड़ी पंक्ति विधि (1.2x 0.6/0.6 मीटर ) में शामिल किया गया, मिट्टी परीक्षण फसल प्रतिक्रिया के आधार पर अंतरफसल, ड्रिप सिंचाई शेड्यूलिंग और फर्टिगेशन, मल्टीपल रैटूनिंग (5 रैटून तक) और फील्ड ऑपरेशनों बुवाई से कटाई तक का यंत्रीकरण) का कुशल संयोजन शामिल है) ने पांच साल के अंत में (1 पौधा + 5 रटून) से 1.93 का लाभ-लागत अनुपात प्रदान किया । इसका परिणाम यह हुआ कि खेती की लागत कम होने के साथ गन्ने की उत्पादकता में सुधार हुआ और पारिस्थितिक स्थिरता सुनिश्चित हुई। चूने वाली मिट्टी में, बेसल डोज सिंगल सुपर फॉस्फेट के रूप में 50% फॉस्फोरस + डीएपी के रूप में 50% फॉस्फोरस 45 दिनों में टॉपड्रेसिंग के रूप में प्रयोग से गन्ने की ऊंचाई, गन्ने का व्यास, सिंगल केन वेट, गन्ने की उपज, वाणिज्यिक गन्ना चीनी उपज और गुड़ की उपज में काफी सुधार हुआ। फॉस्फोरस उपचार से रस की गुणवत्ता प्रभावित नहीं हुई। गन्ने की खेती के तहत अच्छी जल निकासी वाली भूमि, जल भराव वाली भूमि की मिट्टी प्रोफ़ाइल विशेषताओं का अध्ययन किया गया। जलजमाव वाली मिट्टी में कम हाइड्रोलिक चालकता (5.42 सेमी/घंटा) और मिट्टी की बनावट जलजमाव में योगदान करती है। इसके विपरीत, अधिक ऊंचाई अच्छी जल निकास वाली भूमि ने कम कार्बनिक कार्बन (0.37 से 0.28%), उच्च हाइड्रोलिक चालकता (15.11 से 27.77 सेमी घंटा$^{-1}$), और विभिन्न मिट्टी की बनावट प्रदर्शित की।

ड्रोन छिड़काव द्वारा टिलरिंग चरण के दौरान लौह की कमी के लक्षणों को ठीक करने के लिए प्रति हेक्टेयर 25 लीटर में 2.5% फेरस सल्फेट आवश्यक है। तुलनात्मक आर्थिक विश्लेषण भी पर्णीय छिड़काव की 20% लागत बचाकर मैनुअल नैपसेक स्प्रेइंग की तुलना में ड्रोन आधारित छिड़काव का समर्थन करता है।

गन्ने के रस से पॉलीफेनॉल निकालने की एक सरल प्रक्रिया, यौगिकों की प्रकृति की पहचान करने के लिए, उनके बायोएक्टिव कार्य की चिकित्सीय अनुप्रयोगों के रूप में उपयोग के लिए विकसित की गई। एक वैक्यूम-केंद्रित गन्ना सिरप, जिसे "गन्ने का शहद" कहा जाता है, बेहतर स्वरूप और भंडारण स्थिरता के साथ बनाया गया। सफेद चीनी के बिना गन्ने के रस से कैंडी और टॉफ़ी तैयार की गई; और *नन्नारी* और वेटिवर जड़ के अर्क के साथ गन्ने के रस-आधारित स्क्वैश पेय की एक प्रक्रिया स्थापित की गई। इसके अतिरिक्त, गन्ने पर आधारित उत्पादों में विविधता लाने के लिए निलंबित कणों से चीनी सिरप को अलग करने के साथ-साथ गन्ने के रस पर आधारित जेली और गमीज़ की प्रक्रियाएँ विकसित की गईं। लाल गुद्दे वाले *सैकरम रोबस्टम* के तने के अर्क का कार्बनिक विलायक निष्कर्षण के बाद एफटी-आईआर, एनएमआर और एलसी-एमएस का उपयोग करके विश्लेषण किया गया, जिसमें महत्वपूर्ण *in vitro* α-एमाइलेज अवरोधक और α-ग्लूकोसिडेज़ गतिविधियों के साथ संभावित चिकित्सीय लाभ प्रदर्शित किये।

तमिलनाडु और पुडुचेरी की 53वीं गन्ना अनुसंधान एवं विकास कार्यशाला का आयोजन भा.कृ.अनु.प.-गन्ना प्रजनन संस्थान द्वारा किया गया, जिसकी मेजबानी राजश्री शुगर्स एंड केमिकल्स लिमिटेड ने की। गन्ना किसानों और गन्ना विकास कर्मियों के लिए ऑन-कैंपस और ऑफ-कैंपस प्रशिक्षण आयोजित किए गए । तमिलनाडु की विभिन्न सहकारी/सार्वजनिक क्षेत्र की चीनी मिलों के फील्ड स्टाफ के लिए गन्ने की किस्मों और प्रौद्योगिकियों पर छह रिफ्रेशर पाठ्यक्रम आयोजित किए, जिसमें लगभग 385 गन्ना विकास कर्मियों ने भाग लिया और लाभान्वित हुए । आंध्र प्रदेश में एस.एन.जे. शुगर्स एंड प्रोडक्ट्स लिमिटेड के गन्ना कर्मचारियों और सॉलिडेरिडाड, नई

दिल्ली के प्रशिक्षकों के लिए उन्नत गन्ना उत्पादन प्रौद्योगिकियों पर दो वित्त पोषित प्रशिक्षण कार्यक्रम आयोजित किए गए।

मृदा नमी संकेतक (एसएमआई), संस्थान की एक आशाजनक तकनीक का प्रभाव मूल्यांकन के लिए आर्थिक प्रभाव मूल्यांकन किया गया। पूर्व-पूर्व मूल्यांकन ने दर्शाया कि यदि एसएमआई का उपयोग देश के कुल गन्ना क्षेत्र के 38% में अपनाने की दर पर 9,034 लाख क्यूबिक लीटर पानी की बचत की जा सकती है। लगभग 161 लाख टन गन्ने की अतिरिक्त उपज और किसानों को. 6,000 करोड़ रुपये का अतिरिक्त राजस्व प्राप्त हो सकता है। एक बार इसे अन्य प्रमुख खेतों की फसलों तक भी विस्तारित कर दिया जाए, तो पानी की बचत, जल संरक्षण और देश के किसानों के लिए राजस्व कई गुना हो सकता है।

अनुसूचित जनजाति घटक के लिए विकास कार्य योजना (डीएपीएसटीसी) जिसका उद्देश्य बुनियादी सुविधाएं प्रदान करके अनुसूचित जनजातियों के जीवन की गुणवत्ता में सुधार करना है, इरोड जिले के सत्यमंगलम टाइगर रिजर्व में लागू किया गया। इन बस्तियों में जागरूकता शिविर आयोजित किए गए, और अनामलाई टाइगर रिजर्व (एटीआर) के दूरदराज के इलाकों में आदिवासियों के बीच प्रभाव का मूल्यांकन किया गया।

आईटीएमयू ने भा.कृ.अनु.प.-गन्ना प्रजनन संस्थान की समग्र संस्थान बौद्धिक संपदा, प्रबंधन और व्यावसायीकरण गतिविधियों का समन्वय किया। पीपीवी और एफआरए, नई दिल्ली को दो नई गन्ने की किस्में और दो मौजूदा किस्में पंजीकरण के लिए भेजी । आईसीएआर-एसबीआई लोगो के लिए ट्रेडमार्क आवेदन को आईसीएआर-एसबीआई लोगो के लिए अनुदान प्राप्त हुआ। "पैरासिटॉइड रिलीज़ स्टेशन" के लिए एक डिज़ाइन आवेदन जमा किया गया। लाइसेंस प्राप्त मृदा नमी संकेतक प्रौद्योगिकी, SBIEC14006 - एक एनर्जीकेन, और तरल गुड़ प्रौद्योगिकी, कुल आठ समझौता ज्ञापनों पर हस्ताक्षर किए गए और 19,23,080/- रुपये का राजस्व प्राप्त हुआ। एनर्जीकेन किस्म एसबीआईईसी 14006 का लाइसेंस दो फर्मों, मेसर्स वीएस लिग्नाइट पावर प्राइवेट लिमिटेड, बीकानेर, राजस्थान और मेसर्स साई वर्धा पावर जेनरेशन प्रा. लिमिटेड, एमआईडीसी, वरोरा, महाराष्ट्र को दिया गया। फर्मों को उनके खेत में फसल उगाने के लिए बीज सामग्री प्रदान की गई और लाइसेंस के माध्यम से 5,23,500/- रुपये का राजस्व उत्पन्न हुआ।

शुगरकेनएज ने आईपीटीएम-एनएआईएफ घटक-II से अनुदान प्राप्त किया और पायलट पैमाने पर उत्पादन के लिए महत्वपूर्ण उपकरण स्थापित किए । आईसीएआर-एसबीआई और एनएएआरएम, हैदराबाद द्वारा कृषि उड़ान 6.0 सहित कई गतिविधियों का खाद्य और कृषि व्यवसाय त्वरक कार्यक्रम पर स्टार्टअप्स के साथ आयोजन किया और सह-ऊष्मायन, तकनीकी सहायता, प्रयोगशाला सुविधाओं, नेटवर्किंग, मूल्य वर्धित सेवाओं और सह-नेटवर्किंग अवसरों के लिए एमओए पर हस्ताक्षर किए।

मोटे अनाज (मिल्लेट्स) फसलों के पोषण मूल्यों के बारे में जागरूकता पैदा करने और देश में कुपोषण को खत्म करने के लिए भारत सरकार के प्रमुख कार्यक्रम "अंतर्राष्ट्रीय मिल्लेट्स वर्ष -2023" के हिस्से के रूप में, कार्यक्रम 6 जनवरी को शुरू किया गया, जब सांसद श्रीमती सुषमा यादव ने कार्यक्रम उद्घाटन किया संस्थान के फार्म में छह मोटा अनाज बोया गया। संस्थान में, इसके अगाली केंद्र और एसटीसी (अनुसूचित जनजाति घटक) कार्यक्रम के तहत आने वाले आदिवासी गांवों में कई जागरूकता अभियान आयोजित किये गए। आदिवासियों के बीच फिंगर मिलेट, लिटिल मिलेट और प्रोसो मिलेट के बीज वितरित किए गए। बाजरा उद्यमिता को बढ़ावा देने के लिए प्रशिक्षण सत्र आयोजित किए गए, ताकि आदिवासी अपनी उपज में मूल्य संवर्धन और अपने उत्पादों को प्रभावी ढंग से विपणन कर सके।

# 04
# Executive Summary

Research activities in accordance with the mandate of the institute progressed well at the main station at Coimbatore, its regional Centre at Karnal and research Centres at Kannur and Agali.

Four new sugarcane varieties were released and notified by the 90th meeting of the Central Sub-Committee on Crop Standards, Notification and Release of Varieties for Agricultural Crops during 2023. These are Co 11015 (Atulya), a high yielding and early maturing variety and Co 14005 (midlate), both for Peninsular zone, Co 18009 (Punnagai) a midlate climate resilient variety released for Tamil Nadu state and Co 16030 (Karan 16), a mid-late maturing variety for cultivation in North west zone. From Coimbatore, 21 'Co' canes were identified as Co 2023 series, among which three 'Co' canes were developed with new and diverse genetic base. Ten 'Co' canes were promoted for AICRP testing. From the Karnal Centre five 'Co' canes (Co 23021 to Co 23025) were identified. A total of 420 biparental crosses were effected which included 20 crosses involving new hybrids involving wild genetic sources. Two waterlogging tolerant clones developed at Kannur Centre also figured among 'Co' canes *viz.,* Co 22017 (WL 15-1177) selected from Coimbatore and Co 22020 (WL 10-85) from ICAR-SBIRC, Karnal.

Varietal development programmes progressed with regular stage wise selection trials at Coimbatore and Karnal. At Coimbatore, over 47000 seedlings in the ground nursery plant and ratoon were evaluated. In different clonal trials, the best clones were selected and new cross combinations that yielded sugar rich clones combined with red rot resistance with high breeding value could also be identified for deploying in future breeding programs. A total of 263 clones combining high yield, quality, red rot resistance and field stand were selected, which were promoted to PZVT 2023 for identifying 'Co' canes. It is notable that the clone 2018-185 developed from the cross CoVC 14062 x Co 11015 recorded 24.20% sucrose at 11th month of crop age, which is a significant achievement. As the most effective method of managing red rot resistance is through the deployment of resistant varieties, this year also red rot testing of the entries in the second clonal trial were evaluated for red rot resistance, which showed about 37 per cent entries with R /MR reaction to the disease, which is a very encouraging sign.

All the 'Co' canes of 2022 series were botanically described based on DUS guidelines and graphical representation of molecular profiles showed distinct patterns for every clone. Location testing of 23 elite clones at Maharashtra showed the advantage of Co 18001, Co 19008, Co 20005, Co 20006 and Co 21003. In Karnataka, among the 28 elite clones evaluated the clones 2018-14, 2018-123, 2018-161, 2019-3 and 2019-12 were superior for CCS yield over the standards. In the adaptive trials conducted in collaboration with Tamil Nadu Agricultural University, Co 17001 in Multi-location trial, Co 15020 in Adaptive research Trial 1 Plant crop, Co 14004 in the ART ratoon trial performed better in different sugar factories.

At Kannur, the world collection of sugarcane germplasm comprising 3379 clones are maintained in the field gene bank. Maintenance of 2239 wild sugarcane germplasm accessions, 2049 commercial clones and genetic stocks, 229 National Active germplasm was carried out at Coimbatore and 47 accessions from Arunachal Pradesh were maintained at Wellington. Cytological studies in *Saccharum* and allied genera continued during this period and among the *S. spontaneum* clones the chromosome number ranged from 2n=40 in IND 09-1520 and IND 09-1544 to 112 in IND 01-1157, and among the commercial hybrids, Co 09010 recorded the lowest number of 2n=102. Screening of wild germplasm showed that under drought stress, high biomass production was observed in

genotypes like IND 04-1372, IND99-847, IND99-850, IND 11-1620 and SES 600 and less than 3% reduction in fresh biomass was observed in H 60-4-5 and SES 600. At Karnal, the interspecific and intergeneric hybrids *viz.*, 14-90, 14-58, 14-67, 14-474, 14-195, 14-124, ISH-524 and ISH-588 showed less reduction in cane yield at harvest. At Kannur, screening of 119 potential waterlogging tolerant clones could identify 12 clones with high CCS yield over the standard. Five red fleshed *S. robustum* derived back cross had a high Brix content of above 21% at 7$^{th}$ month, These are rare hybrids, so far not reported elsewhere.

The *Erianthus* clones SES 3, SES 7, SES 27 and SES 181 showed high levels of tolerance mechanism against salt stress. Internode anatomical characters showed larger bundle sheaths in Baragua and Lalkadi. Micromorphological characters of internodes of '*Saccharum* complex' was prepared. A trait specific genetic stock TSGS 20-74 was found to be resistant to both CF06 and CF12 isolates of red rot pathogen and TSGS 20-125 was moderately resistant to both smut and red rot pathogen. Also, development of multi-trait genetic stocks was given focus in view of climate change and four elite clones *viz*., 12-127, 003-14, 07-520, 13-457 developed involving *S. barberi*, improved *S. officinarum* and *S. robustum* entered PZVT. A genetic stock (AS 04-635) with waterlogging and cold tolerance derived from the *S. spontaneum* cytotype 2n=72 was submitted for registration with ICAR- NBPGR. Use of abiotic stress tolerant *S. spontaneum* clones as female parents progressed, though the percentage of true F1 hybrids obtained from five such crosses was only 58%. Multi-ratooning potential of 42 different ISH and IGH hybrids progressed to the first ratoon crop. *S. spontaneum* derived hybrids were better for stalk number and cane yield, while the highest sucrose % at harvest was found in *S. officinarum* group. A core collection of wild *Saccharum* species is under development through studying the pattern of morphological traits and molecular diversity. Among the different methods tried for cryopreservation, regeneration was observed only in meristem-derived axillary buds and in the dormant nodal buds after cryogenic treatment in different time intervals.

Studies in sugarcane genomics and molecular markers progressed well. Marker assisted selection was continued for drought and red rot resistance and the markers SNAC1, DREB1A and POM1 associated with drought tolerance and RGA 184 for red rot resistance were found to be promising for further validation. A total of 56646 SSRs and 49974 SSRs were identified from transcript sequences of drought tolerant and susceptible varieties Co 06022 and Co 8021, respectively. Mining for SNPs from the DEGs of the drought transcriptome resulted in a total of 968 SNPs from 995 unigenes. Seven candidate genes identified from the drought transcriptome *viz*., dehydrin (754 bp), TPS (2.5kb), TPP (1.1 kb) ABRE (1.1 kb), glyoxyl transferase (1.5 kb), cytochrome P450 (2.6 kb) and NAC 4 (1.2 kb) were cloned and sequenced. For prospecting differentially expressed genes/Transcription factors, a full length Transcription factor of Homeo domain leucine Zipper (HDLZ) which is induced during drought stress is cloned. The Suppression Subtractive Hybridization product of two drought tolerant clones has been submitted for amplicon sequencing. Protein profiling of tiller nodes in contrasting genotypes (Co 86032 and Co 99004) was performed. The sequence resulted in the identification of 1500 significant proteins at FDR ≥ 0.001 in each genotype. At Karnal, identification of early maturing responsive genes in sugarcane through transcriptome analysis led to the identification of 165 DEG which were exclusively found at 8-month stage of the crop. Differential gene expression analysis could identify 204 genes differentially expressed in the stem tissue of which 19 genes showed differential expression at the same age.

SWEET genes SWEET 3, 4 and 13c implicated in sucrose accumulation were characterized and gene editing is in progress. Genes for low glycemic sugars such as D-allulose epimerase and isomaltose are cloned and sequenced from microbes. The WUE genes such as Angustifolia (AN3) ERECTA, CER9 and WIN1 were successfully isolated and cloned from high and low WUE sugarcane clones. The RT-PCR quantification of the stress responsive GRAS transcription factor from the sugarcane clones under drought, flood, heat and cold

stress environments is being carried out. Gene editing of pdf gene resulted in 74 putative edited plants which were hardened and observed for phenotypic variation for chlorophyll content in the leaves. Mutant frequency was low. Similarly, two CRISPR constructs for lignin modification in sugarcane towards improved biomass conversion have been mobilized into the *Agrobacterium* host and one construct (pGREB31::F5H::sg1439) has been used for tobacco and sugarcane genetic transformation.

For red rot resistance, 12 QTLs were identified in a panel of 540 genotypes. The populations with BO 91 as a parent had a higher number of markers in common and those SNPs were searched for the nearby harbouring genes, also traits with high heritability associated with red rot were also identified.

In AICRP (S), all trials were conducted as per programme at Coimbatore and Karnal. At Coimbatore, based on two plant and one ratoon crops in AVT, two entries Co 16006 and Co 16018 were better. In IVT, Among the 23 entries evaluated, two entries Co 19004 and Co 19008 were better for cane yield and sugar yield and six entries in AVT I Plant were better. Co 180232 was the best entry in AVT 1 Plant crop at Karnal. The climate resilient clones *viz*. ISH 567 (94.58 t $ha^{-1}$), ISH 502 (88.12 t $ha^{-1}$) and ISH 545 (86.38 t $ha^{-1}$) were better under drought stress at maturity in Karnal conditions.

Under National fluff supply programme, fluff weighing 24.30 kg was produced from the crosses made at Coimbatore during 2022 flowering season and supplied to 23 fluff receiving centres. The National Hybridization garden was planted with 447 parents. During the flowering period, which was delayed by two weeks, ICAR-SBI facilitated 21 participating centres to effect 487 biparental crosses. DUS programme progressed with testing of new varieties, which were distinct from the reference varieties at Coimbatore and Agali for tropical varieties and at Karnal for the subtropical variety, Co 13035. Recharacterization of DUS reference lines was carried out at Karnal and the database of the verified DUS reference varieties was submitted to the PPV&FR Authority in tabulation format. At Agali Centre, an active germplasm collection of 1394 accessions were maintained for utilization in distant hybridization programme. During the flowering season 226 crosses were effected for 18 AICRP(S) centres. Clonal trials of Breeding projects and DUS trials were conducted; in DUS trials, five candidate varieties under testing were found to be distinct. The Centre also provided facilities for Offseason nursery of banana by ICAR -NRC on Banana, Trichy.

Seed programme is a big success at the Institute, that from a very low production of 163 tons in 2015-16, seed production not only reached 959.985 tons in 2022-23, but also ensured high quality seed which could increase the yield of the beneficiary farmers and factories. Seed indents for three new releases *viz.*, Co 11015, Co 18009 and Co 14012 were received from the Commissioner of Sugar, Government of Tamil Nadu. The new target is to produce 1100 tons during June – July 2023 under participatory seed production programme. Through micropropagation a total of 1,23,500 quality tissue culture plants of varieties Co 86032, Co 11015, Co 0118, Co 0238 were produced and supplied to sugar mills/ farmers of Tamil Nadu, Karnataka, Kerala, Maharashtra, Uttar Pradesh and Uttarakhand, apart from 118 mother culture flasks of varieties Co 86032, Co 11015, Co 0238, Co 0118 and Co 15023 distributed to 10 tissue culture laboratories of six states. At Karnal, a total of 24398.64 quintals of breeder seed, mainly of Co 15023 (12135.6 quintals) and Co 0118 (11767.1 quintals) was produced and supplied to various stakeholders. For the first time 50,000 settlings were produced during peak winter utilizing settling production facility / plant growth chamber established with RKVY fund and ready-to-transplant settlings were shifted to the multi-layered racks designed for the purpose for winter hardening

With the objective of enhancing sugarcane productivity and sugar recovery in Tamil Nadu through institute-industry Participatory Approach Sweet Bloom 2.0 was implemented with SISMA-SBI collaboration. Trials were in progress in 10 sugar mills with 16 promising entries. Two entries Co 15017 and Co 20010 were better based on preliminary observation.

In Plant Pathology, with regard to the evaluation of red rot disease resistance at Coimbatore, 4791 clones from different breeding trials was carried out under controlled condition testing (CCT) in which 1381 were rated as moderately resistant and 314 were rated as resistant. Among 16 new red rot isolates collected and evaluated for pathogenic variation, three isolates *viz*., were highly virulent and among the sugarcane varieties, Co 2001-13, Co 99004 and Co 09004 were resistant against many red rot isolates. At Karnal, overall disease reactions indicated a clear pathogenic variation on tested host differentials; the pathotype CF13 was more virulent followed by CF11, CF01, CF02, CF08, CF09, CF03 and CF07. A possible emergence of another pathotype in the region was noted, which warranted more studies. Varietal breakdown due to red rot in ruling variety Co 0238 at many sugar mills of the zone with mild to severe incidence was observed.. *Pokkah boeng*, smut (upto 10 percent in plant crop) and mild incidence of other diseases like wilt were also noticed. Out of 225 parental clones in NHG, nine clones were grouped as resistant and 116 clones were rated as susceptible to wilt disease. Nine parental clones were resistant to smut disease. Evaluation of zonal varieties for resistance to red rot was carried out at Coimbatore and Karnal, which showed a predominance of resistant and moderately resistant lines. Testing of two nano formulations for their efficacy against red rot disease under artificially pathogen inoculated field conditions showed that application of BTH and SA nano formulations could reduce red rot incidence by 80.4% and 74.0%, respectively over the pathogen inoculated control.

Mechanized priming of planting materials of vegetatively propagated crops *viz*., sugarcane, tapioca, banana, gladiolus, chrysanthemum, tuberose and crossandra were tested in collaboration with other institutions to accomplish the healthy seed nursery program. Treating sugarcane setts with hot water followed by nutrient treatment was found to significantly improve germination and yield attributes with reduction in YLD and GSD expression till maturity. Popularization of mechanized seed priming technology was done in ten sugar mills, where healthy settling production was initiated. Sugarcane plants infected with grassy shoot disease had shown significant reduction of physiological parameters *i.e.,* 52-80% reduction in leaf area measurement ($cm^2$), 39-78% reduction in chlorophyll content and 4-71% increase in total free amino acids content than healthy plants. At Karnal, Thiophanate methyl (TPM) and 'Amistar' for the sett treatment of susceptible variety Co 0238 was tried with encouraging results.

The surface sterilization protocol was standardized to isolate endophytic bacteria from sugarcane plant and isolated 239 endophytic bacteria from root, stem and leaves of sugarcane variety Co 86032. The yeast expression vector *Pichia pastoris* competent cells preparations and transformation protocols by electroporation methods were standardized for SCYLV coat protein gene expression. A dexamethasone (DEX)-inducible vector, pC1302DEX was developed and validated for controlled transient expression of GFP in tobacco. This novel expression system has showed regulated expression of transgenes under a chemical-inducible promoter.

In Entomology, a low-cost technology for mass production of Bt-62 was developed using agro-industrial by-products and sugarcane and its by-products. The formulation has viability for over 300 days and field trials against *Holotrichia serrata* illustrated mass-production and used for the control of *Holotrichia serrata*, *H. consanguinea* and *H. longipennis*. Expression studies revealed toxicity of *cry9Eb* gene to internode borer *Chilo sacchariphagus indicus* and can be utilised as a candidate gene for developing transgenics against various *Chilo* spp. borers infesting sugarcane. Mass multiplication method was developed to scale-up *Telenomus dignus* production using chimney and box methods. Field efficacy of *T. dignus* was established in augmentative trials against internode borer. The parasitoid releases enhanced parasitism rate and reduced internode borer incidence.

The q-RTPCR analysis with specific primers revealed that the levels of expression of vital genes like chitin synthase A (*CHSA*), chitin synthase 1B (*CHS1B*), juvenile hormone methyl transferase (*JHMT*) and cytochrome P450 in different instars of crambid borers confirmed with the transcriptome data obtained through

RNA Seq and can be used for RNAi-mediated control of Crambid borers in sugarcane. Baseline toxicity data ($LC_{50}$) generated for insecticides for the first time against the mealybug, *Phenacoccus saccharifolii* and among the insecticides, thiamethoxam with the lowest $LC_{50}$ of less than a ppm was found to be more toxic. Among the intergeneric sugarcane hybrids involving *Erianthus arundinaceus*, four and seven hybrids were tolerant against ESB and INB respectively. At Karnal two genotypes; Co 17018 and Co 05011 were least susceptible (<15%) to major pests in AICRP(S) trials.

In Nematology, molecular identification of eight EPN isolates was done by analysis of genomic DNA sequences with internal transcribed spacer (ITS) specific primers. ITS sequences of eight EPN (*Heterorhabditis* and *Steinernema* spp.) isolated from subtropical sugarcane areas have been submitted to NCBI database with accession numbers from OP985087 to OP985094. Novel formulation of EPN *Steinernema glaseri* was delivered through sub surface drip irrigation system. The drip irrigation delivery of EPN *Heterorhabditis indica* caused more than 95% mortality of *G. mellonella* larvae and 75% mortality of white grub. Successful nematode mass production in liquid culturing was observed in two EPN isolates (*S. surkhetense* SBIP3 and *S. siamkayai* SBITNT1). Seventy-eight EPN strains and 45 symbiotic bacteria belonging to *Photorhabdus* spp. and *Xenorhabdus* spp. were regularly sub cultured and stored. The ICAR-SBI EPN Biopesticide formulation technology has been commercialized to two companies (Coordinated by AGRINNOVATE INDIA, New Delhi) with a license fee of Rs. 4 lakhs. Field studies conducted with different doses of *H. indica* revealed that foliar spraying of *H. indica* at 3000 IJs/ml with 2% Glycerol + 1% Tween 20 caused 55% mortality of FAW. Plant parasitic nematodes were extracted from sugarcane rhizosphere, nematodes images captured and processed for development of Artificial intelligence powered diagnostic kit for real-time monitoring of nematode pests of sugarcane.

Early shoot borer, top borer, root borer, stalk borer, pyrilla, black bug and termites were listed as key pests of sugarcane in Haryana, while Gurdaspur borer, pink borer and blister mite and white grub were minor pests of sugarcane in the North western zone.

Studies on new herbicide molecules shows that application of ametryne and 2,4-D amine alone at recommended doses caused minimal injury, while their combination at double the recommended dose resulted in leaf scorching in sugarcane, particularly in Co 0212. Despite this injury, final cane yield was unaffected. Herbicide halosulfuron residues got dissipated to a level of about 95% within 75 days of application with the half-life of 9.12 to 9.71 days.

Among the four elite sugarcane genotypes compared with three standards under two fertilizer levels *i.e.* 100 and 125% RDF, the entries Co 16018 and Co 16006 exhibited significantly higher cane yield over the checks. Juice quality parameters varied significantly among genotypes, with no significant influence from fertilizer levels observed.

Sugarcane based farming system (sugarcane, livestock, poultry and fishery) produced superior productivity, net returns, and energy efficiency compared to conventional sole crop sugarcane systems. The system serves as a resource model generating monthly income, with additional income of 4,11,604/-.

Potassium Salt of Active Phosphorus (PSAP)-based nutrient management (Sett soaking @ 0.8% PSAP solution + RDN, 50% P and 50% K + foliar spray of PSAP @ 0.4, 0.65, 1.10 and 1.10 during 60, 80, 100 and 120 DAP produced significantly higher cane yield (123 t/ha).

Farm Mechanization: Bio Formulation Applicator for white grub control in sugarcane showed limited effectiveness due to low white grub incidence in the later season and the advanced pupal stage. Tractor-operated whole cane harvester, newly developed mini tractor-operated sugarcane sett cutter planter, mini tractor-operated sugarcane settling transplanter has been designed, with CAD drawings and the prototypes prepared were field tested.

A total of 40 bacterial isolates, one fungus and five yeast isolates were obtained from the guts of lignocellulose feeding insects to study

their efficiency in 2G ethanol production from bagasse. Similarly, 10 bacterial, 11 fungal and 7 actinomycetes isolates were obtained from decaying wood samples.

Physiological efficiency of ten sugarcane hybrids was evaluated for their water use efficiency under full and deficit irrigation and Co 85019, Co 14002, Co 15021, and Co 14025 recorded higher irrigation water use efficiency under water deficit conditions.

Comparative physiological efficiencies of tropical and sub-tropical varieties of sugarcane were studied under tropical and sub-tropical conditions. Co 14012 and Co 98014 showed better yield and physiological efficiency under both conditions. Radiation Use Efficiency of promising sugarcane genotypes under full and deficit irrigation showed that Co 85019, Co 14002, Co 15021, and Co 14025 recorded with better light interception, and RUE under water-limited condition. Study on physiological basis for nutrient use efficiency revealed that the traits including leaf area, chlorophyll content, chlorophyll *a* fluorescence, canopy temperature depression, leaf metabolite content (proteins, phenols, free amino acids, sugars and starch), lipid peroxidation and root system traits were correlated to biomass accumulation and nutrient uptake, with differential response among the tested sugarcane varieties. Plant architectural traits for developing ideotype concept on 70 genotypes were assessed. Crop growth and dry matter partitioning studied at the formative and GGP in the sugarcane clones revealed a better association of source-sink relationship in 'Co' canes. Developed hydroponic screening methodologies for sugarcane varietal evaluation in response to abiotic stress under controlled condition. At Karnal, facilities for screening for salinity tolerance were being established with RKVY funding. Screening of 'Co' canes showed that the genotypes Co 17018, Co 18022, Co 21016, Co 21012 and Co 21013 performed better under $EC_{iw}$ - 6 and 8 dS/m of salinity stress.

Sugarcane settling transplanting technology which incorporated efficient combination of nine different sugarcane cultivation practices (Transplanting settlings (25-30 days old) derived from single bud setts of high yielding better quality variety (Co 11015) in wider row spacing (1.2 x 0.6/0.6 m), intercropping, drip irrigation scheduling and fertigation based on soil test crop response, multiple ratooning (up to 5 ratoons) and mechanization of field operations from filed preparation to harvest generated benefit cost ratio of 1.93 at the end of five years (1 Plant + 5 Ratoons). The result was sugarcane productivity improvement with reduced cost of cultivation and ensured ecological sustainability. In calcareous soil, 50% P as SSP at basal + 50% P as DAP as topdressing at 45 days significantly improved cane height, cane diameter, SCW, cane yield, CCS yield, and jaggery yield. Juice quality was not affected by P treatment. Soil profile characters of well-drained and waterlogged land under sugarcane cultivation were studied. The waterlogged soil exhibited low hydraulic conductivity (5.42 cm/hr) and clay texture contributing to waterlogging. In contrast, the well-drained soil at higher elevation shows lower organic carbon (0.37 to 0.28%), higher hydraulic conductivity (15.11 to 27.77 cm $hr^{-1)}$, and different soil textures.

Drone spraying of 2.5% $FeSO_4$ in 25 litre $ha^{-1}$ is required to correct the iron deficiency symptoms during tillering phase. Comparative economic analysis also favours drone spraying over manual knapsack spraying by saving 20% cost of foliar spraying.

A simple process of extraction of polyphenols from sugarcane juice was developed to identify the nature of compounds, their bioactive function for its use as therapeutic applications. A vacuum-concentrated sugarcane syrup, branded as "cane honey," was created with improved appearance and storage stability. Candy and toffee were prepared from sugarcane juice without white sugar, and a process for a sugarcane juice-based squash drink with *Nannari* and *Vetiver* root extract was established. Additionally, processes for sugarcane juice-based jelly and gummies, along with the separation of sugar syrup from suspended particles, were developed to diversify sugarcane-based products. Red flesh *Saccharum robustum* stem extract was analyzed using FT-IR, NMR, and LC-MS after organic solvent extraction, showing potential therapeutic benefits

with significant *in vitro* α-amylase inhibitor and α-glucosidase activities.

Economic Impact assessment of Soil Moisture Indicator (SMI), a promising technology of the Institute was taken for impact evaluation. The *ex-ante* assessment showed a saving of 9,034 lakh cubic litre of water by using SMI with the adoption rate of 38% of the total sugarcane area in the country. The expected additional yield of about 161 lakh tonnes of sugarcane and Rs. 6,000 crores of additional revenue could be earned by the farmer. Once extended to other major field crops, water saving, water conservation and revenue could be in multiple fold to farmers of the country.

The 53rd Sugarcane R&D Workshop of Tamil Nadu and Puducherry was organized by the Institute. On-campus, Off-campus trainings and six refresher courses on sugarcane varieties and technologies were conducted in which about 385 cane development personnel benefitted. Two funded training programmes on improved sugarcane production technologies were conducted for the cane staff of SNJ Sugars and Products Ltd. in Andhra Pradesh and for trainers of SOLIDARIDAD, New Delhi.

The Development Action Plan for Scheduled Tribe Component (DAPSTC) which aims to improve the quality of life for scheduled tribes by providing basic amenities was implemented in the Sathyamangalam Tiger Reserve (STR) in Erode district. Awareness camps were conducted in these settlements, and an impact evaluation was conducted among tribals in remote areas of the Anamalai Tiger Reserve (ATR).

Seeds of finger millet, little millet, and proso millet were distributed among the tribals. Training sessions were held to promote millet entrepreneurship, allowing tribals of STR to add value to their produce and market their products effectively.

ITMU coordinated the overall institute intellectual property, management and commercialization activities. Submitted two new sugarcane varieties and two extant varieties with PPV&FRA, New Delhi. Trademark application for ICAR-SBI logo received grant for ICAR-SBI logo. One design application was submitted for "Parasitoid Release Station". Licensed Soil Moisture Indicator technology, SBIEC14006 - An Energycane, and liquid jaggery technology. A total of eight MoUs was signed that realised a revenue of Rs. 19,23,080/. Licensing of energycane variety SBIEC 14006 was granted to two firms, M/s.VS Lignite Power Private Limited, Bikaner, Rajasthan and M/s. Sai Wardha Power Generation Pvt. Limited, MIDC, Warora, Maharashtra. The seed materials were provided to the firms for raising the crop in their farm and ₹5,23,500/- revenue was generated through licensing.

SugarcaneEdge received grant from IPTM-NAIF component -II and installed vital instruments for pilot scale production. Several activities including AGRI UDAAN 6.0 was organized by ICAR-SBI and NAARM, Hyderabad on Food & Agribusiness Accelerator Programme with startups and signed MoA for co-incubation, technical support, lab facilities, networking, value added services and co-networking opportunities.

As part of the Government of India's flagship programme "International year of Millets -2023" to create awareness about nutritional values of millet crops and to eradicate malnutrition in the country, the programme was launched on January 6th, when Mrs. Sushma Yadav MP, inaugurated the programme. Six types of millets were sown in the Institute farm. Several awareness campaigns were organized at the institute, its Agali Centre and in tribal villages covered under STC (Scheduled Tribe Component) programme.

# 05
# Research Achievements

## 5.1 Crop Improvement

### 5.1.1 Breeding

**Breeding superior sugarcane varieties of different maturity with improved cane yield, quality and resistance to biotic and abiotic stresses.**

#### Breeding sugarcane varieties for tropical region

*New varieties identified/released*

**Notified variety:** Three new sugarcane varieties were released and notified by the 90th meeting of the Central Sub-Committee on Crop Standards, Notification and Release of Varieties for Agricultural Crops which was held on 2nd May, 2023. Co 11015 (Atulya) is a high yielding and early maturing variety notified for release in peninsular zone and recorded an improvement of 9.96% and 8.91% for sugar yield and cane yield over the standard CoC 671. Co 14005 (Arunima) is a midlate variety notified for release in peninsular zone and showed improvement of 12.79% and 19.51% for sugar yield and cane yield over the zonal standard CoC 671 with improved resistance to red rot. Co 18009 (Punnagai) is a midlate variety combining high cane yield and high juice quality released for Tamil Nadu state and showed improvement of 11.45% and 10.85% over the standard Co 86032 for sugar yield and cane yield respectively.

*Field view of Co 11015 released through CVRC for peninsular zone*


*Field view of Co 14005 released through CVRC for peninsular zone*

*Co 18009- Midlate variety released through SVRC for Tamil Nadu*

#### 'Co' canes identified (2023)

Twenty-one 'Co' canes were identified from the pre-zonal varietal trial conducted during 2022-23. The performance of these selections in comparison with the standards is presented in table.

## Performance of 'Co' selections identified at Coimbatore

| Co numbers | Parentage | CCS yield (t/ha) | Cane yield (t/ha) | Sucrose (%) | | Red rot rating | | Smut |
|---|---|---|---|---|---|---|---|---|
| | | | | 300 days | 360 days | Plug | Nodal | |
| Co 23001 | CoC 671 x Co 775 | 22.77* | 156.76* | 18.41 | 20.44 | MS | R | MS |
| Co 23002 | PZVT 2013-157 GC | 22.05* | 150.80 | 18.82 | 20.44 | MR | R | R |
| Co 23003 | PZVT 2012-53 PC | 21.93* | 160.66* | 18.96 | 19.51 | MS | R | S |
| Co 23004 | CoM 0265 PC | 20.90 | 147.73 | 18.90 | 20.02 | MS | R | S |
| Co 23005 | Co 8371 x Co 94005 | 21.56* | 157.11* | 17.94 | 19.47 | MR | R | MS |
| Co 23006 | PZVT 2017-187 x CoVC 14061 | 21.54* | 149.03 | 19.68 | 20.41 | MR | R | MR |
| Co 23007 | Co 0118 GC | 24.68* | 169.81* | 19.96 | 20.49 | MR | R | MS |
| Co 23008 | Co 87044 PC | 18.16 | 111.68 | 22.17 | 22.89 | MR | R | R |
| Co 23009 | Co 86032 x Co 12009 | 21.83* | 155.11* | 17.77 | 19.92 | MR | R | MS |
| Co 23010 | Co 10026 x Co 11015 | 26.20* | 170.42* | 19.26 | 21.73 | MR | R | MS |
| Co 23011 | Co 10033 x CoC 671 | 20.91 | 150.59 | 17.31 | 19.83 | MS | R | MS |
| Co 23012 | PZVT 2017-187 x CoVC 14061 | 25.45* | 187.36* | 16.46 | 19.39 | MS | R | S |
| Co 23013 | Co 0238 x Co 11015 | 21.28* | 152.06* | 17.59 | 19.77 | MR | R | MS |
| Co 23014 | CoVC 14061 x (Co 12009,Co 06022) | 24.34* | 176.22* | 17.56 | 19.40 | MS | R | MR |
| Co 23015 | (Co 0118 x *S. spon*. SES 114) x Co 11015 | 20.57 | 138.25 | 20.29 | 20.94 | MS | R | MR |
| Co 23016 | CYMA 09-1359 x Co 11015 | 21.96* | 146.72 | 19.35 | 21.15 | MR | R | MS |
| Co 23017 | CoC 671 x Co 775 | 22.16* | 154.87* | 18.47 | 20.28 | MS | R | S |
| Co 23018 | Co 16018 x (Co 0209, Co 0303, CoPant 97222) | 22.03* | 159.97* | 18.70 | 19.56 | MR | R | MR |
| **Genetic stocks** | | | | | | | | |
| Co 23019 | 1148-13-11-2-255 x Co 12014 | 22.00* | 138.63 | 18.67 | 22.29 | MR | R | MR |
| Co 23020 | Co 0118 GC | 19.75 | 124.63 | 20.75 | 22.47 | MR | R | MR |
| Co 23021 | GUK 16-967 (GUK13-1180 (IK76-10) x Co 96011 | 17.94 | 135.44 | 18.65 | 18.95 | MR | R | R |
| **Standards** | | | | | | | | |
| Co 86032 | | 16.80 | 127.89 | 17.70 | 18.88 | | | |
| Co 11015 | | 19.00 | 118.49 | 21.26 | 22.57 | | | |
| CoC 671 | | 17.67 | 111.61 | 21.12 | 22.23 | | | |
| CD | | 4.39 | 23.33 | 1.13 | 1.43 | | | |
| CV | | 11.22 | 10.22 | 2.99 | 3.58 | | | |

### 'Co' canes promoted to AICRP(S)

Out of 21 'Co' canes of 23 series, ten 'Co' canes *viz*., Co 23001, Co 23002, Co 23006, Co 23008, Co 23009, Co 23010, Co 23014, Co 23015, Co 23016, Co 23018 were promoted for AICRP(S) evaluation testing in peninsular zone.

## Hybridization (2023)

During the 2023 flowering season, flower initiation was observed during the first week of November and extended up to the fourth week of December 2023 in the arrowing plot. The flowering intensity of parental clones in the arrowing plot was only 50.28%. A total of 420 biparental crosses were effected which included 40 crosses between tropical and sub-tropical clones, 330 crosses involving tropical and tropical clones and 20 crosses involving ISH, IGH, CYM clones and genetic stocks. Thirty polycrosses were effected using high pollen shedding parents *viz.,* Co 12009, Co 19014, CoH 70, CoVC 14061, Co 17005, Co 19006 and Co 16018. Crosses with short duration or high sugar clones as one of the parents were also effected. 'Co' canes of recent years such as Co 19003, Co 17005, Co 22018, Co 18008, Co 20013 and Co 22012 were utilized in the crossing programme. Ten clones combining resistance to both red rot and smut, twenty parents with resistance to smut and twenty clones with resistance to red rot were utilized to effect crosses. A total of 100 general collections were also made.

*(S. Alarmelu, P. Govindaraj, A.J. Prabakaran, A. Anna Durai, R. Karuppaiyan, C. Appunu, K. Elayaraja, Adhini S. Pazhany, H.K. Mahadeva Swamy and K. Gopalareddy )*

## Ground nursery (2023)

A total of 15,000 seedlings were raised from 140 biparental crosses, four polycrosses and 25 general collections were planted in the field. The cross combinations *viz*., Co 0240 x Co 11015, Co 11015 x CoH 70, Co 11015 x ISH 229, Co 13014 x Co 11015, MS 6847 x Co 11015, ISH 100 x Co 11015, Co 8371 x Co 11015, Co 11015 x Co 12009, Co 15027 x Co 0209, 81 V 48 x CoTl 14111, Co 0212 x Co 86032, Co 86032 x Co 11015, Co 1148 x Co 62198, CoVC 14062 x Co 06022, Co 13014 x CoT 8201, Co 0118 PC, Co 11015 x Co 89003 and 97 R 129 x Co 11015 gave more number of progenies. Large number of seedlings was obtained from the biparental crosses involving the clones Co 11015, CoVC 14061, Co 13014, Co 8371, CoM 0265 and CoC 671 as one of the parents.

*(S. Alarmelu, A.J. Prabakaran, A. Anna Durai, R. Karuppaiyan, C. Appunu, K. Elayaraja and H.K. Mahadeva Swamy)*

## Seedling raising for ground nursery (2023)

Fluff of 134 biparental crosses, 36 polycrosses and thirty general collections made during 2022 flowering season were sown in the mist chamber for raising seedlings. The crosses *viz*., Co 13014 x Co 21005, Co 11015 x CoM 20082, Co 86011 x CoVC 14061, Co 21009 x Co 19009, Co 19004 x Co 0212, Co 11015 x Co 94008, Co 11015 x Co 97015, Co 21011 x Co 16018, Co 14020 x Co 16018, Co 19004 x Co 22012 contributed large number of seedling progenies, and a total of 32000 seedlings were transplanted for evaluation in ground nursery.

*(G. Hemaprabha, R.M. Shanthi, S. Karthigeyan, K. Mohanraj, V. Sreenivasa, S. Sheelamary, V. Vinu and R.T. Maruthi)*

## First Clonal trial (2022-2023)

One thousand nine hundred and seven clones were evaluated for NMC, cane thickness, cane height and HR Brix at 300 days. Five hundred and nineteen clones had HR brix of more than 20.0% at 240 days, 200 clones had more than 200 cm cane height, 400 clones had cane thickness of more than 2.5 cm and 52 clones had more NMC. Ten crosses recorded more than 20% H.R. brix at 240 days. The crosses Co 11015 x Co 775, Co 13015 x Co 11015, Co 11015 x Co 94008, Co 10033 x Co 11015 were found to be the best for sucrose and recorded more than 24% brix at 11$^{th}$ month. Progenies derived from crosses involving Co 11015, CoC 671, Co 17003, Co 0118 and Co 12009 as one of the parents recorded higher early sucrose accumulation.

| | |
|---|---|
| Number of clones with more than 20% H.R. brix at 240 days | 519 |
| Cross combination with more than 20% H.R. brix at 240 days | Co 17003 x Co 18009, Co 10026 x Co 11015, Co 13014 x Co 11015, Co 0118 x Co 94005, Co 11015 x Co 8353, Co 17001 x 12009, Co 11015 x CoVC 14061, Co 11015 x Co 97015, Agl 2019N-38 x Co 12009, Agl 2019N-2 x Co 16018 |

*(S. Alarmelu, P. Govindaraj, A.J. Prabakaran, A. Anna Durai, R. Karuppaiyan, C. Appunu, K. Elayaraja, H.K. Mahadeva Swamy and K. Gopalareddy)*

## Second clonal Trial-I

In the second clonal trial, 936 clones promising for yield, juice quality and red rot resistance were planted along with four standards *viz*., Co 86032, Co 09004, CoC 671 and Co 11015 in an augmented RCB design. At 10th month, 65 clones recorded more than 21.0% sucrose indicating the potential of the clones identified for early maturity and 96 clones recorded more than 22% sucrose at 12th month in this trial. The clone 2018-185 developed from the cross CoVC 14062 x Co 11015 recorded 24.20% sucrose at 11th month. One of the effective methods for managing red rot resistance is through the deployment of resistant varieties and 36.64% of the clones were exhibiting resistance to red rot and 114 clones combined both high juice quality and red rot resistance. From this trial, 171 clones combining high yield, quality, red rot resistance and field stand were selected and promoted to PZVT multiplication 2023.

| | |
|---|---|
| Crosses with maximum selection | Co 8371 x Co 11015, 11015 x Co 97015, CoLk 8102 x Co 11015, Co 11015 x Co 94008, Co 11015 x CoH 119, Co 11015 x 775 $S_1$, Co 11015 x CoVC 14061, Co 11015 x Co 12009, Co 11015 x Co 97015, CoVC 14062 x Co 11015 |
| **Outstanding entries for different characters** | |
| No. entries > 21% sucrose at 300 days | 65 |
| No. entries > 22% sucrose at 360 days | 96 |
| Cane height > 300 cm | 34 |
| Single cane weight > 2.5 kg | 21 |
| Cane diameter > 3.5 cm | 28 |
| Red rot resistant entries (R & MR) | 13 (R) & 330 (MR) |
| Clones combining high sucrose (>20 % and red rot resistance | 114 |
| Clones promoted to PZVT 2023 | 171 |

*(G. Hemaprabha, R.M. Shanthi, S. Karthigeyan, K. Mohanraj, V. Sreenivasa, S. Sheelamary, V. Vinu and R.T. Maruthi)*

## Second clonal Trial-II

A total of 772 clones (517 at Coimbatore and 155 at Agali) were evaluated for yield and quality traits along with four standards *viz*., Co 86032, Co 09004, CoC 671 and Co 11015 in an Augmented RCB design. Twenty-seven clones recorded more than 21.0% sucrose at 10th month compared to 19.14% recorded in the best standard Co 11015 and 18 clones recorded more than 22.0% sucrose at 12th month. Sixty-one clones exhibited resistance to red rot and high sucrose content. Among the parents, Co 11015 generated a greater number of progenies with high sucrose. 92 clones with excellent yield, quality, resistance to red rot, and field stand were chosen from this trial and advanced to the PZVT multiplication 2023. A significant portion of the selections were from crosses where one of the parents was Co 11015,

Co 86032, Co 10026, Co 14005, CoVC 14061, Co 17003, and Co 16010. Clones with Co 11015, Co 86032, and CoC 671 as one of the parents showed increased early sucrose buildup. Together, these clones accounted for over 68% of the selections.

Red rot reaction of these entries through CCT indicated that 38.3% clones were resistant and moderately resistant types and crosses *viz.*, Co 13003 x Co 94008, Co 11015 x Co 14008, CoV 09356 x Co 97015, Co 86032 x Co 97015, Co 86032 x CoC 8001, Co 98010 x CoVC 14061, Co 12009 x Co 94008, Co 16001 x Co 10033 and Co 14026 x CoC 671 produced more resistant progenies. A total of 92 clones with good field stand, yield and quality parameters were promoted to PZVT for further evaluation. One thousand four hundred clones in second clonal trial will be evaluated for yield, quality traits and resistance to red rot

| | |
|---|---|
| Crosses with maximum selection | Co 10026 x Co 11015, Co 10033 x Co 97015, Co 11015 x Co 14008, CoV 09356 x Co 97015, Q 69 x Co 16018, CoM 0265 x Co 97015, CoVC 14061 x CoC 671, CoLk 8102 x Co 11015, Co 11015 x Co 94008, Co 11015 x CoH 119 |
| **Outstanding entries for different characters** | |
| No. entries > 21% sucrose at 300 days | 27 |
| No. entries > 22% sucrose at 360 days | 18 |
| Cane height > 300 cm | 39 |
| Single cane weight > 2.5 Kg | 8 |
| Cane diameter > 3.5 cm | 28 |
| Red rot resistant entries (R & MR) | 296 |

*(S. Alarmelu, P. Govindaraj, A.J. Prabakaran, A. Anna Durai, R. Karuppaiyan, C. Appunu, K. Elayaraja, Adhini S. Pazhany, H.K. Mahadeva Swamy and K. Gopalareddy)*

## Pre-Zonal Varietal Trial (Location: Coimbatore)

### Performance of 'Co' canes identified during 2022-23 at Coimbatore

Seventy-three clones and three standards *viz.*, Co 86032, Co 11015 and CoC 671 were evaluated in a randomized block design with two replications. Data were analyzed for cane yield, sucrose%, red rot and smut resistance. A total of 21 'Co' canes (Co 23001 to Co 23021) were identified. Among these 'Co' canes, Co 23010 (26.20 t/ha) recorded highest CCS yield, followed by Co 23012 (25.45 t/ha), Co 23007 (24.68 t/ha) and Co 21009 (24.34 t/ha) which showed significantly superior commercial sugar yield over the best standard Co 11015 (19.00 t/ha) in the trial. Twelve 'Co' canes recorded significantly higher cane yield than the three standards Co 86032 (127.89 t/ha), Co 11015 (118.49 t/ha) and CoC 671 (111.61 t/ha). Of these, seven 'Co' canes combined resistance to red rot and smut diseases. Co 23008 exhibited the maximum early sucrose accumulation in addition to red rot and smut resistance. Three 'Co' clones were identified as genetic stocks, two of them recorded superior sucrose% at 12$^{th}$ month and also combined resistance to red rot and smut.

*(C. Appunu and V. Vinu)*

### Pre-Zonal Varietal Trial (2023-24)

A total of 229 clones along with four standards (Co 86032, CoC 671, Co 11015 & Co 09004) were multiplied for conducting PZVT in the subsequent year. Among the clones 2022-154 recorded the maximum of 21.83% sucrose followed by 2022-200 (21.52%) compared to the standards Co 86032 (17.87%), CoC 671 (20.42%) and Co 09004 (21.04%) at 300 days. About 20 clones recorded sucrose percent of >20% at 300 days. About 154 clones showed resistance to red rot (CCT). Based on cane yield, quality, field stand, flowering, absence of spines and resistance to red rot, 80 clones were selected and planted along with four standards with two replications in PZVT trial for evaluation.

*(R. Karuppaiyan and S. Sheelamary)*

## Pre-Zonal Varietal Trial (Multiplication) 2023-24

In the PZVT multiplication, 297 clones from Coimbatore and six clones from SBIRC, Kannur were planted in two rows with four checks (Co 11015, CoC 671, Co 09004, Co 86032) on 18.03.2023.

*(K. Elayaraja and R.T. Maruthi)*

## Arrowing plot

A total of 345 clones including recently developed 'Co' canes, parents of proven crosses, genetic stocks, CYM and CD clones and energy canes were planted for making crosses during the year 2023.

*(K. Elayaraja, H.K. Mahadeva Swamy and K. Gopalareddy)*

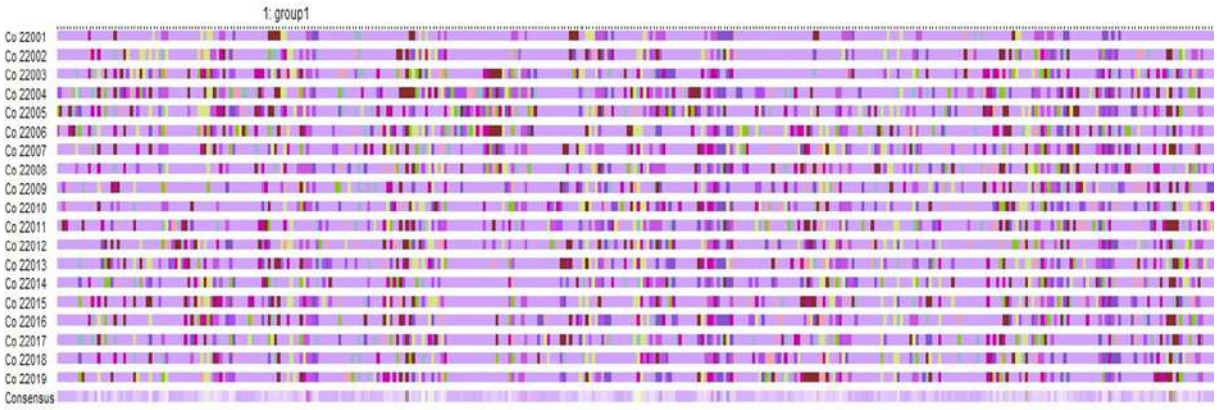
## Screening for diseases

**Red rot:** Seventy eight PZVT clones of 2022 series were screened for red rot resistance under field conditions by both plug and nodal methods with CF06 (*Cf671*) pathotype. In plug method 30 clones were identified as moderately resistant (MR), 29 were moderately susceptible (MS), 14 were susceptible (S) and 5 were highly susceptible (HS) to red rot. In nodal method of screening 54 clones were identified as R and 22 were rated as S to red rot.

**Smut:** Among 78 PZVT clones screened for smut resistance, 3 entries *viz*., 2022-80, 2022-110 and 2022-214 were rated as R, while 17 were rated as MR, 18 were MS, 9 were S and 31 were HS to smut.

*(A. Ramesh Sundar and V. Jayakumar)*

## Botanical characterization and DNA Fingerprinting of elite selection and varieties




*Graphical representation of Molecular profile 22 series 'Co' canes (Co 22001 to Co 22019)*

The 19 'Co' canes of 2022 (Co 22001-Co 22019) series developed at Coimbatore were botanically described based on DUS guidelines. The molecular fingerprints of the recently developed 2022 series 'Co' canes (22001 to Co 22019) were done. The molecular fingerprints of Co 14005, Co 15025 and Co 16030 which were identified for release were developed. On payment basis the molecular fingerprints of CoA 17321 and MS 16081 were developed in the current year.

*(H.K. Mahadeva Swamy and G. Hemaprabha)*

## Identification and testing of short duration sugarcane clones

Evaluated 11 prospective short duration (SD) clones and five standards in replicated trial (3 R x 6m x 0.9m) for two years (2021-22 to 2022-23). Three crops (1 plant + 2 ratoons) were taken in a span of two years as against two crops (1 plant + 1 ratoon) as control. Out of 11 prospective SD clones evaluated, three clones namely, Co 16001, Agl2018-24 and RK 2020-12 full-filled the criteria of short duration variety (SDV; 18% brix, 16% sucrose and 85% purity at 8$^{th}$ month) as well as having ratooning ability (up to 2 ratoons) in addition to the short duration standards Co 8338, Co 11015 and Co 09004. The short duration clones identified above such as Co 16001, Agl2018-24 and RK 2020-12 were relatively thin with lower single cane weight (also flowering). Therefore, its direct utility as commercial cultivar is limited

and requires further improvement. However, they may be used as parents for early sucrose accumulation and early maturity. Nonetheless, the standard Co 11015 may be promoted as SDV with good ratoon management practices. The mean cane yield of selected SD clones in plant crop, 1st ratoon, 2nd ratoon (all were harvested at 8m) were 100.68 t/ha, 98.42 t/ha and 51.93 t/ha, respectively. The total cane yield of 1 P + 2 R harvested in two years was 251.03 t/ha in comparison to the yield of 12 months crop 120 t/ha in plant crop and 104.34 t/ha in ratoon 1 harvested in span of two years (total cane yield: 224.39 t/ha). In summary, 1P+2R system of short duration clones recorded 26.64 t/ha higher cane in comparison to 1P+1R in normal harvesting system (in a span of two years). The cane yield of second ratoon was drastically reduced in short duration clones. If this was managed well, perhaps the 1P+2R system could have showed higher yield gain in comparison to 1P+1R system. The mean CCS yield of selected SD clones in plant crop, 1st ratoon, 2nd ratoon (all are harvested at 8m) were 12.03 t/ha, 11.72 t/ha and 6.29 t/ha, respectively. The total CCS yield of 1 P+2 R harvested in two years was 30.04 t/ha in comparison to the yield of 12 months crop 17.47 t/ha in plant crop and 15.98 t/ha in 1st ratoon harvested in span of two years (total CCS yield: 33.45 t/ha).

*(R. Karuppaiyan, G. Hemaprabha and V. Krishnapriya)*

## Evaluation of elite clones for identifying promising location specific sugarcane varieties

### Maharashtra

Twenty-three test entries *viz*., Co 14012, Co 14027, Co 15010, Co 15017, Co 15020, Co 15021, Co 18001, Co 18009, Co 18023, Co 18024, Co 19002, Co 19004, Co 19008, Co 19009, Co 20005, Co 20006, Co 20007, Co 20010, Co 20011, Co 21003, Co 21007, Co 21008 and Co 21011 along with the standards Co 86032, CoM 0265 and CoVSI 12121 were planted in RBD with two replications at factory farm of M/s. Sahakar Maharshi Shankarrao Kolhe Sahakari Sakhar Karkhana Ltd., Kopargaon, Maharahshtra. Juice analysis at 360 days revealed that sucrose% ranged from 18.11% (Co 18023) to 21.49% (Co 20010). All clones recorded higher sucrose% and CCS% than the standard CoM 0265 with 17.82% and 12.43% respectively. Thirteen clones recorded higher sucrose% and CCS% than Co 86032 with 19.25% and 13.45%, respectively. The clones *viz*., Co 14027 (119.37 t/ha), Co 15020 (135.00 t/ha), Co 18001 (119.78 t/ha), Co 19008 (123.24 t/ha), Co 20005 (124.19 t/ha), Co 20006 (136.00 t/ha), Co 21003 (154.39 t/ha) recorded on-par or higher cane yield than CoM 0265 (119.21 t/ha). Sixteen clones recorded higher cane yield and sugar yield than Co 86032 with 100.23 t/ha and 13.50 t/ha, respectively. Overall, considering the field stand, flowering, quality and yield parameters the clones *viz*., Co 18001, Co 19008, Co 20005, Co 20006 and Co 21003 were better than standards.

**Performance of the test entries at M/s. Sahakar Maharshi Shankarrao Kolhe Sahakari Sakhar Karkhana Ltd., Kopargaon, Maharahshtra.**

| Clones | CCS Yield (t/ha) | Cane Yield (t/ha) | CCS% | | | Sucrose% | | |
|---|---|---|---|---|---|---|---|---|
| | | | 360 days | 300 days | 240 days | 360 days | 300 days | 240 days |
| Co 14027 | 15.70 | 119.37 | 13.27 | 12.26 | 10.41 | 18.97 | 17.67 | 15.37 |
| Co 15017 | 15.53 | 113.76 | 13.49 | 13.13 | 10.06 | 19.33 | 18.93 | 14.88 |
| Co 15020 | 18.61 | 135.00 | 13.78 | 10.81 | 10.79 | 19.70 | 15.85 | 15.89 |
| Co 15021 | 15.09 | 113.49 | 13.28 | 12.72 | 10.83 | 19.07 | 18.44 | 15.78 |
| Co 18001 | 16.31 | 119.78 | 13.61 | 11.47 | 10.74 | 19.49 | 16.68 | 15.87 |
| Co 19002 | 12.26 | 93.07 | 13.18 | 11.33 | 11.34 | 18.90 | 16.46 | 16.48 |
| Co 19008 | 16.11 | 123.24 | 13.08 | 11.02 | 9.17 | 18.81 | 16.04 | 13.58 |
| Co 20005 | 18.45 | 124.19 | 14.86 | 11.97 | 10.63 | 21.21 | 17.37 | 15.56 |
| Co 20006 | 18.49 | 136.00 | 13.60 | 10.99 | 10.33 | 19.47 | 16.01 | 15.26 |
| Co 20007 | 14.57 | 101.43 | 14.18 | 12.54 | 12.10 | 20.22 | 18.19 | 17.03 |

| Clones | CCS Yield (t/ha) | Cane Yield (t/ha) | CCS% | | | Sucrose% | | |
|---|---|---|---|---|---|---|---|---|
| | | | 360 days | 300 days | 240 days | 360 days | 300 days | 240 days |
| Co 20010 | 16.30 | 108.65 | 15.01 | 12.40 | 10.40 | 21.49 | 17.92 | 15.34 |
| Co 20011 | 13.18 | 91.77 | 14.38 | 10.88 | 10.09 | 20.64 | 15.94 | 14.90 |
| Co 21003 | 21.52 | 154.39 | 13.97 | 11.83 | 8.64 | 19.96 | 17.11 | 13.25 |
| Co 21007 | 8.19 | 62.27 | 13.12 | 12.39 | 10.70 | 18.77 | 17.93 | 15.77 |
| Co 21011 | 14.02 | 98.23 | 14.27 | 12.47 | 10.37 | 20.49 | 17.96 | 15.28 |
| Co 86032 | 13.50 | 100.23 | 13.45 | 12.01 | 10.39 | 19.25 | 17.39 | 15.34 |
| CoM 0265 | 14.87 | 119.21 | 12.43 | 10.63 | 9.62 | 17.82 | 15.55 | 14.26 |
| Co VSI 12121 | 17.33 | 119.62 | 14.48 | 11.81 | 10.81 | 20.61 | 17.11 | 15.91 |
| CD | 5.42 | 32.84 | NS | NS | NS | NS | NS | 1.35 |
| CV | 17.83 | 14.76 | 6.67 | 6.64 | 5.16 | 6.05 | 6.14 | 4.26 |

*(V. Sreenivasa and C. Appunu)*

## Karnataka

Twenty-eight PZVT clones namely PZVT 2018-3, 2018-7, 2018-8, 2018-11, 2018-14, 2018-22, 2018-34, 2018-36, 2018-72, 2018-83, 2018-92, 2018-95, 2018-108, 2018-116, 2018-123, 2018-124, 2018-134, 2018-136, 2018-161, 2019-3, 2019-5, 2019-12, 2019-19, 2019-20, 2019-90, 2019-102, 2019-104 and 2019-105 along with popular standard Co 86032 were planted in randomised block design with two replications at S. Nijalingappa Sugar Institute, Belagavi, Karnataka. Juice analysis at 360 days has shown that the clones *viz*., 2018-36, 2018-95, 2018-108, 2018-161 and 2019-3 recorded significantly superior values for sucrose% and CCS% over the standard Co 86032 (21.27% & 15.13%). For cane yield, the test entries 2018-116, 2018-123, 2018-161, 2019-3 and 2019-12 recorded significantly superior cane yield over best standard Co 86032 (112.32 t/ha) at harvest. For CCS yield, the clones 2018-14, 2018-123, 2018-161, 2019-3 and 2019-12 were significantly superior CCS yield over the standard Co 86032 (17.00 t/ha) at harvest. The test clones 2018-161 and 2019-3 recorded superior values for cane yield traits at harvest and juice quality parameters at 8$^{th}$, 10$^{th}$ and 12$^{th}$ months over the standard Co 86032 at the location and these clones may be promoted for MLT in Northern Karnataka.

**Performance of the PZVT clones at SNSI, Belagavi, Karnataka**

| Clones | CCS yield (t/ha) | Cane yield (t/ha) | Sucrose% | | | CCS% | | |
|---|---|---|---|---|---|---|---|---|
| | | | 360 days | 300 days | 240 days | 360 days | 300 days | 240 days |
| 2018-14 | 21.00 | 140.52 | 20.91 | 20.45 | 15.59 | 14.93 | 14.29 | 10.55 |
| 2018-36 | 12.89 | 83.42 | 21.63 | 21.38 | 17.95 | 15.45 | 15.11 | 12.43 |
| 2018-95 | 16.14 | 100.14 | 22.68 | 21.20 | 17.94 | 16.11 | 14.77 | 11.85 |
| 2018-108 | 18.41 | 117.60 | 22.28 | 20.19 | 17.36 | 15.65 | 14.22 | 12.11 |
| 2018-116 | 19.47 | 139.75 | 20.02 | 19.89 | 17.93 | 14.00 | 14.15 | 12.43 |
| 2018-123 | 20.39 | 143.27 | 20.14 | 19.89 | 18.37 | 14.07 | 14.08 | 12.88 |
| 2018-161 | 21.57 | 142.23 | 21.38 | 18.72 | 18.34 | 15.16 | 13.19 | 12.57 |
| 2019-3 | 20.88 | 137.16 | 21.51 | 20.60 | 17.24 | 15.24 | 14.63 | 11.86 |
| 2019-12 | 22.08 | 163.93 | 19.38 | 20.34 | 17.05 | 13.47 | 14.27 | 11.63 |
| Co 86032 | 17.00 | 112.32 | 21.27 | 19.49 | 15.25 | 15.13 | 13.74 | 10.32 |
| CD | 5.65 | 22.42 | 1.32 | 1.46 | 2.11 | 1.12 | 1.14 | 2.11 |
| CV | 11.24 | 12.32 | 3.09 | 3.51 | 8.85 | 3.73 | 3.89 | 10.20 |

*(V. Sreenivasa, K. Mohanraj and H.K. Mahadeva Swamy)*

## Breeding special varieties for high biomass and total sugars for cogeneration, ethanol and forage production.

### a) Cogeneration and ethanol Production.

A total of 67 energycane clones and SBIEC 14006 are maintained. During 2022-23, licensing of energycane variety SBIEC 14006 was granted to two firms, *viz.,* M/s.VS Lignite Power Private Limited, Bikaner, Rajasthan and M/s. Sai Wardha Power Generation Pvt. Limited, MIDC, Warora, Maharashtra. The seed materials were provided to the firms during March-April 2023 for raising the crop in their farm and ₹ 7,08,000/- revenue was generated through licensing of this technology

*(P. Govindaraj and K. Elayaraja)*

### b) Nutritional evaluation, improvement and utilization of newer feed resources for livestock production

**Development of alternate source of feed stocks**: Six non-pubescent fodder type clones were selected from the backcrosses involving fodder Bajra x (Bajra x *Erianthus*), (Bajra x *Erianthus*) x Sugarcane, (Bajra x *Erianthus*) x Bajra. The propagules of the selection were multiplied and evaluation will be taken in the ensuing season. Seeds of 22 crosses (also backcrosses) made between Napier grass and $BC_1$ of Bajra x *Erianthus*, Napier grass x sugarcane, IGH clones x *Erianthus etc*., was transplanted in field for further study.

*(R. Karuppaiyan and P. Govindaraj- ICAR-SBI Coimbatore;*
*Vijay. K. Yadav, A.K. Misra,*
*S.B. Maity, K.K. Singh, Sultan Singh and P. Koli -ICAR-IGFRI, Jhansi)*

## Identification of superior sugarcane varieties suitable for different agro-eco climatic regions of Tamil Nadu (ART/ MLTs in collaboration with TNAU)

**Multi-location Trial 2022-23 – I plant:** The trial was planted with seven test entries *viz*., Co 13003, Co 15003, Co 17001, C 16337, C 16338, C 16122, G 15060 and SI 2014-049 along with six standards *viz*., Co 86032, Co 11015, CoC 13339, CoG 6, CoG 7, and TNAU (SC) Si 8 at ICAR-SBI, Coimbatore. For sugar yield Co 11015 was the best in the trial with 15.17 t/ha and test entry Co 17001 was superior to Co 11015 (16.46 t /ha) because of its higher cane yield combined with high sucrose content. In MLT ratoon 2022-23, seven test entries *viz*., C 2015-006, C 2015-021, C 2015-095, Co 15020, Co 18023, G 11035 and SI 2013-032 along with five standards *viz*., CoC 13339, Co 86032, Co 11015, CoG 6 and TNAU SI 8 were evaluated for thier ratooning potential at ICAR- SBI, coimbatore during 2022.23. For CCS yield, Co 15020 (15.33 t/ha) was on par with the best standard Co 11015 (15.20 t /ha).

**Adaptive Research Trial - I plant 2022-23**: Three test entries *viz*., C 2015-095, Co 15020 and G 11035 along with the five standards *viz*., Co 86032, Co 11015, CoC 13339, CoG 6, CoG 7 and TNAU (SC) Si 8 were evaluated at three locations *viz*., Sathyamangalam, Appakudal and Odapalley. At Sakthi Sugars, Appakudal, Erode Co 15020 recorded the highest cane yield of 181.76 t/ ha which was superior to the best standard Co 11015 (165.1 t/ha). Further the clone Co 15020 (21.21 t/ha) showed on par performance with Co 11015 (21.41 t/ha) with respect to CCS yield. At Bannariamman Sugars, Sathyamangalam, Co 15020 (187.87 t/ha) and G 11035 (182.91 t/ ha) were superior to Co 11015 (164.05 t/ha) for cane yield. At Ponni Sugars Co 15020 with cane yield of 184.96 t/ha and sugar yield of 24.87 t/ha and G 11035 with 179.94 t/ha of cane yield and 23.90 t/ha of CCS yield were superior to the best standards Co 86032 (167.87 t/ha) and Co 11015 (22.96 t/ha) for the respective traits. Overall, with regional mean cane yield of 184.86 t/ha, Co 15020 which recorded on par performance for sugar yield was the best in the trial for cane yield in the Coimbatore region.

**Adaptive Research Trial – II plant and Ratoon 2022-23**: Four entries *viz*., C 2014-516, Co 14004, Co 14012 and G 10045 were evaluated along with five standards (Co 86032, Co 11015, CoC 13339, CoG 6 and TNAU (SC) Si 8) in three locations under ART II P and ART ratoon during 2022-23. At Bannariamman Sugar Sathyamangalam, overall (mean of second plant and ratoon crops), Co 14012 showed its superiority for cane yield (149.40 t/ha) and sugar (21.69 t/ha) and on par performance for sucrose traits for the respective best standards (Co 11015 with 136.19 t/ha and

19.82 t/ha of sugar yield respectively). At Sakthi Sugars Appakudal, G 10045 recorded the highest cane yield (178.00 t/ha) and sugar yield of 21.42 t/ha was found on par with Co 86032 (175.13 t/ha) for cane yield and Co 11015 (21.81 t/ha) for sugar yield. In the ART ratoon trial Co 14004 (152.51 t/ha) and G 10045 (157.36 t/ha) were found to be better than the standard vareities for cane yield while Co 14012 (12.85 t/ha) was on par with Co 11015 (12.97) for sugar yield. At Ponni Sugars, Odapalley, Co 14012 recorded the highest cane yield (158.94 t/ha) and sugar yield of 21.49 t/ha was found superior to the best standard Co 11015 (cane yield of 150.32 t/ha and sugar yield of 21.42 t/ha). In the ART ratoon trial, Co 14004 with cane yield of 121.87 t/ha and sugar yield of 23.96 t/ha was found to be better than the best standard Co 11015 for cane yield (119.48 t/ha) and on par for sugar yield (24.41 t/ha).

*(A. Anna Durai and K. Mohanraj)*

## Marker-assisted selection in sugarcane for drought tolerance and red rot resistance

Sixty-one genotypes were planted in RBD with two replications in two sets. One set was imposed with drought after 90 days of planting, by withholding irrigation and the other set was irrigated normally. Observations were recorded on number of millable canes, cane biomass, cane length, cane diameter, internode length, internode number, top weight, cane weight, cane dry weight and top dry weight at harvest. Analysis of variance revealed the presence of significant variation in the panel for all the traits. Individual BLUPs were estimated, and were used for marker trait association (MTA) studies. The GLM and MLM based analysis revealed MTAs with phenotypic variance ranging from 9.16 to 14.5 percent. The marker SNAC1, DREB1A POM1 which were found associated with drought tolerant traits were confirmed and they will be used to screen the genotypes in the crossing block.

To identify the markers associated with red rot, a panel of 204 genotypes were tested for red rot resistance against CF6 isolate through CCT. Based on the red rot reaction the genotypes were grouped into resistant (22; R), moderately resistant (80; MR), moderately susceptible (37; MS) susceptible (51; S), highly susceptible (14; HS). Five DNA bulks were constituted based on the red rot results as R, MR, MS, S and HS by pooling the DNA of ten genotypes from each category. 72 SSR and 37 RGA markers were analyzed for their polymorphism, nine SSRs (A-1.12, A-1.8, A-3.14, A-3.15, A-4.1, A-4.2, A-4.3, A-7.8, and A-8.2) and seven RGA primers (RGA 12, RGA 16, RGA 57, RGA 169, RGA 185, RGA 184 and RGA 326) were found polymorphic among the bulks. These polymorphic markers were used to genotype the entire panel and genome wide association studies were done to identify the marker trait associations. The GLM based analysis revealed four MTAs, the markers RGA 184, RGA 57, A1-12 and RGA 169 with phenotypic variance of 23.56%, 15.90%, 9.27% and 7.58% respectively were found associated with red rot resistance. The MLM based analysis found only one MTA with the marker RGA 184 which possessed phenotypic variance of 12.95% for red rot resistance. The marker RGA 184 found to be promising, it can be used in maker assisted selection after further validation.

**MTAs found for drought traits using MLM and GLM**

| **GLM** | | | |
|---|---|---|---|
| **Trait** | **Marker** | **p value** | **Phenotypic variance** |
| Resistance | RGA184 | 1.32E-12 | 23.569 |
| Resistance | RGA57 | 1.65E-08 | 15.907 |
| Resistance | A1.12 | 2.63E-05 | 9.271 |
| Resistance | RGA169 | 0.000313 | 6.929 |
| **MLM** | | | |
| Resistance | RGA184 | 0.000255 | 12.95 |

*(H.K. Mahadeva Swamy, K. Mohanraj, C. Appunu, G. Hemaprabha, P. Malathi and R. Manimekalai)*

## Molecular profiling of sugarcane gene pool for brown rust and identification of novel genomic regions for rust in *Bru1* gene null background

Molecular profiling of clones in the arrowing plot for the *Bru1* gene-related markers is initiated**.** The *Bru1* negative rust-resistant parents (Co 8353, BO 91, CoPant 97222 and ISH 12) were crossed with rust-susceptible parents (Co 62198, Co 15027, CoH 70, ISH 100, and CoN 18071) to develop mapping population. The parental clones in 2023-24 were screened for natural incidence of rust disease and 23.0% of the clones were found to be susceptible to rust disease.

*(K. Gopalareddy, H.K. Mahadeva Swamy and R. Selvakumar)*

## Enhancement of sugarcane germplasm and development of pre-breeding material

### Maintenance at Coimbatore and Wellington

Two thousand two hundred and thirty nine accessions were maintained at Coimbatore which include *Saccharum spontaneum* (1706), *Erianthus arundinaceus* (230), *Erianthus* spp. (177), Allied Genera (62), improved *Erianthus* for fibre (48) in the field at Coimbatore. This year, for the first time, ratoon of 2239 accessions and thirty accessions of wild *Saccharum* spp. and allied genera in museum plots were done with drip irrigation facility. The establishment and growth of the accessions were good. Forty-seven accessions from Arunachal Pradesh are being maintained at IARI Regional Station, Wellington.

*(S. Karthigeyan, S. Sheelamary, Adhini S. Pazhany and M. Sivaswamy)*

### Maintenance of commercial hybrids and genetic stocks

A total of 2049 clones which includes 'Co' canes (1397), Co allied (18), foreign hybrids (52), ISH (284), IGH(38), CD(86), PL (58), CYM(96), IA (13), GU(1) and IND(6) were maintained at Coimbatore.

*(H.K. Mahadeva Swamy and K. Elayaraja)*

### National active germplasm maintenance

Seed material of eleven clones received from different centres were submitted to quarantine and periodical monitoring was done for their growth. Two hundred and ninety-one notified varieties and registered genetic stocks were maintained. During this period 21 clones namely CoP 11438, CoP 18437, CoP 20440, CoP 15437, Co 17008, Co 85019, Co 98017, CoM 11086, CoM 13082, Co 15002, Co 14005, Co 15025, Co 16030, CoPant 12221, CoPant 12226, CoPant 13224, CoSe 11453, CoS 16233, CoS 17231, CoLk 16466 and CoLk 15206 were assigned index number.

*(C. Jayabose and S. Alarmelu)*

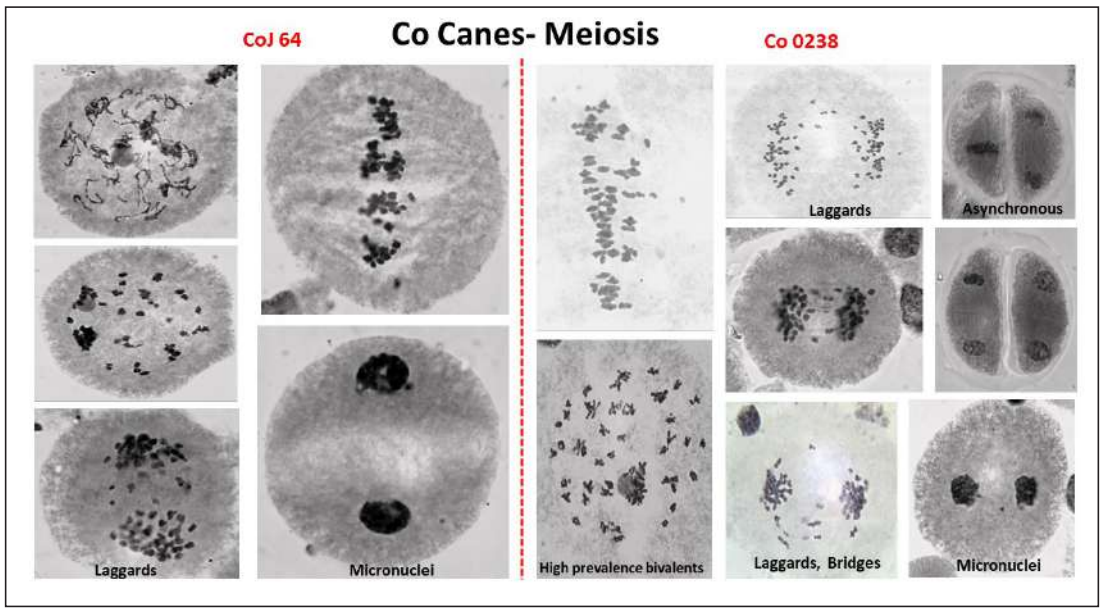
### Characterization, evaluation and cataloguing

**Flowering behavior of allied Genera:** Recording of flowering data was initiated at weekly interval from July 1st week onwards during 2022-23 season. Out of the 1775 *Saccharum spontaneum* accessions planted during 2023 in Coimbatore, 892 accessions flowered during 1st of July 2023 to 31st of December, 2023. Flowering behavior was also observed in eight allied genera which comprises 245 clones maintained in the germplasm field. Flowering was initiated in 12 clones during 2nd week of August, 26 clones during 1st week of September, 37 clones during 4th week of September, 81 clones flowered during the third week of October, 34 clones during 3rd week of December, and three clones flowered during second week of March 2023.

*(C. Jayabose and S. Karthigeyan)*

### Cytological studies in *Saccharum* and allied genera -*S. spontaneum*

Meiotic analysis has been done in 12 'Co' canes *viz*., Co 11015, Co 97015, Co 12009, Co 0238, Co 86032, Co 94012, Co 775, Co 94008, Co 62198, CoSe 92423, CoJ 64 and CoC 671. Many abnormalities were observed during different stages of meiosis like chromosomes were not lined up in the metaphase plate, during the anaphase and telophase lagging of chromosomes, bridges and micronuclei were also observed. Asynchronous or unequal division of chromosomes were observed during telophase. Reduction of chiasma per bivalent is reported as the potential mechanism for meiotic diploidization. Somatic chromosome number (2n) was determined in 47 *S. spontaneum* clones collected from different places of India in different periods of time. Chromosome number of 13 varieties were also determined through root tip mitosis.




*Meiotic analysis of two varieties CoJ 64 and Co 0238 with abnormalities in different stages of meiosis.*

## Chromosome number of *S. spontaneum* & 'Co' canes studied

| Clone | 2n | Clone | 2n | Clone | 2n | Clone | 2n |
|---|---|---|---|---|---|---|---|
| IND 01-1157 | 112 | IND 09-1546 | 60 | IND 16-1801 | 48 | IND 21-2078 | 64 |
| IND 03-1219 | 64 | IND 09-1544 | 40 | IND 16-1749 | 56 | IND 21-2065 | 64 |
| IND 04-1353 | 88 | IND 10-1573 | 80 | IND 16-1813 | 40 | Co 7201 | 108 |
| IND 04- 1355 | 92 | IND 10-1574 | 60 | IND 16-1809 | 54 | Co 775 | 108 |
| IND 04-1381 | 60 | IND 10-1577 | 70 | IND 17-1860 | 64 | Co 12009 | 104 |
| IND 05-1393 | 62 | IND 10-1576 | 62 | IND 18-1975 | 56 | Co 1148 | 104 |
| IND 07-1463 | 80 | IND 11-1664 | 80 | IND 18-1994 | 96 | Co 13013 | 110 |
| IND 07-1482 | 70 | IND 11-1598 | 72 | IND 18-1933 | 72 | Co 97015 | 110 |
| IND 07-1476 | 70 | IND 11-1670 | 64 | IND 19-2026 | 72 | Co 62198 | 104 |
| IND 07-1480 | 64 | IND 11-1674 | 80 | IND 19-2028 | 80 | Co 0238 | 104 |
| IND 07-1466 | 80 | IND 11-1690 | 64 | IND 21-2069 | 64 | Co 09010 | 102 |
| IND 08-1495 | 64 | IND 11-1613 | 80 | IND 21-2074 | 62 | Co 0209 | 106 |
| IND 09-1546 | 64 | IND 15-1705 | 72 | IND 21-2075 | 64 | Co 12014 | 114 |
| IND 09-1520 | 40 | IND 16-1763 | 56 | IND 21-2076 | 64 | Co 11015 | 110 |
| IND 09-1544 | 40 | IND 16-1812 | 56 | IND 21-2077 | 64 | CoJ 64 | 108 |

*(V.P. Sobhakumari)*

## Floral biological and cytological characterization of *Erianthus*

Data on 36 descriptors on 180 clones of *E. arundinaceus* were incorporated in DELTA software. Meiotic studies in three clones of *E. arundinaceus* indicated predominance of bivalents. Laggards were observed from 1-10 with unequal distribution of chromosomes. As anthesis in *E. arundinaceus* occurs from 3.0 pm to 10.00 pm, pollen was collected and dusted in the evening. Seed formation and germination was observed in the crosses.

*(A. Suganya)*

## Evaluation of sugarcane germplasm for biotic and abiotic stresses at Coimbatore

### *Saccharum spontaneum*

Forty *S. spontaneum* accessions identified as drought tolerant in the preliminary evaluation were planted in split plot design in two replications as control and drought treatments along with standards for evaluating drought stress tolerance at two locations *viz*., Coimbatore and Agali.

**Coimbatore:** Seventeen genotypes recorded less than 15% reduction in number of tillers per clump in comparison to control after exposing to water deficit stress. Few genotypes *viz*., SES 507, SES 515/7, IND 03-1307, IND 04-1372 and IND 11-1620 recorded high canopy temperature depression (CTD) values and indicated a cooler canopy and drought tolerance. Under drought stress, high biomass production was observed in genotypes like IND 04-1372, IND99-847, IND99-850, IND 11-1620 and SES 600.

**Agali:** Twelve genotypes recorded less than 15% reduction for number of tillers per clump in comparison to control after exposing to water deficit stress. Eleven genotypes *viz*., SES 32A, SES 69, SES 49, SES 297A, R-119, IND 99-879, IND 99-847, IND 99-882, IND 04-1372, US 57-19-1 and *S. spontaneum* Coimbatore recorded positive CTD values and implied drought tolerance. Nineteen genotypes *viz*., IND 04-1372, SH 147, SES 286, IND 03-1307, IND 99-850 *etc*., recorded high fresh biomass under drought stress. Two genotypes *viz*., H 60-4-5 and SES 600 recorded less than 3% reduction in the fresh biomass under drought stress compared to control.

Two hundred and twenty six *S. spontaneum* accessions were evaluated in augmented design along with two standards. Seventy genotypes recorded positive CTD values and implied drought tolerance. Thirty-four clones recorded less than 20% reduction in number of tillers per clump and total fresh biomass under drought condition compared to control treatment. Based on different morphological and physiological observations 90 clones were found promising under drought stress.

### *Erianthus arundinaceus*

From the panel of *E. arundinaceus* clones evaluated for drought stress tolerance in field conditions second batch of ten clones were selected and evaluated for salinity stress tolerance in pot culture. Salinity screening at formative phase was carried out after 90 days of planting under 16 $dSm^{-1}$ salinity treatment. Salinity treatment was given by irrigating saline water at regular interval. The saline water was prepared by mixing desired amount of NaCl, $Na_2SO4$, $CaCl_2$. $2H_2O$ in the ratio of 2:2:1. After one week of saline water treatment morphological and physiological data were recorded in treated as well as control plants. The study found that *Erianthus* clones exhibited a wide range of physiological and biochemical responses to salinity, with some clones *viz*., SES 3, SES7, SES 27 and SES 181 showing high levels of tolerance mechanism against salt stress in terms of higher stability of photosynthetic pigments, high biomass, higher accumulation of proline and lower lipid peroxidation. Among the 20 clones of *E. arundinaceus* evaluated for red rot resistance 14 clones showed R reaction and six clones showed MR reaction.

*(V. Vinu, H.K. Mahadeva Swamy, R. Valarmathi and R. Arun Kumar)*

## Anatomical characterization of *Saccharum* complex and core collections

Internode anatomy in 12 *Saccharum* complex members revealed thin-thick cuticle with 2-3 layer of chlorenchyma or collenchyma. Vascular bundles are dense in the rind portion and differed in size from small-median-large bundles with sclerenchymatous sheath. Bundle sheath is larger in Baragua and Lalkadi. In Mankia the vascular bundles are smaller. Metaxylem 2 and protoxylem 1-3. In Co 86032 rind vascular bundles are distributed at higher frequency. *S. spontaneum* had 3 protoxylem with scattered vascular bundles in periphery.

Micromorphological characters of internode of clones of '*Saccharum* complex' were diagnostic and identification key was prepared as denoted below.

**Identification key**

| | |
|---|---|
| Short cells occurs with only cork cells | *E. arundinaceus* |
| Short cells occurs with both cork and silica cells | |
| Papillae present in long cells | IJ 76-314 |
| Papillae absent in long cells | |
| Long cells are very long | *Sclerostachya* |
| Long cells are medium | |
| Cork cells pointed | |
| Long cells wavy | Co 8371 |
| Long cells sinuous | Laukona-15 |
| Cork cells not pointed | |
| Stomata rare | IND 04-1122 |
| Stomata absent | |
| Short cells single - 2/multiple pairs with two silica cells | CoH 114 |
| Short cells single pairs only | |
| Silical cells in higher frequency | Baragua |
| Silica cells in lower frequency | |
| Cork cells solitary | IND 09-1501 |
| Cork cells rarely solitary | IND 03-1201 |

## Developing trait specific genetic stocks with biotic and abiotic stress tolerance, quality and yield traits in sugarcane through pre-breeding

### Identifying multi trait genetic stocks with improved *Saccharum* genetic base evaluation of prebred clones

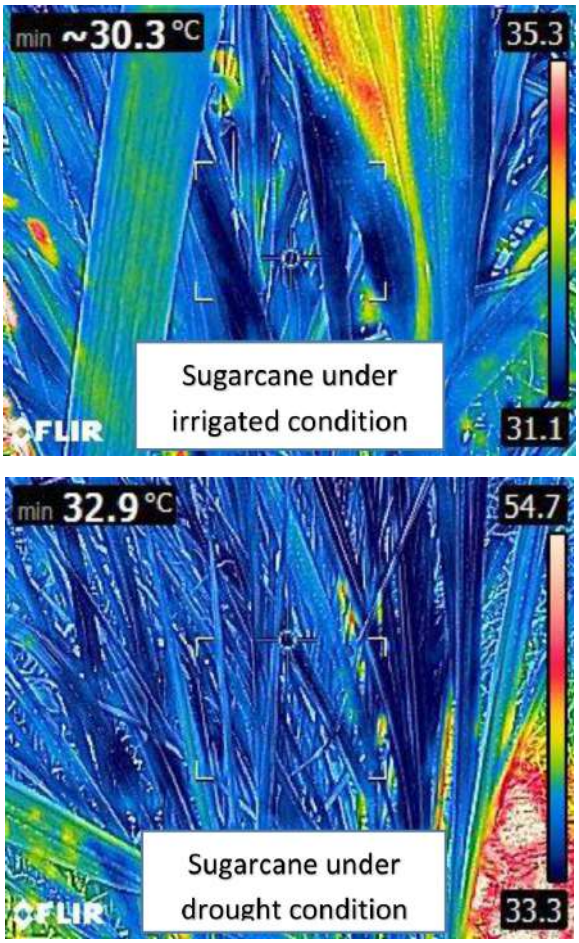
Fifty clones were selected and planted in a split plot design along with standards CoM 0265, Co 85019 and Co 10026 under drought and normal conditions. Drought stress was induced during formative phase of the crop by withholding irrigation. The drought stress was initiated at 60 days after planting and continued as rain fed crop till harvest. Germination was satisfactory and as rainfall was received intermittently during drought treatment the crop was raised under rainfed condition and phenotypic traits *viz*., plant height (cm), cane diameter (cm), NMC per row, yield per row (kg), number of internodes and internode length were recorded after 150 days. Mean yield at stress condition was 43.74 kg/row with a range of 13.1 kg/row to 83.9 kg/row. Under non- stressed condition, the mean yield of the clones was 48.84 kg/row with a range of 18.7 to 92.5 kg/row. There was a significant reduction in the both yield and quality indices. Maximum reduction of 46% was recorded for cane volume followed by NMC/row (37.66%) and cane yield (36.92%) under drought. Twenty clones recorded higher cane yield than the trial mean of 28.32 kg/row under drought.

There was 2.75% reduction in Brix, 4.38% in sucrose%, 5.18% in CCS%, 1.84% in purity, 8.91% cane height, 1.10% in cane diameter, 6.45% in juice weight, and 12.52% in extraction%. Correlation analysis also revealed that in water stressed condition the NMC/row was negatively correlated with pol% (-0.15), cane diameter (-0.23), cane weight (-0.15), juice weight (-0.18), extraction percent (-0.17) and single cane weight (-0.15). Cane volume per row was negatively correlated with pol% (-0.01) whereas estimated yield was negatively correlated with pol% (-0.03) and cane height was negatively correlated with pol%(-0.17) and cane diameter (-0.08).

The clone 14-97 produced the highest yield, 121.56 kg/ row and 21.75 kg/row, under non-stressed and stressed conditions, respectively. The clones *viz*., 07-520, 13-474, 14-39, 14-001, 14-90 were severely affected and had low cane population, cane height and cane formation. There was reduction in internode number and length in drought affected clones. Among the clones tested for red rot by CCT, 31.21% of the clones were moderately resistant to red rot. For juice quality at 360 days, clone 14-47 recorded juice sucrose of 21.53% followed by 14-30 with 21.02%. Under drought stress, high biomass production was observed in genotypes *viz*., 14-144(Co 7201 x (Co 0209 x Pathri), 14-95 (PIO 001100 x PIR 001174), 13-645 (PIR 96-285 x Co 09014) and 14-68 (PIR 96-285 x Co 09014). Four clones *viz*., 12-127, 003-14, 07-520, 13-457 entered PZVT testing.

**New trials:** Elite entries from two years evaluation were planted for drought evaluation during 2023 in two locations *viz*., Coimbatore and Agali. Drought was imposed after 60 days. Physiological traits *viz*., canopy temperature (CT) by thermal imaging IR camera, SPAD index, biomass and relative water content (RWC) were recorded in the sugarcane clones grown under both irrigated and drought conditions. Significant decline in SPAD, biomass and RWC was observed under drought condition compared to the irrigated condition. The interspecific hybrids under drought condition showed relatively higher canopy temperature compared to the irrigated condition.

*Field view of sugarcane clone grown under irrigated and drought condition at Agali*




*Higher canopy temperature was observed in drought compared to sugarcane clone raised under irrigated condition*

*(S. Alarmelu, S. Sheelamary and R. Arunkumar)*

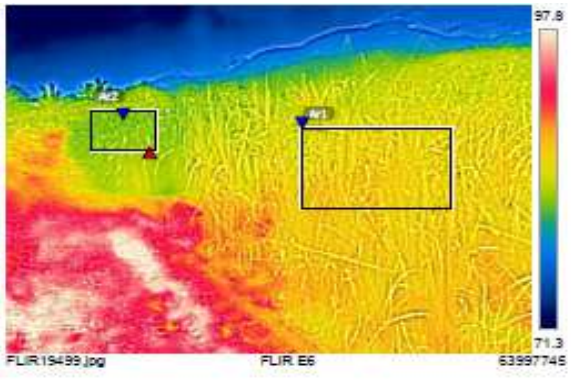
## Developing trait specific genetic stocks for biotic and abiotic stress tolerance utilizing novel *Saccharum* germplasm

**Red rot:** In field condition 94 genetic stocks along with 2 susceptible checks were inoculated with CF06 (*Cf671*) pathotype by plug method and 60 days after pathogen inoculation they were screened for red rot resistance. Among the screened genotypes 1 exhibited Resistant reaction, 48 were Moderately Resistant, 37 were Moderately Susceptible, 2 were Susceptible and 6 were Highly Susceptible to red rot.

**Smut:** Totally 94 parental clones were evaluated against sugarcane smut during the crop season 2023-24. Among the 94 entries, 36 clones were R, 9 were MR, 10 were MS, 9 were S and 30 clones were rated as HS.

**Drought**: Two sets of trials including 62 inter-specific hybrids were planted in a randomised block design along with two susceptible standards *viz*., Co 775 and Co 8021 and two tolerant standards *viz*., Co 85019 and CoM 0265 in two replications at ICAR-SBI, Coimbatore and 81 entries in ICAR-SBI RC, Agali. Physiological parameters on canopy temperature, SPAD value, total biomass and relative water content were observed in the TSGS clones in irrigated and drought conditions. The interspecific hybrids showed relatively higher canopy temperature in drought condition than in the irrigated condition.

*Drought trial at ICAR-SBIRC, Agali*




*Thermal imaging of the drought trial at ICAR-SBIRC, Agali*

All the cane and juice quality characters were influenced by the less frequency of irrigation. Single cane weight was the character which was most affected by the drought situation while cane thickness was less affected character in these newly developed ISH clones. Compared to cane characters juice characters were less influenced by the drought.


*Influence of less irrigation on the juice and cane characters*

*(A. Anna Durai, A.J. Prabakaran, V. Sreenivasa, H.K. Mahadeva Swamy, R.T. Maruthi, K. Mohanraj, A. Ramesh Sundar, V. Jayakumar, K. Chandran and R. Arun Kumar)*

## Developing trait specific genetic stocks with *Erianthus* genetic base

**Fluff sowing and raising $BC_3$ progenies:** The fluff of 30 backcrosses involving *E. procerus* was sown during September 2023 and 1516 $BC_3$ progenies were raised. Maximum of 360 seedlings were obtained from the cross GU19-1 x Co 11015.

**Clonal evaluation of $BC_2$ progenies:** A total of 100 clones were evaluated clonally for cane yield and juice quality traits. The cane yield ranged from 45.1 t/ha to 260.0 t/ha with the mean yield of 111.13 t/ha. The mean sucrose was 16.67% and four clones recorded more than 20.0% sucrose content at 11$^{th}$ month. The GU 20-3 recorded 240.3 t/ha of cane yield with a sucrose content of 18.55%.

**Evaluation of $BC_2$ progenies for water deficit stress:** Ninety $BC_2$ progenies from 14 crosses were planted in a spilt plot design for evaluation under water deficit stress. Twenty clones recorded more than 200 cm cane height and six clones recorded more than 1.50 kg single cane weight under drought at 10$^{th}$ month. Sucrose% ranged from 7.30 to 17.89% with the mean of 13.10% under drought. Among the cane traits, maximum of 16.90% reduction observed for cane height under drought.

**Screening for red rot resistance:** Eighty $BC_2$ clones were evaluated for red rot resistance under CCT. In this trial, 60% of the clones were MR to red rot and 76.9% clones from the cross GU 12-25 x Co 12009 were resistant.

**New Trials:** Two new trials were planted one each at Coimbatore and SBIRC, Agali for identifying drought tolerant BC progenies involving *E. procerus*

*(K. Mohanraj, A. Suganya and H.K. Mahadeva Swamy)*

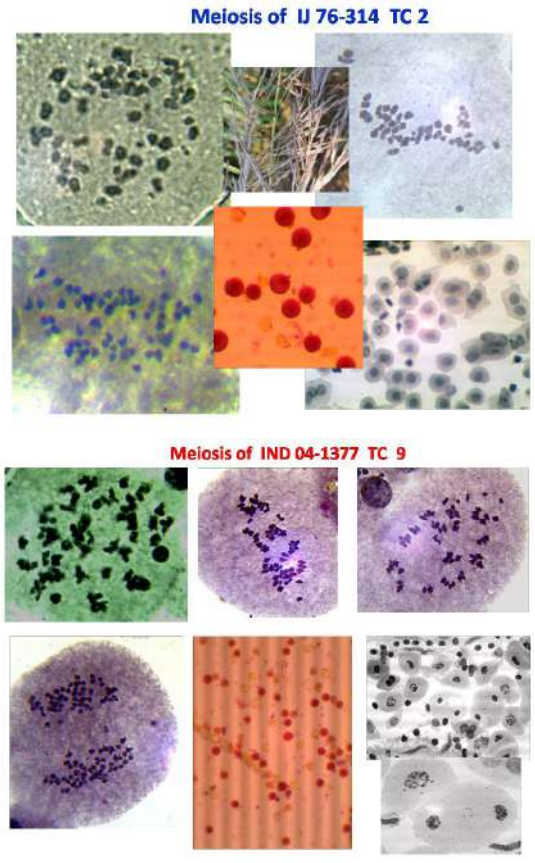
## Improvement of elite interspecific hybrids derived from different cytotypes of *S. spontaneum* through nobilisation with typical clones of *S. officinarum* (2n=80)

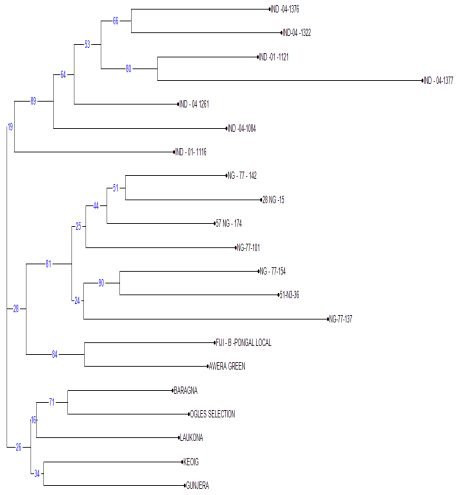
**Hybridization in the flowering plants of *in vitro* rejuvenated clones:** About 50 crosses were effected with *in vitro* rejuvenated plants of IND 04-1377 and IJ 76-314 and 'Co' canes, *S. officinarum* (Laukona, Chapina, Seleri, Baragua) and elite hybrids at Coimbatore and Agali. Ten polycrosses were made with IND 04-1377 TC plants and it was used as male in two crosses. The genetic stock AS 04-635 tolerant to cold, drought and waterlogging was backcrossed with Co 0233 and Co 98008. Seed set was observed in tissue cultured flowering plants of *S. officinarum* involved crosses. Germination percentage ranged from 20 to 100%.

**Cytological studies:** Meiotic studies were carried out for TC rejuvenated plants of *S. oficinarum*. In the typical clone (IJ 76-314), meiosis was normal with few laggards in A-I and tetrads were also normal. In the atypical clone (IND 04-1377) derived plants secondary association of bivalents was observed. Laggards ranged from 0-5 with unequal distribution. Micronuclei were noticed from 1-3 in 70% of the tetrads. Pollen fertility ranged from 57.4-70.0%.

**Molecular studies:** Molecular affinity: PCR in 21 clones (typical (11) and atypical clones (10) -exotic and Indian) of *S. officinarum* with 20 SSR markers indicated that the exotic clones (14) produced 230 fragments with 77% (177 fragments) polymorphism while the Indian collections (7) showed 68.6% polymorphism from 182 fragments generated. Among the typical and atypical clones, the typical clones generated higher number of fragments (228) and more diversed with 75% polymorphism (171 fragments) whereas the atypical clones were less polymorphic with 45% polymorphism (84 fragments). The clustering pattern of the clones revealed distinct clustering pattern for the exotic and Indian collections with three major clusters. The atypical clones of Indian collections clustered together while the exotic collections clustered in two major groupings. The atypical clone Baragua found to have closer affinity with Ogles Selection followed by Laukona 15. This subcluster had 66% similarity with the typical clones Keong and Gunjera. The other typical clones distributed in 3 groups with subcluster I includes NG 77-142, 28 NG15,57 NG-174, NG 77-101, cluster II : NG 77-154,51 NG-36,NG 77-137 and cluster III: Fiji B and Aveola Green.

**Red rot screening:** Among the 50 backcross hybrids derived with the genetic stock AS 04-1687, 12 were MR. Genetic stock registration for waterlogging and cold tolerance in the hybrid derived with the cytotype 2n=72 (AS 04-635) have been submitted. Two hybrids of the higher cytotypes were given for PZVT.





*Cluster analysis of Indian and exotic clones of S. officinarum*

*(A. Suganya, A. Selvi, P. Govindaraj and V. Sreenivasa)*

## Targeted prebreeding with different cytotypes of *Saccharum spontaneum* L. characterized for abiotic stress tolerance

**Phenotype Variation of the Hybrid $F_1$ Population:** Seventy one true $F_1$ hybrids obtained from five different crosses between the contrasting parental accessions were evaluated. The average plant height of the $F_1$ hybrids was 280.85 cm. The maximum height among the hybrids was 370 cm (hybrid 62), while the minimum height was 200 cm. The variance of all the traits ranged from 0.03 to 15.17. The stem diameter in 71 true hybrids ranged from 0.91 to 2.04 cm, with a mean of 1.46 cm. The single cane weight ranged from 0.19 to 1.18 kg with the mean value of 0.53. The number of internodes recorded a mean value of 21.21 and it is ranged from 14 to 30 internodes per cane. Plant height (cm) and number of internodes showed a relatively high (greater than 10) variation, and the traits stalk diameter (cm), and single cane weight (kg) exhibited a relatively small variation, having the minimum variation (0.03), indicating that these traits were relatively stable in the population.

**Construction of Hybrid $F_1$ Population:** Primer combinations were used to genotype the parental lines and identify the hybrid plants. In this study, 6 SSR markers (SMC222CG, SMC226CG, SMC248CG, SMC319CG, SMC477CG and SMC863CG) were detected to be differentially amplified in five different crosses out of seven markers. The primer combinations were used for genotyping the 120 seedlings based on the male parent specific bands, and 71 true $F_1$ hybrids were detected. The SSR marker amplified both female (150 bp) and male parent (200 bp) specific loci in $F_1$ plants. Thus, it confirmed the genuinity of the hybrid. Other $F_1$ plants amplified either allele of female specific loci or not present in either parent at SSR marker locus. This indicates that these are selfed progenies of female parent. The percentage of true $F_1$ hybrids obtained from five different crosses is only 58%. Finally, after removing false seedlings, we constructed a $F_1$ population with 71 progenies, and this population was used for the genetic diversity analysis.

**New planting:** During the crossing period 2021, a total of 46 crosses were made between the wild sugarcane *Saccharum spontaneum* with different cytotypes used as a female parent and were characterized for resistance to abiotic stress tolerance and high tillering capacity. Commercial sugarcane varieties with high sucrose content and yield (Co 11015, Co 12009, CoC 671, Co 17003, Co 62198, Co 99006 and Co 15027) were used as male parents and characterized. About 2000 seedlings from 41 *S. spontaneum* clones being maintained in ICAR-SBI, Coimbatore and 7 commercial canes were utilized for the development of $F_1$ progenies. A total of 400 $F_1$ progenies derived from crosses made during 2020 were selected based on the plant height, stem diameter, single cane weight and number of nodes for further evaluation.

*(S. Sheelamary, S. Karthigeyan and V.P. Sobhakumari)*

## Identification of multi ratooning potential of selected interspecific and intergeneric hybrids of *Saccharum* spp.

The experiment was conducted to study the multi ratooning potential of forty two clones of different ISH and IGH hybrids involving *S. officinarum, S. spontaneum, S. robustum, S barberi/sinense*, IGH / CYM and PIO/PIR clones comprising of seven clones in each group and were planted in RBD along with three standards *viz*., Co 86032, CoC 671 and Co 14016 with two replications. ISH and

IGH hybrids were planted as single bud settlings during April 2021 as first plant crop in 4 rows of 6 meter length and 1.2 meter spacing between the rows. After the harvest of first plant crop during April 2022, the crop was ratooned to raise ratoon crop during the year 2022-23. Gap filling was not done in the ratoon crop to understand the performance of ratooning of genotypes. The test clones along with standards were evaluated for the tillering, cane yield and quality traits and also performance was compared with different groups in first ratoon crop. In first ratoon crop, among the different groups it was found that *S. spontaneum* involved hybrids had the highest stalk number with 147.85 ('000/ha) followed by *S. barberi/sinense* with 138.80 ('000/ha) and CYM/IGH clones (123.10 '000/ha) compared to commercial clones (95.11 '000/ha). Among the different groups, *S. spontaneum* group (158.02 t/ha) recorded the highest cane yield (t/ha) at harvest followed by *S. robustum* group (154.36 t/ha) and CYM/IGH involved hybrids (148.21 t/ha) in comparison with the standards (121.24 t/ha). The highest sucrose% at harvest was found in *S. officinarum* involved group (18.86%) followed by *S. robustum* clones (18.73%) and PIO/PIR involved clones (18.44%) compared to commercial clones (20.48%). After the harvest of first ratoon crop, the field was ratooned in April 2023 for raising second ratoon crop and tillering potential, cane yield and juice quality traits will be recorded and ratooning ability will be studied further.

*(K. Elayaraja)*

## Cryopreservation of sugarcane genetic resources for longterm storage and future utilization

The following cryopreservation techniques were used to standardize long-term storage of *Saccharum* spp. clones under low-temperature conditions: two-step freezing, desiccation followed by direct immersion, verification, and encapsulation. The meristem-derived auxiliary buds of Co 86032 were subjected to cryo treatment which responded well and regenerated after cryo treatments at various time intervals including 15 minutes to 70 hours. Genetic fidelity of Co 86032 was confirmed using SRAP markers. It showed monomorphic bands across all the samples. Work initiated on the meristem culture of IND 19 2045 for getting disease-free meristem-derived axillary clones to enable a safe and efficient cryopreservation technique. Under encapsulation dehydration method the meristem derived axillary buds of IND 19 2045 responded well. The apical meristems were also subjected to various cryogenic treatments but did not respond. Only control samples of the apical meristem were able to regenerate. Dormant nodal buds of four clones namely IND 03 1310, IND 03 1294, IND 03 1295 and IND 03 1296 responded well after cryo-treatments at different time intervals ranging from 15 minutes to 70 hours under desiccation direct immersion method and encapsulation dehydration method. Among the different methods tried, regeneration was observed only in meristem-derived axillary buds and the dormant nodal buds after cryogenic treatment under different time intervals.

*(C. Jayabose, R. Valarmathi and D. Neelamathi)*

## Development of core collection of wild sugarcane (*Saccharum spontaneum*) germplasm

A total of 1709 *Saccharum spontaneum* accessions collected from different locations of the states of the country (1916-2019) along with exotic collections imported from various countries through germplasm exchange programme was used as the study material. Each accession were grown in a plot size of single row of 3 m x 0.9 m with four clumps in each row with 0.50 m distance between each clump. Eleven quantitative morphological characters of Number of nodes (NON), Number of root eyes (NRE), Leaf length (LL-cm), Leaf width (LW-mm), Midrib width (MW-mm), Dewlap width (DW-mm) Sheath length (SL-cm), Plant height (PH-cm), Stalk thickness (ST-mm), Stalk height (SH-cm) and Internode length (IL-cm), were measured from 1624 accessions and for each character average value of three readings were taken for analysis.

**Variation of morphological characters:** Summary statistics such as mean, standard deviation (SD), minimum and maximum values were determined. The number of nodes and number of root eyes ranged from 3.00 to 51.67 and 3.33 to 72.33 respectively, whereas leaf

length varied from 44.33 cm to 206.67 cm. The average leaf width and midrib width were 0.92 and 0.24 cm respectively. The mean dewlap width and sheath length were 0.93 mm and 22.17 cm respectively. The plant height ranged from 91.67 cm to 370.00 cm with the mean value of 219.29. The stalk thickness and stalk height ranged from 2.23 to 43.67 mm and 30.00 to 293.33 cm respectively. The internode length recorded a maximum of 46.90 cm and a minimum of 1.83 cm with the overall mean of 8.74 cm. All the traits except leaf width, midrib width, dewlap width and stalk thickness showed a relatively low (< 10) variation, with the lowest variance is being 0.15 for midrib width followed by dewlap width (0.52) indicating that these traits contained less variation in the germplasm accessions. On the other hand, the traits number of nodes, number of root eyes, leaf length, sheath length, plant height, stalk height and internode length exhibited a relatively high variation, having the maximum variation (65.86).

**Correlation analysis of quantitative characters:** The correlation among 11 different quantitative characters of 1624 accessions was studied. Stalk thickness showed a positive significant correlation with number of root eyes (0.690) and plant height (0.677). Stalk height showed positive and significant correlation with plant height (0.818). Sheath length was negatively correlated with midrib width (-0.041).

**Principal component analysis (PCA):** The Principal component analysis (PCA) was carried out using 11 quantitative characters of 1624 accessions, which revealed that there were 9 PCA (with an Eigen value above 1) explaining the total variance. The PC 1 contributed maximum variability of 83.3% followed by PC 2 shows total phenotypic variability of 12.3% of the total variation.

**Molecular Characterization:** For the development of core collection, DNA isolation from germplasm collections was completed. The molecular characterizations of 1624 germplasm collections is in progress using 11 NKS markers.

*(S. Sheelamary S. Karthigeyan, C Jayabose, V. Vinu and M. Nisha)*

## Population improvement and development of sugarcane genetic stocks for high sugar accumulation potential for sub-tropical India

During 2023 crossing season, a total of eight bi-parental crosses and self's were carried out at DHF, Agali, which included three crosses involving *S. officinarum* clones.

**Crosses attempted in 2023 season and number of clones advanced to clonal stage 1 from 2022 crosses**

| Sl. No | Crosses attempted in 2023 season | Crosses attempted in 2022 season | No. of seedlings advanced to C-1 |
|---|---|---|---|
| 1. | PIO 98-573 x Co 16001 | LG 09487 GC | 12 |
| 2. | CP 52-1 x LG 05493 | LG 08422 GC | 35 |
| 3. | LG 14564 x Co 62198 | LG 14565 GC | 42 |
| 4 | PIO 99-741 x Co 0238 | LG 08422 x LG 09487 | 8 |
| 5. | Keong x Co 775 | LG 14565 x Co 62198 | 7 |
| 6. | Laukona 15 x Co 89003 | LG 01118 x LG 05493 | 21 |
| 7. | SO Hybrid x Co 89003 | LG 14564 x LG 09475 | 3 |
| 8. | IG 91-100 X Co 89003 | LG 01118 GC | 34 |
| | | Total | 162 |

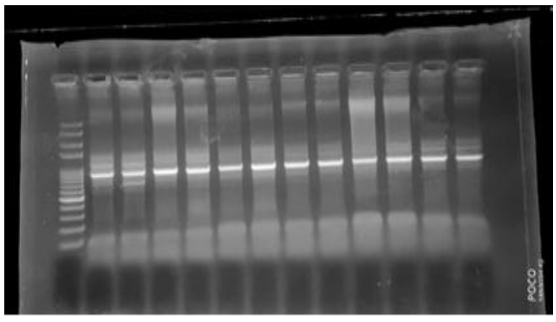
The seedlings which were transplanted to the field during 2022 and promising seedlings were advanced to C-I stage with the critical selection criteria of > 20.0% HR brix. The cross Seleri x CoPant 97222 gave four seedlings, but only two survived in the field which had a mean HR Brix value of 19.8%. These have also been advanced further for further observations. During January 2024, out of the 250 clones that were evaluated, ten promising clones had 20.0 sucrose% in juice and they will be advanced to C-2 stage.

*(V. Sreenivasa and Maruthi RT -ICAR-SBI;, M. Swapna, Sanjeev Kumar (Plant Breeding) and Sanjeev Kumar (Agri Biotechnology) - ICAR-IISR, Lucknow)*

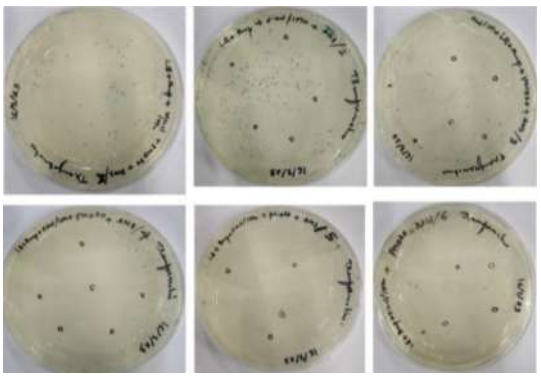
## Sugarcane genomics and molecular markers

### Isolation and characterization of genes associated with high Water Use Efficiency (WUE) in sugarcane cultivars

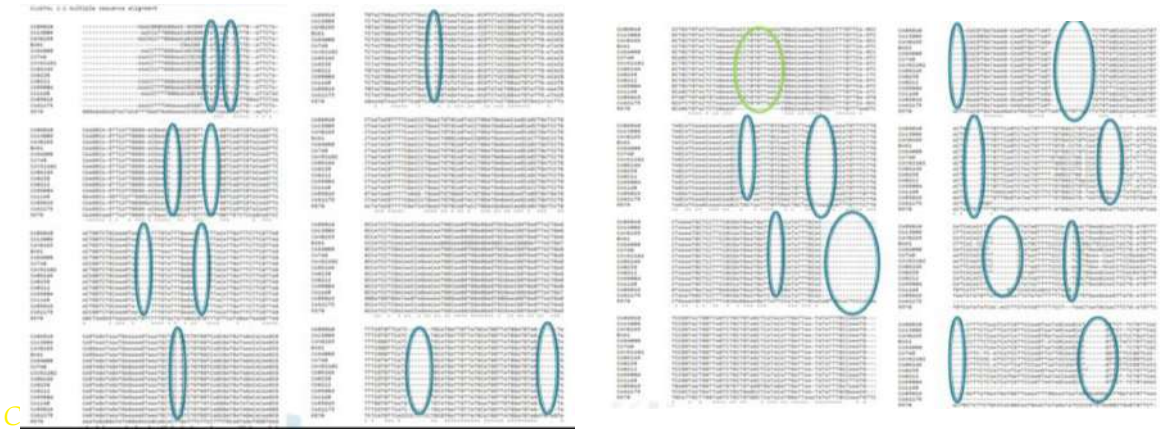
**PCR amplification and sequencing of Angustifolia (AN3) gene:** The designed primer for AN3 gene consistently amplified 870 bp PCR fragment in all the samples and these fragments were cloned. The cloned fragments were confirmed by colony PCR and restriction digestion. AN3 Transcription co-activator is the master regulator of cell proliferation. Plants lacking ANGUSTIFOLIA3 (AN3) activity have high drought stress tolerance because of low stomatal densities and improved root architecture, reduced leaf width and length; petal width reduction and more leaf number. Such plants also exhibit enhanced WUE through reduced transpiration without a demonstrable reduction in biomass accumulation. Many primers were designed to amplify the full and partial gene sequences of AN3 gene from the high and low WUE as well as 14 clones of moderately WUE. An 870 bp fragment amplified consistently in all the samples and the fragment was cloned and sequenced. All the 14 sequences matched with the AN3 (GIF3) genes in the sugarcane monoploid genome as well as GIF genes of monocots in the NCBI database. Efforts are underway to amplify and clone the full length (3.67Kb) gene with various long range amplification Taq Polymerases. The partial AN3 gene sequences (870 bp) of the sugarcane clones Co 740, Co 62175, Co 0238, Co 92102, CoM 0265, Co 86249, Co 1148, Co 85019, Co 99004, Co 0212, Co 94008, Co 94008, Co 86010, and BO 91 and their sequence similarity with R570 sugarcane sequence and other crops maize, sorghum from the NCBI databases are given below. The multiple sequence alignment of the AN3 gene from all the sugarcane 'Co' clones showed 22 deletions and one addition as compared to the R570 cultivar. The AN3 gene sequence of R570 sugarcane cultivar matched exactly 100% with the Maize AN3 gene sequence.



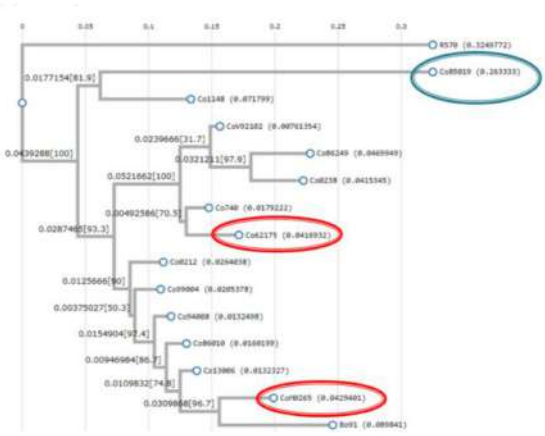
*PCR amplification of the 870 bp fragment of Angustifolia gene (AN3) I high and low WUE sugarcane clones*



*Cloning of PCR amplified fragments of AN3 gene from various sugarcane clones*



*One Addition (green) and 22 deletions (Blue) in Co varieties as compared to the 870 bp AN3 sequence of R570 cultivar. The R570 cultivar is 100% identical to the Maize AN3 gene.*



*Dendrogram showing the genetic relationship of PCR amplified, 870 bp fragment, AN3 gene sequences 'Co' varieties with the R570 cultivar. The HWE clone in blue and low WUE clone highlighted in red*

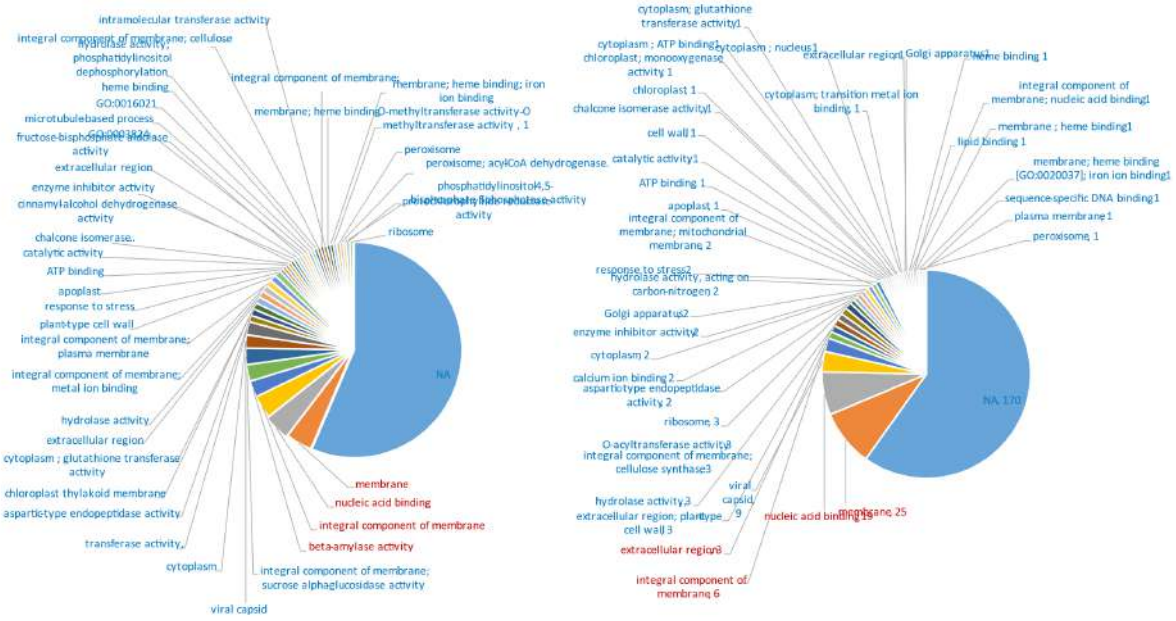
## Identification of functionally relevant SSRs and SNPs from drought and oxidative stress responsive transcriptomes of sugarcane and functional validation of key genes for stress tolerance

**Mining of simple sequence repeats from drought transcriptome:** SSRs were mined from the transcripts obtained from two sugarcane varieties Co 06022 and Co 8021 that are drought tolerant and susceptible respectively. A total of 56646 SSRs were identified in 45880 SSR containing sequences of the variety Co 06022 of which 3329 sequences were in compound formation and 8439 sequences were found to contain more than one SSR. Similarly, 49974 SSRs were identified in 40749 sequences in the variety Co 8021 of which 3044 sequences were in compound formation and 7243 sequences contained more than one SSR. Tetranucleotide repeats where the highest in both varieties *viz*., 16435 and 18311 followed by trinucleotide repeats *viz*., 12862 and 13433 in varieties Co 06022 and Co 8021 respectively. The number of dinucleotide repeats that are capable of detecting more polymorphisms were 4996 in Co 06022 and 5525 in Co 8021. The SSR containing transcripts of both varieties were annotated to identify the putative gene functions.

**Validation of candidate gene SSRs:** To amplify functional SSRs identified from candidate genes, primers were designed and synthesised from fifteen genes and the primers were validated on a set of *Sachharum* species clones and sugarcane varieties. Of the fifteen primers that were tested 66.6% of the primers amplified the desired SSR amplicons.

**Mining of SNPs from drought transcriptome and characterisation:** SNPs were identified from the drought transcriptome of drought tolerant and drought susceptible sugarcane varieties Co 06022 and Co 8021. Upon screening the significant differentially expressed genes in control, drought and recovery comparisons, a total of 968 SNPs with a read depth of more than 40X was identified from 995 unigenes. Both transitions and transverions were identified with the transition to transversion ratio being around 2.00 in different groups. The number of SNPs in each unigene varied from 1-17. Genes like ABA stress protein, beta amylase, soluble acid invertase, peroxidase and RuBpcase had more than five SNPs each. Most SNPs were observed in the uncharacterised protein. The most enriched GO terms were membrane, intergral component of membrane, extracellular region and nucleic acid binding in the stress comparisons and enriched GO terms in the recovery comparisons were intergral component of membrane, chloroplast, cytoplasm and response to stress.

Cloning of candidate genes for drought tolerance: Seven candidate genes identified from the drought transcripome *viz*., dehydrin (754 bp), TPS (2.5kb), TPP (1.1 kb) ABRE (1.1 kb), glyoxyltransferase (1.5 kb), cytochrome P450 (2.6 kb) and NAC 4 (1.2 kb) were cloned and sequenced.




*Comparisons of SNPs detected in transcripts with gene ontology classes in control and 2D stress*

*(A. Selvi, R. Manimekalai, PT Prathima, K. Lakshmi and K. Devakumar)*

**Development of affordable genomic selection tools for sucrose content and genomic prediction models for yield in sugarcane.**

The trails having the selected clones (66 numbers from all the 4 biparental populations, Co 86002 x BO 91, BO 91 x Co 775, Co 1148 x BO 91 and CoM 0265 x Co 775.) were phenotyped for number of tillers, red rot, sucrose and yield traits in ratoon. Additionally, selected clones (~350 clones/ 'Co' canes) from the tropical and sub tropical regions were planted in field trial in RBD with two replications at ICAR- SBI, Coimbatore and at ICAR- SBI, Karnal Centre for phenotyping and genotyping work. Two clones were selected for PZVT based on genomic predicted breeding values. Red rot screening based on CCT data of the trial Co 1148 x BO 91 (100 clones) and the plug rating for the population from BO 91 x Co 775 were analyzed for the heritability. Heritability

analysis showed high values for the red rot traits in the population BO 91 x Co 775 which was 93% when compared to Co 86002 x BO 91 which was 96% (based on plug method). Twelve QTLs were identified for red rot resistance in a panel of 540 genotypes (AX-118043665, AX-117935826, AX-117133355, AX-117294199, AX-117184350, AX-117134612, and AX-117135059). The two populations with BO 91 as a parent had a higher number of markers in common compared with numbers in common between other pairs of populations. Those SNPs were searched for the nearby harbouring genes.

The SNPs nucleotides were local blasted against the sugarcane CDS and Sorghum v 2.1 as reference genome. The co-located genes are putative LRR receptor-like serine/threonine-protein kinase, Lysine-specific demethylase SE14, Pectate lyase, and GRF1-interacting factor 3, Protein G1-like5. Map construction done with the identified markers, associated with red rot resistance. The set of markers were examined for linkage with each other *via* correlation analysis for each of the four populations. The analyses showed a general pattern of two groups of linked markers. The markers in group 1 (LG1) and linkage group 2 (LG2) and it showed high proportion of clones, the markers within each of these two groups are linked to the same chromosomal region or QTL affecting resistance to red rot. In plug data, the traits such as TOP, NT, LW and WS for the population Co 86002 x BO 91 and common clones showed high heritability (> 80%).

*(R. Manimekalai, G. Hemaprabha, A. Ramesh Sundar, K. Mohanraj and P.T. Prathima)*

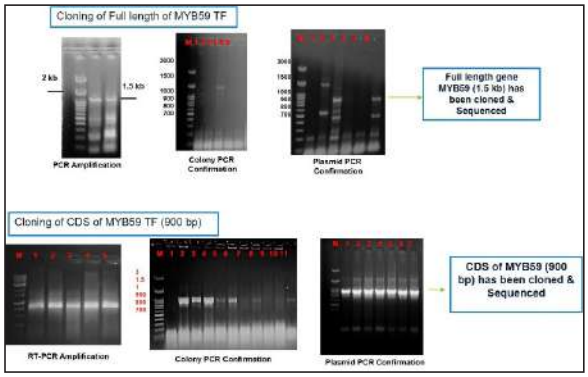
## Deep sequencing of suppression subtractive libraries for prospecting differentially expressed genes / Transcription factors from the sugarcane hybrids exposed to drought and salinity stress.

**Drought analysis:** A set of 18 clones along with two (Co 86032 & Co 775) standards were planted in randomized Complete Block Design with two replications. Each clone was planted in 6 rows of 6 m length and spacing of 1.2 m between rows. In this experiment, drought was artificially imposed by withholding irrigation starting from tillering stage. The crop was planted in month of February so that tillering stage gets exposed to drought conditions that generally occur in month of May to June (dry season). The brix% and sucrose% was recorded in drought imposed canes as compared to normal grown canes. Among the twenty entries evaluated, at 300 days the sucrose% ranged from 15.86 to 19.86 in water stress condition when compared to normal which ranged from 14.93 to 19.95. Brix ranged from 18.37% to 21.35% under water stressed condition in comparison to 17.95% to 21.96%. Results showed that sucrose% and Brix% marginally decreased in drought canes than normal canes. The physiological data such as chlorophyll fluorescence and SPAD values were recorded for 20 clones.

**Salinity treatment:** All the 18 clones were planted in pots for salinity treatment. They were irrigated with saline water (Ec 6ds/m and 8ds/m) for seven days. Out of the 18 clones, six clones were chosen for the total RNA isolation. A total of 18 samples with two replications, i.e. 36 samples were subjected for cDNA conversion and normalized with 25s rRNA primers. Expression profiling of these six genotypes for 13 salinity responsive genes were performed. Fifteen genes/ transcription factors representing three gene families such as (a) salinity responsive gene (Glyoxalase II & lll, MYB 59, antiporter genes NHX, and salinity related protein SOS); (b) cell wall related genes (Laccase, Caffeic acid 3-O-methyltransferase, Cellulose synthase, Peroxidase) and other abiotic stress signaling genes (Glutathione transferase, Aquaporin synthesis, Nitric oxide synthase, genes encoding NAC domain). Among which, 5.69, 4.28, 3.3 and 2.8-fold change of gene expression were observed for Glutathione transferase, rolled leaf peroxidase, Pectin esterase and Glyoxalse I respectively in comparison to the control conditions. Similarly, 1.8, and 1.2-fold changes were observed for genes encoding laccase and photosystem II respectively while the fold change in the expression of other genes and transcription factor were down regulated during salinity stress.

**Cloning and characterization of MYB59 TF:** Genomic DNA was isolated from AS 04-635 and used as template for the amplification of the full

length gene of MYB59. Obtained a fragment of 1.1 kb in size which was cloned and sequenced. Total RNA was isolated from AS 04-635 clone using trizol method. The RNA has been converted into cDNA using First strand cDNA synthesis kit. The cDNA was used for the amplification of coding sequence (CDS) of the transcription factor MYB59. The PCR amplified product shows a fragment approximately at 800bp. The amplified product was gel eluted, ligated with pJET and transformed. Nearly 20 colonies were chosen, for the cloning confirmation and the colony PCR were used for screening of positive colonies. Transcription factor MYB59 is involved in plant growth and stress responses especially during drought and salinity stress by acting as negative regulator of Ca signalling and homeostasis. Hence the identified and cloned MYB59 Transcription factor might be used for transgenic development for drought/salinity stress tolerance.



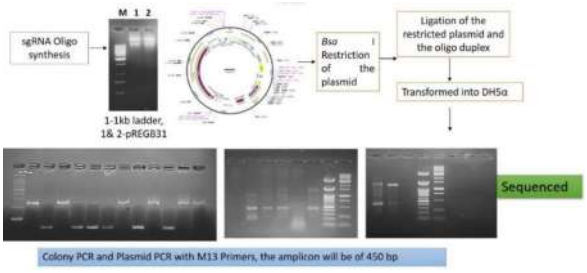

*Cloning of full length and the coding sequence of Transcription factor MYB59 from AS 04-1687 (ISH-577).*

*(K. Lakshmi, A. Selvi, R. Gomathi, A. Suganya, K. Deva Kumar, S. Sheelamary and D. Pooja)*

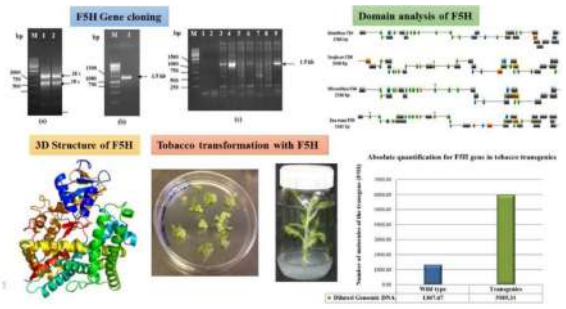
## Development of CRISPR/Cas9-based system for lignin modification in sugarcane towards improved biomass conversion.

**Designing sgRNA for F5H:** The sequence of F5H was submitted in CRIPOR. It showed 366 possible guide sequences. One 20-bp sequence followed by a trinucleotide (50 -NGG-30) protospacer adjacent motif (PAM) located in the second exon region of F5H was selected as the sgRNA complementary site. CRISPOR produced a table with parameters indicates the position and strand of the PAM, possible restriction enzymes. Potential off-targets with up to four mismatches are shown. Based on these parameters two guide RNA sequences were chosen for F5H gene and oligonucleotides were synthesized. This sgRNA is cloned in pGREB vector using BsaI restriction digestion. The sgRNA cloned vector was transformed into DH5α and the cloning was confirmed through sequencing.

**Sub-cloning of Ferulate 5 hydroxylase (F5H) gene into pCAMBIA vector:** The F5H gene was sub-cloned into the pCAMBIA 1305.1 binary vector and mobilized into agrobacterium LBA4404 through freeze thaw method. Plasmid DNA was isolated from the selected transformants's and confirmed through PCR analysis. The positive colonies showed an amplification of size ~1.5 kb. The genetic transformation of F5H gene into the model tobacco plants was performed and the expression and the copy number was calculated. The F5H gene copy number was quantified using the absolute quantification method. As it is a simplest method with accurate calculations which employs the serially diluted standards of known concentration. The reference curve with the plasmid DNA of F5H has been generated to calculate the copy number of the genes in varying tissues. A 10-fold diluted F5H plasmid ranging from $1\times10^5$ to $1\times10^9$ copies/l, and the Ct values of the corresponding plasmid DNA was used to calculate the slope- intercept. The curves were linear in the range tested (R2>0.9817) by the reactions. The slope value was -3.22 which falls under the range of $-3.1 \leq \text{slope} \leq -3.6$. The amplification and the PCR efficiency were calculated from the above-mentioned equation 2 and 3 which was 2.05 and 104.59% respectively. The reference curve of F5H plasmid makes a linear relationship between the number of F5H copy number and the Ct values. The presence of the transgene was confirmed through PCR analysis showing the amplification of the transgene. The copy number of the transgene F5H was 5985.31 in the transgenic, while in the wild type it was 1307.47. Our results showed that the transgenic tobacco plant showed a 4.5-fold increased expression in comparisons to the wild type. The tobacco transgenic plant was overexpressed which assist the functional characterization of the F5H gene.




*Cloning of SgRNA:: F5H into pGREB vector and confirmation of the cloning*




*Sub-cloning of Ferulate 5 hydroxylase (F5H) gene into pCAMBIA vector and tobacco transformation.*

*(K. Lakshmi, P.T. Prathima and C. Appunu)*

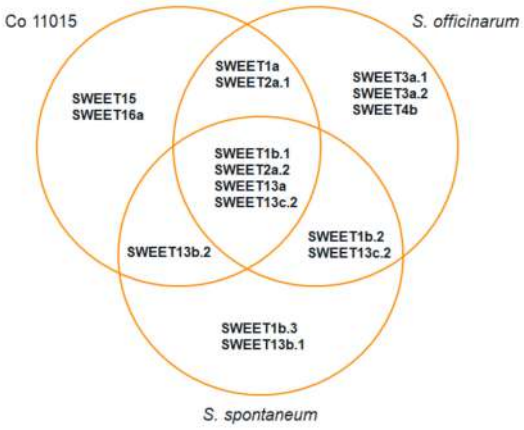
## Genome wide identification, characterization and comparative genome analyses of SWEET genes regulating sucrose accumulation in sugarcane

Genome-wide identification of SWEET genes in sugarcane: The long read transcriptomes of sugarcane hybrid Co 11015 and the progenitor species *S. officinarum* and *S. spontaneum* were used for identifying SWEETs. Protein sequences were derived from the transcript sequences using the ExPASy translate tool. A comparative phylogenetic analysis of SWEETs was performed using the protein sequences from the sugarcane hybrid species Co 11015 and R570, the *S. officinarum*, *S. spontaneum* (Cbe) and *S. spontaneum* (AP85-441), *Sorghum bicolor*, and *Zea mays*. The physicochemical characteristics such as the molecular weight, protein length, Isoelectric point, grand average of hydropathicity, and the instability index of the candidate SWEET protein sequences were identified. The subcellular localization, secondary structure and conserved domains were predicted.

**Cloning of full-length SWEET genes from sugarcane:** Full-length cloning of the SWEET genes, SWEET1, SWEET2, SWEET3, SWEET3b, SWEET4, SWEET6b, SWEET14 and SWEET16 from sugarcane was performed.

**Expression profiling of SWEET genes in sugarcane:** Twenty genotypes differing in sugar content (high and low sugar) were taken for stage specific expression studies of SWEETs. The results showed varying expression in the low and high-sugar varieties.

**CRISPR-Cas mediated functional gene validation of SWEETs in sugarcane:** Leaf explants from Co 11015 and Co 86032 were used for callus initiation. The SWEET genes SWEET4a, 13c, and 3b that have significant roles in sucrose accumulation were selected as target genes for gene editing and single guide RNA (sgRNA) synthesis.




*Common and unique SWEET transcript distribution in sugarcane hybrid and progenitor species*

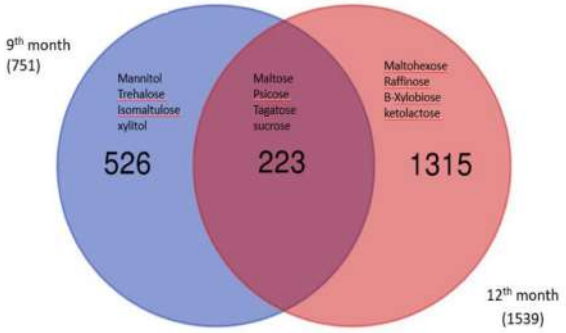
*(P.T. Prathima, A. Selvi, R. Manimekalai and K. Lakshmi)*

## Metabolic engineering of sugarcane for enhanced accumulation of low calorie sugars through gene editing

**Identification and profiling of low calorie sugars from sugarcane juice:** Metabolite profiling of sugarcane juice was performed at two stages of crop growth in the sugarcane hybrid Co 86032. Cane samples were collected, fresh juice was extracted from 9$^{th}$ and 12$^{th}$ month after planting and lyophilization was done. The lyophilized sugarcane juice samples were subjected to metabolome analysis using liquid

chromatography-mass spectrometry (LC-MS). Metabolites were profiled, and KEGG metabolic pathway analysis was performed for both the stages.

**Cloning and characterization of genes for low calorie sugars:** Trehalose phosphate synthase (TPS) trehalose phosphate phosphatase (TPP) of trehalose synthesis pathway and D-Allulose 3 epimerase gene (DAE; an enzyme that converts fructose to allulose), xylitol dehydrogenase, xylitol reductase, tagatose 6 phosphate phosphatase, L-arabinose isomerase, iso-maltulose synthase were selected to be prospective candidate genes for further studies for low glycaemic sugars. The full length sequences of TPS and TPP from sugarcane were obtained by cloning and sequencing. The DAE gene was cloned from bacterial isolates identified to be sugarcane endophytes. The 700 bp fragment was cloned and sequenced. Protein expression studies for the DAE gene is in progress.

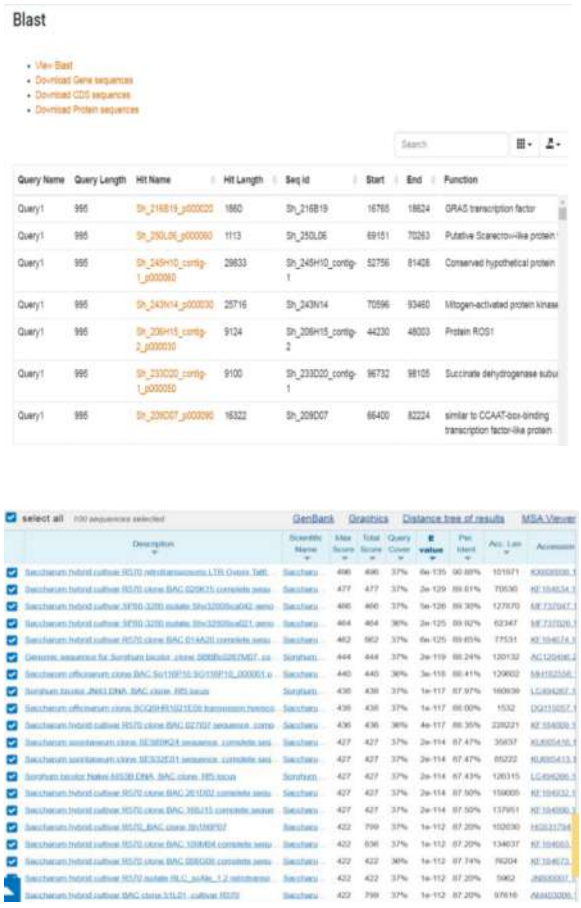



*Comparative study of metabolites from juice in the two different growth stages of sugarcane hybrid Co 86032*

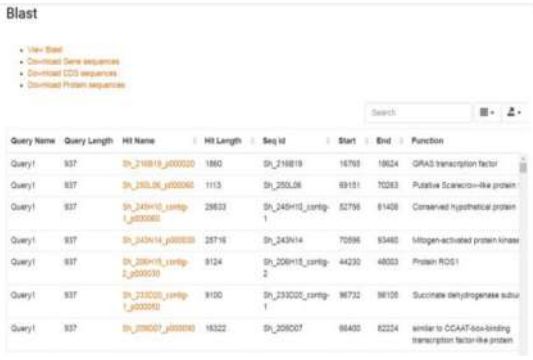
*(P.T. Prathima, K. Lakshmi, A. Selvi, R. Manimekalai and V. Krishnapriya)*

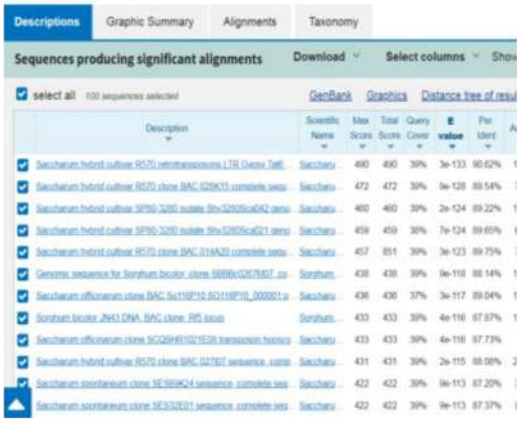
## Identification and functional characterization of GRAS transcription factor family of genes and its response to various abiotic stresses in sugarcane

Plant materials with differential tolerance potential for drought, salinity, flooding and cold tolerance were collected and raised in pots. RNA and DNA were extracted from young leaves and cDNA prepared from selected clones. The genomic DNA was subjected to PCR analysis with GRAS specific primers and the PCR fragments were sequenced. The sequences matched exactly with the GRAS gene in the sugarcane monoploid database and sugarcane sequences in the NCBI database.




*GRAS gene amplified PCR fragment Sequence of Co 86032 cultivar matches with GRAS transcription factor in monoploid sugarcane database (left) and sugarcane cultivars in the NCBI database (Right).*






*GRAS gene amplified PCR fragment Sequence of Co 0238 and its match with GRAS transcription factor in Monoploid sugarcane database (left) and sugarcane cultivars in the NCBI database (Right).*

*(K. Deva Kumar and K. Lakshmi)*

## Gene discovery and genetic transformation in sugarcane

### CSISPR/Cas9-mediated targeted mutagenesis in sugarcane

Phytoene Desaturase (PDS) gene was targeted to validate the genome editing in Co 86032 clones through CRISPR/Cas9 mediated gene editing. Four sgRNA were designed. These sgRNA were cloned in pRGEB31 vector independently. Transformation was performed using these vectors. Transformed calli were selected on selection medium and subsequently after eight rounds of selection calli were allowed for regeneration. More than 74 putative transgenic plants were hardened and observed for phenotype variations. Mutant frequency was low. Low molecular level screening is in progress.

*(C. Appunu and R. Valarmathi)*

### Deciphering the molecular mechanism regulating tillering in sugarcane through functional genomics approach

The study was initiated to understand the molecular mechanism regulating tillering in sugarcane through functional genomics approach. Protein profiling of tiller nodes in contrasting genotypes was carried out. Gel free protein profiling and sequencing of Co 86032 and Co 99004 tiller nodes at 25 days after planting was carried out. Total protein from the tiller node was isolated using tris buffer saturated phenol based extraction method. Both peptide spectrum match and protein false discovery rate were set to 0.01 FDR. The sequence resulted in the identification of 1500 significant proteins at FDR ≥ 0.001 in each genotype.

*(R.Valarmathi, C. Appunu and K. Mohanraj)*

## Multi-disciplinary

### Standardization of true seed production technique through developing homozygous parental lines and apomixes

### Inbreeding

Thirty four selfs and 13 inbred x inbred crosses were attempted in the 2023 flowering season. Three different populations of advanced generation inbreds of Co 1148 in the ground nursery along with the parents were genotyped using 20 STMS markers and STRUCTURE analysis was performed. Based on the STRUCTURE analysis, visual scoring of the gel and phenotypic evaluation, thirteen 7$^{th}$ generation inbreds, eighteen 9$^{th}$ generation inbreds and eighteen 6$^{th}$ generation inbreds of Co 1148 with a high proportion of homozygosity and high HR Brix at the 10$^{th}$ month were identified. Juice analysis and evaluation of cane parameters have been done for five advanced generation inbred populations of Co 1148 at 12$^{th}$ month. Juice sucrose ranged from 8.22% to 18.88% and the highest mean sucrose per cent (16.30%) was recorded in the seventh generation inbred family 1148-13-11-2-4-252-24-350. Cane height and single cane weight (SCW) recorded variation and as high as 320 cm for height and 1.22 kg for SCW, indicating the scope of developing inbreds combining high cane yield and sugar content. Among the six traits studied SCW had high coefficient of variation (24.84% - 40.77%) in all the populations and the lowest CV was reported by Brix percent (7.88% - 11.51%). The highest inbreeding depression was observed for SCW with a range of 41.26% to 67.36%. One hundred and twelve selfs derived from seven inbred parental clones were tested for red rot resistance. Following table summarises the parental and progeny behaviour for red rot reaction.

| Parent | | Progeny | | |
|---|---|---|---|---|
| Selfed parent No. | Red rot reaction | Number tested | Generation | Frequency for the disease |
| 0112-65 | MR | 11 | S2 | 8MR:3 MS |
| 1148-13-11-252-162 | MS | 5 | S5 | 5S |
| 1148-s4-252-24-350 | MS | 6 | S8 | 1R: 1MS: 4S |
| 1148-s4-252-184 | MS | 8 | S7 | 4S: 4HS |
| 1148-s4-237-2-61 | MS | 24 | S8 | 4MS: 11S: 9HS |
| 1148-13-11-2-252-170 | MR | 26 | S6 | 6R: 7MR: 13MS |
| 1148-s4-242-1-46 | MS | 32 | S8 | 4MS: 17S: 11HS |

It could be seen that parents with MR reaction produced a high proportion of resistant progenies while those with MS rating produced predominantly susceptible progenies. This study implied the scope for developing true breeding genetic stocks for red rot resistance and high sucrose content and which can lead to more precision in sugarcane breeding.

*(G. Hemaprabha, A. Anna Durai and V. Vinu)*

## Anther culture

In 2022-23 flowering season, Co 86032, Co 11015 and Co 775 were used for anther culture studies and cultured around 1200 test tubes. The current year inoculated anthers were symptomatic, but did not respond to androgenesis except Co 86032. In the current year based on the previous year results two media were selected and 6 combinations of 2, 4-D, BAP, Kinetin, NAA were tried and their response observed was poorer than the two parental media selected. A new setup with nutrient solution of the anthers up to 50 days at 10 $^{0}$C was found helpful. Total of 10 calli were formed from anthers of Co 86032 and were transferred to shoot regeneration medium. From the Calli of previous year, 20 putative haploid plants derived from Co 86032 anthers were transplanted in the filed for general observation and chromosomal studies. Cytology and morphology of previously identified putative haploids was carried out. The newly identified putative haploids had narrow leaves, small eye buds, less than one cm cane diameter and one had reduced plant height, and they possessed less plant vigour and less NMC.


*Morphological characterization of newly identified putative haploids*

*(H.K. Mahadeva Swamy and A. Suganya -ICAR-SBI; Sanghamitra Samantaray -ICAR-NRRI, Cuttack)*

## All India Coordinated Research Project (Sugarcane)

### Peninsular Zone

### Advanced Varietal Trial (Mean Performance of two plant and one ratoon trials)

Five entries *viz*., Co 16006, Co 16010, Co 16018, CoVSI 16121 and PI 16131 were evaluated under AVT I plant during 2021-22 and AVT II plant and AVT ratoon during 2022-23. Two entries Co 16006 with sugar yield of 16.88 t/ha, 114.98 t/ha cane yield and 20.68% sucrose and Co 16018 with 15.70 t/ha sugar yield, 118.93 t/ha cane yield

were promising. The clone Co VSI 16121 (22.52%) recorded numerically higher sucrose% over the best standard CoC 671 (22.20%) followed by Co 09004 (21.71%) and Co 86032 (20.17%). The other entries Co 16006, Co 16010 and PI 16131 were on par with the popular standard, Co 86032.

**Pooled analysis of two plant and one ratoon crops (2021-2023)**

| S.No | Clone | CCS (t/ha) | Cane yield (t/ha) | CCS% | Sucrose% |
|---|---|---|---|---|---|
| 1 | Co 16006 | 16.88 | 114.98 | 14.69 | 20.68 |
| 2 | Co 16010 | 14.84 | 104.37 | 14.22 | 20.16 |
| 3 | Co 16018 | 15.70 | 118.93 | 13.13 | 18.56 |
| 4 | CoVSI 16121 | 11.69 | 72.58 | 16.10 | 22.52 |
| 5 | PI 16131 | 12.28 | 85.95 | 14.29 | 20.26 |
| Stds | | | | | |
| 1 | Co 86032 | 15.36 | 107.65 | 14.26 | 20.17 |
| 2 | Co 09004 | 16.73 | 108.49 | 15.43 | 21.71 |
| 3 | CoC 671 | 17.21 | 108.99 | 15.78 | 22.20 |
| | Mean | 15.09 | 102.74 | 14.74 | 20.78 |

*(S. Alarmelu, S. Sheelamary, P. Govindaraj, V. Sreenivasa and V. Vinu)*

## Initial Varietal trial

Twenty three entries along with three checks *viz*., Co 86032, CoC 671 and Co 09004 were evaluated for cane yield and quality traits in RBD with three replications. Among the entries, Co 19014 recorded highest cane yield of 158.27 t/ha followed by Co 19008 (154.61 t/ha). Other entries recording significantly higher cane yield than the check Co 86032 (122.31 t/ha) were Co 19014 (158.27 t/ha), Co 19008 (154.61 t/ha), CoR 19143 (148.66 t/ha), and CoR 19141 (143.51 t/ha). Three entries *viz*., Co 19014 (22.65 t/ha), CoR 19143 (20.65 t/ha) and Co 19008 (20.39 t/ha) recorded significantly higher sugar yield than the best check Co 09004 (17.97 t/ha). For juice quality, none of the entries were superior to the best standard Co 09004 at 10$^{th}$ month, however six entries *viz*., Co 19003 (19.61%), Co 19005 (19.34%), Co 19009 (19.46%), Co 19014 (19.42%), CoT 18366 (19.25%) and CoT 18369 (19.21%) recorded significantly higher sucrose% than the check Co 86032 at 10$^{th}$ month (18.14%). Test entries significantly superior to Co 86032 (19.39%) for sucrose content at 12$^{th}$month were Co 19003 (20.71%), Co 19004 (20.39%), Co 19009 (21.11%), CoR 19145 (20.52%), CoT 18366 (20.41%), CoT 18369 (21.08%), CoT 19366 (20.72%) and CoT 19367 (21.03%).

*(K. Mohanraj and R.T. Maruthi)*

## AVT-I Plant Crop

Twelve clones were under evaluation along with three standards (Co 86032, Co 09004, CoC 671) during the crop year 2022-23. Co 09004 (22.39 t/ha) was the best standard at 12$^{th}$ month for sugar yield followed by Co 86032 (20.44 t/ha). Of the twelve clones under testing, CoVC 17061 (24.72 t/ha) ranked first for CCS yield recording a substantial improvement of 20.94% as compared to the commercial variety Co 86032. Four other test entries *viz*., Co 17001 (23.30 t/ha), Co 17002 (23.70 t/ha), Co 17013 (22.96 t/ha), MS 17082 (22.70 t/ha) recorded a significant improvement of more than 10.0% over the midlate standard Co 86032. For cane yield, Co 86032 (144.34 t/ha) was the best among standards followed by Co 09004 (143.94 t/ha). Two clones, Co 17002 (171.35 t/ha), CoVC 17061 (173.90 t/ha) recorded a significant improvement of 18.71% and 20.48% over the best yielding standard Co 86032. Four clones-Co 17001 (146.63 t/ha), Co 17004 (149.94 t/ha), Co 17013 (158.04 t/ha), MS 17082 (158.41 t/ha) were numerically on par with the best standard Co 86032. Among the standards, Co 09004 was the best standard recording high juice sucrose values of 21.92% and CCS% of 15.56% while the midlate standard Co 86032 recorded 19.97% sucrose and CCS% 14.16% at 12$^{th}$ month. Co 17001 was the best clone in this trial recording the highest juice

sucrose value of 22.40% at 12th month with an improvement of 12.17% over the midlate standard Co 86032. Co 17003 (21.17%) was the second-best clone for juice sucrose with an improvement of 6.01% over the standard Co 86032. Two clones *viz*., Co 17004 (1.89 kg) and CoN 17072 (1.88 kg) recorded significantly superior values for single cane weight as compared to the best standard CoC 671 (1.64 kg).

*(R.M. Shanthi and K. Elayaraja)*

## AVT – II Plant Crop

Five test entries (Co 16006, Co 16010, Co 16018, CoVSI 16121 and PI 16131) and three standards (Co 86032, Co 09004 and CoC 671) were evaluated in AVT II Plant trial for cane parameters and quality traits. The test entries Co 16018 and Co 16006 recorded 18.54 t/ha and 17.85 t/ha of CCS yield respectively at harvest which are numerically superior over best standard CoC 671 (17.90 t/ha). For cane yield at harvest, the test entries Co 16018 and Co 16006 recorded 133.63 t/ha and 119.22 t/ha respectively and which are numerically superior over the best standard Co 86032 (117.05 t/ha). In case of CCS%, among the test entries CoVSI 16121 recorded highest values of 16.10 at harvest, but was numerically inferior to CoC 671 (16.16%). The highest sucrose% was recorded by CoC 671 (22.64%) followed by test entry CoVSI 16121 (22.09%). In comparison with Co 86032 (14.26%), the three test entries *viz*., CoVSI 16121 (16.10%), Co 16006 (14.97%) and Co 16010 (14.36%) recorded numerically higher CCS% at harvest.

*(V. Sreenivasa and V. Vinu)*

## AVT Ratoon

Five entries *viz*., Co 16006, Co 16010, Co 16018, CoVSI 16121, PI 16131 and three standards (Co 86032, CoC 671 and Co 09004) were evaluated. None of the entries was significantly superior for cane and sugar yield. The entry Co 16006 recorded the maximum CCS yield of 15.91 t/ha followed by Co 16018 (15.17 t/ha). Among the standards, CoC 671 recorded the highest CCS yield of 15.92 t/ha followed by Co 86032 (15.33 t/ha) and Co 09004 (14.13 t/ha). For cane yield, the entry Co 16018 recorded the highest cane yield of 115.32 t/ha followed by Co 16006 (107.19 t/ha). At harvest Co 86032 was the best standard which recorded 103.95 t/ha cane yield followed by CoC 671 (102.95 t/ha) and Co 09004 (91.64 t/ha). CoC 671 was the best standard with juice sucrose of 21.88% followed by Co 09004 (21.82%). Among the entries CoVSI 16121 and Co 16006 recorded juice sucrose of 22.88% and 21.04% respectively and numerically superior to Co 86032 (20.90%). CoC 671 was the best standard with 21.93% sucrose followed by Co 09004 (21.25%) and Co 86032 (19.02%) at 270 days. Two entries Co 16006 (19.52%) and CoVSI 16121 (22.06%) were promising for quality at 270 days.

*(S. Alarmelu and S. Sheelamary)*

## Exchange of seed materials

Ten clones *viz*., Co 22004, Co 22005, Co 22006, Co 22007, Co 22009, Co 22010, Co 22012, Co 22015 and Co 15020 accepted during the AICRP Group Meeting held at IISR, Lucknow in 2022 were supplied to Padegaon. Sixteen other clones *viz*., Co 21002, Co 21003, Co 21004, Co 21005, Co 21006, Co 21007, Co 21009, Co 21010, CoN 21071, CoN 21072, CoM 21082, CoM 21083, VSI 21121, CoR 21141, CoT 21366 and CoM 21081 were multiplied and supplied to Mandya, Powarkheda, Pugalur, Rudrur, Sameerwadi, Sirugamani and Thiruvalla. Apart from these, 13 clones *viz*., Co 18001, Co 18002, Co 18003, Co 18009, Co 18012, Co 18013, Co 18024, CoVC 18061, CoN 18071, CoN 18072, CoVSI 18121, Co 17009 and CoT 16366 were multiplied for conducting AVT- I plant trial during 2023-24. Similarly, 17 clones *viz*., Co 20001, Co 20002, Co 20003, Co 20005, Co 20006, Co 20007, Co 20009, Co 20010, Co 20011, Co 20012, CoN 20071, CoN 20072, CoM 20082, CoSnk 20101, CoSnk 20102, CoSnk 20103, CoT 20366 were multiplied for conducting IVT 2023-24.

*(A. Anna Durai and K. Gopalareddy)*

## Fluff Supply / National Hybridization Programme

**Fluff Supply 2022:** Fluff weighing 24.30 kg of crosses made at Coimbatore during 2022 flowering season was supplied to 23 fluff receiving centres. The centres in North West Zone received the maximum quantity of 8.09 kg of fluff followed by the centres in Peninsular

Zone (7.28 kg). The centres in North Central and North East Zones and East Coast Zone received 5.20 and 3.72 kg of fluff respectively. Among the participating centres of fluff supply programme, Shahajahanpur centre received the highest quantity of fluff (1.87 kg) followed by Lucknow (1.79 kg).

**Number of crosses effected and quantity of fluff supplied during 2022 flowering season**

| Centre | Biparental cross | | General collections | | Poly crosses | | Total quantity of fluff (g) |
|---|---|---|---|---|---|---|---|
| | No. | Fluff weight (g) | No. | Fluff weight (g) | No. | Fluff weight (g) | |
| **Peninsular Zone** | | | | | | | |
| Mandya | 20 | 477.59 | 17 | 329.14 | 4 | 43.53 | 850.26 |
| Navsari | 18 | 507.97 | 21 | 505.69 | 2 | 15.34 | 1029.00 |
| Padegaon | 15 | 282.27 | 15 | 247.02 | 6 | 55.35 | 584.64 |
| Perumalapalle | 19 | 488.62 | 15 | 340.35 | 3 | 22.47 | 851.44 |
| Powarkheda | 15 | 461.19 | 20 | 401.17 | 4 | 33.57 | 895.93 |
| Pune | 15 | 255.76 | 16 | 297.25 | 3 | 30.14 | 583.15 |
| Rudrur | 26 | 672.81 | 15 | 254.72 | 3 | 22.98 | 950.51 |
| Sankeshwar | 23 | 615.31 | 15 | 248.96 | 3 | 29.63 | 893.90 |
| Thiruvalla | 16 | 279.53 | 17 | 299.66 | 7 | 66.88 | 646.07 |
| ***Total*** | **167** | **4041.05** | **151** | **2923.96** | **7** | **319.89** | **7284.9** |
| **East Coast Zone** | | | | | | | 0 |
| Anakapalle | 27 | 758.51 | 15 | 289.86 | 3 | 24.56 | 1072.93 |
| Cuddalore | 27 | 622.31 | 17 | 274.45 | 5 | 44.19 | 940.95 |
| Nayagarh | 18 | 559.22 | 15 | 312.32 | 4 | 32.56 | 904.10 |
| Vuyyuru | 19 | 495.03 | 15 | 279.51 | 4 | 31.45 | 805.99 |
| ***Total*** | **91** | **2435.07** | **62** | **1156.14** | **5** | **132.76** | **3723.97** |
| **North West Zone** | | | | | | | |
| Gurdaspur | 16 | 489.84 | 20 | 574.87 | 2 | 14.41 | 1079.12 |
| Kapurthala | 26 | 747.38 | 17 | 551.14 | 3 | 23.53 | 1322.05 |
| Lucknow | 27 | 805.37 | 30 | 964.17 | 2 | 17.26 | 1786.80 |
| Pantnagar | 16 | 435.07 | 15 | 424.97 | 2 | 15.36 | 875.40 |
| Shahjahanpur | 31 | 869.37 | 35 | 978.21 | 2 | 17.6 | 1865.18 |
| Uchani | 22 | 634.62 | 21 | 508.68 | 2 | 16.64 | 1159.94 |
| ***Total*** | **138** | **3981.65** | **138** | **4002.04** | **5** | **104.8** | **8088.49** |
| **North central Zone** | | | | | | | |
| Buralikson | 17 | 510.21 | 20 | 590.32 | 5 | 42.44 | 1142.97 |
| Motipur | 20 | 517.13 | 20 | 643.93 | 3 | 23.81 | 1184.87 |
| Pusa | 25 | 729.56 | 36 | 1008.33 | 3 | 27.24 | 1765.13 |
| Seorahi | 23 | 639.49 | 15 | 429.62 | 5 | 42.06 | 1111.17 |
| ***Total*** | **85** | **2396.39** | **91** | **2672.2** | **5** | **135.55** | **5204.14** |
| **Grand total** | **481** | **12854.16** | **351** | **10754.34** | **11** | **693.00** | **24301.50** |

**National Hybridization Programme 2023:** Four hundred and forty seven parents were planted in NHG during 6th to 12th January 2023. Six new introductions to NHG were LG 14568, LG 14436 and LG 14450 from ICAR-IISR, Lucknow and CoH 06266, CoH 13263 and CoH 14261 from CCS HAU Regional Research Station, Uchani. Besides, NHG-2023 also included two poly-cross nurseries one each for the centers in tropical (13 females and eight males) and sub-tropical region (ten females and eight males).

Out of 447 parents 344 flowered with flowering intensity of 76.96%. Data on different phenol-phases of flowering was made available to the participating centres by the hosting the data in the ICAR- Sugarcane Breeding Institute website and the data were updated at weekly interval during the II fortnight of October to first fortnight of December, 2023. Flowering was delayed by two week and hybridisation work was initiated on 2nd November 2023 and concluded on 6th December 2023. All the centres other than Nayagarh, Bethudahari and Buralikson attended the crossing programme. ICAR-SBI facilitated 21 participating centres to effect 487 biparental crosses at NHG-2023.

Centres from Peninsular Zone effected maximum number of crosses (192) followed by those from North West Zone (144). Centres in East Coast Zone (77) and North Central and North East zones (74) were facilitated to have almost equal number of crosses. Individually, Lucknow centre effected the highest number of crosses (32) followed by Shahjahanpur (30) during 2023 flowering season.

*(A. Anna Durai and Adhini S. Pazhany)*

## Evaluation and identification of climate resilient ISH and IGH genetic stocks

A total of 40 genotype including 20 ISH, three IGH and 17 WL clones were maintained and were replanted for supply to the participating centres of AICRP (sugarcane)

*(V. Sreenivasa)*

## Identification of pathotypes / races of red rot pathogen

Six red rot isolates collected from various fields along with two red rot pathotypes CF06 and CF12 were tested against 19 red rot differential varieties and their red rot reactions were recorded. Mostly all the isolates behaved at par with each other and with the standard pathotypes CF06 and CF12. Among the new isolates, Cf11015 (Thiruvendhipuram) was comparatively more virulent than other tested isolates result in more number of intermediate reactions followed by Cf11015 (Periyasevalai).

The isolate CfV09356 (Mundiyampakam) was highly avirulent on many varieties and Cf86032 (Nellikuppam) isolate was highly virulent on many varieties. All the isolates were virulent on known susceptible varieties CoC 671and CoJ 64 and the varieties CoS 8436, CoSe 95422, CoV 92102, Baragua, SES594 and Co 7805 varieties remained resistant to all the tested red rot isolates. Bo 91 and Khakai were showing intermediate reactions (MS) against many isolates.

*(R. Selvakumar and K. Nithya)*

## Survey of sugarcane diseases naturally occurring in the area on important sugarcane varieties

During the month of July, 2023 disease surveys were conducted in Lalgudi, Tirumangalam, Siruthaiyur, Thenkal, Poovalur, Sembiangudi, Thirumazhapady, Keelakulathur areas growing Co 11015 and Co 86032 in Trichy district, Tamil Nadu. All the fields visited were having Pokkah boeng and mealy bug infestation. The farmers were advised to spray Thiamethoxam and Propiconazole as prophylactic measure. In August, sugarcane fields in Kulathur, Kaduvanur, Aethanur, Seerpanandal, Thalayaapalayam villages of Kallakurichi district were visited where the variety Co 86032 showed drying of leaves and lodged in larger areas. There was no rain during the crop season and root grubs were observed in the field. Early harvest of the crop was advised. In Karnataka, sugarcane disease survey was undertaken in farmers'field of Chamrajnagar, Khandhali, Kongrahali, Doddinduwadi, and Kestur villages. There was a mild incidences of PB, rust, YLD, GSD noticed in few fields.

*(A. Ramesh Sundar, P. Malathi, R. Selvakumar, V. Jayakumar and K. Nithya)*

## Evaluation of IVT / Zonal varieties for resistance to red rot, smut, YLD, brown rust and pokkah boeng

**Screening for red rot:** Totally, 28 IVT+AVT entries were evaluated against sugarcane red rot with CF06 and CF12 by plug and nodal methods during the crop season 2023-24. Among the 28 entries, two entries identified as resistant and 17 were identified as moderately resistant by plug methods in CF06 inoculum and 13 entries identified as resistant by nodal methods in CF06 inoculum. In CF12, 17 were identified as R/MR by plug method and 23 were identified as R by Nodal method.

**Screening for smut:** Totally, 28 IVT+AVT entries were evaluated against sugarcane smut during the crop season 2023-24. Out of 28 entries, five entries were identified as resistant, and three clones were identified as moderately resistant.

*(A. Ramesh Sundar and P. Malathi)*

**Screening for YLD:** IVT and AVT entries were monitored throughout the crop season with regard to YL severity based on the 0-5 scale. In IVT, out of 17 entries 29.41% (5/17) were identified as R *viz*. Co 20002, Co 20005, Co 20007, CoM 20082, CoSnk 20102, 53% (9/17) were MR, and 11.76% (2/17) were S *viz*. Co 20012 and CoT 20366). In total of 11 entries in AVT I plant, 36% (4/11) were identified as MR *viz*. Co18003, Co18012, Co 18024, and CoVc 18061, 18.18% (2/11) were S *viz*. Co 18001, CoVSI 18121. Out of 12 entries in AVT II plant, 16.66% (2/12) were R *viz*. Co 17010 and Co 17012, 8.3% (1/12) were MR (CoT 17366) and the remaining 50% were S. The same entries maintained in ratoon, 66.66% (8/12) were identified as S and the remaining were MS *viz*. Co 17001, Co 17005, Co 17010, and Co 17012.

*(K. Nithya and P. Malathi)*

**Screening for brown rust and pokkah boeng:** In AVT I plant trial, mild PB was observed on Co 18001, Co 18009, Co 18024 and CoVc 18061 entries and there was no rust incidence on any of these entries. In AVT II trial, rust was observed in traces on clones Co 17001, Co 17005, Co 17010 and other clones were free from rust. GSD was noticed on CoC 671, CoN 17072 and other entries were free from GSD. In PZVT plot traces of rust was observed on 2022-48, 49, 50, 51, 53, 55, 71, 72, 82, 89, 96, 97, 102, 103, 105, 131, 139, 145, 153, 161, 165, 175, 177, 191, 197, 200, 214, 217, 224 and 224. Only the clones 2022-146 and 2022-149 had 10-20% rust severity. Other plants were free from any rust pustules. PB was not noticed in any of the clones during this crop season. GSD was noticed in single plant in clones of 2022-37, 50 and 2022-168. In PZVT multiplication plot, rust was observed in traces on 2023-13, 29, 39, 53, 65, 68, 71, 72, 79, 81, 91, 99, 100, 106, 109, 120, 123, 133, 163, 168. The entries 2023-101 and 154 were affected by rust (5-10%). All other entries were free from rust infection.

*(R. Selvakumar and V. Jayakumar)*

## Efficient delivery of fungicides and other agro-inputs to manage major fungal diseases in sugarcane

To demonstrate efficient delivery of plant protection chemicals or agro-inputs / microbes through mechanized delivery for effective disease management and increased settling vigour: Efficacy of recently CIB recommended azoxystrobin (Amistar 23 SC) has been evaluated at 100ppm in comparison with the existing fungicides *viz*, thiophanate methyl against red rot in CoC 671, propiconazole against wilt in Co 11015 and smut in Co 97009. Results of all the experiments indicated that, efficacy of Azoxystrobin was found to be on par with thiophanate methyl in reducing red rot incidence and propiconazole against smut and wilt incidence with corresponding increase in yield. Based on our findings, combination of Azoxystrobin – 50ppm + propiconazole – 50ppm+Fipronil-50ppm along with nutrients *viz*., urea, $ZnSO_4$ and $FeSo_4$ at 0.5% concentration each has been used to treat breeding clones *viz*., NHG (410); Arrowing Plot (250); Co-canes (500); AVT I Plant (14); SISMA (26) and Technology Park (19 varieties) at the institute level in order to demonstrate the efficacy of mechanized sett treatment to prevent disease incidence. In addition, FYM enriched with Trichoderma has been applied in NHG for wilt management. Observations on three months old crop of NHG clones indicated that the pokkah boeng incidence was less than 1%.

*(P. Malathi and A. Ramesh Sundar)*

## Management of YLD through meristem culture

Nearly seven generation of meristem culture derived tissue culture materials (TC-0 to TC-7) of Co 86032 and one generation of Co 11015 (TC-0 and TC-1) were maintained under field condition along with the infected control or diseased material of the same variety. YLD severity was assessed in all the TC materials using the 0-5 scale. TC-0, TC-1 and TC-2 of Co 86032 have not shown any YLD, whereas YLD incidence was observed from TC-3 to TC-7 generations with disease grade of MS to HS. Similarly, the TC-0 seedlings of Co 11015 has not shown any YLD whereas the TC-1 had shown HS severity grade.

*(K. Nithya, P. Malathi and D. Neelamathi)*

## Evaluation of zonal varieties/genotypes for their reaction against major insect pests

In AVT-I, out of 15 entries only one entry (CoC 671) has recorded Moderately Tolerant (MT) reaction and the rest were Susceptible (S). The incidence of the borer was the lowest (38.7%) in CoC 671 and highest (69.3%) in Co 09004. The intensity of the borer attack was the lowest (2.17%) in Co 17005 whereas it was highest (3.65%) in the entry Co 17001. Infestation index was maximum (2.48) in Co 17001 and minimum (0.92) in CoC 671.

In AVT-II, out of eight entries including three checks, only one entry (Co 16010) was Tolerant (T) to INB and two were Susceptible (S) (Co 16006 & Co 16018). Five entries showed Moderately Tolerant (MT) reaction. The incidence of the borer ranged between 17.3 (Co 16010) to 45.3% (Co 16018) with the intensity being the lowest (0.79%) in the entry Co 16010 and highest in the entry Co 16006 (2.06%). The Infestation Index was the lowest (0.14) in Co 16010 and highest in Co 16018.

In AVT-Ratoon, all the eight entries including three checks showed Susceptible reaction. The incidence of the borer ranged between 40 (Co 16018 & CoC 671) to 78% (Co 09004). The intensity of attack of the borer was the lowest (2.34%) in Co 16018 whereas it was the highest (4.32) in the entry Co 09004. Infestation index was minimum (0.51%) in CoVSI 16121 and maximum (3.37) in the entry Co 09004.

*(K.P. Salin, P. Mahesh and M. Punithavalli)*

## Assessment of yield losses caused by borer pests of sugarcane under changing climate scenario

In a three-year study percent of contribution of sample canes in different infestation categories did not show clear-cut differences though it tended to be lower in canes with multiple bore holes. As in the previous two years, percent of intensity was significantly higher in canes with multiple bore holes than in canes with single bore hole. Internode number, cane diameter, cane length and cane weight did not differ among different categories of infestation and uninfested control. Percent of intensity was negatively, yet non-significantly, related to yield parameters.

Length and diameter of borer attacked internodes were significantly lower than those of healthy internodes both below and above them, though the differences were more pronounced for internode length. In contrast, length and diameter of all internodes were uniform in uninfested canes. The trends in internode length and diameter in infested and healthy canes very clearly pointed out the effect of borer damage. Both length and diameter of bottom internodes (IN-5 & In-6) in affected cane, which were on par with those in healthy cane, decreased significantly due to borer damage (IN-3 & IN-4). However, length and diameter of the top internodes (IN-1 & IN-2), i.e. those above the affected internodes, were not only on par with those of bottom internodes in the affected canes but also with the corresponding internodes in the healthy canes. When the overall growth parameters of infested cane segments were compared with those of healthy cane segments, mean length, mean diameter, surface area and volume were significantly lower in infested cane portions. Also, weight, weight per unit area and weight per unit volume of infested cane segments were significantly lower than those of healthy cane segments.

*(K.P. Salin, P. Mahesh, B. Singaravelu and M. Punithavalli)*

## Survey and surveillance of sugarcane insect pests

Overall incidence of borer pests, *viz*. shoot borer (SB), internode borer (INB) and the subterranean white grub in Tamil Nadu indicated medium incidence of SB (2.3-32.2%) and INB (4.5-20.1%); white grub incidence in endemic areas varied from 8 to 11 grubs/m$^2$. Whitefly incidence was 19.4-39.5/leaf in Mundyampakkam area alone. Other pests like mealybug and white woolly aphid were low in individual farmers' fields which were kept under check by periodical detrashing and natural enemies respectively. An outbreak of mealybug *Phenacoccus saccharifolii* which is a new invasion in Tamil Nadu was observed in Sathamanglam area of Ariyalur. The affected plants had severe yellowing, sooty mould development, stunting, drying /rotting of the central whorl, failure to produce canes, profuse grassy tillering as well as failure of establishment of sprouted ratoons. The farmers are following the recommendations made earlier years for its management and it is now under check.

*Crown mealybug/Pokkah boeng affected field*

*(K. P. Salin, P. Mahesh, B. Singaravelu, T. Ramasubramanian and M. Punithavalli)*

## Monitoring of insect pests and bioagents in sugarcane agro-ecosystem

In a monitoring plot, planted in March 2022, pest incidence was assessed at monthly intervals in five random spots. Shoot borer and internode borer were the borer pests but both occurred at low intensity. Shoot borer dead hearts ranged 5.1-17.7% during March-July. Internode borer incidence ranged 25.0-45.3% during September-January, but it was slightly higher (69.3%) at harvest. Whitefly, mealybug and yellow mite were observed at low levels. Parasitoid activity was recorded on the larvae collected and reared in the lab. *Sturmiopsis inferens* activity in shoot borer ranged between 0.9 (February) to 20% (October). Field collected crown mealybug has shown 6.0 to 29.8% parasitization by two parasitoids *Aenasius* sp. and *Leptomastix dactylopii*.

*(K.P. Salin, P. Mahesh, B. Singaravelu and M. Punithavalli)*

## Externally funded projects

## Identification, characterization and verification of new sugarcane varieties for DUS testing at Coimbatore

First year DUS testing of two new varieties *viz*., CoA 14321 and CoA 14323 and one extant variety CoM 0265 along with its closely resembling reference varieties (RV) (CoG 93076, Co 97009 for CoA 14321 and CoC 773, Co 7527 for CoA 14323, Co 87044, CoN 07072 for CoM 0265) and zonal standards (CoA 92081, CoV 92102, Co 86032 and CoC 671) was completed and the candidate varieties CoA 14321 (NV) and CoA 14323 were distinct from the respective RV's with respect to DUS traits.

DUS test for two new varieties namely, Co 11015 and Co 10026 along with closely resembling RV's namely, Co 85002, Co 85019 for Co 11015 and CoN 95132, Co 7508 for Co 10026 and zonal standards (Co 86032 and CoC 671) was completed. The candidate variety Co 11015 (NV) was distinct from the RV's (Co 85002 and Co 85019) in respect of DUS traits. The candidate variety Co 10026 (NV) was distinct from the RV's (Co 7508 and CoN 95132) with respect to DUS traits. Both the candidate varieties were distinct from the respective reference varieties for DUS traits.

**Maintenance breeding:** During the crop season, a total of 244 RV of sugarcane (tropical varieties) were clonally maintained in field at lead centre (Coimbatore, TN).

**New Planting**: Two candidate varieties *viz*., Phule 11082 (CoM 11082) and Phule 15012 (MS 17082) along with its RV's Co 8347, Co 8371, CoA 89081, Co 7805 for Phule-11082 (CoM 11082), Co 8347,

Co 8371, Co 853, Co 6304 (for Phule Sugarcane 15012) and zonal check varieties Co 86032, CoC 671 were planted during March 2023. A new cane variety (NV) - Phule Sugarcane 13007 (MS 14082) was multiplied for DUS test in 2023-2024.

*(S. Alarmelu and C. Jayabose)*

## AICRP on seed (Crops) – Sugarcane

**Quality planting material production**: Seed production and supply is a continuous activity. From a very low production of 163 tons in 2015-16 to 959.985 tons in 2022-23 the seed production activity has reached a milestone and the Institute has become visible. The farmers and sugar mill personals are highly satisfied and the demand for quality seed to achieve increased yields in sugarcane is being realised.

Breeder seed multiplication was taken up using the initial source of the tissue culture plants produced from the nucleus clones at the Institute. The varieties included were Co 86032, Co 11015 and the newly released varieties Co 18009 and Co 14012. Production of breeder seed using TC plants for further multiplication in farmers' fields in 2022-1 had also been taken up. About 27.655 tons of breeder seed thus produced had been supplied to the selected farmers to undertake the quality seed production during July 2022 under the guidance from ICAR-SBI in addition to the seed indents from sugar factories. In addition, 7.870 tons of Co 86032 breeder seed produced was also supplied during 4$^{th}$ week of August 2022 along with 12000 settlings of Co 11015 for planting 9.0 acres of fields to Kallakurichi II CSML quality seed material production requirements.

The need to produce a large quantity of quality seed cane coupled with the limited availability of resources in the Institute provided an opportunity to explore the farmers' participatory mode under ICAR Seed Project. An indent of about 400 tons of quality seed has been received from the Director of Sugars, Government of Tamil Nadu for subsidy scheme under NADP. Private sugar factories have communicated indent for 475 tons and the total requirement for the breeder seed was 875 tons. Progressive seed farmers have been selected to undertake farmers' participatory seed production from Seyur, and Neelambur and seed production was undertaken in about 15.7 ac. in Coimbatore and Tirupur Dist. and 9.0 acres at Kallakurichi II cane growing areas *viz*., V. Alampalayam, Mattikaikurichi and Nayinarpalayam. The seed crops were strictly monitored and about 702.785 tons of quality seed has been supplied during February – April, 2022 to both cooperative and private sugar factories as per allotments received from Directorate of Sugar, Govt. of Tamil Nadu. Maximum seed cane yield of 49.104 tons/acre was recorded in Seyur field and average seed cane yield for the season 2022-23 was 44.763 tons. In Kallakurichi II seed cane production area, 259. 050 tons (161.470 tons of Co 86032 and 97.580 tons of Co 11015) of seed cane material has been lifted by Co-operative Sugar Mills during this 2022-2023 supply season.

For the year 2023-2024 quality seed cane materials supply, an indent of about 290 tons (Co 11015 = 140 tons; Co 18009 = 160 tons & Co 14012 = 75 tons) of quality seed has been received from the Director of Sugars, Government of Tamil Nadu for subsidy scheme under NADP and 800 tons of quality seed cane material from private factories were received. A total of 1100 tons has been planned for production and seed crop has already been planted in farmers' fields during June – July 2023 under participatory seed production programme.

**Training Programmes**: Organised one day Quality Seed Production – Training Programme at Kothari Sugars and Chemicals Ltd., Sathamangalam Unit, Cane Development Area on 21.02.2023. Seed day and Field Day was conducted on 15.3.2023 at Seyur Village and all the seed farmers and breeders attended the meeting along with seed team.

As part of the Government of India's flagship program "International year of Millets -2023" to create awareness about nutritional values of millet crops and to eradicate malnutrition in the country, an awareness campaign was organized at ICAR-SBI Agali Research Centre in TSP program and celebrated the International Year of Millet on 17.03.2023 and 18.03.2023. Eighty seven tribal families from five villages' *viz*., Vellamari, Kalkandiyoor, Malle Chavadiyoor, Kerala Kudapatti and Tamil Nadu Kudapatti participated in the programme. A lecture on importance of millets in human nutrition

was organized for the benefit for the tribal community. Each and every tribal household was provided with three kgs. of high quality ragi seed, two Coconut seedlings and three Areca nut seedlings. Five battery operated sprayers were distributed as common asset to the villages and six types of millets *viz*., Ragi, Bajra, Little Millet, Foxtail millet, Kodo millet and Proso millet were sown in the millet cafeteria at the center.

Under STC component, a meeting was organized to distribute the millet seeds and areca nut seedlings to the tribal farmers at ICAR-SBI, Research Center, Agali during 2023. About 120 farmers from two villages (Kalkandiyur and Vellamari) of Attapadi hills, Palakkad District participated in the program. Five areca nut saplings and two kg of ragi seeds were distributed to the farm families.

*(A.J. Prabakaran, S. Karthigeyan, A. Anna Durai, K. Mohanraj and V. Sreenivasa)*

Sugarcane varieties *viz*., Co 18009, Co 14012,Co 86032, Co11015, Co 0238, Co 0118 and Co 15023 were multiplied *in vitro* through apical meristem culture and a total 1,23,500 of quality tissue culture seedlings of varieties Co 86032, Co 11015, Co 0118, Co 0238 were supplied to six sugar mills of Tamil Nadu and one factory of Karnataka, for Breeder seed production at Sugarcane breeding institute Coimbatore, progressive farmer of Tamil Nadu, Karnataka, Kerala, Maharashtra, Uttar Pradesh and Uttarakhand.

Training on "Meristem culture techniques for production of disease-free quality planting material" was imparted to four technician /lab in-charge from tissue culture laboratories of Shree khedut sahakari khand udyog Mandli, Gujarat, Shamanur Agro Tech Pvt. Ltd., Karnataka and ICAR-SBI regional station, Karnal. Two days training programme were organised on "Quality seed production through micropropagation in sugarcane" under NFSM for 21 cane officials/ tissue culture lab in charge from 16 sugar factories in Tamil Nadu. Total revenue of Rs 14,63,250 was generated from the supply of tissue culture plants, mother culture flasks and imparting training in micropropagation to the Lab incharge /technician from tissue culture laboratories.

*(D. Neelamathi, R. Valarmathi and C. Jayabose)*

## Novel application of sugarcane vacuolar targeting technology for recombinant protein

The project was initiated with the idea to validate vacuolar technology developed by ICAR-SBI for commercial recombinant protein production in sugarcane. A total of 89 transgenic events were generated and all of them were analyzed for the presence/absence of transgene by promoter and gene fusion amplification using PCR. Fifty-six events were found positive with amplicon size of 968 bp. Untransformed control didn't show signal. GCS expression was quantified using quantitative PCR. Further, juice was extracted and tested for GCS in SDS page. All events were grouped in three categories as low, medium and high level expression. Representative sample from each category was further analyzed through microplate assay. Some of the events reach the expression level as per the expectation of TRANALAB. Downstream process standardization is in progress to increase the GCS yield.

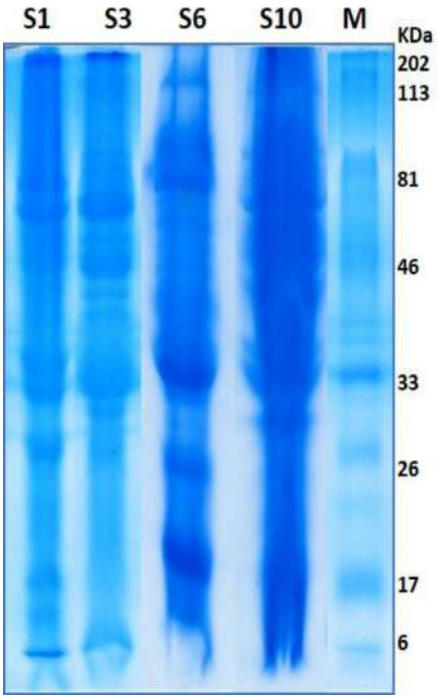
*(C. Appunu and G.S. Suresha)*

## A proteomic approach for identification and characterization of new ligninolytic enzymes for improved sugarcane bagasse delignification

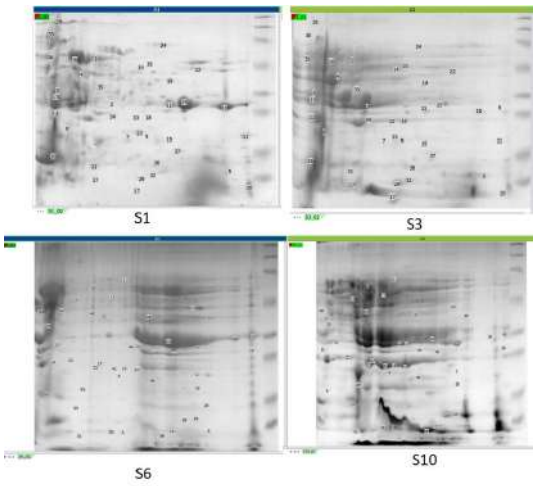
Laccase enzyme was isolated from the strains (S1, S3, S6 and S10). It was grown in 500 ml baffled Erlenmeyer flask with 200 ml of Potato Dextrose medium for seven days at 50 °C with orbital shaking at 180 rpm. After seven days of growth, the cultures were centrifuged at 15,000× g for 20 min at 4 °C, the supernatant was collected and 40% trichloro-acetic acid (TCA) was added to final volume of supernatant. The protein was allowed to precipitate at 4 $^{0}$C for 2 hours. Then the solution was centrifuged at 15,000× g for 20 min and the pellet was washed with ice cold acetone thrice to remove the TCA from protein and the pellet was air dried. The samples were separated based on their molecular weight by 12% reducing SDS-PAGE. After electrophoresis, the protein bands were visualized in the gel by Co-omassie Blue R-250 staining.

**Protein Estimation & 2D Electrophoresis Analysis:** Proteins were quantified using

Bradford Protein Assay. The estimated concentration of the protein for S1, S3, S6 and S10 were 34.23, 32.66, 30.74 and 30.33 ug/5ul respectively. These samples were processed for 2D Proteomic analysis. Two dimensional gel electrophoresis of processed protein (200 ug) was done as following, 13 cm IPG strips of pH 3-10 were employed in the first dimension. Proteins were focused for a total of 40,000 Vhs at a constant temperature (20 °C) under linear voltage ramp after a passive IPG rehydration. Following IEF, each IPG strip was placed in the equilibration buffer containing 2% DTT first followed by incubation in another buffer in which the DTT was replaced by 2.5% iodo-acetamide. The second dimension PAGE (12.5%) was carried out in an SE600 (GE Healthcare, Uppsala, Sweden) at 1W/ gel for 1 hr and 13W/ gel for 3 hr. By Comparing S1 and S3; we identified 39 spots. In which spots 18, 33, 17, 2 and 35 showed an expression value of 16.81, 8.27, 8.26, 5.34 and 4.95. While for the S6 and S10 comparison we identified 47 spots, in which spot 17, 22, 44, 41 and 36 showed an expression values of 9.02, 8.84, 8.13, 6.57 and 5.81 among the spots identified we have picked 25 spots for (S1 vs S3) and 22 spots for (S6 vs S10) and submitted for MALDI-TOF analysis.




*SDS PAGE analysis of proteins isolated from four cultures (S1, S3, S6 and S10) after digestion of the sugarcane bagasse for 17 hrs.*




*Two dimensional gel electrophoresis of the processed proteins of four cultures (S1, S3, S6 and S10)*

*(K. Lakshmi)*

## Development of white grub (*Holotrichia serrata*) resistance in sugarcane and groundnut by deploying novel Cry toxin holotype genes

To study the individual toxicity of the Cry8Sa1 and Cry8Ib, purified crystal protein fraction was used to conduct bioassay against 1st, 2nd & 3rd larval instars. The bioassay was conducted in 12 well tissue culture plate containing carrot disc contaminated (smeared), grated carrot, FYM, host root tissues and artificial nutrient media with purified Cry8Sa1 and Cry8Ib toxin. Ten first instar larvae of whitegrub (*H. serrata*) were released for each replication of cry8Sa1, cry8Ib, HD73- (negative control), Bt62 (positive control) and distilled water (control). Bioassay was replicated five times for each toxin along with positive and negative control.

Insect mortality data was recorded at 24 h interval for 7–15 days. The bioassay results indicated that only Cry8Sa1 toxin exhibited significantly higher mortality of up to 96% in the replications. It is clear from this study that Cry8Sa1 is an ideal and potent candidate for developing white grub (*H. serrata*) resistant transgenics in sugarcane. Artificial diet developed at ICAR-SBI was used to ascertain toxin efficacy against major species of *Holotrichia serrata* and *H. consanguinea* with the help of collaborators and other groups. Also toxicity was tested against *Holotrichia* species *viz.*, *H. longipennis*, *H. sikkimensis*, *Brahmina coriacea* and *Brahmina mysoriensis*. Cry8Sa1 was found

effective against *H. longipennis*, *H. sikkimensis* but not on *Brahmina coriacea* and *Brahmina mysoriensis*.

Associated with TNAU along with our regular monitoring to record incidence of white grub species in Tamil Nadu. More than 90% incidence of *Holotrichia serrata* and traces of other species *viz*., *Anomala* spp (2.7%), *Brahmina mysoriensis* (1.8%), *Phyllognathus dionysius* (1.6%) and *H. consanguinea* (1.3%) new insect (0.9%, given for identification to Dr. Sreedevi, Principal Scientist, NBAIR incidence were noticed.

Taken help from Co-PI, Gujarat and All India Network Project on Soil Arthropod Pests (AINPSA), Durgapura, Jaipur, Rajasthan to record the incidence of whitegrub species in Gujarat and Rajasthan states. More than 87% of incidence by *H. consanguinea* and traces of other species recorded were *H. reynaudi* (4.8%), *H. serrata* (2.4%) and *H. rufoflava* (1.1%).

*(C. Appunu, B. Singaravelu, K. Hari, G.S. Suresha and P. Mahesh)*

## CRISPR/Cas mediated targeted editing for virus resistance in sugarcane

Yellow leaf disease (YLD) caused by Sugarcane yellow leaf virus (ScYLV) occurs in sugarcane across the varieties and locations in epidemic form that causes 20-40% loss in cane yield with 40-50% reduction in juice yield in the country. One of the most efficient and sustainable strategies for controlling plant virus infections is the use of genetically resistant plants. Viruses establish and exhibit symptoms using proviral factors of host plants. Hence, one of the proviral factor, eukaryotic translation initiation factor eIF4G was isolated from commercial sugarcane variety to develop virus resistant edits through genome editing approach. Four CRISPR/Cas9 guide RNAs *viz*., pCas9-eIF4G-gRNA1, pCas9-eIF4G-gRNA2, pCas9-eIF4G-gRNA3 and pCas9-eIF4G-gRNA4 were used to develop edits. Before these binary vector transformation, constructs were confirmed through restriction and sequence analysis. These constructs were transferred to *E. coli* and later mobilized into *Agrobacterium tumefaciens* LBA4404 strain.

The absence of SCYLV was confirmed in the leave whorl explant with primer pair SCYLV-615F (GGATCCATGAATACGGGCGCTAACCGYY-CAC) and SCYLV-615R (AGATCTG TGTTGGG-GRAGCGTCGCYTACC) targeting 615 nt partial genome of SCYLV coat protein-ORF3. After the confirmation, leaf whorl explant was used for genetic transformation. *Agrobacterium* mediated transformation was performed by culturing with leaf whorl. Sugarcane edits are in different stages and phenotyping is in progress.

*(C. Appunu, R. Viswanathan, R. Valarmathi and K. Nithya)*

## Improving tillering and yield in sugarcane through creating novel alleles of strigolactone biosynthesis gene MAX4-1 using CRISPR/CAS9

Stridolactones (SL) are produced through the Carotenoid Cleavage Dioxygenase (CCD) pathway sequentially regulated by MAX2, MAX3 and MAX4 (More Axillary Branching) genes. Synthesis of strigolactone (SL) starts with the all trans β-carotene, which is converted to 9-cis-β-carotene by the activity of Dwarf 27 (D27), MAX3 then converts it into 9 cis β–apo 10′-carotenal, MAX4 converts 9 cis β–apo 10′-carotenal to strigolactone precursor called carlactone. The coregulation of MAX3, MAX4 and a receptor (MAX2) results in producing the branch-inhibiting hormone called strigolactone. Strigolactone interacts with auxin and inhibits side branching and thus a strong negative regulator for tillering. A preliminary study was carried out to understand the tillering behaviour and relative expression of strigolactone branching inhibitor gene More Axillary Branching (MAX4) among seven sugarcane genotypes that show different degrees of tillering. More Axillary Branching (MAX4) gene *ShMAX4* SgRNA was designed for cloning. CRISPR-PLANT platform was used for designing sgRNA sequence for *ShMAX4* (http://www.genome.arizona.edu/crispr). Forward and reverse DNA oligos were synthesized for MAXsgRNA with appropriate adaptors: 5′-GGCA-3′ as adaptor sequence for forward primer and 5′-AAAC-3′ as adaptor sequence for reverse primer to facilitate directional cloning at *Bsa I* restriction site in pRGEB31 vector. The forward and reverse oligos were annealed together to form the DNA oligo-duplex. To create precise mutations in *SoMAX4* genes through genome

editing, sgRNA targeting *MAX* gene was cloned under OsU3 promoter in the plant transformation vector pRGEB31 harboring hygromycin resistant gene as the selectable marker. The construct was mobilized into *E. Coli* and the putatively transformed colonies were subjected to sanger sequencing to confirm the cloning of SgRNA in the vector backbone. Plasmid was isolated from the sequence confirmed colonies and used for transformation in the variety Co 99004. Callus was initiated from the variety Co 99004 and transformed with pRGEB31 vector harbouring MAX4gRNA through particle bombardment method using gene gun.

*(R. Valarmathi, C. Appunu and K. Mohanraj)*

## Deciphering the genetic basis of root-system architecture for developing climate resilient sugarcane

The project was initiated to understand the genetic basis of root system architecture in sugarcane. The project was started with the following objectives to screen contrasting sugarcane genotypes for root system architecture (RSA) related traits under control and drought stress conditions. Whole genome transcriptome analyses to delineate the genes/regulatory network(s) associated with RSA in selected drought tolerant contrasting genotypes and to identify candidate genes controlling drought adaptive root traits. Besides to develop mutant populations of Co 99004 through gamma ray induced mutagenesis.

Validation of genes/regulatory network(s) using the contrasting sugarcane genotypes. In the first experiment extensive screening was carried out to understand the root system architecture in different commercial genotypes as well as wild germplasm. In a parallel experiment callus initiated from Co 99004 was irradiated with different concentrations of gamma rays at BARC Mumbai. LD 50 was standardised for gamma treatment and a 20 Gy was found to be the LD50 with 60% regeneration efficiency. The treated calli were regenerated and different batches of mutants were screened for RSA under control conditions. Root imaging of *in vitro* grown plants was carried out using DIRT imaging software. Based on the output from the first objective contrasting genotypes will be selected from both the experiments and screened for RSA under drought and wholegenome transcriptome analyses will be carried out to delineate the genes/regulatory network(s) associated with RSA.

*(R.Valarmathi, C.Appunu and Ashish Kumar Srivastava -Scientific Officer F, BARC)*

## CRISPR Crop Network: Targeted improvement of stress tolerance, nutritional quality and yield of crops by using Genome Editing

Developed of codon optimized Cas9 vector for transformation of sugarcane callus tissues and the full length genes of CENH3 (510 bp) was characterized from sugarcane. To study the full length genes of CENH3 and Matl, genomic DNA and total RNA were extracted from Co 86032, Co 13013, Co 775 and Co 671. High RNA concentration samples were converted into cDNA and confirmed by 0.8% agarose gel electrophoresis. Amplification of DNA and cDNA was done with CENH3 gene primers. Amplification was obtained at 510 bp. The sequence showed >90% similarity with CENH3 sequence of sugarcane, maize and sorghum. The cDNAs were used for PCR amplification using MATL and 25s rRNA primers. Amplifications at 640 bp and the sequence showed similarity with matrilineal of maize and sorghum. Pollen samples of sugarcane was showed differential expression of malt genes and CenH3. Multiplex Gene editing vectors (BK212_CRISPR Agro_ ScMATL B3 and B1 gRNAs), (BK213_CRISPR Agro_ScMATL C3 and C2 gRNAs), (BK214_ CRISPR Agro_ScMATL C2 and c5 gRNAs) targeting the matl genes were constructed.

To study the expression of MATL genes from pollen, pollen viability was tested. The pollen viability and pollen germination was observed for 'Co' canes of sugarcane, *S. spontaneum* and *Erianthus* species using acetocarmine staining procedures from the top, middle and bottom florets. The pollen collected in the tubes was transferred to the cavity slide and the acetocarmine stain of 1% was used for pollen viability test. The viable pollens appeared red (uptaking the stain), non-viable pollens remains unstained. Callus was developed for Co 86032, Co 13013 and Co

671. Subculturing done in MS+2,4D media. Basic and multiplex vector of CRISPR/Cas 9 editing-vector was used for the transformation. For that (BK212_CRISPR Agro_ScMATL B3 and B1 gRNAs), (BK213_CRISPR Agro_ScMATL C3 and C2 gRNAs), (BK214_CRISPR Agro_ScMATL C2 and c5 gRNAs) plasmids isolated from overnight culture. Plasmid concenteration was checked with 0.8% gel and loaded along with 1kb ladder. The vectors were bombarded into the callus of Co 13013, Co 775 and Co 671. The plasmid pCAMBIA1302 is used for generating transgenic plants with Agrobacterium transformation method.

*(R. Manimekalai, V.P. Sobakumari and C. Appunu)*

## Enhancing Sugar Productivity in Tamil Nadu through Institute-Industry Participatory Approach (SISMA-TN funded – Sweet Bloom 2.0)

**Programme Initiation:** A MoU was signed between The Director, ICAR-SBI, Coimbatore and The President, SISMA-TN, Chennai on 09.12.2022 to initiate the institute-industry participatory collaborative project with financial support from SISMA-TN, Chennai.

**Supply of seed cane materials of advanced stage of clones:** As per the approved programme, a total of sixteen promising genotypes (Co 14012, Co 15010, Co 15017, Co 15020, Co 18001, Co 19002, Co 19004, Co 19008, Co 19009, Co 20005, Co 20009, Co 20010, Co 20011, Co 21003, Co 21004 and Co 21007) were multiplied at ICAR-SBI, Coimbatore during January-July 2022. These clones were supplied for multiplication to ten sugar factories *viz.,* (1) Bannari Amman Sugars Ltd., Alathukombai, Sathyamangalam, Erode 638401, (2) Bannari Amman Sugars Limited Unit-V, Vengur, Tirukoilur - 605751, (3) Dhanalakshmi Srinivasan Sugars Pvt. Ltd., Udumbiyum, Venganor, Veppanthattai, Perambalur – 621116, (4) EID Parry (India) Ltd., Nellikuppam Sugar Factory, Cuddalore 607105, (5) Kothari Sugars and Chemicals Ltd, Kattur, Lalgudi, Trichy, (6) Kothari Sugars & Chemicals Ltd., Vetriyur, Sathamangalam, Ariyalur 621707, (7) Ponni Sugars (Erode) Ltd., Odapalli, Cauvery RS, Erode 638007, (8) Rajshree Sugars & Chemicals Ltd., Mundiambakkam, Villupuram 605601, (9) Sakthi Sugars Limited, Appakudal, Erode – 638315, (10) Sakthi Sugars Ltd., Sivaganga Unit, Jothinagar, Padamathur and Sivaganga 630561.

**Multiplication of seed cane at factory location and trial planting:** Seed cane material of all sixteen clones were supplied to factories during July-August 2022 for further multiplication in respective locations. All these clones were planted in replicated randomized block design with three replications under wider row spacing (4 feet) during February-March 2023. Technical programme for location specific varietal evaluation trial was finalised and shared with all sugar factories.

**Identification of location specific varieties:** Trial planting was done in randomized block design (three replications) with three to four standards among Co 86032, PI 1110, CoV 09356, Co 11015, CoVSI 12121 with plot size of 6m X 6 rows X 1.2 m/replication in ten factory locations. Very good germination was recorded in evaluation trial plot. Field stand of all sixteen clones was good in the trial plot of all factory locations. Juice quality data was recorded after eight months of planting. Three clones *viz.*, Co 20009 (16.59%), Co 15017 (16.57%) and Co 20010 (16.53%) recorded higher sucrose than standard Co 86032 (16.08%) at Bannari Amman Sugars Ltd., Sathyamangalam. Similar trend was observed in other factories as well.

**Survey and surveillance of pests and diseases:** There are two visits planned per year *viz.*, January-February 2024 (during harvest and early planting time) and June-July 2024 (during vegetative growth period). Survey and surveillance planned to inspect fields at harvest to assess stalk diseases and insect-pests by observing symptoms on the harvested canes, dead canes, stools *etc.,* with destructive sampling (uprooted /split open and inspected for diseases) and at vegetative growth period to assess YLD, smut, GSD, RSD, foliar diseases (rust, brown spot, brown stripe, eye spot, ring spot *etc*). Observation of emergence of new pathotypes and races.

**Supply of healthy seed programme:** To meet the demand of factories for tissue culture plantlets, mother culture stock preparation is in progress for varieties Co 86032, Co 11015, Co 14012 and

Co 18009. To enhance the tissue culture plantlets production capacity, expansion/alterations of required facilities/works are in progress at ICAR-SBI, Coimbatore.

*(G. Hemaprabha, C. Appunu, S. Karthigeyan, A. Annadurai, R. Karuppaiyan, K. Mohanraj, V. Sreenivasa, Maruthi R.T, Adhini S.P, K. Elayaraja, S. Sheelamary, K. Gopalareddy, V. Vinu, H. K. Mahadeva Swamy, D. Neelamathi, C. Jayabose, R. Valamathi, K. P. Salin, A. Ramesh Sundar, B. Singaravelu, P. Malathi, R. Selvakumar, P. Mahesh ICAR-SBI; Project Members from TNAU, Coimbatore. D. Sassikumar and T. Thirumurugan- SRS Cuddalore, M. Sakila -SRS Sirugamani, N.A. Saravanan- SRS Melalathur)*

## ICAR-SBI and ISMA Collaborative Project

### Identification of suitable location specific sugarcane varieties for commercial cultivation under different agro-climatic situations in India.

A collaborative project has been signed between ICAR-SBI and ISMA during August 2023 for identification of location specific sugarcane varieties. Seed material of nine clones *viz*., Co 14005, Co 14012, Co 16006, Co 17001, Co 18009, Co 11015, Co 15023 and Co 0118 and Co 86032 were supplied to all the 11 sugar mills in tropical zone for multiplication and conduct of the experimental trial during 2024. Seed material of entries *viz*., Co 16029, Co 17018, Co 20016, Co 20017, Co 20019, Co 21012, Co 14012, CoLk 14201 and CoLk 15207 will be supplied during second fortnight of February 2024 for planting of trial in the sugar mills in subtropical zone.

*(G. Hemaprabha, K. Mohanraj, V. Sreenivasa, R.M. Shanthi, S. Alarmelu, A. Anna Durai, S. Karthigeyan, R. Karuppaiyan, C. Appunu, R.T. Maruthi, S. Sheelamary, K. Elayaraja, Adhini S. Pazhany, K. Gopalareddy, H.K. Mahadeva Swamy, V. Vinu, D. Neelamathi, A. Ramesh Sundar, Ravinder Kumar, M.R. Meena, M.L. Chhabra and M. Nisha)*

## 5.2. Crop Production

### 5.2.1 Agronomy, Microbiology, Farm Machinery and Power

**Development of cropping systems and improved agronomic practices to enhance sugarcane productivity**

**Development and promotion of tools and machinery for sugarcane mechanization**

**Evaluation of Bioformulation Applicator using new formulations against white grubs under field condition:** A field experiment was conducted to evaluate the Bioformulation Applicator (previously known as EPN applicator) using other biopesticides (Bt)/formulation for the control of white grub in sugarcane crop. But, due to the low incidence of white grub in the later season and the low population of white grub advanced to later instar stage (pupal stage), the formulations were not so effective in this pupal stage (about to pupation stage) of the grub. However, the biopesticides (Bt) formulation will be again evaluated against the appropriate stage of the grub using this Bioformulation Applicator during the next year/next season.

*Field evaluation of Bioformulation Applicator using new formulations*

*(T. Arumuganathan, C. Palaniswami, C. Sankaranarayanan, T. Senthil Kumar - ICAR-CIAE RC, Coimbatore and S. Syed Imran – ICAR-CIAE RC, Coimbatore)*

**Weed management in sugarcane under wide row planting**

A field experiment was initiated during February 2022 to evaluate the crop injury and yield response of two sugarcane varieties Co 86032 and Co 0212 to the application of herbicide molecules ametryne, 2,4-D amine and ametryne in combination with 2,4-D amine. The experiment was laid out in factorial RBD with four replications. Factor A comprised sugarcane varieties (Co 0212 and Co 86032); factor B herbicides ametryne, 2,4-D amine and its mixture (ametryne in combination with 2,4-D amine) and factor C the doses (0.0, 1.0x and 2.0x the recommended dose), where 1.0x dose = 2.4 kg a.i $ha^{-1}$ for ametryne; 1.0 litre a.i $ha^{-1}$ for 2,4-D amine and 2.4 kg + 1.0 litre a.i $ha^{-1}$ for the mixture. The mean germination in all plots at 45 DAP was more than 50 per cent. Major weed flora observed in the field was *Datura metel, Trianthema portulacastrum, Commelina benghalensis, Cyperus rotundus, Brachiaria reptans, Dactyloctenium aegyptium, Digitaria sanguinalis* and *Cyanadon dactylon*. These weeds were removed by hand weeding and hoeing. The herbicides were applied to sugarcane foliage at 60 days after planting. Visual phytotoxicity evaluations were taken at 7, 14, 30 and 60 days after herbicide application. Phytotoxicity ratings of the different treatments ranged between 0 and 5. Herbicides ametryne and 2,4-D amine applied alone at recommended dose at 60 DAP did not cause any injury to Co 86032 and Co 0212. Ametryne at double the recommended dose caused very slight discolouration to Co 86032 and Co 0212. Ametryne + 2,4-D combination at double the recommended dose caused pronounced leaf scorching injury to Co 0212 and slight injury to Co 86032 which recovered later. The crop was

harvested in February 2023. Leaf scorching injury due to ametryne + 2, 4-D combination at double the recommended dose in Co 0212 had no effect on final cane yield when applied at 60 DAP. The results demonstrated the margin of sugarcane tolerance with ametryne+2, 4-D combination which provides the basis for optimization of application time, dose and sugarcane varietal selection to mitigate crop injury.

Another field experiment was taken up during October 2022 to study the persistence of herbicide halosulfuron methyl 75% WG applied to sugarcane field for early post emergence weed control. Halosulfuron methyl was applied to sugarcane variety Co 86032 at recommended dose (RD) of 67.5 g a.i. $ha^{-1}$ and double the recommended dose (2RD) of 135 g a.i. $ha^{-1}$ along with control and replicated thrice. Calculated quantity of herbicides was applied as early post emergence (25 days after planting) at two-three leaf stage of weeds by maintaining optimum moisture in the field. Major weed flora observed in the field was *Datura metel, Trianthema portulacastrum, Commelina benghalensis, Cyperus rotundus, Brachiaria reptans, Dactyloctenium aegyptium, Digitaria sanguinalis, Rottboellia cochinchinensis* and *Cyanadon dactylon*. The knapsack sprayer with flat fan nozzle was used for spraying herbicides with the spray volume of 375 L of water $ha^{-1}$. Visual phytotoxicity evaluations were taken at 7, 14, 30 days after herbicide application. No phytotoxicity was observed in the sugarcane variety Co 86032 with the application of halosulfuron methyl herbicide even at double the recommended dose. Soil samples were collected from the field at different intervals (0, 3, 5, 10, 14, 21, 30, 45, 75, 90, 105 days after spraying) to study the residue levels. A simple and sensitive chromatographic method has been developed and validated to determine the residues of halosulfuron-methyl in the soil matrix. The method developed is in compliance with European Commission's regulations for Trace Residue Analysis. By adopting this method, the persistence and dissipation kinetics of halosulfuron-methyl was studied. The initial deposits of halosulfuron-methyl were 0.288 and 0.501 $\mu g g^{-1}$ at RD and 2RD, respectively. A week after application (7 DAA), the residues were 0.177 and 0.346 $\mu g g^{-1}$, respectively for RD and 2RD. The residues got dissipated to a level of about 95% within 75 days of application with the half-life of 9.12 and 9.71 days.

*(S. Anusha, P. Geetha and T. Ramasubramanian)*

## Inter Institutional Collaborative Research Project on Testing and evaluation of IISR sugarcane machineries under tropical condition

**Fabrication of IISR-Sugarcane cutter planter cum raised bed multicrop seeder:** The sugarcane machinery namely Sugarcane cutter planter cum raised bed multicrop seeder has been fabricated at the workshop in the Division of Agricultural Engineering, ICAR-IISR, Lucknow. The testing and evaluation of this machinery under tropical condition will be done in Coimbatore during the next planting season.



*Fabricated Sugarcane sett cutter planter- cum- raised bed multi crop seeder*

The developed machine is capable of planting two rows of sugarcane in furrows and drilling seeds of the intercrop in the raised beds simultaneously.

*(A.K. Singh – ICAR-IISR, Lucknow, T. Arumuganathan, R. Karuppaiyan and T. Senthil Kumar - ICAR-CIAE RC, Coimbatore)*

## Development of tractor operated whole cane harvester

**Field testing of tractor operated whole cane harvester:** The developed tractor operated whole cane harvester was field tested at Research and Development farm of M/s. Bannari Amman Sugars (BAS) Limited – Unit I, Sathyamangalam, Erode District, Tamil Nadu and field observations were taken. The harvester unit consists of different components namely main frame and Hitching system, base cutter system, crop gathering unit, De-topper unit, cane walker unit, cane collection trolley and power transmission system.

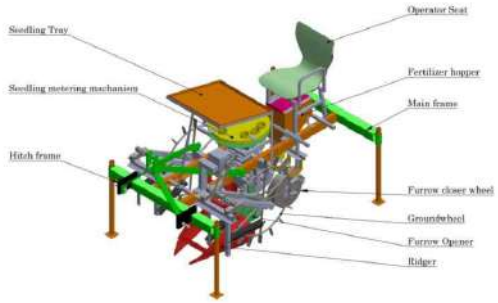
*Field testing of tractor-operated whole cane harvester*

All these mechanisms are hydraulically operated and to be mounted on a tractor three point links. Base cutter and hydraulic system are operated by tractor PTO power. Based on the observations and feedback from the stake holders during the previous field testing & evaluation, the required modifications were carried out.

*(T. Senthilkumar - ICAR-CIAE RC, Coimbatore, T. Arumuganathan, A.K. Singh and M.K. Singh - ICAR-IISR, Lucknow)*

## Development and promotion of Mini tractor operated sugarcane planters for small-farm mechanization

**Field testing and performance evaluation of mini tractor operated sugarcane sett cutter planter:** To conduct the field testing and performance evaluation of the newly developed mini tractor operated sugarcane sett cutter planter, a field experiment was laid out in Field No. 33 in additional land area at ICAR-SBI, Coimbatore. The experiment was planned in split-plot design. The field trial was designed in such a way that two different spacing *viz*., 4 feet and 5 feet were taken as main plot and three planting methods namely Mini tractor operated sugarcane sett cutter planter method, IISR sugarcane sett cutter planter method and manual sett planting method were considered as sub plot with four replications. The planting of sugarcane plant crop (Variety Co 86032) was completed in the month of February 2023 and the field trial is in progress.





*Design and development of mini tractor operated sugarcane settling transplanter*

*Design and development of mini tractor operated sugarcane settling transplanter*: A mini tractor operated sugarcane settling transplanter has been designed and the CAD drawing of the single row sugarcane settling transplanter has been prepared. Accordingly the prototype of mini tractor operated sugarcane settling transplanter has been developed for mechanised sugarcane settling planting in the field using mini tractor. The developed unit consists of main frame, furrow opener/ridger, furrow closer wheel, ground wheel, settling metering mechanism, settling tray, fertilizer hopper and operator seat. The planter is suitable for mounting with mini tractors ranging from 24 hp.

*(T. Arumuganathan, T. Senthilkumar - ICAR-CIAE RC, Coimbatore and S. Anusha)*

## Natural farming for sustainable use and management of natural resources to improve productivity in sugarcane based cropping system

Natural Farming (NF) is a unique chemical-free farming method that is considered to be an agroecology-based diversified farming system, which integrates crops, trees and livestock, allowing functional biodiversity. It is considered to drastically cut down production costs by replacing the chemical fertilizers and pesticides with home-grown products like *Jeevamritha, Beejamritha, Neemastra, etc,* and adopting intercropping and mulching.

An experiment on Natural farming has been initiated at the Institute farm (11°00'34"N latitude and 76°55'02"E longitude) of ICAR-Sugarcane Breeding Institute, Coimbatore, with the following treatments such as 1. Conventional farming, 2. Natural farming (NF) with mulch 3. Natural farming without mulch, 4. Natural farming (NF) + intercrop/ cover crop with mulch 5. Natural farming (NF) + intercrop/cover crop without mulch. The three major components of natural farming *Jeevamritha, Beejamritha*, and *Agniasthra* were common for all the NF treatments.

Field preparation has been done to fine tilth before leveling and ridge and furrow opening. Treatments with different manures such as FYM, Goat manure and vermicompost @ 12.5 t $ha^{-1}$ has been imposed before planting of sugarcane to access the nutrient use efficiency and productivity of the crop. The entire field was mulched with the shredded trash initially for weed management to provide a weed free environment to the crop. Upon decomposition this trash will add to the organic matter of the soil. Sugarcane has been planted at 5 feet row spacing so as to accommodate blackgram as intercrop. Blackgram has been cultivated as intercrop in sugarcane and the haulms has been mulched *in-situ* in to the sugarcane for increasing the organic matter content of the soil. No chemical fertilizers / pesticides/ herbicides were used. The crop is in formative stage.

*(P. Geetha, K. Hari and A. Vennila)*

## Exploring novel microorganisms for sugarcane biomass based 2G ethanol

Sugarcane bagasse from commercial varieties *viz.*, Co 86032, Co 11015 and Co 62175, and energy canes EC 11001, EC 11002, EC 11003, EC11004, EC 11005, EC 11006, EC 11007, EC 11008, EC 13001, EC 13005 and EC 14006 biomass were collected processed and stored for further studies. Lignocellulose feeding insect grub samples of white grub (*Holotrichia serrata*), red palm weevil (*Rhynchophorus ferrugineus*), sugarcane beetle (*Holotrichia consanguinea*) were collected and the gut system was dissected. The gut system was macerated and plated on cellulose, xylan, lignin, xylose, glucose and alkali digest of bagasse,

supplemented mineral media. Also the samples were used for isolation of yeast isolates using yeast extract peptone dextrose agar medium.

*Yeast isolate capable of xylose and glucose fermentation to ethanol from gut system of Holotrichia serrata*

A total of 40 bacterial isolates, one fungi and five yeast isolates were obtained. Gut system samples were processed stored for further metagenomic analysis. Six wine yeasts available in the market were obtained and yeast isolated were purified, labeled and stored for further studies. Isolation of microbes from the decaying wood samples collected from Western Ghats of Karnataka gave 10 bacterial, 11 fungal and 7 actinomycetes isolates.

*(K. Hari, G.S. Suresha, B. Singaravelu and P. Govindaraj)*

## Externally Funded Projects

### Agricultural Drone Project funded by ICAR-Agricultural Technology Application Research Institute, Hyderabad under Sub Mission on Agricultural Mechanization: Drone Technology Demonstration

**Demonstration of sprayer drone technology:** Conducted 62 field demonstrations on agriculture sprayer drone in 119.2 ha (298 acres) in Coimbatore, Erode, Thiruvannamalai and Kallakurichi districts in sugarcane farmers field located in the regions of Bannari Amman Sugars limited, Sathyamangalam, Thirukoilur and Thiruvannamalai units using hired drones from TNAU, Coimbatore, BIT-Sathyamanagalam, and Annai Drone, Chinnasalem. Micronutrient mixtures and herbicides were sprayed using the 10 L capacity drone in the sugarcane crop based on the requirement and sugarcane farmers showed lot of a interest for drone demonstration. The drone was allowed to fly around two meter above the crop canopy and it could spray around 10-13 litres of spray fluid per 0.5 acre which could be done in 10 minutes of time. Twenty litres of spray fluid was sprayed using the drone in 1 acre area.

*Field demonstration of sprayer drone technology*

The various advantages observed with drone technology were time saving, quick coverage, minimal handling of chemicals and minimum exposure to chemicals, water saving and uniform coverage. The disadvantages/drawbacks of the drone technology were the drift effect, not suitable for fields with coconut trees as border crop/inter-crop and electric lines in between the field, critical stage of crop stand, requirement of skilled person/licenced pilot for drone flying and powder formulations are difficult to use when compared to liquid formulations. The measures for enhancing/accelerating the adoption needed extensive demonstration of this technology, sensitizing this technology to farmers and other stake holders like sugar factory personal, agricultural officers *etc.* Rural youth/unemployed youths may be trained and

given priority for this technology, High cost of initial investment may be reduced/supported for accelerating the adoption of this technology and SOP should be standardized/developed for different crop level and chemical level are the other measures for enhancing the adoption of this spraying drone technology

*(T. Arumuganathan)*

### Doubling Income of Small Farms through Sugarcane Based Farming System (NADP/ RKVY)

The sugarcane based farming system model with various components such as sugarcane intercropping system with pulses, and allied enterprises like dairy, goat, vermicompost unit, fish cum poultry+duck unit, sugarcane settling production unit, mushroom production, and apiary, has been established. Currently, the unit functions with dairy animals (3 Heifer and 2 calves), goat (Salem black 13 does +1 buck), and country chicken (15) and ducks (12) and fish culture with Thilapia. Two dairy animals are in lactation and produces around 18-20 liters per day.

Under sugarcane based cropping system component the yield and energy efficiency of sugarcane and intercrops, and quality of sugarcane juice were determined. Results showed that sugarcane based cropping systems superior to conventional sole crop of sugarcane system in terms of system productivity, net returns, benefit-cost ratio and net energy returns. The farming system serves as resource model with income generation on monthly basis. Sugarcane Based Farming System (SBFS) produced additional income of Rs. 4,11,604/year from other enterprises (livestocks, poultry and fishery).

*(P. Geetha, T. Rajula Shanthy, C. Palaniswami and M. Thirunavukkarasu - TNAU, Coimbatore)*

### Intellectual Property Management and Technology Transfer/ Commercialization – Institute Technology Management Unit (ITMU) (National Agricultural Innovation Fund Scheme (NAIF) - Component I, IP & TM, ICAR)

ITMU coordinated the overall institute intellectual property, management and commercialization activities of ICAR-SBI. ITMC meetings were conducted to take decisions on different aspects pertains to technology disclosures, patent applications and commercialization of technologies developed by ICAR-SBI. Submitted two new sugarcane varieties and two extant varieties with PPV&FRA, New Delhi. Trademark application for ICAR-SBI logo submitted which received grant for ICAR-SBI logo. One design application submitted for "Parasitoid Release Station" received FER-1 which has been appropriately replied. Two new technology disclosures received has been processed. Licensed Soil Moisture Indicator technology, SBIEC14006 - An Energycane with High biomass production, Licensed liquid jaggery technology, Production of Cane Dietary Fibre Food Products and ICAR-SBI EPN Biopesticide formulation. A total of eight MoUs signed and realised a revenue of Rs. 19,23,080/-.

*(K. Hari, G. Hemaprabha, K. Mohanraj, B. Singaravelu, K. Rathnavel (CICR RS, Coimbatore), R.M. Shanthi, C. Palaniswami and P. Murali)*

## All India Coordinated Research Project (Sugarcane)

### Agronomic performance of elite sugarcane genotypes

Four elite sugarcane genotypes Co 16018, Co 16010, Co 16006, CoVSI 16121 were assessed and compared with three standard checks *i.e.* Co 09004, Co 86032 and CoC 671 under two fertilizer levels i.e. 100 and 125% RDF. The sugarcane was planted in wide row spacing (150 cm). The crop was harvested at 12$^{th}$ month and observation on NMC, cane height, cane girth, number of nodes, cane weight and cane yield per plot was recorded. Sugarcane cane yield was influenced significantly due to different genotypes wherein, sugarcane genotypes, Co 16018 (139.1 t ha$^{-1}$) and Co 16006 (131.3 t ha$^{-1}$) has recorded significantly higher cane yield than the standard check varieties Co 86032 (125.6 t ha$^{-1}$), Co 09004 (121.20 t ha$^{-1}$) and CoC 671 (97.70 t ha$^{-1}$). The cane yield of Co 16006, Co 16010 and Co 16018 were on par with each other. Juice quality (Brix, sucrose, purity and CCS percent) were not influenced significantly due to fertilizer levels; however juice Brix, Sucrose%, Purity% and CCS% at harvest showed significant varietal differences.

**Yield attributes as influenced by fertilizer levels and elite genotypes (2022-23)**

| Treatments | Cane height (cm) | Cane girth (mm) | SCW (kg) | NMC (x10³) |
|---|---|---|---|---|
| **Fertilizer level** | | | | |
| 125% RDF | 222.70 | 30.68 | 1.60 | 82.40 |
| 100% RDF | 221.40 | 30.41 | 1.64 | 77.20 |
| SED | 3.506 | 0.87 | 0.08 | 3.85 |
| CD | NS | NS | NS | NS |
| **Genotypes** | | | | |
| Co 16006 | 220.53 | 37.00 | 1.70 | 77.25 |
| Co 16010 | 251.97 | 29.09 | 1.55 | 79.08 |
| Co 16018 | 213.88 | 31.47 | 1.70 | 76.58 |
| Co VSI 16121 | 204.72 | 27.37 | 1.40 | 73.58 |
| Co 86032 | 214.35 | 32.24 | 1.67 | 83.50 |
| Co 09004 | 241.38 | 30.00 | 1.63 | 81.42 |
| CoC 671 | 207.50 | 32.24 | 1.42 | 62.33 |
| SED | 15.06 | 1.11 | 0.19 | 4.40 |
| CD | 31.26 | 3.00 | NS | 8.46 |
| **Interactions** | | | | |
| G at RDF | | | | |
| SED | 21.29 | 2.04 | 0.27 | 5.7 |
| CD | NS | NS | NS | NS |
| RDF at G | | | | |
| SED | 20.03 | 2.08 | 0.26 | 6.5 |
| CD | NS | NS | NS | NS |

**Yield and juice quality parameters as influenced by fertilizer levels and elite genotypes (2022-23)**

| Treatments | CCS yield (t/ha) | Cane yield (t/ha) | CCS (%) | Sucrose (%) |
|---|---|---|---|---|
| **Fertilizer level** | | | | |
| 125% RDF | 18.12 | 125.8 | 14.4 | 20.50 |
| 100% RDF | 16.67 | 117.4 | 14.2 | 20.46 |
| SED | 0.4 | 4.23 | 0.26 | 0.11 |
| CD | NS | NS | NS | NS |
| **Genotypes** | | | | |
| Co 16006 | 18.64 | 131.3 | 14.2 | 20.44 |
| Co 16010 | 17.39 | 126.9 | 13.7 | 19.94 |
| Co 16018 | 18.91 | 139.1 | 13.6 | 18.42 |
| Co VSI 16121 | 14.79 | 94.2 | 15.7 | 22.77 |
| Co 86032 | 17.21 | 125.6 | 13.7 | 19.84 |
| Co 09004 | 18.18 | 121.2 | 15.0 | 21.65 |
| CoC 671 | 14.95 | 97.7 | 15.3 | 22.13 |

| Treatments | CCS yield (t/ha) | Cane yield (t/ha) | CCS (%) | Sucrose (%) |
|---|---|---|---|---|
| SED | 1.4 | 5.81 | 0.65 | 0.64 |
| CD | 2.8 | 12.06 | 1.36 | 1.33 |
| **Interactions** | | | | |
| G at RDF | | | | |
| SED | 1.7 | 8.2 | 0.93 | 0.91 |
| CD | 3.9 | 22.0 | NS | NS |
| RDF at G | | | | |
| SED | 1.7 | 8.7 | 0.90 | 0.85 |
| CD | 3.8 | 23.0 | NS | 2.25 |

*(P. Geetha, S. Anusha, C. Palaniswami and G. Hemaprabha)*

## Evaluating efficacy of PSAP for enhancement of sugarcane growth, yield and quality

The experiment on evaluating efficacy of Pottasium Salt of Active Phosphorus (PSAP) for enhancement of sugarcane growth, yield and quality was initiated during March 2023. The experiment was conducted in Randomized Block Design with three replications with 12 treatments. The treatment details are given in the table. Juice analysis was done at 10$^{th}$ and 12$^{th}$ months after planting. The crop was harvested after twelve months and NMC, cane height, cane girth, number of nodes, cane weight, and cane yield per plot were recorded.

**Yield and yield attributes as influenced by PSAP in plant cane (2022-23)**

| Treatments | Cane height (cm) | Cane girth (mm) | SCW (kg) | NMC (x10$^3$) | Cane yield (t ha$^{-1}$) |
|---|---|---|---|---|---|
| 100% RDF + WSS | 231.7 | 32.43 | 1.8 | 66.56 | 103.84 |
| 100% RDF + SS (0.8% PSAP) | 227.8 | 32.49 | 1.6 | 68.64 | 96.44 |
| 100% N + 50% PK + WSS | 237.2 | 33.99 | 1.8 | 59.60 | 97.13 |
| 100% N + 50% PK + SS (0.8% PSAP) | 245.0 | 32.53 | 1.9 | 45.65 | 87.42 |
| 100% RDF + SS + three FS (0.4, 0.65, 0.8% PSAP) | 232.2 | 31.32 | 1.5 | 61.60 | 93.03 |
| 100% RDF + SS + three FS (0.4, 0.65, 1.1% PSAP) | 223.9 | 32.81 | 1.5 | 56.56 | 102.29 |
| 100% RDF + SS+ four FS (0.4, 0.65, 1.1, 1.1) | 236.1 | 33.16 | 1.8 | 57.28 | 103.94 |
| 100% N + 50% PK + SS + four FS (0.4, 0.65, 0.8 and 1.1% PSAP) | 242.0 | 34.17 | 1.9 | 60.40 | 102.67 |
| 100% N + 50% PK + SS + three FS (0.4, 0.65 and 1.1% PSAP) | 227.8 | 32.45 | 1.6 | 72.88 | 113.69 |
| 100% N + 50% PK + SS + four FS (0.4, 0.65, 1.1 and 1.1% PSAP) | 230.2 | 31.32 | 1.7 | 81.16 | 124.39 |
| SED | 10.54 | 1.32 | 0.18 | 7.7 | 13.9 |
| CD | NS | NS | NS | 16.2 | 25.3 |

*RDF: Recommended dose of fertilizers, WSS: Without sett soaking, SS: Sett soaking FS: Foliar spray*

**Quality parameters as influenced by PSAP in plant cane (2022-23)**

| Treatments | Brix (%) | Sucrose (%) | Purity (%) | CCS (%) | CCS Yield (t ha$^{-1}$) |
|---|---|---|---|---|---|
| 100% RDF + WSS | 18.3 | 18.30 | 92.17 | 13.4 | 13.91 |
| 100% RDF + SS (0.8% PSAP) | 20.4 | 18.73 | 92.13 | 13.2 | 12.73 |
| 100% N + 50% PK + WSS | 20.1 | 18.37 | 91.67 | 12.9 | 12.53 |
| 100% N + 50% PK + SS (0.8% PSAP) | 19.9 | 17.73 | 89.83 | 12.3 | 10.75 |
| 100% RDF + SS + three FS (0.4, 0.65, 0.8% PSAP) | 20.0 | 18.73 | 93.60 | 13.3 | 12.37 |
| 100% RDF + SS + three FS (0.4, 0.65, 1.1% PSAP) | 18.9 | 18.00 | 96.20 | 12.9 | 13.20 |
| 100% RDF + SS + four FS (0.4, 0.65, 1.1, 1.1) | 19.4 | 18.60 | 96.23 | 13.3 | 13.82 |
| 100% N + 50% PK + SS + four FS (0.4, 0.65, 0.8 and 1.1% PSAP) | 19.4 | 18.20 | 94.20 | 12.9 | 13.24 |
| 100% N + 50% PK + SS + three FS (0.4, 0.65 and 1.1% PSAP) | 19.5 | 18.83 | 96.73 | 13.6 | 15.46 |
| 100% N + 50% PK+SS+ four FS (0.4, 0.65, 1.1 and 1.1% PSAP) | 18.9 | 18.40 | 97.53 | 13.3 | 16.54 |
| SED | 1.014 | 0.65 | 4.10 | 0.71 | 0.55 |
| CD | NS | NS | NS | NS | 1.03 |

The influence of PSAP-based nutrient management on yield attributes were found non-significant except NMC. However, PSAP-based nutrient management in plant sugarcane crop showed significantly higher cane yield (123 t ha$^{-1}$) with sett soaking @ 0.8% PSAP solution + RDN, 50% P and 50% K + foliar spray of PSAP @ 0.4, 0.65, 1.10 and 1.10 during 60, 80, 100 and 120 DAP. The quality parameters such as Brix%, Sucrose%, Purity and CCS% did not vary due to the application of PSAP, however the high sugar yield (16.54 t ha$^{-1}$) was recorded with 100% Nitrogen +50% PK + sett soaking + four FS (0.4, 0.65, 1.1 and 1.1% PSAP).

*(P. Geetha, S. Anusha and V. Krishnapriya)*

## Evaluation of new herbicide molecules for weed management in sugarcane plant crop

A new experiment was initiated during January 2023 in RBD with nine treatments and three replications to evaluate the effect of new herbicide molecules for the management of weeds in sugarcane plant crop. The treatment includes T1: Pre emergence application of Clomazone 22.5% + Metribuzine 21% WP (ready mix) 2.5 kg ha$^{-1}$ followed by one inter-cultivation at 60 days after planting (partial earthing up), T2: Pre emergence application of Clomazone 30% + Sulfentrazone 28% WP (ready mix) 2.5 kg ha$^{-1}$ followed by one inter-cultivation at 60 days after planting (partial earthing up), T3: Post emergence application of 2-4 D sodium salt + Metribuzine+ Pyrazosulfuron ethyl (ready mix) 3 kg ha$^{-1}$ at 2-4 leaf stage of weeds followed by earthing up at 120 DAP, T4: Post emergence application of Halosulfuron methyl + Metribuzine (ready mix) @ 1 L ha$^{-1}$ at 2-4 leaf stage of weeds followed by earthing up at 120 DAP, T5: Post emergence application of Topramezone + Atrazine (ready mix) 3 L ha$^{-1}$ at 2-4 leaf stage of weeds followed by earthing up at 120 DAP, T6: Pre emergence application of Atrazine 80% WP @ 2.5 kg ha$^{-1}$ followed by one inter-cultivation at 60 days after planting (partial earthing up), T7: Post emergence application of 2, 4-D Na salt @ 2.5 kg ha$^{-1}$ at 2-4 leaf stage of weeds followed by earthing up at 120 DAP, T8: Weed free check and T9: Weedy check. The major weed flora observed in field *Cyperus rotundus, Boerhavia erecta, Trianthema portulacastrum, Commelina benghalensis, Parthenium hysterophorus, Brachiaria reptans, Digera muricata* and *Cyanadon dactylon*. Germination was more than 50% in all the treatments.

*(P. Geetha and S. Anusha)*

### Public-Private Partnership Project

**Improving water use efficiency and economizing water use in sugarcane cultivation in sub-tropical India (ISMA-funded)**

The project was initiated by March, 2023 with the objective of 1. To work out the best water saving ago-techniques in sugarcane cultivation in subtropical and tropical India. 2. To work out the irrigation requirement of the most prominent crops/cropping system with sugarcane at different locations. 3. To work out the annual irrigation water use in sugarcane cropping at various techniques. The experiment has been designed in RBD with 7 methods of irrigation as treatments. Planting was taken up by March, 2023 with double bud setts. Irrigation was given as per IW/CPE ratio. The crop is in grand growth stage.

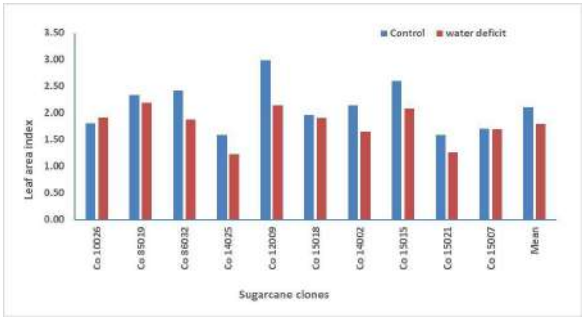
*(P. Geetha and S. Anusha)*

## 5.2.2 Plant Physiology

**Enhancing physiological efficiency of sugarcane**

**Evaluation of physiological efficiency of commercial hybrids and species clones of *Saccharum* for water use under water-limited conditions**

Ten promising commercial sugarcane (*Saccharum*) hybrids were raised in the research farm at ICAR-SBI, Coimbatore during 2022-23. The sugarcane was planted in March, 2022 and the canes were harvested 12 months later in 2023. A split-plot design was adopted, with irrigation treatment as the main plot and sugarcane clones as the subplots. Each treatments were replicated twice and the recommended cultural practices were followed except irrigation. Irrigation scheduling was based on a climatological approach, *ie.,* Cumulative Pan Evaporation (CPE) method. Evaporation rates were measured using "class A" pans. The irrigation treatments includes $I_o$: full irrigation at the recommended interval, with 100% crop evapotranspiration (ET) replacement (control); and $I_1$: restricted irrigation at the recommended interval, with 50% crop ET replacement (50% by volume). Detrashing of dried leaves was done at 5, 7, and 10 months after planting for proper sunlight penetration. Above-ground biomass from an area of one square meter was determined through destructive sampling during the different phenophases of the crop. The weather data during the 2022-23 experimental period showed that the rainfall was comparably less to the 40-year (1940-1990) average rainfall (674 mm), and the irrigation treatments led to significant differences in the recorded physiological parameters, cane yield, IWUE, and water productivity.




*Effect of deficit irrigation on leaf area index in sugarcane clones*

Significant variations in leaf, stem, and sheath biomass, leaf area index along with leaf number, SPAD index, and canopy temperature were observed under control and deficit irrigated conditions. Drought tolerant clones exhibited better physiological traits and cane yield. A significant decline in cane yield was observed under the water deficit ($I_1$) condition by 18% compared to the control ($I_o$). The mean cane yield of the sugarcane clones under control conditions was 88 ton $ha^{-1}$, while it was registered 71 t $ha^{-1}$ under deficit irrigated condition. Among the studied clones the Co 85019, Co 12009, Co 14025, Co 15021 recorded better cane yield (>88 ton $ha^{-1}$) under control conditions, while the Co 85019, Co 14002, Co 15021, and Co 14025 were recorded better cane yield under water deficit condition ($I_1$). The mean irrigation water use efficiency (IWUE) under control and water deficit conditions were 0.75 and 0.87 respectively. Among the studied clones the Co 85019, Co 12009, Co 14025, and Co 15021 recorded IWUE (>0.75 ton $ha^{-1}$) under control conditions, while the Co 85019, Co 14002, Co 15021, and Co 14025 were observed better IWUE under water deficit condition ($I_1$). The mean water productivity (WP) under control and water deficit conditions were 5.27 and 5.38 ($kg/m^3$) respectively. Among the studied clones the Co 12009, Co 14002, Co 14025, Co 15007, Co 15015, Co 15018, and Co 15021 recorded WP under control conditions, while

the Co 85019, Co 14002, Co 15021, Co 14025, and Co 86032 were observed better WP under water deficit condition ($I_1$). A significant correlation was observed between canopy temperature and cane yield under water deficit condition.

*(R. Arunkumar, S. Anusha, G. Hemaprabha, V. Krishnapriya, V. Sreenivasa, M. Alagupalamuthirsolai and A.S. Tayade)*

## Comparative physiological analysis of tropical and sub-tropical varieties of sugarcane

Six sub-tropical clones (Co 0238, Co 15023, Co 15027, Co 98014, BO 91 and CoLk 8102) and six tropical clones (Co 11015, Co 0212, Co 06022, Co 13006, Co 14012 and Co 86032) were planted at two different climatic conditions *viz.,* ICAR-Sugarcane Breeding Institute, Coimbatore (Tropical) and ICAR-SBI, Regional Centre, Karnal (sub-tropical) with an objective of identifying a superior common variety for both tropical and sub-tropical India by assessing physiological efficiency and yield potential at two locations.

**Biometric observation at different growth phases:** In the present study, irrespective of the location, varieties, and groups, the shoot population reached a maximum at 120 DAP (90.4 '000 $ha^{-1}$) and later declined at 340 DAP (82.7 '000$ha^{-1}$). In location I, at maturity phase (MP), among a tropical group Co 14012 produced the highest shoot population (86.8 '000 $ha^{-1}$) and it was followed by Co 86032 (80.9 '000 $ha^{-1}$), while in sub-tropical groups, CoLk 8102 recorded the maximum shoot population (94.1 '000 $ha^{-1}$) followed by BO 91 (90.1 '000 $ha^{-1}$). In location II, at the MP, among the sub-tropical group, the highest NMC was recorded in CoLk 8102 (107.0 '000 $ha^{-1}$) followed by BO 91 (106.3 '000 $ha^{-1}$), while in tropical clones, Co 13006 produced the maximum NMC (93.2 '000 $ha^{-1}$) and it was followed by Co 14012 (90.3 '000 $ha^{-1}$) recorded maximum. The result of the pooled data indicates that the NMC of sub-tropical groups was reduced significantly when grown under tropical conditions, while tropical varieties' population potential was not much influenced by the locations.

Irrespective of the location, varieties, and groups, the Total Dry Matter Production (TDMP) increased from FP (2.08 kg $m^{-2}$), GGP (2.57 kg $m^{-2}$) and MP (3.73 kg $m^{-2}$). At the maturity phase, the difference in the TDMP between the two locations was negligible, however, the tropical varieties found good in producing higher TDMP under tropical conditions (3.90 kg $m^{-2}$) compared to the sub-tropical varieties (3.74 kg $m^{-2}$), and sub-tropical varieties recorded higher TDMP under sub-tropical conditions. Under tropical conditions, among the groups, Co 14012 (4.86 kg $m^{-2}$), Co 86032 (4.36 kg $m^{-2}$), Co 15027 (4.46 kg $m^{-2}$) and Co 98014 (4.43 kg $m^{-2}$) recorded higher biomass compared to other tested varieties. Under sub-tropical conditions, Co 15027 (4.98 kg $m^{-2}$) Co 15023 (4.73 kg $m^{-2}$), Co 0238 (4.50 kg $m^{-2}$) and Co 14012 (4.15 kg $m^{-2}$) produced higher TDMP. Under tropical conditions, data on partitioning efficiency towards stem at MP was found comparatively higher in the tropical group (77.5%) than sub-tropical group (70.2%), while the sub-tropical group showed higher leaf and sheath partitioning efficiency (18.8 and 10.0%) compared to tropical group (13.5 and 7.7%) respectively which results in the poor economic sink in sub-tropical varieties (0.83 kg $cane^{-1}$) compared when grown sub-tropical situations (1.17 kg $cane^{-1}$).

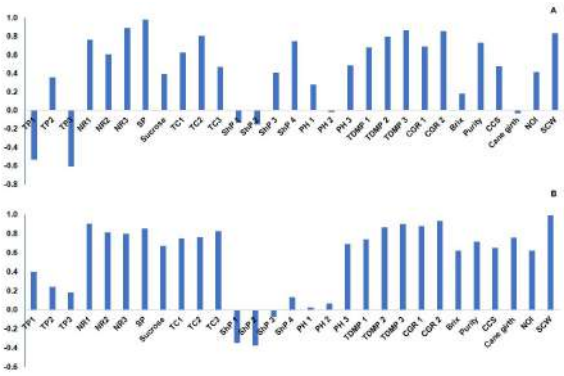
**Physiological and Biochemical parameters at different growth phases:** Except for total phenolics content, other metabolic traits *viz.,* total chlorophyll content, NRase activity, soluble protein, total soluble sugars, sucrose synthesis and accumulating enzymes were found high in tropical varieties compared to sub-tropical varieties. The results showed that the soluble protein content was comparatively higher in tropical varieties (45.8 mg $g^{-1}$) than in the sub-tropical varieties (40.5 mg $g^{-1}$), indicating that tropical groups possess higher photosynthetic efficiency which favours achieving higher TDMP (biomass). Unlike other biochemical parameters, total phenolics content at FP, GGP, and MP was comparatively higher in sub-tropical varieties (96.1, 103.1, and 109.6 µg $g^{-1}$ FW, respectively) than in tropical varieties (84.1, 80.6, and 94.0 µg $g^{-1}$ FW, respectively), particularly in Co 15027 (110.0, 120.0, and 116.7 µg $g^{-1}$ FW, respectively), and Co 15023 (105.5, 115.5, and 123.7 µg $g^{-1}$ FW, respectively) indicating their resistance mechanism against biotic and abiotic stresses.

**Yield and yield components:** The result of cane girth under tropical conditions showed that

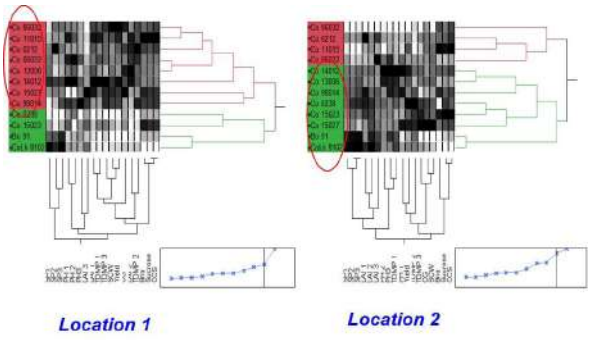
the varieties Co 86032 and Co 13006 recorded the highest value of 3.1 cm, while Co 11015 recored the lowest cane girth of 2.6 cm. In the sub-tropical group, the variety Co 15027 recorded the highest cane girth of 3.2 cm, whereas BO 91 recored the lowest cane girth of 2.0 cm, with an average cane girth of 2.5 cm. Among the varieties studied under tropical climatic conditions, Co 86032 recorded the highest single cane weight (SCW) of 1.33 kg, closely followed by Co 14012 (1.18 kg), and Co 11015 (1.09 kg) with an average SCW of 1.07 kg for the tropical group. Under sub-tropical conditions, tropical varieties did not influence any significant difference in SCW, however, among the sub-tropical varieties, Co 15027 recorded the highest SCW of 1.68 kg, which was followed by Co 0238 (1.31 kg).

Cane yield under sub-tropical conditions was significantly higher (102.82 t $ha^{-1}$) than tropical conditions (82.09 t $ha^{-1}$). Under tropical experiments (LI), the variety Co 86032 than in the sub-tropical group (69.3 t $ha^{-1}$). Among the tropical groups, the variety recorded higher cane yield Co 86032 recorded the highest cane yield of 110.0 t $ha^{-1}$, while the lowest was found in Co 13006 (77.1 t $ha^{-1}$). In the sub-tropical group, the highest cane yield was found in Co 15027 (98.5 t $ha^{-1}$), closely followed by Co 98014 (95.3 t $ha^{-1}$), whereas the lowest value was recorded in BO 91 (50.1 t $ha^{-1}$). Under sub-tropical experiments (LII), the variety Co 0238 recorded the highest cane yield of 126.0 t $ha^{-1}$, while the lowest was found in BO 91 (85.4 t $ha^{-1}$). In the tropical group, the highest cane yield was found in Co 14012 (122.1.5 t $ha^{-1}$), closely followed by Co 13006 and Co 11015 (111.30 t $ha^{-1}$), whereas the lowest value was recorded in Co 86032 (53.2 t $ha^{-1}$).

**Juice quality parameters:** Under tropical conditions, data on juice quality parameters in the 12$^{th}$ month showed that the tropical group recorded higher juice quality parameters *viz.*, brix% (20.7%), sucrose% (18.8%), and CCS% (13.2%) compared to sub-tropical (19.6%, 17.2%, and 11.9% respectively). The varieties Co 11015 (tropical) and Co 15023 (sub-tropical) comparatively recorded higher juice quality parameters, sucrose and CCS% respectively than other varieties studied. The results of the juice quality parameters inferred that when tropical varieties are grown under sub-tropical conditions quality aspects (21.6, 20.2 and 14.3% of brix, sucrose and CCS% respectively), were not affected in fact it was numerically higher as compared to tropical conditions (20.7, 18.8, and 13.2% brix, sucrose and CCS% respectively), however when sub-tropical varieties grown under tropical conditions drastic reduction juice quality parameters (19.6, 17.2 and 11.9% of brix, sucrose and CCS% respectively) was observed compared to sub-tropical conditions (21.0, 20.2 and 13.8% of brix, sucrose and CCS% respectively) indicating that the climatic conditions have a profound effect on juice quality of sub-tropical varieties.



*Correlation coefficients of morphological, physiological and biochemical traits with cane yield and quality under (A) tropical and (B) sub-tropical conditions*




*Two-way hierarchical clustering of varieties based on their performance under tropical (location 1) and sub-tropical (location 2) conditions*

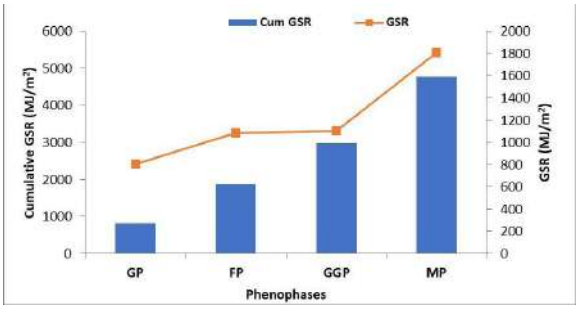
**Correlation Analysis:** The result of the correlation analysis of tropical data showed that the physiological traits (total chlorophyll, soluble protein and NRase at GGP), growth parameters *viz.*, CGR, TDMP, NMC and SCW were positively associated with cane yield of tropical varieties. A similar trend was observed

for sub-tropical grown under tropical conditions with a highly significant positive correlation. The data on total phenolic content showed a negative association with the yield of tropical varieties, while it had a highly positive association with the yield of sub-tropical varieties indicating the acclimatization potential of the latter. The result of the correlation analysis of sub-tropical data showed that the physiological traits (total chlorophyll, at GGP), growth parameters *viz.*, plant height, CGR and LAI at FP & GGP, TDMP, Number of internodes and SCW were positively associated with cane yield of all group of varieties. The data on total phenolic content showed a negative association with the yield of sub-tropical varieties, while it showed a highly positive association with the yield of tropical varieties indicating the acclimatization potential of the latter. Two-way hierarchical clustering based on varietal performance under tropical and sub-tropical conditions revealed the best performing varieties as Co 86032, Co 11015, Co 0212, Co 06022, Co 13006, Co 14012, Co 15027 and Co 98014 under tropical condition, while Co 14012, Co 13006, Co 98014, Co 0238, Co 15023, Co 15027, BO 91, CoLK 8102 yielded better under sub-tropical conditions. Varieties with better yield and physiological efficiency under both tropical and sub-tropical conditions were Co 14012 and Co 98014.

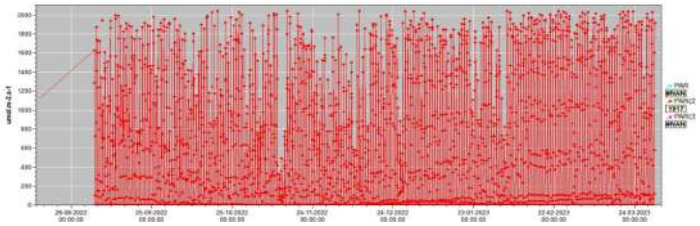
*(R. Gomathi, R. Arun Kumar, Pooja, K. Elayaraja and V. Krishnapriya)*

## Radiation use efficiency of sugarcane genotypes as influenced by water levels and crop geometry

An experiment was conducted in ICAR-SBI during 2022-23 with 10 sugarcane clones in field condition under irrigation treatments *viz.*, $I_0$- Irrigation at 100% cumulative pan evaporation, and $I_1$-50% reduction in volume of water irrigated). Controlled irrigation was provided to individual clones and treatment through PVC pipes monitored by water meter. Irrigation was quantified based on pan evaporation, KC value (crop coefficient depending on the age of crop) and area of plots. The total global solar radiation received during the experimental period was 5234 MJ $m^{-2}$. Line quantum sensors (LICOR) along with digital data logger (LI-1400) were used to record the light interception and light reflection data. The cumulative global photosynthetically active radiation (PAR) recorded during the germination phase (GP), formative phase (FP), grand growth phase (GGP), and maturity phase (MP) were 388, 903, 1427, and 2292 MJ/$m^2$, respectively. The mean, maximum, and minimum daily global solar radiation during the crop period was 312 Cal.$cm^{-2}$.$d^{-1}$, 459 Cal.$cm^{-2}$.$d^{-1}$ and 30 Cal.$cm^{-2}$.$d^{-1}$ respectively. Above-ground biomass from an area of one square meter was determined through destructive sampling during the formative phase and grand growth phase. The weather data during the 2022-23 experimental period showed that the rainfall was comparably less to the 40-year (1940-1990) average rainfall (674 mm), and the irrigation treatments led to significant differences in the recorded crop growth and physiological parameters, and finally resulted in declined solar energy utilization efficiency for biomass and stalk productivity. The hourly PAR data was also recorded and the data revealed that the crop receives peak PAR of 2000 µmoles/$m^2$/$s^1$. The mean solar energy utilization efficiency (Eu effy) under control and water




*The cumulative global solar radiation in different phenophases of sugarcane*



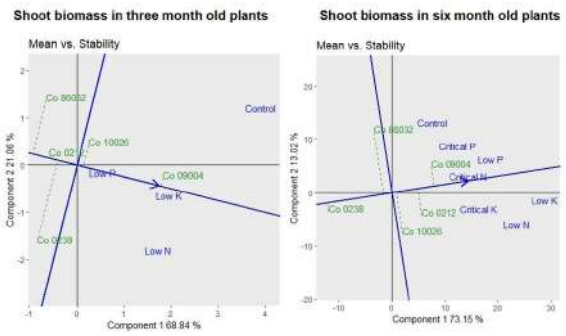
*The hourly PAR data during the GGP and MP phase of sugarcane*

deficit conditions were 2.53 and 1.99 respectively. Among the studied clones Co 85019, Co 12009, Co 14025, and Co 15021 recorded better Eu effy (>2.53) under control conditions, while the Co 85019, Co 14002, Co 15021, and Co 14025 were observed to better Eu effy under water deficit condition ($I_1$). Significant variations in leaf, stem, and sheath biomass along with leaf number, SPAD index, and canopy temperature were observed under both conditions and the water deficit tolerant clones exhibited better physiology combined with cane yield. Significant variation in biomass, light interception, shoot population was also recorded. Few clones *viz*., Co 85019, Co 14002, Co 15021, and Co 14025 recorded with better light interception, and RUE under water-limited condition.

*(R. Arun Kumar and P. Geetha)*

## Deciphering the physiological basis of nutrient use efficiency in sugarcane

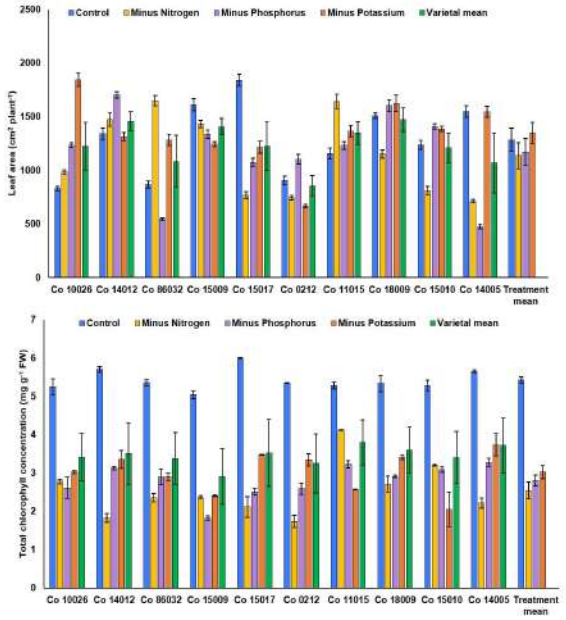
**Experiments under controlled condition:** Experiments were conducted under controlled condition through hydroponic culture to investigate the effects of low (20 µM) and critical threshold (375 µM) for nitrogen (N), low (2 µM) and critical threshold (87.5 µM) for phosphorus (P), low (10 µM) and critical threshold (175 µM) for potassium (K) in five sugarcane varieties (Co 86032, Co 0212, Co 09004, Co 0238, Co 10026). Control treatment comprised sufficient (2 mM) supply of N, P and K. Morphological, physiological, biochemical traits, and nutrient estimation was recorded in three-month and six-month-old plants. Mean versus stability analysis of shoot biomass showed varieties Co 09004 and Co 10026 (at three-month stage), Co 09004, Co 0212, and Co 10026 (at six-month stage) to perform better under the tested treatment levels. Leaf area under nutrient deficiency was higher in these varieties as compared to the varietal average, with corresponding increase in canopy temperature depression. Lipid peroxidation measured in terms of malonaldehyde accumulation was relatively lesser under nutrient deficiency as compared to the varietal mean, especially in the case of low K. This was attributed to the activity of enzymes superoxide dismutase, catalase, and peroxidase, which play a major role in scavenging the reactive oxygen species under nutrient deficiency. Specific root length (length of fine roots/ root dry weight) and root length density (cumulative root length/ volume) increased under stress as compared to control. Varieties Co 09004 and Co 10026 maintained lesser specific root length and root length density as compared to the varietal mean under nutrient deficiency, attributed to increased exploratory root length. Root anatomical features under nutrient deficiency revealed prominent traits including reduced root diameter, greater number of metaxylem elements under low N, a greater number of root hairs under low P, suberised exodermis, U-shaped thickening of endodermis and disintegration of cortical cells to form lysigenous aerenchyma under N, P and K deficiency. Overall results revealed that traits including leaf area, chlorophyll content, chlorophyll *a* fluorescence, canopy temperature depression, leaf metabolite content (proteins, phenols, free amino acids, sugars, starch), lipid peroxidation and root system traits were associated with biomass accumulation and nutrient uptake under controlled condition, with differential response among the tested sugarcane varieties.



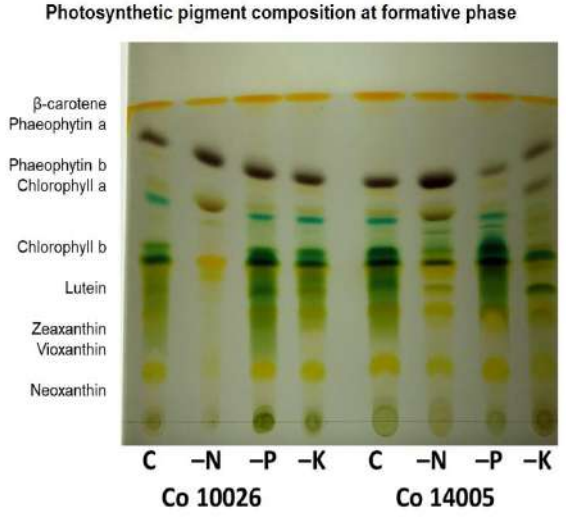

*Three- and six-month-old plants of sugarcane varieties subjected to N,P & K deficiency under controlled condition*

**Experiments under field condition:** Field evaluation in a strip-plot design was initiated during the cropping season 2023-24 with four main treatment plots (Control: 280:62.5:120 kg $ha^{-1}$ NPK + $ZnSO_4$ 37.5 kg $ha^{-1}$ + $FeSO_4$ 100 kg $ha^{-1}$, Minus N: 62.5:120 kg $ha^{-1}$ PK + $ZnSO_4$ 37.5 kg $ha^{-1}$ + $FeSO_4$ 100 kg $ha^{-1}$, Minus P: 280:120 kg $ha^{-1}$ NK + $ZnSO_4$ 37.5 kg $ha^{-1}$ + $FeSO_4$ 100 kg $ha^{-1}$, Minus K: 280:62.5 kg $ha^{-1}$ NP + $ZnSO_4$ 37.5 kg $ha^{-1}$ + $FeSO_4$ 100 kg $ha^{-1}$) and twenty-two

genotypes in sub-plots (Co 86032, Co 11015, Co 0212, Co 09004, Co 10026, Co 18009, Co 14012, Co 14005, Co 14004, Co 15006, Co 15009, Co 15010, Co 15017, Co 97010, Co 0238, Co 06022, CYM 08-922, GUK 06402, ISH 1875, ISH 924, ISH 939, BC391-ISH 100), with two replications. Soil pH, EC, organic carbon, available N, available P, and available K prior to planting was 8.4, 496 µS $m^{-1}$, 0.51%, 149.62 kg $ha^{-1}$, 13.07 kg $ha^{-1}$ and 596.76 kg $ha^{-1}$, respectively.




*Variation in leaf area and total chlorophyll concentration of sugarcane varieties in response to N,P & K deficiency under field condition*




*Variation in composition of photosynthetic pigments of sugarcane varieties in response to N,P & K deficiency under field condition*

Observations during formative phase indicated significant effect of nutrient availability, sugarcane genotypes and their interaction on shoot population, plant height, leaf area, photosynthetic pigments (chlorophyll a, chlorophyll b, carotenoids, anthocyanin), leaf metabolites (sugars, starch, protein, free amino acid, phenol), lipid peroxidation and antioxidant enzyme activity (catalase, peroxidase, superoxide dismutase). Shoot population of commercial hybrids was highest under control (66 per row), followed by minus phosphorus (60 per row), minus nitrogen (59 per row) and minus potassium (51 per row) treatments. Among the Co-canes, Co 14005 and Co 86032 exhibited highest shoot population at formative phase irrespective of treatment. Plant height was highest in minus phosphorus (82 cm) treatment, followed by control (72 cm), minus potassium (68 cm) and minus nitrogen (66 cm). Co-canes Co 18009, Co 14012, Co 86032, and Co 14005 recorded on par and higher plant height as compared to other tested clones. Highest leaf area was observed in minus potassium (1348 $cm^2$ $plant^{-1}$), followed by control (1284 $cm^2$ $plant^{-1}$), minus phosphorus (1171 $cm^2$ $plant^{-1}$) and minus nitrogen (1135 $cm^2$ $plant^{-1}$) treatments, wherein Co 18009 and Co 14012 exhibited highest leaf area across treatments**.** Total chlorophyll content was highest under control (5.43 mg $g^{-1}$ FW), followed by minus potassium (3.03 mg $g^{-1}$ FW), minus phosphorus (2.81 mg $g^{-1}$ FW) and minus nitrogen (2.54 mg $g^{-1}$ FW). Chlorophyll a concentration was least and on par in minus nitrogen (0.25 mg $g^{-1}$ FW) and minus potassium (0.30 mg $g^{-1}$ FW), while chlorophyll b concentration was least (2.30 mg $g^{-1}$ FW) and on par in minus nitrogen, and minus phosphorus treatments. Total carotenoid concentration was highest and on par in minus potassium (6.37 mg $g^{-1}$ FW) and minus phosphorus (6.36 mg $g^{-1}$ FW) treatments, followed by minus nitrogen (5.34 mg $g^{-1}$ FW) and control (2.54 mg $g^{-1}$ FW). Anthocyanin accumulation was highest under control (17.7 mg $g^{-1}$ FW), followed by minus phosphorus (9.2 mg $g^{-1}$ FW), minus potassium (7.8 mg $g^{-1}$ FW) and minus nitrogen (3.6 mg $g^{-1}$ FW). Composition of photosynthetic pigments revealed by thin layer chromatography showed differential banding pattern of pheophytin b, chlorophyll a, chlorophyll b, and xanthophyll

pigments under minus nitrogen and minus potassium treatments, which in turn influenced the photochemical efficiency of photosystem II. Content of leaf metabolites was higher in control as compared to low nutrient availability treatments, wherein the Co-canes Co 14012, Co 18009, Co 15009, Co 11015, and Co 10026 exhibited higher leaf metabolite content when averaged over treatments. Lipid peroxidation was highest under minus nitrogen treatment, followed by minus potassium, minus phosphorus, and control. Catalase activity was on par and higher in all three low nutrient treatments as compared to control. Superoxide dismutase and peroxidase activity was higher under control compared to low nutrient treatments. Irrespective of treatments, the Co-canes Co 14012, Co 14005, Co 11015, and Co 10026 recorded higher antioxidant enzyme activity.

*(V. Krishnapriya, R. Arun Kumar, Anusha, V. Vinu and M. Alagupalamuthirsolai)*

## Plant architectural traits for developing ideotype concept in sugarcane for tropical conditions

Observations were recorded from two experiments (32+ 38) in seventy genotypes (comprising species clones, pre-breeding clones, commercial types) on physiological (Chlorophyll content, chlorophyll fluorescence (*Fv/Fm*), SPAD index, canopy temperature (CT), leaf epidermal wax content,), leaf angle, canopy cover, growth (shoot height, tiller count, leaf, sheath, stem, and dry matter partitioning), juice analysis (mother shoot, primary, secondary, tertiary, quaternary tiller/shoots) and yield and yield attributes (NMC, Single cane weight (SCW).

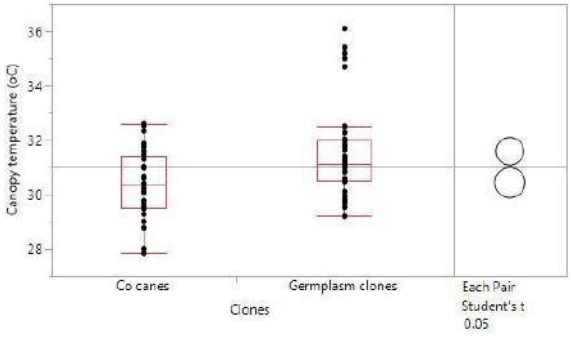
**Variability in physiological traits:** The mean, minimum, and maximum chlorophyll content in 'Co' canes were 7.374, 5.512, and 9.471 (mg/g. Fwt), while the mean, minimum, and maximum carotenoid contents were 1.539, 1.139, and 2.093 (mg/g.Fwt) respectively. The mean, minimum, and maximum chlorophyll content in pre-breeding and species clones were 7.432, 3.362, and 9.604 (mg/g.Fwt), while the mean, minimum, and maximum carotenoid contents were 1.553, 0.766, and 2.051 (mg/g.Fwt), respectively. Significant variations in chlorophyll 'a' and 'b' content were also observed.

The canopy temperature recorded through a thermal IR (FLIR-E6) camera also showed significant variability among the studied clones. The mean, minimum, and maximum canopy temperature were 31.06, 27.83, and 36.10°C respectively. Canopy cover (%) at the early stage of the crop indicates the phenomena of early canopy cover developing in certain clones favors in harvesting solar radiation effectively and translation in the form of biomass production and subsequent partitioning towards sink development. The mean, minimum, and maximum canopy coverage in 'Co' canes were 38.6, 30.3, and 51.6%, while among the pre-breeding clones the mean, minimum, and maximum canopy coverage were 33.0, 20.4, and 51.3% respectively. Among 'Co' canes Co 8021, Co 0212, Co 99004, and Co 15021 were recorded with better CC%, while among the germplasm clones 14-161, 20-335, 04-472, 004-73, GUK 06-402, 20-191, 99-19, and 99-291 were recorded better CC%. Considerable variations in CC% were also observed among the studied pre-breeding clones. Tiller production and synchrony for better sink size were studied by marking tillers formed at different days after plating. Tillers formed up to 100 days of age contribute to millable cane and a maximum number of tillers during the early peak tillering phase plays a major role in the conversion efficiency of tillers to millable stalks. Further observations on the conversion efficiency of tillers to millable stalk were observed to elucidate the sink size. A significant decline in NMC of 14% and 11% was observed in both 'Co' canes and the studied clones compared to the NMC recorded at the grand growth phase (GGP). Crop growth and dry matter partitioning studied at the formative and GGP in the sugarcane clones revealed a better association of source-sink relationship in 'Co' canes, while few clones in the species and pre-breeding types showed vice versa.

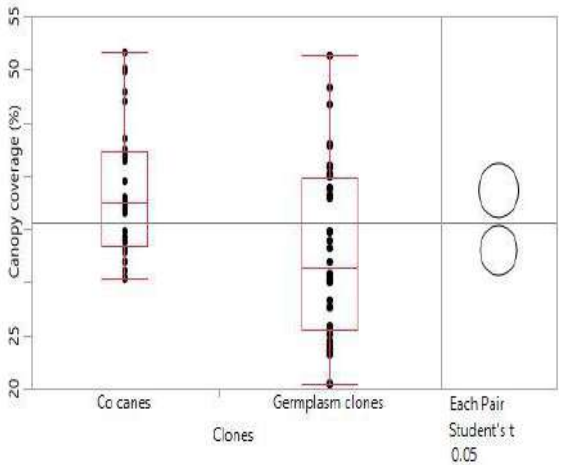
**Cane yield and juice sucrose%:** The mean, minimum, and maximum cane yield in 'Co' canes were 80.94, 39.69, and 114.82 (t ha-1). Among the clones, Co 15015, Co 85019, Co 15021, and CoM

0265 recorded better cane yield compared to other studied clones. Significant variations in cane yield were observed among the pre-breeding and species clones. Among the 'Co' canes the Co 11015, Co 12009, 2019-40, 2019-114, and Co 14002 were recorded with better sucrose content, while among the pre-breeding and species clones the 01-807, 12-127 indicated better sucrose.

**Variability of sucrose content in primary, secondary, tertiary and late formed tillers:** Variability of sucrose content in different category of tillers *viz.*, primary, secondary, tertiary and quaternary tillers/shoots was studied by individually marking the tillers by different colors of paint for different category of tillers. The juice sucrose content estimation revealed a gradual reduction in the late formed tillers compared to the early ones. Among the studied 'Co' canes & genetic stock, the Co 11015 variety has registered better sucrose content in all the category of tillers. Among the studied sugarcane germplasm clones, the 004-73 and ISH 107 clones has registered better sucrose content in all the category of tillers. The high biomass type clones *viz.*, Co 8371, Co 85019 were recorded with poor sucrose, and it is plausibly due to the more activity of invertase enzyme towards biomass production and the higher invertase generally results in lower sucrose accumulation. Among the germplasm clones the 81 GUK 192 was recorded with poor sucrose content in all the categories of tillers. Overall, the correlation among the juice analysis data revealed that the plant height had significant positive correlation ($r=0.579^{**}$) with sucrose%, while cane girth had significant negative correlation ($r=-0.272^{**}$) with sucrose% in Co Canes.




*Variability in canopy temperature in sugarcane clones*




*Variability in canopy coverage (CC%) in sugarcane clones*

*(R. Arun Kumar, G. Hemaprabha, S. Alarmelu, K. Mohanraj, T. Arumuganathan, V. Sreenivasa, V. Krishnapriya, S. Anusha and M. Alagupalamuthirsolai)*

## Development of hydroponic screening methodologies for sugarcane varietal evaluation in response to abiotic stress under controlled condition

Due to uncertainty in weather variability the field-level screening for identifying tolerant sugarcane clones is tedious, and finding simple hydroponic methods for screening the sugarcane clones for drought, salinity and waterlogging stress is essential for climate resilience. Based on our experiment we found that EC of 8 dS $m^{-1}$ salinity can be used for screening salinity-tolerant sugarcane clones. Two sugarcane clones *viz.*, Co 86032, and Co 85019 were planted in plastic trays, and well-established plants were shifted to hydroponic culture condition (Tank size: LxBxH=20x20x50cm) and Hoagland solution (Major nutrient: $Ca(NO_3)2.4H_2O$, $KNO_3$, $MgSO_4.6H_2O$, $KH_2PO_4$, Fe EDTA, Minor nutrient: $H_3BO_3$ $MnCl_2.4H_2O$ $ZnSO_4.7H_2O$ $CuSO_4.5H_2O$ $(NH_4)$ $6MO_7O_{24}$ $4H_2O$ were used for nutrient supply and maintenance of crop. Artificial aeration by bubbling air from the bottom of the tank was provided and the tanks were covered by a black color polythene sheet for avoiding algal growth. Sugarcane clones *viz.*, Co 86032, and Co 85019 were subjected to salinity stress (imposed by treating hydroponically grown plants to 8 dS $m^{-1}$ salt stress for 15 days has led to salt stress. The physiological responses *viz.*, leaf drying, SPAD

index, and chlorophyll fluorescence (*Fv/Fm*) were recorded and it was observed that the salt stress has led to a significant decline in the studied parameters. Salt stress has induced a significant decline in the estimated chlorophyll content in the studied sugarcane clones. The SPAD index determined through the SPAD meter revealed that there was a non-significant decline in the SPAD at the topmost leaves in both the Co 86032 and Co 85019, while the bottom leaves showed a significant decline in the SPAD index in Co 86032 indicating the more loss of chlorophyll molecule in the bottom leaves of susceptible clones compared to the tolerant clone. The chlorophyll fluorescence (*Fv/Fm*) determined and revealed that there was a significant decline (21%) in the *Fv/Fm* at the bottom most leaves in the Co 86032, while the topmost leaves showed a non-significant decline in the *Fv/Fm* in both the clones indicating the more damage of in the bottom leaves compared to the top leaves. Significant differences in the Chlorophyll 'a', Chlorophyll 'b', total Chlorophyll, and carotenoid were observed under salt stress. Biometric traits *viz.*, plant height, cane weight, and cane thickness were also recorded.

*Sugarcane crop (early stage) under hydroponic condition*


*Effect of salinity on sugarcane clones grown under hydroponic conditions*

*(R. Arun Kumar, V. Krishnapriya, K. Hari and M. Alagupalamuthirsolai)*

## 5.2.3 Soil Science and Agricultural Chemistry

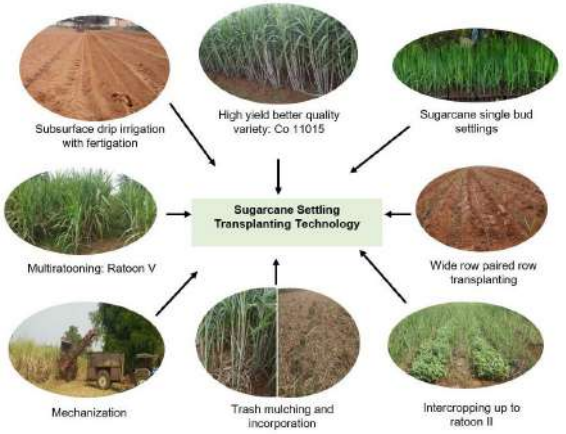
### Natural Resource Management for Enhancing Productivity and Sustainable Sugarcane Production

### Demonstration of Settling Transplanting Technology for Sugarcane

The fourth ratoon was harvested on 16 March 2022 by harvester. Broadcasted Urea @ 50 kg $ha^{-1}$ and then broadcasted *Trichoderma viride* @ 10 t $ha^{-1}$ mixed with 100 kg FYM in the morning hours to promote trash decomposition. Nutrient (N, P and K) requirement was calculated based on the STCR for the target of 125 t $ha^{-1}$. The ratooning operations and basal application of manures (FYM @ 12.5 t $ha^{-1}$) and fertilizers (entire dose of P and $FeSO_4$ +$ZnSO_4$) were carried out in April 2022. Fertigation started in the first week of ratooning with 55% N and 30% K till 12$^{th}$ week, and the remaining 70% N and K from 13 to 25$^{th}$ week on weekly interval. The drip irrigation was scheduled based on crop co-efficient and pan evaporation with alternate day irrigation. Detrashing and Trash mulching was carried out. NMC at 180 Days after ratoon initiation (DARI) and biometric observations 270 DRAI were recorded. The insecticide and fungicide spraying as per the recommendation was carried out to manage crown mealy bug and Pokkah boeng. However, disease and pest could not be completely controlled and crop suffered from the infestation. The residual effect after three years of intercropping in ratoon V showed no significant difference in number of millable canes, internode

numbers, single cane weight, cane yield and CCS yield. However, cane height and cane diameter differed significantly among intercropping treatments three years after intercropping. Cane height in coriander intercropping was at par with green gram and sole sugarcane and significantly higher than black gram intercropping. The cane diameter with intercropping was significantly higher than sole sugarcane. The mean yield of ratoon V was 78.31 t $ha^{-1}$. The juice quality did not differ significantly and the mean Brix, sucrose, purity and CCS were 21.96, 21.20, 96.48 and 15.25%, respectively. This technology was evaluated and demonstrated in Alfisol during 2017-2023. Hence, this technology will be evaluated and demonstrated in Vertisol from 2023 onwards.

**Technology developed:** Sugarcane settling transplanting technology (STT): Efficient combination of nine different sugarcane cultivation practices (Transplanting settlings (25-30 days old) derived from single bud setts of high yielding better quality variety (Co 11015) in wider row spacing (1.2 x 0.6/0.6 m), intercropping (black gram, green gram, coriander, *etc.*), drip irrigation scheduling based on crop demand and pan evaporation and fertigation based on soil test crop response, multiple ratooning (up to 5 ratoons) and mechanization of field operations from filed preparation to harvesting under STT). STT generated benefit cost ratio of 1.93 at the end of five years (1 Plant + 5 Ratoons). STT results in sugarcane productivity improvement with reduced cost of cultivation and ensures ecological sustainability.




*Technological components integrated under STT*

*(A. Vennila, S. Anusha, C. Palaniswami, V. Kasthuri Thilagam and P. Malathi)*

## Standardization of nutrient management package for sugarcane under wide-row planting in calcareous soil

**Effect of phosphorus treatment in calcareous soil on jaggery yield and quality:** Availability of phosphorus is one of limitations in calcareous soils. In order to overcome this limitation, a trial on P source and time of application was conducted with two commercial varieties (Co 86032 and Co 09004) in the planting season 2022-23. The P treatments are, P1: 100% P (62.5 kg $ha^{-1}$ $P_2O_5$) as SSP at basal i.e. control, P2: 50% P as SSP at basal + 50% P as Diammonium phosphate at Topdressing I and P3: P2 + symptomatic foliar application of micronutrients. Application of N and K as standard practice was followed in all the treatments after adjusting the N contributed by Diammonium phosphate in P2 and P3. Foliar application of $FeSO_4$, $ZnSO_4$ and urea was carried out in P3 at 150 days after planting which showed interveinal chlorosis. NMC at 240 days after planting was significantly higher in Co 86032 than Co 09004. Phosphorus treatment and varieties showed significance with respect to cane height, cane diameter, SCW, Cane yield, CCS yield, and Jaggery yield at 350 days after planting. The P treatments, P2 and P3 were on par and significantly higher than control (P1) with respect to cane height, cane diameter, mean internode number, SCW, Cane yield, CCS yield, and Jaggery yield. Among the varieties Co 86032 showed significantly higher cane height, cane diameter, SCW, Cane yield, CCS yield, and Jaggery yield than Co 09004. Juice quality was not affected by P treatment while Co 09004 showed significantly higher juice Brix and sucrose per cent than Co 86032. Jaggery quality was not affected by phosphorus source and time of application. All the treatments yielded Excellent Quality A1 Grade Jaggery. Hence, application of 50% P as SSP (Basal) and 50% P as DAP at Topdressing I in calcareous soil would improve the cane, sugar and jaggery yield without compromising jaggery quality. However, this result is of one season study, which needs to be studied in detail with ratoon crop.

**Effect of phosphorus treatment in calcareous soil on cane and sugar yield, jaggery yield and recovery (Plant 2022-23)**

| Cane and sugar yield, and jaggery recovery and yield | | | | | Statistical analysis | | | |
|---|---|---|---|---|---|---|---|---|
| Cane yield (t ha$^{-1}$) | | | | | | | | |
| | P1 | P2 | P3 | Mean | Factors | C.D. | SE(d) | SE(m) |
| Co 09004 | 95.55 | 113.87 | 126.65 | 112.02 | Variety (A) | 16.01 | 7.10 | 5.02 |
| Co 86032 | 149.77 | 178.10 | 174.53 | 167.46 | P treatment (B) | 19.61 | 8.69 | 6.14 |
| Mean | 122.66 | 145.99 | 150.59 | | Interaction (AXB) | N/A | 12.29 | 8.69 |
| CCS yield (t ha$^{-1}$) | | | | | | | | |
| | P1 | P2 | P3 | Mean | Factors | C.D. | SE(d) | SE(m) |
| Co 09004 | 15.32 | 18.41 | 19.69 | 17.81 | Variety (A) | 2.41 | 1.07 | 0.75 |
| Co 86032 | 20.06 | 22.10 | 23.09 | 21.75 | P treatment (B) | 2.95 | 1.31 | 0.92 |
| Mean | 17.69 | 20.26 | 21.39 | | Interaction (AXB) | N/A | 1.85 | 1.31 |
| Jaggery recovery (% w/w) | | | | | | | | |
| | P1 | P2 | P3 | Mean | Factors | C.D. | SE(d) | SE(m) |
| Co 09004 | 10.64 | 10.35 | 10.59 | 10.53 | Variety (A) | 0.91 | 0.41 | 0.29 |
| Co 86032 | 9.11 | 9.11 | 9.60 | 9.27 | P treatment (B) | N/A | 0.50 | 0.35 |
| Mean | 9.88 | 9.73 | 10.10 | | Interaction (AXB) | N/A | 0.70 | 0.50 |
| Jaggery yield (t ha$^{-1}$) | | | | | | | | |
| | P1 | P2 | P3 | Mean | Factors | C.D. | SE(d) | SE(m) |
| Co 09004 | 10.19 | 11.75 | 13.30 | 11.75 | Variety (A) | 1.70 | 0.76 | 0.53 |
| Co 86032 | 13.61 | 16.23 | 16.79 | 15.54 | P treatment (B) | 2.09 | 0.93 | 0.65 |
| Mean | 11.90 | 13.99 | 15.05 | | Interaction (AXB) | N/A | 1.31 | 0.93 |

P1=100% P as SSP (Basal); P2=50% P as SSP (Basal) and 50% P as DAP at Topdressing I and no spray; P3=50% P as SSP (Basal) and 50% P as DAP at Topdressing I and Fe and Zn spray (Symptomatic)

*(A.Vennila, C. Palaniswami, I. Rajendran (up to February 2023), G. Hemaprabha and V. Kasthuri Thilagam))*

## Evaluation of hydraulic characteristics of waterlogged soil under sugarcane cultivation for deriving suitable management strategies

The project was initiated in October 2022 to characterize and evaluate the hydraulic properties of waterlogged soils under sugarcane cultivation. A survey was undertaken in the Bhavani River basin of the Sathyamangalam area to identify the waterlogged fields under sugarcane. After the preliminary survey, two fields are identified for profile excavation and soil characterization. From the selected fields two soil profiles are excavated in Sathumugai region. The name Sathumugai (Wetland) indicates that the fields in this region are mostly submerged for most of the year. One profile is excavated from well-drained land, and one is from a waterlogged field. So that the difference in the soil characteristics between waterlogged and well-aerated soils can be clearly understood. In the waterlogged profile, there are five distinct soil horizons.

**Waterlogged soil profile and their characters**

| Profile | Soil depth (cm) | Characteristics |
|---|---|---|
|  | **0-22** | No clear boundary, mottling absent; Granular structure; cutans absent; micro pores; few fine roots, coarse fragments: 8.3%; Strongly calcareous |
| | 22- 37 | No clear boundary, mottling absent; thin patchy cutans; many Micro size pores; Granular structure, Few fine roots |
| | 37- 60 | Clear boundary, mottling absent; cutans absent; many Micro size pores; Few fine roots, Strongly calcareous |
| | 60-120 | Clear boundary, mottling absent; cutans absent; many Micro size pores; no roots, Strongly calcareous |
| | 120-170 | Clear boundary, mottling absent; cutans absent; many Micro size pores; no roots, Strongly calcareous |
| | >170 | Micacious parent material |

The pH of the surface soil is 8.78, which increases with the soil depth and the pH of 5$^{th}$ horizon is 9.32. Soil organic carbon was highest in the top layer of waterlogged soil. The soil organic carbon content is reduced with the soil depth. The soil is calcareous in nature. The clay loam soil texture indicates a higher percentage of clay in the top two soil layers. The hydraulic conductivity of the soil is also very low (5.42 cm hr$^{-1}$) in the top layer and reduces with the soil depth. These inherent soil characteristics may cause waterlogging and reduces the crop yield.

**Physical and chemical characters of waterlogged soil profile**

| Soil depth (cm) | pH | EC (dS m$^{-1}$) | O.C% | % $CaCO_3$ | BD Mg m$^{-3}$ | Hydraulic conductivity (cm hr$^{-1}$) |
|---|---|---|---|---|---|---|
| 0-22 | 8.78 | 1.12 | 0.77 | 2.9 | 1.66 | 5.42 |
| 22- 37 | 8.79 | 0.89 | 0.48 | 2.3 | 1.86 | 2.03 |
| 37- 60 | 9.08 | 0.86 | 0.33 | 1.6 | 1.70 | 0.88 |
| 60-120 | 9.17 | 0.84 | 0.26 | 1.5 | 1.87 | 0.27 |
| 120-170 | 9.32 | 0.97 | 0.22 | 0.9 | 1.95 | 0.26 |

Another soil profile is excavated at the same toposequence. The field is at higher elevation where the profile is well-aerated. In this soil profile, there are only three distinct soil horizons.

**Soil characters of aerated soil profile excavated at Sathumugai**

| Aerated soil profile | Soil depth (cm) | Characteristics |
|---|---|---|
|  | 0-20 | Clear smooth boundary, Loamy sand texture, Yellowish red colour, mottling absent; moderate grade medium size angular blocky type structure; cutans absent; many medium size pores; few fine roots, coarse fragments: 8.3%; non calcareous |
| | 20-35 | Abrupt and wavy boundary, Sandy clay loam, red colour, moderate grade medium size angular blocky type structure; cutans absent; many medium size pores; few fine roots, coarse fragments: 10.9%; non calcareous |
| | 35-50 | Abrupt and wavy boundary, Sandy clay loam, red colour, No roots, coarse fragments: 61.0% ; non calcareous |
| | > 50 | Parent material |

**Physical and chemical characters of aerated soil profile**

| Soil depth (cm) | pH | EC (dS $m^{-1}$) | O.C % | Calcareousness | BD Mg $m^{-3}$ | Hydraulic conductivity (cm $hr^{-1}$) |
|---|---|---|---|---|---|---|
| 0-20 | 5.76 | 0.03 | 0.37 | Nil | 1.42 | 27.77 |
| 20-35 | 6.79 | 0.03 | 0.30 | Nil | 1.50 | 16.44 |
| 35-50 | 6.92 | 0.04 | 0.28 | Nil | - | 15.11 |

The organic carbon content of the well-drained soil is ranged from 0.37 to 0.28% which is in the low category. The hydraulic conductivity of well drained profile soils ranges from 15.11 to 27.77 cm $hr^{-1}$ and is comparatively high. The soil texture is loamy sand at the surface and sandy clay loam at the sub-surface. The soil colour of the aerated and waterlogged soils showed a distinct variation due to soil erosion and deposition processes along the toposequence. The soil at the higher elevation has less clay and organic carbon content, and the soil colour is yellowish red (5 YR 4/6) at the surface. The waterlogged soil located in the same topographic sequence at lower elevation has high clay and organic carbon content, which is brown (7.5 YR 4/2).

*Soil profile study at the waterlogged site (Sathumugai)*

*Well drained soil profile*

*(V. Kasthuri Thilagam, A. Vennila and C. Palaniswami)*

## Value addition and product diversification in sugarcane

### Development of technologies for value-added products from sugarcane

**Development of process for extraction of polyphenols from sugarcane juice:** A simple process of extraction of polyphenols from sugarcane juice was developed to identify the nature of compounds, their bioactive function for its use as therapeutic applications. Sugarcane juice was subjected to freeze drying and brought to solid powder form using the already developed freeze drying processing technology in the institute. The powdered sugarcane juice was used for different organic solvent extraction and purification. The extract from each solvent was further purified using XAD resin column purification to achieve pure phenolic group of compounds without any sugar contamination. The purified juice extract was evaluated for polyphenol, flavonoid, anthocyanin and antioxidant content. Further these polyphenols will be charactered using advanced techniques and bioactivity of these compounds will be studied for therapeutic applications.

**Development of process for vacuum concentrated sugarcane syrup:** Liquid jaggery is well known form of concentrated sugarcane juice available in the market. But liquid jaggery prepared by heating sugarcane juice in an open pan is having some negative effect on the quality of the product. The real problem of this process is precipitation and crystallization during storage. To avoid this problem, we attempted concentrating the juice under vacuum by optimizing the temperature, pressure and heating time. The resulted product is having better appearance, no precipitation and crystallization during storage. Since the product texture, consistence, appearance and taste is similar to honey, this product may be branded in the name of cane honey for commercial production.

**Development of process for preparation of candy and toffee from sugarcane juice:** Sugarcane juice was explored to prepare candy and toffee without the addition of white sugar. In candy percent optimum brix at hard boil consistency was achieved with the addition of softening agent and natural coloring and flavoring agent. In toffee, we achieved soft boil consistency by optimizing the concentration of cream and high fat milk.

**Development of process for sugarcane juice-based squash drink with plant root extract:** The process for preparation of sugarcane juice-based squash with the addition of Nannari and Vetiver root extract was developed mainly for the purpose of using sugarcane juice as more healthy drink. We have optimized the parameters for separation of sugar and other suspended particle by the addition of different stabilizers. The final product can be used by blending with any fruit juice or diluting with water.

**Development of process for sugarcane juice-based jelly and gummies:** Sugarcane juice-based jelly was prepared by optimizing the concentration of three different stabilizers whereas gummies was prepared using four different stabilizers. Both these processes have flavoring agent and texture stabilizer to improve texture and to achieve good consistency.

**Development of process for separation of sugar syrup with the suspended particles:** Separation of concentrated sugarcane juice syrup from suspended particle was standardized by optimizing the parameters such as brix, stabilizer and the concentration of antioxidants. This is mainly to achieve clear transparent sugarcane juice syrup without the suspended debris.

*(G.S. Suresha, K. Hari, I. Rajendran, K. Chandran and P. Murali)*

### Functional analysis of bioactive compounds from stem extracts of red-fleshed *Sacharum robustum* genotypes for therapeutic applications and their product development

Red flesh *Saccharum robustum* stem extract was subjected to different organic solvent extraction and fractions were isolated for spectral analysis using FT-IR, NMR and LC-MS. Different fractions were characterized through FT-IR, NMR and LC-MS was carried out. Preliminarily freeze-dried stem extract was analyzed for *in vitro* α-amylase inhibitor and α-glucosidase activities and found significant bioactivity of stem extract indicating the therapeutic role. However, study of *in vivo* bioactivity of these compounds would give detailed information on functional role of this product.

*(G.S. Suresha, K. Hari, K. Chandran and V. Sreenivasa)*

## Externally Funded Projects

### Sub-cellular targeting of invertase inhibitory proteins: a novel approach to enhance sucrose yield in sugarcane

Sugarcane invertase inhibitors (ShINH1 and ShINH2) over expressed transgenic lines were successfully developed through sub-cellular targeting under DST-ECR project (ECR/2017/000412). Currently, a total of 63 transgenic events having with/without vacuolar targeting sequences (ShINH1+VT, ShINH1-VT and ShINH2-VT) were developed in which 29 transgenic events are in V2 generation, 37 events are in V1 generation. These were selected after PCR confirmation from many putative transgenics events. PCR confirmation of transgene was done using three sets of primers specific for the regions within the gene, promoter and hygromycin resistance marker. PCR confirmed over expressed lines are maintaining in transgenic glass house facility at ICAR-SBI under controlled conditions. These transgenic events were developed using four gene constructs having two invertase inhibitor genes (ShINH1 and ShINH2) identified by us earlier as part of DBT's Indo-Australian Career Boosting Gold fellowship (IACBGF) awarded to PI of this project (Suresha et al., 2018). These gene constructs were developed by cloning into modified pCAMBIA1305.2 vector developed earlier at our institute, which was having the *Porteresia coarctata* Ubiquitin promoter (Philip et al., 2013) fused with GRP (glycine-rich protein) signal peptide (SP) and vacuolar targeting determinant (VT78) (Palaniswamy et al., 2016). In order to validate the sub-cellular targeting of transgenic events, we have developed the constructs mimicking the stable transformation events by fusing the GFP fluorescent marker protein at C-terminal end of ShINH1 and ShINH2 protein. These constructs were transformed into sugarcane embryonic calli for transient expression assay and GFP expression was observed under fluorescent microscope. The results have clearly indicated the sub-cellular (Vacuole, Cell wall and or Cytoplasm) localization of inhibitor proteins. Preliminary examination of transgene expression revealed 3-10-fold increase in the expression of invertase inhibitor gene over untransformed control (wild type). Brix content also significantly increased over wild type control. Apart from these studies, we have also performed genome wide identification and isolated 17 invertase gene homologues from sugarcane genome and developed the temporal and spatial expression profiles of these gene homologues to understand their role in sucrose accumulation in sugarcane.

Based on the results obtained and lead taken through our DST-ECR project, work is under progress to evaluate the transgenic events for sucrose yield, juice quality and yield parameters in sugarcane. As per the results from the 8$^{th}$, 10$^{th}$ and 12$^{th}$ month juice analysis for the current year revealed that 5 transgenic events namely ShINH2+VT-16, ShINH2+VT-25, ShINH2+VT-29, ShINH2+VT-32 and ShINH2+VT-44 reported 2-3 percent increased sucrose yield over untransformed control. These results have clearly demonstrated the effect of sub-cellular targeting and over expression of invertase inhibitor proteins in sugarcane.

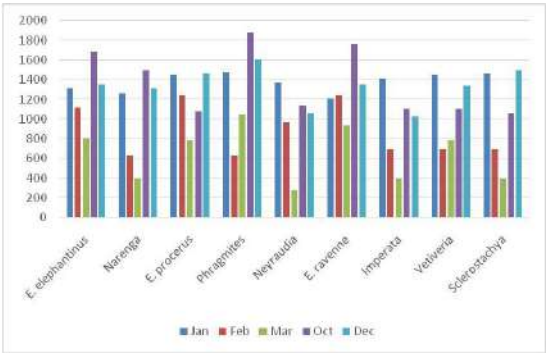
*(G.S. Suresha)*

## Natural Resource Management for Enhancing Productivity and Sustainable Sugarcane Production

### Development of simulation model for sugarcane production system

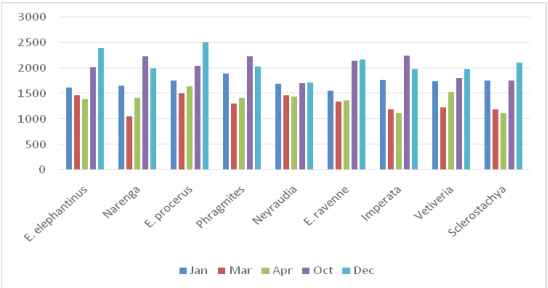
The information on start and flowering dates and planting time for nine allied genera for the flowering season 2015 to 2022 were collected. The Growing Degree Days (GDD) were calculated for start and end of flowering for species. The average minimum and maximum GDD to start of flowering was 1022 °C and 1452 °C for the species *Neyraudia* and *Phragmites*, respectively. The average minimum and maximum GDD to end of flowering were 1641 °C and 1891 °C for the species *Neyraudia* and *E. procerus* respectively.

In general species starts flowering during June-July period. The GDD for the February-March planting had lower value than that of October-December planting.




*GDD for Species at start of the flowering for different month of planting*

The end of flowering ranged from July to December for the species studied. The GDDs were lower for March-April planting period. It was overserved that January planted year had shorter duration of flowering *i.e* lower difference of GDD of start and end of flowering.




*GDD for Species at end of the flowering for different month of planting*

The GDD study leaf formation upto tillering stage of the sugarcane varieties observed that GDD 47 °C was required to emergence of a new leaf.

*(C. Palaniswami, G. Hemaprabha, A. Vennila, V. Kasthuri Thilagam, K. Hari, R. Gomathi, R. Karuppaiyan, A. Anna Durai, K. Mohanraj, P. Geetha, S. Anusha, G.S. Suresha, R. Arun Kumar, V. Krishnapriya, R. Valarmathi, T. Arumuganathan and C. Jayabose)*

### Diagnosis of nutrient deficiencies and diseases, characterisation of canopy and estimation of biomass in sugarcane using drone based optical images

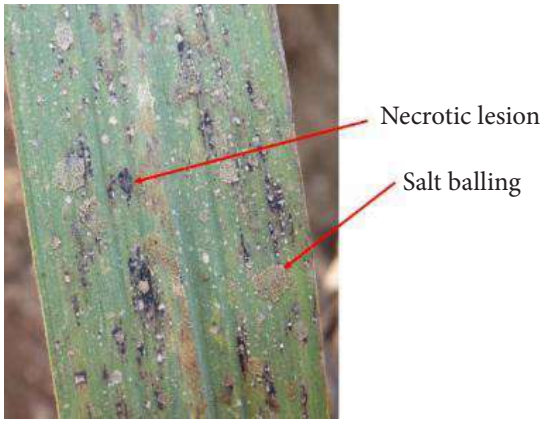
A drone image was obtained from 7 month old sugarcane crop for diagnosis of disease in the infected fields. At the same time image was also obtained from a healthy sugarcane crop. Based on the images intensity of disease can be assessed.

A field survey was conducted to assess the feasibility of using a drone for micronutrient foliar spraying for sugarcane growing in calcareous soils in Annur Block, Coimbatore District, Tamil Nadu. The soil samples were tested for calcareousness using 1:1 HCl. The field that showed very strong effervescence in the HCl test was selected for the study. Soil samples were analyzed for $CaCO_3$ content and other soil characteristics. The soil is of clay loam texture, with pH and EC of 8.46 and 0.23 dS $m^{-1}$. The calcium carbonate content in the soil was 5.87%. Seventy days old sugarcane crop was in the field with Fe deficiency symptoms. Four treatments of drone spraying (Two concentrations of $FeSO_4$ : 2.5 and 5.0% and two spray volumes: 25 and 50 litres $ha^{-1}$ by adjusting the drone speed to 5 and 2.5 m $s^{-1}$, respectively) were used. The drone spraying was carried out at the height of 2 m from the canopy in the morning hours to minimize the drifting effect. Ten Top Visual Dewlap (TVD) leaves were selected from each treatment in the middle two rows at 21 days after spraying, and Soil Plant Analysis Development (SPAD) value was recorded. A visual evaluation was carried out for recovery from iron deficiency and toxicity symptoms. The greenness of the leaves in all the iron sulphate foliar sprayed treatments, while the control showed interveinal

chlorosis and paleness as it was observed before spray. However, the manual spray with 5% $FeSO_4$ showed localized necrotic lesions and leaf burning or scorching. The salt balling on the leaves was also observed in this treatment. SPAD values of TVD leave recorded at 21 DAS showed a significant increase in all the foliar treatments over control. Among the iron treatments, no significant difference with respect SPAD values. Since, drone spraying of 5% $FeSO_4$ was on par with 2.5% $FeSO_4$ in correcting the iron deficiency symptom. The excess iron in 5% $FeSO_4$ will not reach the actively growing part since the mobility of iron within the plant is intermediate. This provides the clue that drone spraying of 2.5% $FeSO_4$ in 25 litre $ha^{-1}$ is required to correct the deficiency symptoms during tillering phase. Comparative economic analysis also favours drone spraying over manual knapsack spraying by saving 20% cost of foliar spraying.

*Sugarcane at 70 days after ratooning with severe iron chlorosis*

*Sugarcane at 21 days after spraying of $FeSO_4$*




*Iron toxicity symptoms in foliar spray of 5% $FeSO_4$ using knapsack sprayer*

*(C. Palaniswami, A. Vennila, T. Arumuganathan, V. Kasthuri Thilagam, A. Anna Durai, K. Mohanraj, G. Hemaprabha, R. Raja (ICAR-CICR Research Centre, Coimbatore) and R. Arun Kumar)*

## 5.3 Crop Protection

### 5.3.1 Plant Pathology

**Host resistance, interactomics, pathogen variability, diagnosis and disease management in sugarcane**

**Screening of sugarcane progenies & germplasm for disease resistance, disease survey & surveillance and impact of climate changes on sugarcane diseases and disease management**

**Screening for red rot and smut resistance**

**Red rot**

**Controlled condition testing:** During 2023 crop season, a total of 4791 clones from different clonal trials, parental clones from NHG, germplasm and waterlogging tolerant clones from Kannur, ISH and IGH clones, Energy cane, PZVT-2023 series, PZVT multiplication, Drought BC2 hybrids of *Erianthus procerus*, Red flesh hybrids, Economic breeding, Inbreeding, Genomic selection, ISMA, Targeted Pre-breeding and Clonal trial clones were screened in CCT chamber of ICAR-SBI, Coimbatore. Among the screened clones, the majority of them *i.e.,* 1381 (28.8%) were categorized as moderately resistant (MR) and 314 clones (6.5%) were free from any red rot infections and rated as resistant (R). Around 1341 clones (27.9%) were rated as susceptible (S) and 1226 clones (25.5%) were grouped as moderately susceptible (MS) and around 363 clones (7.5%) were rated as highly susceptible (HS). The susceptible clones were mainly from germplasm and many R and MR clones were from first and second clonal trials. Among the screened clones 166 clones were recommended for retesting.

**Field tolerance:** Seven sugarcane clones varying in red rot resistance were tested against soil borne inoculum of 6 *Colletotrichum falcatum* isolates collected from Tamil Nadu under field conditions to assess their filed tolerance to red rot. All the clones recorded reduced bud sprouting due to the presence of *C. falcatum* inoculum in the soil as compared to their respective controls. Out of 6 Cf isolates, CfC24 Athimur, Cf11015 Thiruvanthipuram and Cf86032 Srikandapuram found to be more virulent than other three isolates. Virulence behaviour of CfC24 Athimur is unique against PZVT 2020-76 than rest of the isolates. Virulence behaviour of Cf671 and Cf94012 are almost similar and less virulent when compared to other isolates. Field tolerance/host resistance level of PZVT 2020–117 is almost equal to Co 86032. Out of 5 PZVT clones, field tolerance level of PZVT 2020–117 is highest followed by PZVT 2020–152; whereas, PZVT 2020–15 is the most susceptible clone. Re-testing of PZVT 2020-28 is recommended as the planting material shared was very less.

**Smut**

**Parental clones:** Totally, 30 parental clones were evaluated against sugarcane smut during the crop season 2023-24. Among the 30 entries, 9 clones were R, 2 were MR, 5 were MS, 3 were S and 11 clones were HS to smut.

*(A. Ramesh Sundar, P. Malathi, R. Selvakumar, V. Jayakumar and K. Nithya)*

**Disease surveillance**

During the month of July, 2023 disease surveys were conducted in Lalgudi, Tirumangalam, Siruthaiyur, Thenkal, Poovalur, Sembiangudi, Thirumazhapady, Keelakulathur areas growing Co 11015 and Co 86032 in Trichy district, Tamil Nadu. All the fields visited were having Pokkah boeng and mealy bug infestation. The farmers were advised to spray Thiamethoxam and Propiconazole as prophylactic measures. During August, sugarcane fields in Kulathur, Kaduvanur, Aethanur, Seerpanandal, Thalayaapalayam villages of Kallakurichi district were visited where the variety Co 86032 showed drying of leaves and lodged in larger areas. There was no rain during the crop season and root grubs were observed in the field. Early harvest of the crop was advised. In Karnataka, sugarcane disease survey was undertaken in farmers' field of Chamrajnagar, Khandhali, Kongrahali, Doddinduwadi, and Kestur villages. There were mild incidences of PB, rust, YLD, GSD was noticed in a few fields.

*(R. Selvakumar and K. Nithya)*

**Disease quarantine**

The following clones *viz*., CoP 18437, CoP 20440 (Pusa), LG 15533, LG 16581 (Lucknow), CoS 13235, CoS 17231 and UP 14234 (Shahjahanpur)

were handed over to NHG after quarantine. Similarly, the following clones CoLk 15206, CoLk 16466 (Lucknow), CoS 16233 (Shahjahanpur) and CoA 20325 (Anakapalle) were handed over to NAG after quarantine.

The following clones CoSe 11453 (Kushinagar), CoS 18231 and CoS 18232 (Shahjahanpur) were received for NHG and are in quarantine. The following clones CoP 11438, CoP 15437, CoP 17437, CoP 18437, CoP 20440, CoP 022 (CoP 02182) (Samastipur), CoS 14233, CoS 17235, CoS 18231, CoS 18232 (Shahjahanpur), CoPb 17215, CoPb 18211, CoPb 18213, CoPb 18214 (Kapurthala), CoLk 15201, CoLk 15207, CoLk 15466, CoLk 16202, CoLk 16470 (Lucknow), CoPant 12221, CoPant 12226, CoPant 13224 (Pantnagar), CoSnk 08101, CoSnk 20102, CoSnk 20103 (Sankeshwar), MS 14082, MS 17082, CoM 11086 and CoM 13082 (Phaltan, Satara, Maharashtra) were received for NAG and are in quarantine.

*(A. Ramesh Sundar and P. Malathi)*

## Virus indexing

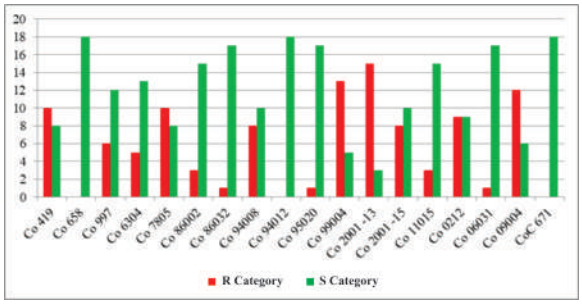
Nearly 61 tissue culture materials were received from TC lab, ICAR-SBI in that 34 samples from Co 86032, 21 Samples from Co 11015 and 6 samples from Co 18009 were evaluated for virus indexing. Most of the samples were found negative to all sugarcane viruses *viz.* SCMV, SCSMV, and SCYLV whereas found positive to SCGS phytoplasma.

*(K. Nithya and P. Malathi)*

## Characterization of red rot pathotypes

Screening for RR differentials were carried out for new isolates collected from farmers' fields. During 2023 crop season, About 18 *C. falcatum* isolates *viz.*, CF06 (Cf671-O) (Std), CF12 (Cf94012-O) (Std), CfC671 (Sathyamangalam), CfV09356 (Mundiampakkam), Cf11015 (Periyasevalai), Cf11015 (Pannaikuppam), Cf11015 (Thiruvendhipuram), Cf06030 (Pazhangur), Cf11015 (Erayur), Cf 11015 (Mundiampakkam), Cf86027 (Thachampattu), Cf11015 (Pambur), Cf11015 (Edapalayam), CfC24 (Edapalayam), Cf11015 (Kondangi), CfM0265 (A. Gudalur), Cf86027 (Panayur), Cf 0238 (Manakpur) were assessed for their pathogenic variation on 18 sugarcane varieties *viz.*, Co 419, Co 658, Co 997, Co 6304, Co 7805, Co 86002, Co 86032, Co 94008, Co 94012, Co 95020, Co 99004, Co 2001 -13, Co 2001 -15, Co 11015, Co 0212, Co 06031, Co 09004 and CoC 671 with an objective to ascertain relative and gain of virulence in the new isolates.

Among the isolates, Cf86027 (Thachampattu), Cf06030 (Pazhangur) and CfM0265 (A. Gudalur) were highly virulent on many tested sugarcane varieties showing susceptible reactions. Many varieties (12 Nos.) were still tolerant to the known pathotype CF12 isolated from Co 94012 exhibiting resistant reactions (R/MR). Similarly, the isolate Cf11015 (Edapalayam) isolated from Co 11015 was less virulent on many varieties (10 out of 18 tested varieties). The pathotype CF06 was avirulent on 8 varieties and virulent on 4 varieties and showed intermediate MS reactions on 6 varieties. One isolate Cf0238 (Manakpur) from sub-tropical region was avirulent or less virulent on 12 varieties indicating the resistant status of many varieties grown in tropical zones.




*Interaction of red rot isolates on selected sugarcane varieties showing differential reactions*

Among the varieties Co 2001-13, Co 99004 and Co 09004 were resistant against many red rot isolates and the varieties Co 658 and CoC 671 were completely susceptible against all the tested isolates. The variety Co 06031 and Co 11015 showed MS reactions against 12 and 11 isolates respectively.

*(R. Selvakumar and K. Nithya)*

*Behaviour of C. falcatum isolates on red rot differential varieties*

## Developing chitosan based nano-delivery systems for disease management and enhancing nutrient use efficiency in sugarcane (a) Inducer nano-particles as smart delivery system for harnessing red rot resistance in sugarcane

Nano formulations of Benzothiadiazole (BTH) and Salicylic acid (SA) were tested for their efficacy against red rot disease in field conditions. Seven treatments *viz*., $T_1$- BTH nano formulation, $T_2$- BTH control, $T_3$- SA nano formulation, $T_4$- SA control, $T_5$- Fungicide (Thiophenate methyl-0.1%), $T_6$- Pathogen inoculated control and $T_7$- Healthy control were imposed on two bud setts of CoC 671, planted in field under artificially pathogen (*C. falcatum* grain inoculum) inoculated conditions and the disease incidence was recorded. The least incidence of red rot (5.5%) was recorded in BTH nano formulation applied plots followed by SA nano formulations applied plots (7.3%). The reduction in red rot incidence over the pathogen inoculated control was 80.4% in $T_1$, 74% in $T_3$ and 67.6% in $T_5$. The nano formulations applications ($T_1$ and $T_3$) also showed significantly higher efficacy over their respective controls ($T_2$ and $T_4$) in controlling red rot disease.

*(V. Jayakumar and A. Ramesh Sundar)*

## Epidemiology and management of *Fusarium* diseases in sugarcane

Once in 15 days the NHG was monitored regularly for appearance of any symptoms of pokkah boeng (PB), yellowing and wilt. We made an attempt to assess impact of wilt on sugarcane flowering and subsequently on ratoon establishment on selected varieties. A total of 225 parental clones were monitored for yellowing and wilt along with their flowering intensity. After harvest they were observed for germination and number of shoots were counted. Based on wilt severity, the parental clones were grouped as wilt free clones, group I (<25% wilt severity), group II (<25-50% wilt severity) and group 3 (>50% wilt severity). From the observations, 109 clones were grouped as wilt resistant and did not show any yellowing throughout the crop period till harvest and 116 clones were rated as wilt susceptible. Out of the 116 clones, 91 clones were categorised in Group I, 16 clones *viz*., Co 81615, Co 11001, Co 2000-10, Co 8371, Co 86010, Co 93020, Co 94007, Co 98010, CoA 92081, CoA 99082, CoC 8201, CoH 119, CoS 8436, CoTI 1153, CoV 89101, ISH 100 were categorised as group II and the nine clones *viz*., Co 0237, Co 419, Co 8353, Co 86002, Co 88025, CoC 671, CoC 90063, CoOr 03152, MS68/47 were rated as highly susceptible in group III.

### Effect of wilt on flowering behaviour of sugarcane parental clones

| Wilt group | Number of flowering clones | | | | | | % of flowering canes | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | No flowering | >0-25% | >25%-50% | >51-75% | >75% | Total | No flowering | >0-25% | >25%-50% | >51-75% | >75% | Total % |
| Healthy | 5 | 5 | 5 | 9 | 85 | 109 | 2.22 | 2.22 | 2.22 | 4.00 | 37.33 | 48.00 |
| <25% Wilt | 5 | 11 | 8 | 9 | 59 | 91 | 2.22 | 4.89 | 3.56 | 4.00 | 26.22 | 40.89 |
| >25%-50% Wilt | 1 | 2 | 3 | 2 | 8 | 16 | 0.44 | 0.89 | 1.33 | 0.89 | 3.56 | 7.11 |
| **>50% Wilt** | **2** | **3** | **2** | **2** | **0** | **9** | **0.89** | **1.33** | **0.89** | **0.89** | **0.00** | **4.00** |

*Wilt affected cane bearing the unfit "arrow" for crossing with the suitable parent*

In SBI Research Centre, Kannur, the disease pokkah boeng was noticed in a few clones such as C 278, PR 1063, EPC 32667, 33332 of foreign hybrids and IK 76 70, IK 76 70A of *S. officinarum* with maximum 100% incidence in EPC 32667, EPC 33332. The symptoms such as crinkling, chlorosis was generally found. Most of the clones recovered after sometimes by themselves.

*(R. Selvakumar, P. Malathi, A. Ramesh Sundar, V. Jayakumar, M.L. Chhabra, R. Gopi and R. Arun Kumar)*

## Harnessing antagonistic microbes for the management of wilt and rot diseases in sugarcane

Trichoderma and PGPR isolated from the rhizosphere were tested in pot culture conditions using the varieties CoC 671 and Co 86002 against the red rot (*Colletotrichum falcatum*) and wilt (*Fusarium sacchari*) pathogens, respectively. Single budded setts of the susceptible varieties were treated overnight using different *Trichoderma* and bacterial isolates and planted in trays. The pathogen cultured in sorghum grain + sand mixture was used for inoculation @ 2gm/ bud. Trichoderma isolates T12, TK 13, TK 16 @ 0.25% were found to be effective for red rot with maximum germination of 62.5%. Among the treatments, PF 4 @ 0.25% was effective against wilt with maximum germination of 75%. Field experiment was laid out for studying the growth promotion using Plant Growth Promoting Bacteria (PGPR). Three budded setts of Co 86032 were treated with PGPR at 0.25 and 0.5% concentration. The percent germination and tiller count was taken after the 30$^{th}$ and 60$^{th}$ day after planting. Among the PGPR treatments studied for growth promotion, PF 4 @ 0.25% recorded 47.08% germination, followed by PF 60 @ 0.25% (42.85%) and the tiller count was maximum in PF 60 @ 0.25% (36.66 tillers) followed by PF 4 (34 tillers). The bacterial isolates PF 4, PF 60 and BC 36 were identified as, *Lysinibacillus xylanilyticus, Proteaus* spp. *Bacillus* spp, respectively through molecular methods.

*(R. Gopi and K. Nithya)*

## Smart delivery of agro-inputs using Sett Treatment Device for biotic and abiotic stress management in sugarcane and other vegetatively propagated crops

**ICAR-SBI:** Effect of mechanized sett treatment with physical and chemical agents against non-fungal diseases: like fungal diseases, attempts have been made with uniform treatments including hot water (physical) and nutrients (chemical) for the management of non-fungal diseases *viz.*, Yellow Leaf Disease – YLD (Viral) and Grassy Shoot Disease – GSD (Phytoplasma). For which, two field experiments have been laid out with infected planting materials of Co 86032 for YLD and CoV 92101 for GSD. The treatments imposed include T1 – 54 °C in STD-HWT; T2 – 56 °C in STD-HWT; T3 –T1+ Nutrients in STD; T4 –T2 + Nutrients in STD; T5 – Nutrients in STD; T6 – Infected control and T7 – Healthy control. Recorded observations indicated that the varieties have differential response to hot water treatment. Hence based on results, it was inferred that, 54 °C was suitable for Co 86032, while CoV 92101 was able to tolerate up to 56 °C. However, invariably for both the diseases, hot water followed by nutrient treatment was found to be significantly effective in improving the germination and yield attributes with reduction in YLD/GSD expression till maturity. Besides, from the infected control plot at 6 months stage, setts from infected clumps were subjected to hot water from 54 °C to 60 °C and studied their effect on germination, plant growth and GSD

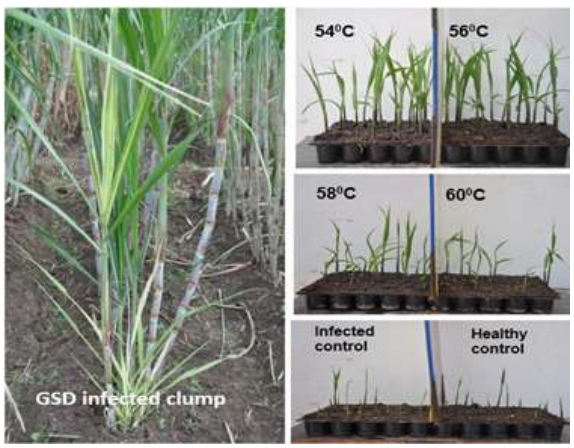
incidence. Observations indicated that, there was significant improvement in early germination and huge vigour from the setts treated at 54 and 56 °C as compared to higher temperatures along with infected and healthy control. In addition, there was no GSD expression in all the treated plots.

*Infected control* | *Healthy control* | *Nutrient treatment* | *Hot water at 54 $^0$C + Nutrient treatment*

*Effect of mechanized sett treatment with hot water and nutrients on YLD incidence*

*Infected control* | *Healthy control* | *Nutrient treatment* | *Hot water at 54 $^0$C + Nutrient treatment*

*Effect of mechanized sett treatment with hot water and nutrients on GSD incidence*




*Mechanized sett treatment with combination of hot water and nutrients on GST infected setts in the Sett Treatment Device*

**Technology dissemination:** About 20 demonstrations were conducted at the institute level through various training programmes during 2022-23. By which, about 350 farmers and 400 factory staff were benefitted apart from Exhibitions.

*Demonstration on Sett Treatment Device to the field staff from Solidaridad, sugar mills in TN, AP and Karnataka*

*Training to 16 Sugar Mills Staff, Entrepreneurs, Progressive farmers*

*Demonstration on the role of Sett Treatment Device for the management of pokkah boeng and mealy bug*

*Farmers from M.R.K. Co-op Sugar Mills at ICAR-SBI*

**ICAR-IISR (Sugarcane):** Efficacy of fungicide, bacterial bioagent and their combination by different delivery methods for red rot management in Co 0238: A field trial was laid out in Autumn season at Mankapur Unit, Balram Chinni Mills to demonstrate the efficacy of fungicide–Thiophanate methyl (TM) @ 0.1%, TM + bacterial antagonist *Paenibacillus alvei* @ 0.05% each by mechanized treatment in the Set$^{t}$ Treatment Device before planting and subsequent delivery on 60$^{th}$ day as soil drenching with TM/*P. alvei* at the same concentration. Intercropping with mustard was carried out from 1$^{st}$ to 4$^{th}$ month. Till maturity, there was no red rot incidence observed even in control. However, significant improvement in germination and establishment by both the treatments was observed than control. Among the treatments, treatment with a combination of fungicide and bacterial antagonist was found to be better than fungicide alone in improving yield attributes.

T1 - Sett treatment + Soil drenching with Thiophanate methyl - 0.1%

T2 - Sett treatment + Soil drenching with Thiophanate methyl - 0.05% + Bactorial antagonist - 0.5%

T3 - Control

*Demonstration plot on red rot management using Thiophanate methyl and Paenibacillus alvei in Co 0238 in Sub-tropics - in Collaboration with ICAR-IISR*

In addition, one-acre plot trial on mechanized sett treatment with thiophanate methyl at 0.1% had been laid out in two places at Rauzagaon unit under Balram Chinni Mills in the spring season to study the efficacy of fungicidal treatment for the management of red rot under sub-tropical conditions. In this location, only treated plot was free of red rot incidence with surrounding untreated plots.

**Tapioca (TNAU, ICAR-CTCRI):** In Yethapur-TNAU, a series of experiments conducted with fungicide, insecticide, microbes, inducers, nutrients and cassava booster, significantly improved germination and vigour of settlings in the nursery and further improvement of yield in the main field. In ICAR-CTCRI, standardized and validated raising of nursery from mini setts treated with various agro-inputs *viz.*, fungicide, insecticide and nutrients. Significant improvement in germination and settling vigour from treated setts was recorded in glasshouse trials followed by efficacy of this treatment on pest incidence (mealy bug and mite) and improvement of plant growth vigour was recorded.

Besides, the effect of hot water treatment was conducted with three treatments of two node cuttings of cassava (T1. Hot water treatment @ 56 °C – for 15 min @ 200 mmHg in STD (Sugarcane Sett Treatment Device; T2. T1 followed by Propiconazole 50 ppm (0.2ml Tilt-25Ec) +Azoxystrobin 50 ppm (Amistar 23SC – 0.3 ml) + Imidacloprid 50 ppm (Codfidar 17.8% SL – 0.3 ml) + urea 0.05% + zinc sulphate (0.0.05%) + ferrous sulphate (0.05%) @ vaccum level 200 mmHg for 15 min; T3. Infected Control. The cuttings were treated at ICAR-SBI and planted at ICAR-CTCRI. Results showed that the setts treated with hot water did not show any symptoms of Cassava Mosaic Disease till four months. While hot water followed by pesticides and nutrients showed 89% free of symptom whereas in control it was 100% after 3 months of planting. The germination percent was recorded as 90, 61 and 100 in the above treatments respectively. Further, it was noticed that, there was no mealy bug infestation observed upto 3 months in the treatment receiving insecticide, while it was 100% in other treatments. Since combination of hot water and chemical treatment has given promising results for pest and disease incidence. Hence standardization of hot water treatment will be carried out to improve the germination.

**ICAR-IIHR:** Validation of Sett Treatment Device in ornamental crops: An experiment was conducted to evaluate the effect of mechanized sett treatment device on growth and disease incidence of fungal pathogens at initial stage in ornamental crops. For which, four ornamental crops, i.e. Gladiolus, Chrysanthemum, Tuberose and Crossandra were selected with 3 treatments 1. Mechanized treatment, 2. Conventional method and 3. Control. Among the crops, in Gladiolus significant difference was observed on corm germination compared to control. Also, in Crossandra number of seeds germinated was highest in machine treatment. For other crops, standardization is being done.

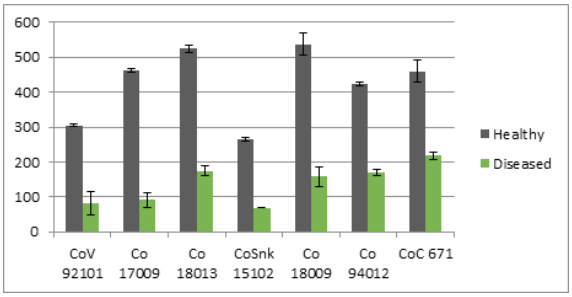
**ICAR-NRCB:** Validation of Sett Treatment Device for wilt management in Banana: A pot culture experiment was conducted with uniform sized, diseased suckers of cv. Grande Naine to study the comparative effect of mechanized and conventional treatment with microbial consortia involving *Bacillus subtilis* and *Trichoderma asperellum.* Results of the study revealed that there was a significant reduction of disease incidence in terms of internal score in corms by different treatments involving fungicide and biocontrol agents irrespective of treatment method. Among the methods, mechanized means of treatment was found to be significantly effective in reducing disease incidence with the fungicide treatment followed by combination of both fungal and bacterial antagonists.

*(P. Malathi, A. Ramesh Sundar, R. Selvakumar, V. Jayakumar, K. Nithya, A. Vennila, T. Ramasubramanian, T. Rajula Shanthy, R. Viswanathan, Shweta Singh (IISR, Lucknow), Ravindra Naik (ICAR- CIAE), S.S. Veena (ICAR-CTCRI), R. Thangavelu (ICAR-NRCB), Priti Sonavane (ICAR-IIHR) and G. Karthikeyan (TNAU))*

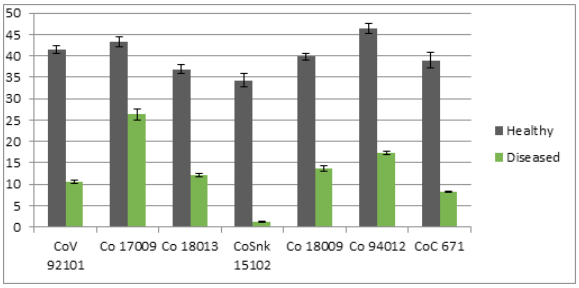
## Sugarcane phytoplasma diseases: diagnosis, understanding the molecular mechanism of plant host phytoplasma interactions

During this period impact of sugarcane grassy shoot disease on physiological parameters

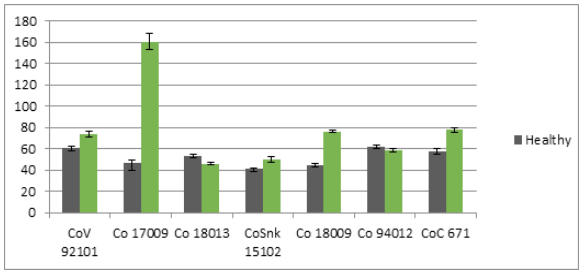
including photosynthetic efficiency, leaf fluorescence (FV/FM) and chlorophyll content, membrane stability index, leaf area, total soluble protein, free amino acids, total sugar, total phenolics were assessed on physiologically active leaves of healthy and diseased plants during tillering phase of the crop in cvs. CoSnk 15102, Co 17009, Co 18009, Co 18013, CoC 671, CoV 92101, and Co 94012. Diseased plants had shown significant reduction of physiological parameters *viz*. 52-80% reduction in leaf area measurement ($cm^2$), 39-78% reduction in chlorophyll content whereas, 4-71% increase in total free amino acids content than healthy plants. Overall, all the diseased leaves had shown significant reduction of physiological parameters with the tune of about 10-65% in comparison with the respective apparently healthy plants. Amongst, the cv. Co 18009 recorded highest reduction due to complete bleaching of chlorophyll content and the affected leaves turned into cream white color. Increased free amino acids content in diseased leaves may be due to total protein denaturation of pathogen.




*Leaf area measurement ($cm^2$)*

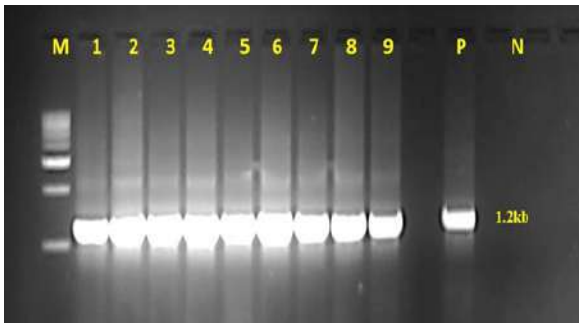



*Leaf chlorophyll content*




*Total free amino acids content 575 nm*

Besides, in search of SCGS phytoplasma vectors SCGS samples with aphid infestation were collected from our institute fields on different varieties *viz*. Co 86032, Co 87023, Co 15021, Co 16010, Co 17009, Co 18001, Co 18024, CoC 671, CoT 18368, CoV 92101, and CoV 92102 along with aphids in the respective varieties. Aphid colonization was found in April, May, June and July months followed by December and January and persists in plants till harvest. Aphid colonization was high in diseased plants compared to its nearby healthy plants of the same variety. All the collected samples were processed for diagnosis by nested PCR assay using the SCGS phytoplasma universal ribosomal region primers. Positive amplification of 1.2 kb was obtained in all the samples including the aphids and double pass sequencing was done. The pairwise multiple sequence alignment of all the consensus sequences of this study from sugarcane as well as from the aphid (*M. sacchari*) had clearly shown the highest nucleotide similarities of 97.4% to 100% among themselves as well as to other SCGS phytoplasma sequences submitted from India and other countries. With this study, the presence of SCGS phytoplasma in *M. sacchari* was confirmed. However, further studies are needed to confirm the transmission efficiency to analyse the role of insect vector and climatic factors in SCGS disease epidemiology.




*Aphid samples shown positive amplification to SCGS phytoplasma*

*Lane 1: Co 86032, 2: Co 87023, 3: Co 15021, 4: Co 16010, 5: Co 17009, 6: Co 18001, 7: Co 18024, 8: CoC 671, 9: CoT 18368, and P: CoV 92101*

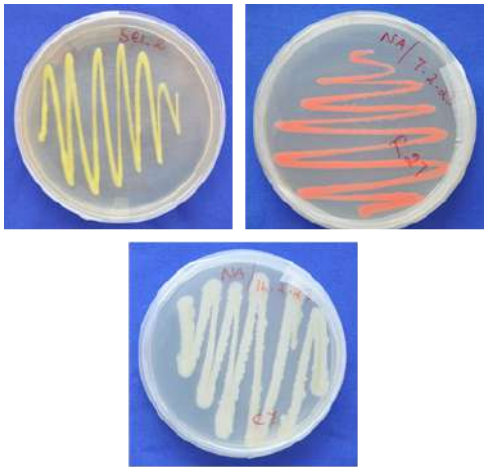
*(K. Nithya, R. Manimekalai, M. Punithavalli and V. Krishnapriya)*

## Structural and functional characterization of endophytic bacterial microbiome of sugarcane

**Standardization of surface sterilization protocol:** Surface sterilization protocol was successfully standardized to exclude exophytic microorganisms from leaf, root and cane, so that endophytic bacteria could be isolated exclusively. Leaf samples could be sterilized by treating with 70% ethanol for 2 min and 4% sodium hypochlorite for 2 min. The fibrous cane portion of sugarcane could be sterilized by treating the cut canes with 70% ethanol for 2 min followed by treatment with 4% sodium hypochlorite for 2 min, while the root portion could be sterilized by treating with 70% ethanol for 2 min followed by treatment with 4% sodium hypochlorite for 5 min and then again in 70% ethanol for 2 min. Subjecting the sterile water from the last wash of the above sterilized leaf, cane and root to culturing on media did not yield any bacterial culture and that confirmed the effectiveness of sterilization protocol.

**Isolation of endophytic bacteria:** Formulated 10 media in such a way that the identified media could isolate maximum possible cultivable endophytic bacteria from leaf, cane and root parts of sugarcane. Successfully isolated 239 endophytic bacteria from root, stem and leaves of sugarcane variety Co 86032. The developed surface sterilization protocol, maceration technique and selected media could isolate 78 bacteria from leaf, 71 bacteria from stem (cane) and 90 endophytic bacteria from root. The results indicate that maximum endophytic bacteria are present in the root of sugarcane, where the pronounced activities of microbes are recorded. Among the isolation media formulated, the maximum number of bacteria could be isolated from solid media than semi solid media and among solid media LGI (1%) could isolate maximum number of bacteria followed by tryptic soy agar (TSA). The results also showed that all media formulated could isolate morphologically different bacteria.

**Characterization of endophytic bacteria:** All isolated bacteria were characterized based on morphology and culture characters such as form, elevation, size, margin, opacity, surface and colony colour. Among isolated bacteria white and yellow colonies were dominant and in case of shape the circular colonies were found to be dominant followed by rhizoid colonies. In the case of colony margin the entire regular and undulate colonies were dominant in leaf, cane and root isolates. In case of cane and leaf isolates the circular colony shape was found to be dominant followed by rhizoid but in case of root isolates the irregular shape colonies were prominent. In the case of elevation, convex smooth and rough colonies were prominent among leaf isolates, while among cane isolates the raised, smooth and shiny colonies were dominant and in case of root isolates the convex, smooth and shiny colonies were prominent.



*Endophytic bacteria isolated from sugarcane showing varied morphological characters*

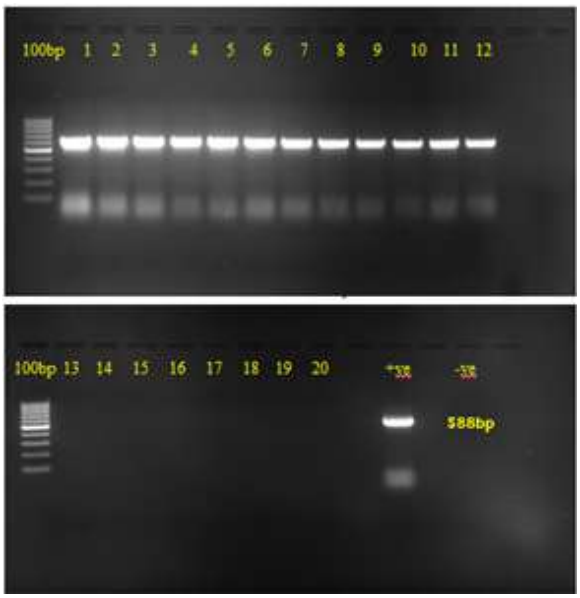
*(V. Jayakumar, R. Gopi, P.T. Prathima and K. Hari)*

## Externally Funded Projects

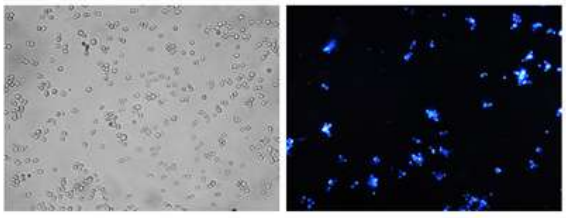
## ICAR CRP on development and application of diagnostics to viruses and phytoplasmas infecting sugarcane

**SCYLV coat protein purification for pAB production:** The yeast expression vector *Pichia pastoris* competent cells preparations and transformation protocols by electroporation methods were standardized for SCYLV coat protein gene expression. For *P. pastoris* transformation, the host cells were washed in two simultaneous steps with Milli-Q water and 1M sorbitol. The competent X-33 *P. pastoris* cells were linearized (SacI enzyme digested),

plasmid DNA of pPICZ alpha B with and without insert individually was pulsed in 0.1 cm electroporation cuvettes at 1.5 kV, 50 F, 250 Ω and 10-12 millisecond. The transformed cells were selected on YPD plates containing Zeocin (100µg/ml). Around 12 colonies were selected from transformants with SCYLV CP insert and 8 colonies from transformants without insert were grown in YPD broth overnight at 30° C, 220 rpm. The cells were harvested by centrifugation at 10000 rpm for 5 mins and RNA was extracted from the pellet by TRIzol method and confirmed by RT-PCR using SCYLV CP primers.




*PCR profile showing presence of amplicon of desired size (588bp) in P. pastoris X33 with insert (Lanes 1-12) and without insert (Lanes 13-20)*



a. Under visible light

b. Under UV fluorescence Calcofluor white stained

*Microscopic view of transformed P. pastoris under visible and fluorescent light*

**Recombinant protein production and concentration by ammonium sulphate precipitation:** Finally, the culture was centrifuged and the proteins in the supernatant were pelletized using ammonium sulphate to a final concentration of 60%. The cell pellets were subjected to RNA extraction and the expression of target ScYLV-CP was confirmed using a specific primer. The precipitated protein was subjected to desalting in amicon filter and purified using Ni-NTA column. The samples collected at different stages of purification was analysed by SDS-PAGE and further confirmed by western blotting. From the Bradford estimation results, it was observed that the protein concentration was as high as at 96 hours of post inoculation in BMMY broth. The supernatant from BMMY was analysed in SDS-PAGE and transferred the protein to nitrocellulose membrane and subjected to western blot using anti-C-myc antibody. The results showed the presence of protein at an expected 26.5 kDa size. In total, 0.941µg/µl of purified protein was obtained from elution1 of Ni-NTA purification and it will be used for polyclonal antisera production for immunological diagnosis development.

*(K. Nithya, R. Selvakumar and D. Neelamathi)*

## Mechanized priming of planting material and technology popularization for revival of sugarcane productivity in Tamil Nadu (RKVY)

A preliminary survey has been conducted in 5 Co-operative (i. Chengalrayan Co-op. Sugar Mills Ltd., Cuddalore, ii. The Kallakurichi Co-op Sugar Mills Ltd. – II, Kallakurichi 2, iii. The Salem Co-op. Sugar Mills Ltd., Mohanur, Namakkal, iv. Subramaniya Siva Co-op. Sugar Mills Ltd., Harur, Dharmapuri, v. Madurantakam Co-op. Sugar Mills Ltd., Kancheepuram); 2 Public (*viz.*, Arignar Anna Sugar Mills, Kurungulam, Thanjavur, vii.. Perambalur Sugar Mills Ltd. (Jawaharlal Nehru Sugar Mills) Eraiyur – Perambalur); 3 Private Sugar Mills (viii. Bannari Amman Sugars Limited, Thirukoilur, ix. E.I.D Parry (India) Limited, Nellikuppam, and x. Kothari Sugars & Chemicals Limited, Kattur) to assess the existing situation with respect to settling production in their respective factory limits. It is to note that, invariably all the 10 selected Sugar Mills have shown their interest to produce healthy settlings, as they are facing problem in settling production. Most of the Mills have established the shade net facility in their

premises. Besides, a few farmers/ entrepreneurs also have shade net facility for settling production. During the survey, the following issues such as poor germination of single bud setts, nutrient deficiency in settlings as there is no nutrient treatment of single bud setts, low settling vigour, dipping or soaking of setts for short duration in less effective chemicals, no exposure about newer effective chemicals, no idea about mechanized sett treatment except in Private Mills, the substrate used in portrays needs quality improvement were observed with respect to settling production. After the survey, with the consent of factory officials, the Sett Treatment Device – 10 units were supplied @ 1 Unit/Mill. Depending on the need and establishment of facility for initiating settling production, mechanized sett treatment technology is being demonstrated in detail to avoid above said problems in all the 10 selected Mill areas.


*Preliminary survey on existing situation of setting production and supply of Sett Treatment Devices to 10 sugar mills for healthy programme in Tamil Nadu*

*Trainings and Demonstrations in 10 Sugar Mills*

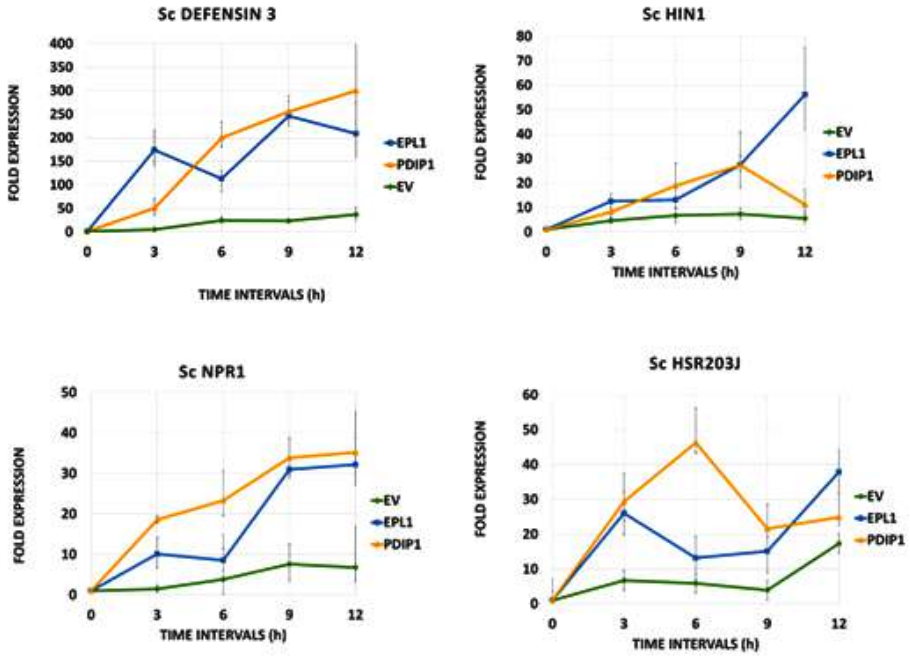
*(P. Malathi, A. Ramesh Sundar, T. Rajula Shanthy, A. Vennila, T. Ramasubramanian and Ravindra Naik (CIAE-RS, CBE)*

## Decoding the molecular events of PAMP-triggered immunity (PTI) by unlocking the interactome of the PAMP-CfEPL1 of *Colletotrichum falcatum* during interaction with sugarcane

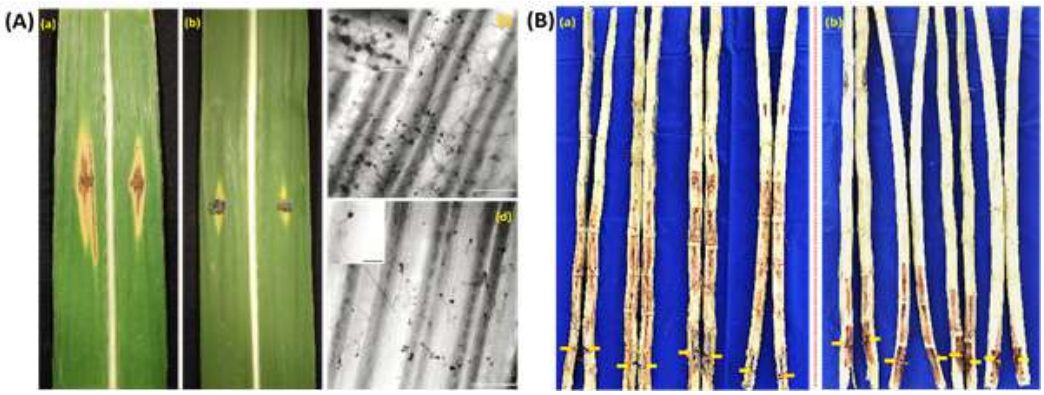
Ectopic expression of CfEPL1 and CfPDIP1 in sugarcane protoplasts under an inducible vector system: The project envisages dissecting the functional role of putative pathogen associated molecular pattern - PAMP/Effector of *C. falcatum* namely CfEPL1 (Eliciting plant response like protein 1), CfPDIP1(Plant defence inducing protein 1) and CfBYS1 (Blastomycetes Yeast Phase-Specific Protein 1) that induce innate immunity in sugarcane. In planta expression of fungal effectors is a method of functional genomics which will aid in delineating their role in host pathogen interaction. However, owing to the phytotoxicity induced by the constitutive expression of effectors, ectopic expression of such transgenes warrant its regulated transactivation, probed by a suitable inducer. Hence, in the previous year, a Dexamethasone (DEX)-inducible vector, pC1302DEX was developed and validated for controlled transient expression of GFP in tobacco. Following which, candidate effectors were transiently expressed in sugarcane protoplasts using the novel chemical–inducible vector system *via.,* PEG-mediated transformation. The transformed protoplasts were induced using optimised concentration of 10 µM dexamethasone. Inducibility of DEX promoter in sugarcane protoplasts was verified through GFP fluorescence by fluorescent microscopy. Induced expression of CfEPL1 and CfPDIP1 in sugarcane protoplasts upregulated the expression of various defence-related genes. The novel expression system has proven its efficacy in the regulated expression of transgenes under a chemical-inducible promoter. This novel vector-based expression system, can also be harnessed for stable transgenic development and conditional heterologous expression of any fungal effectors in sugarcane.

Targeted gene disruption of CfBYS1 gene delineates its role in morphology and virulence in *C. falcatum:* Functional characterization of CfBYS1 can be achieved through development of null/knockout mutants through targeted gene replacement. Earlier, a novel vector, pUC19_

mut_BYS1 was designed and constructed to generate CfBYS1 gene deletion mutants through homologous recombination strategy. Following which, Cf671ΔBYS1 mutants were generated using the standardized protoplast-based transformation protocol. Stable mutants were evaluated for its role in sporulation and virulence. Culture morphology of the mutant was altered showing more aerial hyphae without sporulation. This discernible phenotype indicated the role of CfBYS1 in fungal growth and development. Further, to assess the role of CfBYS1 in pathogenesis, culture plugs of both wild type and mutant were inoculated on detached leaves as well as on 6-month-old canes of susceptible variety CoC 671. Results showed a significant reduction of disease progression in case of mutant inoculated canes and leaves, when compared with those inoculated with the wild type. There is a distinct reduction in the pathogen colonisation and its biomass, as revealed in microscopy as well as qRT-PCR analyses respectively. The role of BYS1 gene in pathogenesis is not obvious in other homologs of *BYS1* family. However, as per the gene deletion studies, BYS1 of *C. falcatum* is crucial for its virulence and proper condition.




*Expression profiling of major defence-related genes of sugarcane during transient expression of CfEPL1 and CfPDIP1. Error bars represent standard deviation from triplicates*




*Targeted gene disruption of CfBYS1 gene delineates its role in virulence of C. falcatum (A) Pathogenicity of CfΔBYS1 assessed by detached leaf assay in the red rot sugarcane cultivar CoC 671. Disease development was documented*

*after three days. Six leaf samples each were assayed for wild type and mutant. (a and b) Disease lesions, (c and d) Appressorium count recorded from inoculated leaf samples 3 dpi for WT and mutant respectively (light microscope, bar indicates 200 microns). (B) Phenotyping of disease severity on sugarcane cane stalk tissues of cv.CoC 671 inoculated with WT (a) and the Cf671ΔBYS1 (b) were split opened on 25th day post-inoculation to evaluate the mutation effect on disease uptake and pathogen colonisation.*

*(A. Ramesh Sundar, V. Jayakumar, G.S. Suresha and P. Malathi)*

### Biogenesis of nanomaterials from effective *Trichoderma* spp. for the management of red rot disease in sugarcane (DST-SERB-TARE)

The extracellular metabolites of *T. asperellum* (T1) and *T. atroviride* (T5) synthesized from Czapek's Dox broth with 1mM, 2mM, 3mM, 4mM, 5mM Zinc nitrate were used for *in-situ* synthesis of zinc oxide material using T1 and T5. The same extracellular metabolites of T1 and T5 were used to synthesize 10mM, 20mM and 30mM using *ex-situ* synthesis. Since previous studies confirmed efficacy of extracellular metabolites of T1 than the T5, further work was carried out only with extracellular metabolites of T1. The *in-situ* synthesis followed by 10mM of *ex-situ* synthesis was found to be the best in inhibiting the pathogen growth in both solid and liquid media under *in-vitro* conditions. Further, it was found to be effective against the primary source of red rot inoculum under pot culture conditions. The use of chitosan did not enhance the efficacy of nanomaterial in inhibiting the pathogen growth in *in-vitro* and *in-vivo* conditions. Further it is interesting to note that, the prepared nanomaterial of different concentrations in water or in medium or in medium along with metabolite specifically inhibited the growth of the pathogen *C. falcatum* but not the growth of *Trichoderma* sp. Under pot culture conditions, the growth of sugarcane was enhanced significantly without red rot incidence as compared to >90% incidence in inoculated control. In this study the percent germination of different treatments varied from 72.16 to 83.3 as against 44.33 in inoculated and 55.5 in healthy controls. All these results form the basis for developing a cost effective Zn based nanomaterial from our effective Trichoderma isolates against the primary inoculum of all fungal pathogens.

*(P. Malathi (Mentor) and V. Bhuvaneshwari, KASC, BU, CBE)*

## 5.3.2 Entomology

### Studies on Sugarcane Pests and Their Management

### Standardization of mass production of scarabaeid specific *Bacillus thuringiensis* using agro-Industrial by products for white grub management

The present study was on production technology of a biopesticide containing an isolate (Bt-62) of *Bacillus thuringiensis* on low-cost media for the management of white grub *Holotrichia serrate.* In this study, we standardized a bio-insecticide formulation for Bt-62 which contains the novel coleopteran-specific crystal toxin *Cry*8Sa1. The low-cost technology for mass production of Bt-62 was developed using agro-industrial by-products and sugarcane products like juice, jaggery, trash, and by-products such as bagasse and molasses in incubator-shaker and lab-scale fermentor (20 litre). Liquid formulations were prepared using cell protectants as preservatives and their shelf-life was examined. The liquid biopesticide formulated using dimethyl sulfoxide (DMSO) 0.5% and glycerol 0.5% retained a maximum number of colonies for more than 300 days. Toxicity of the product observed in laboratory studies and efficacy demonstrated in field trials against *H. serrata* illustrated that the formulation can be mass-produced and used for the control of *Holotrichia serrata.*

*(P. Mahesh, B. Singaravelu, J. Srikanth and K. Hari)*

### Isolation of novel Bt isolates from biodiversity hot spots and functional validation of indigenous crystal toxin genes against sugarcane insect pests

A total of 501 soil samples were collected along with GPS coordinates from Bajegoli, Karnataka and surrounding areas for isolation of *Bacillus thuringiensis.* The collection was made from Bajegoli to isolate *cry* 9 type Bt isolate based on previous NCBI report. Twenty-nine Bt isolates were isolated from these samples. In addition, 2 Bt isolates were isolated from soils collected from

Damoh district of Madhya Pradesh. Thirty-two Bt isolates including 9 Bt isolates, isolated from Bajegoli were sent for whole genome sequencing to identify the *cry* genes composition

Bioassay of Bt isolates Bt41, Bt62 and cry8Sa crystal toxin was conducted on the subtropical sugarcane white grub *Holotrichia consanguinea,* at Rajasthan Agriculture Research Institute, Jaipur. The bioassay was conducted on 2nd instar and 3rd instar grubs collected from groundnut fields. For conducting bioassay studies, 12 well plates containing artificial diets incorporated with Bt toxins were prepared at ICAR–SBI and taken to Jaipur. The 2nd instar grubs of *H. consanguinea* were released in 12 well plates containing artificial diet incorporated with 100 and 200 ppm dose of cry toxins of Bt62 and Bt41 and Cry8Sa1toxin. For 3rd instar grubs carrot disc method was adopted for bioassay to determine the toxicity of Bt isolates Bt41, Bt62 and Cry8Sa1 toxin. Lyophilized Bt spore crystal mixtures of Bt41 and Bt62 were spread on both sides of carrot disc after dissolving in sterile water and 10 grubs each for Bt41, Bt62 and cry8Sa1 toxin were tested in a plastic container along with a control.

**Bioassay results of 2nd instar *H. consanguinea* with various doses of crystal toxin**

| Isolate | Bt62 | Bt62 | Bt62 | Cry8Sa1 | Cry8Sa1 | Cry8Sa1 | Bt41 | Bt41 | Control |
|---|---|---|---|---|---|---|---|---|---|
| Dose (ppm) | 200 | 100 | 20 | 200 | 100 | 20 | 200 | 100 | 0 |
| Grubs tested | 12 | 12 | 12 | 24 | 23 | 12 | 12 | 12 | 12 |
| Dead grubs | 8 | 12 | 5 | 12 | 14 | 1 | 2 | 4 | 1 |

In the carrot disc method 50% mortality was observed for 3rd instar grubs with Bt62 while only 10% was observed for Bt41 indicating Bt62 is toxic to *H. consanguinea* than Bt41.

Bioassay studies of Bt isolates Bt41, Bt62 and cry8Sa crystal toxin was also conducted on *Brahmina coriacea, H. longipennis* and *H. sikkimensis* at CSK Himachal Pradesh Krishi Vishwavidyalaya, Palampur. Ten grubs each were released for Bt62, Bt41 and Cry8Sa1 at doses of 200 and 100 ppm along with a control containing no toxin. *H. longipennis* showed 100% mortality with Bt62 while with *H. sikkimensis* 100% mortality was observed for Bt41. The effect of Bt41 on *H. sikkimensis* was also further corroborated with another bioassay study at National Bureau of Agricultural Insect Resources (NBAIR), Bengaluru.

The *cry9Da* and *cry9Eb* gene from Bt isolate Bt8 was cloned in Bt shuttle vector pSTK and was expressed as 130kDa protein in acryctalliferous Bt HD73. Bioassay of the expressed *cry9Da* and *cry9Eb* crystal toxin against 1st instar internode borer *Chilo sacchariphagus indicus* showed cry9Eb is more toxic than *cry9Da*. *cry9Eb* can be a good candidate gene for developing transgenics against various *Chilo* spp. bores infesting sugarcane.

*(B. Singaravelu, C. Appunu, G.S. Suresha, C. Sankaranaryanan, K. Deva Kumar and P. Mahesh)*

## Screening for novel genes in the transcriptomes of cane Crambids for RNAi-mediated control

The expression profiles of genes *viz.*, chitin synthase A *(CHSA)*, chitin synthase 1B *(CHS1B)*, cytochrome P450 genes *(CYP9A68, CYP4, CYP9, CYP4AU10, CYP4AU11)*, glutathione-S-transferase (GST), odorant binding protein (OBP25) and juvenile hormone methyl transferase (JHMT) were studied after isolating the total RNA from all the instars of the crambids (early shoot borer and internode borer) using gene-specific primers. The q-RTPCR analysis revealed that the levels of expression of genes across the instars were in corroboration with the transcriptome data obtained through RNA Seq. For example, the $2^{(\Delta\Delta CT)}$ values of CHSA were 4.0, 2.52, 20.15, 23.47 and 3.71 for second through sixth instar of ESB when we considered the $2^{(\Delta\Delta CT)}$ value of CHSA was 1.0 for first instar. Similarly, the relative expression levels of CHS1B in terms of $2^{(\Delta\Delta CT)}$ values were 7.11, 9.33, 20.83, 39.16 and 49.48, respectively for the II, III, IV, V and VI instars of ESB. Thus, a gradual increase

in the expression level of CHS1B was observed with the advancement of instars in ESB. The $2^{(\Delta\Delta CT)}$ values of JHMT gene were less than 0.8 as against 3.9 for the 5th instar of ESB. It was the lowest for the 6th instars ($2^{(\Delta\Delta CT)}$ value of 0.26) of ESB, which was very well corroborated the RNA seq data. The P450 gene *CYP9A68* had the $2^{(\Delta\Delta CT)}$ values between 1.0 and 432.7 with lowest level of expression in the first instar. Besides, we have also studied the persistence and dissipation kinetics of flubendiamide in/on sugarcane crop.

*(T. Ramasubramanian, S. Mohankumar (TNAU) and P.T. Prathima)*

## Prospects for conjunctive use of *Telenomus dignus* and *Cotesia flavipes* against internode borer

Laboratory parasitization and multiplication studies: When *Telenomus* adults were exposed to freshly laid lab-reared INB egg masses in chimney method, parasitization was 100% among the egg masses and 36.88-88.11% parasitisation within eggs with variable adult emergence (46.0-87.12). In box as a mass multiplication method, 27.19-63.20% parasitization within egg masses and moderate to high adult emergence (28.03-68.07%) were recorded.

## Laboratory parasitisation of egg parasitoid *Telenomus* sp. on internode borer eggs

| Batch No | No. of INB eggs exposed | No. of INB parasitoid released | Host: parasitoids ratio | % parasitisation | % parasitoid emergence |
|---|---|---|---|---|---|
| Chimney method | | | | | |
| 1 | 126 | 1 | 10: 1 | 42.06 | 52.38 |
| 2 | 122 | 1 | 12:1 | 36.88 | 47.54 |
| 3 | 133 | 1 | 13:1 | 57.14 | 62.40 |
| 4 | 150 | 1 | 15:1 | 46.0 | 46.0 |
| 5 | 97 | 1 | 10:1 | 48.45 | 49.48 |
| 6 | 44 | 1 | 04:1 | 72.72 | 77.27 |
| 7 | 174 | 1 | 17:1 | 84.48 | 84.48 |
| 8 | 128 | 1 | 13:1 | 52.34 | 51.56 |
| 9 | 221 | 1 | 20:1 | 52.94 | 53.84 |
| 10 | 101 | 1 | 10:1 | 88.11 | 87.12 |
| Box method | | | | | |
| 1 | 201 | 1 | 20:1 | 58.20 | 58.20 |
| 2 | 250 | 1 | 25:1 | 63.20 | 64.40 |
| 3 | 239 | 1 | 24:1 | 27.19 | 28.03 |
| 4 | 330 | 1 | 33:1 | 49.09 | 49.09 |
| 5 | 166 | 1 | 17:1 | 60.24 | 68.07 |
| 6 | 400 | 1 | 36:1 | 39.50 | 40.25 |

Parasitisation potential of single female *Telenomus* sp. on internode borer eggs: The parasitization potential of single female *Telenomus* sp. was examined by exposing them to variable egg masses. The fecundity of single parasitoid varied from 3-9 days. The mean percent parasitization among egg masses varied from 30.0- 93.0% and the percent parasitoid emergence was 46.66-83.78%.

### Parasitisation potential of single female *Telenomus* sp.

| Batch No | Female number | No. of INB eggs exposed | Number of days survived | % parasitisation | | % parasitoids emergence |
|---|---|---|---|---|---|---|
| | | | | Mean | Range | |
| 1 | 1 | 10-17 | 3 | 30.0 | 20.0-88.23 | 73.17 |
| 2 | 1 | 15-24 | 3 | 93.0 | 73.33-83.33 | 83.78 |
| 3 | 1 | 9-24 | 4 | 38.0 | 70.0-77.77 | 76.59 |
| 4 | 1 | 7-16 | 8 | 76.0 | 13.0-100 | 71.69 |
| 5 | 1 | 9-13 | 9 | 42.0 | 8.33-100 | 46.66 |

**Parasitoid trapping with sentinel INB eggs:** Leaf bits containing INB egg masses obtained from laboratory cultures were placed in leaf axles of 6-9-month old crop of parasitoid release and control plots. These sentinel egg masses were collected 24 h later, maintained in the lab and examined for adult emergence. In trial 1, 25% egg masses kept in the release plot showed parasitism as against 0.0% in the control plot. In trial 2, 14.28% egg masses placed in the release plot trapped the parasitoid as opposed to the nil control plot.

**Adult longevity at low temperature:** Longevity of *Telenomus* adults at low temperature (10 °C) in comparison with room temperature was examined. Different batches of 10 freshly emerged adults were collected in glass specimen tubes, kept at 10 °C and room temperature continuously, and mortality data were recorded. From five such batches, longevity of adults at room temperature ranged 2-32 days whereas at 10 °C, adults survived for a longer period of 3-44 days.

### Effect of temperature on adult longevity of *Telenomous* sp.

| Batch | 10 °C | | Room Temperature | |
|---|---|---|---|---|
| | Mean | Range | Mean | Range |
| 1 | 24.6 | 7.0-37.0 | 20.09 | 8.0-32.0 |
| 2 | 13.8 | 3.0-36.0 | 12.0 | 2.0-31 |
| 3 | 18.6 | 4.0-29.0 | 12.0 | 4.0-20 |
| 4 | 18.2 | 8.0-23.0 | 15.3 | 8.0-23.0 |
| 5 | 23.60 | 3.0-44.0 | 15.70 | 2.0-30.0 |

**Parasitisation of *Cotesia flavipes* in INB:** The extent of parasitism of *Cotesia flavipes* Cameron (*Hymenoptera: Braconidae*) on internode borer was assessed in laboratory and field at Coimbatore and Sathyamangalam areas. *Cotesia flavipes* caused a lower rate of parasitism on INB in the field (0.86-2.38%) in Coimbatore. In contrast, a parasitism rate of more than 6% was recorded in Sathyamangalam. Higher rates of parasitism were recorded in the laboratory conditions (3.33–7.50%) on INB.

### Field parasitisation rates of INB by *Cotesia flavipes*

| Field (Coimbatore) | | | |
|---|---|---|---|
| Month | Number of larvae collected | Number of cocoons obtained | % parasitized |
| Jan | 404 | 7 | 1.73 |
| Feb | 205 | 4 | 1.95 |
| Mar | 231 | 2 | 0.86 |
| April | 284 | 4 | 1.40 |
| May | 168 | 4 | 2.38 |
| Field (Sathyamangalam) | | | |
| Feb | 115 | 8 | 6.95 |

Laboratory parasitisation rates of INB by *Cotesia flavipes*

| Batch | No. of parasitoids released | No. of larvae exposed | No. of cocoons obtained | % parasitized |
|---|---|---|---|---|
| 1 | 49 | 30 | 2 | 6.66 |
| 2 | 32 | 28 | 2 | 7.14 |
| 3 | 69 | 40 | 3 | 7.50 |
| 4 | 77 | 40 | 1 | 3.33 |
| 5 | 52 | 38 | 2 | 5.26 |

**Field evaluation parasitoid against INB:** Three trials were conducted to evaluate *Telenomus sp.* and *Cotesia flavipes* against INB. In trial-1 with *Telenomus* sp. at 3000/ha and *Cotesia* at 1500 females/ha released over a 3-month period, INB incidence increased at a lower rate in release plot than in control plot at 60 and 120 d after release; intensity was more or less same in both plots.

In trial-2 with *Telenomus* sp. at 1500/ha was released as a multiple dose. INB incidence increased at a lower rate in release plot than in control plot at 30 and 60 d after release; intensity also decreased in released plot than in control plot.

In trial-3 with *Telenomus* sp. at 1500/ha and Cotesia at 1000/ha, the parasitoid was released at over a six-week period in an 8-month old crop. Post-release observation at 30 and 60 days later indicated a low INB incidence in the release plot than in the control plot.

**Parasitisation of *Telenomus* sp. at SBIRC-Kannur:** The natural occurrence of INB egg parasitoid, *Telenomus* sp. at the Kannur Centre has been studied. The natural parasitization from *Telenomus* sp. ranged from 0-64.44% (egg mass basis) and 0-92.85% (within the egg mass basis) were recorded on field-collected INB eggs. No larval parasitisation was recorded in field collected larvae that reared in the laboratory conditions during the study period.

*(P. Mahesh, K.P. Salin and B. Mahendran)*

## Formulation and field application of *Metarhizium anisopliae* (Metchnikoff) Sorokin (1883) as a mycoinsecticide

Two trials were conducted with Ma16 formulation along with other treatments. In trial I, Ma16 formulation was tested along with *Beauveria brongniartii,* insecticide Lesenta and control. Population of the grub was taken at random from 10 locations of the field. At each location one $m^2$ area was dug at the root zone and grub population was recorded before imposing the treatments. Similarly, one month after imposition of treatments, grub population was recorded from 10 randomly selected one $m^2$ area in each treatment. Data indicate that Ma16 significantly reduced the grub population over other treatments proving the superiority of the EPF formulation.

In the second trial formulation of Ma16 cultured in solid and liquid media were compared with *B. brongniartii* cultured in solid and liquid media and *B. bassiana* cultured in solid media. These EPF formulations were tested against the insecticide Lesenta and a control. The methodology for assessing pre and post treatment grub population was the same as in Trial I. Data indicate that, there was 97% reduction of grub population in the treatment *B. bassiana* solid media which was significantly superior over rest of the treatments except Ma16 liquid media. Population reduction was similar in Ma16 liquid media and *B. bassiana* solid media. The result indicates the superiority of the new strain of *B. bassiana* which could infect even the third instar grubs.

*(N. Geetha, K.P. Salin and T. Ramasubramanian)*

## Early detection of mechanism of resistance operating in sugarcane intergeneric hybrids against shoot borer, *Chilo infuscatellus* (Snellen) and internode borer, *Chilo sacchariphagus indicus* (Kapur) (Lepidoptera: Crambidae)

**(i) Observation of ESB & INB incidence on the intergeneric hybrids (IGHs) involving *Erianthus arundinaceus:*** Approximately, 15 *E. arundinaceus* derived intergeneric sugarcane hybrids were screened under field conditions to study their relative degree of resistance against early shoot borer *Chilo infuscatellus* and the incidence ranged from 0 to 30%. Among the entries, 13 and two genotypes were graded as tolerance and moderately tolerance category, respectively. The IGH clones CYM 04-388, CYM 08-922, CYM 09-167, CYM 07-971 and CYM 10-172 were recorded <5% ESB incidence. In the genotypes, only one entry (CYM 69-24) was recorded with absolutely nil ESB incidence. Similarly, internode borer *Chilo sacchariphagus indicus* varied from 0.00 to 33% among the entries. Nil INB incidence was recorded in the genotypes CYM 07-981 and CYM 08-314. Also, five entries *viz.*, CYM 08-922, CYM 07-971, CYM 69-24, CYM 07-649 and CYM 10-172 were recorded 5-10% INB incidence.

**(ii) Observation of ESB & INB incidence on the climate resilient IGHs:** Out of 38 climate resilient IGHs screened against early shoot borer under field conditions, 17, 16 and 5 clones were graded as tolerance, moderately tolerance and susceptible category. The IGHs namely IGH 804, IGH 807, IGH 809, IGH 826, IGH 830, IGH 828 and 836 were free from ESB attack. Likewise, INB incidence in the climate resilient IGHs varied from 0.00 to 45%. Nil INB incidence was recorded in the genotypes IGH 804, IGH 806, IGH 823, IGH 836, IGH 810, IGH 828 and IGH 837. Biochemical basis of resistance was studied in the ESB and INB tolerant climate resilient IGHs.

**(iii) Screening of energy canes and their mechanism of resistance against ESB & INB:** Approximately, 26 type I and type II energy canes comprising 10 and 16 clones from *E. arundinaceus* and *S. spontaneum* were field screened against ESB, *C. infuscatellus* and INB, *C. sacchariphagus indicus* and the incidence ranged from 0.00 to 16.66% and 1.25 to 22.50% in ESB and INB, respectively. Among the two energy canes groups, ESB and INB incidence level was quite high in *S. spontaneum* than *E. arundinaceus.* Based on the field and lab screening studies, each of the seven energy canes of *S. spontaneum* and *E. arundinaceus* were selected for the confirmation of true resistance and susceptibility. A significant reduction of larval & pupal survival; larval & pupal weight; extended larval duration; declining fecundity and adult's longevity of ESB and INB was observed in the both groups of energy canes. However, it was considerably higher in *E. arundinaceus* energy canes. The total phenolic content, oxidative enzymes (Peroxidase (PO) and Polyphenol oxidase (PPO) enzymes, proteinase inhibitors (PIs) and silicon contents were significantly higher in the energy canes of *E. arundinaceus* than *S. spontaneum.*

**(iv) Observation of INB incidence on the BC2 progenies involving *Erianthus procerus* (Drought and Control trial):** Out of 88 intergeneric hybrids involving *E. procerus* were screened against internode borer and the incidence ranged from 0.00 to 60% and 5 to 70% in the drought and control trials, respectively. Similarly, INB intensity also varied from 0.00 to 5.80% in the drought and 0.16 to 5.64% in the control trials. INB incidence was considerably lower in the BC2 progenies involving *E. procerus* under drought conditions than in the control.

*(M. Punithavalli, K.P. Salin and K. Mohanraj)*

## Standardization of diet-based bioassay for white grub

**Food suitability:** In our earlier preliminary bioassay tests, Bt62 spore crystal contaminated carrot discs fed to first instar *H. serrata* produced mortality in the grubs. Early instars are not voracious feeders of roots and use of sugarcane roots in bioassays is often impracticable due to logistic reasons. Hence, as a prelude to bioassays, suitability of diet as food was evaluated in comparison with carrot, potato, sugarcane root and FYM for first instar *H. serrata.*

To assess the growth pattern of grubs in different food materials, two indices, namely growth ratio and growth rate per day were estimated as follows:

$$\text{Growth ratio} = \frac{\text{Final weight (g)}}{\text{Initial weight (g)}}$$

$$\text{Growth rate per day} = \frac{\text{Final weight (g)} - \text{Initial weight (g)}}{\text{Survival (d)}} \times 10$$

## Survival and growth rate of *Holotrichia serrata* grubs on different food materials

| Food material | Survival period (d) | | Mean initial wt (g) | Mean final wt (g) | Overall growth ratio |
|---|---|---|---|---|---|
| | Mean | Range | | | |
| Carrot | 24.5 | 0.0 - 91.0 | 0.0177 | 0.0672 | 3.43 |
| Potato | 15.2 | 0.0 - 36.0 | 0.0198 | 0.0421 | 2.12 |
| Sugarcane root | 14.9 | 0.0 - 36.0 | 0.0196 | 0.0479 | 2.33 |
| Powdered FYM | 7.7 b | 0.0 - 13.0 | 0.0217 | 0.0195 | 0.89 |

Survival analysis of *H. serrata* grubs on four types of food material was significant ($\chi^2$= 8.67, df = 3, P = 0.034). Survival functions showed similar initial drop-off for carrot, potato and sugarcane roots but faster drop-off rate for FYM. Drop-off rate was slower in carrot than in potato and sugarcane roots beyond 15 days. Pair-wise comparisons of grub survival indicated non-significant differences among carrot, potato and sugarcane root but these three were significantly superior to FYM. Among the four groups, carrot had the highest percent of censored responses beyond 30 days.

**Suitability of different diet:** Three types of diet combinations were evaluated for rearing of *H. serrata.* The mean survival period of *H. serrata* from egg laying to adult emergence on diet 1 ranged from 0.0 to 120 days. In diet 2 the survival period was 0.0-92 days but no adults emerged. The shortest survival period was recorded on diet 3 (0.0-39.0 d) with no pupation and adult emergence. Weight gain of grubs that survived longest in the three groups indicated a typical pattern of steep increase followed by gradual decline of weight.

## Survival and growth rate of first instar *Holotrichia serrata* grubs on different food materials

| Food material | Survival period (d) | Mean initial wt (g) | Mean final wt (g) | Overall growth ratio |
|---|---|---|---|---|
| | Range | | | |
| Diet 1 | 0.0 – 120.0 | 0.2171 | 0.6980 | 3.21 |
| Diet 2 | 0.0 – 92.0 | 0.2122 | 0.4468 | 2.10 |
| Diet 3 | 0.0 - 39.0 | 0.1965 | 0.2289 | 1.16 |

**Laboratory bioassays:** Diet incorporation method: Diet incorporation method of bioassays was conducted with different media containing the spore-crystals and applied at $10^9$ cfu/ml spore strength. Five to seven days old grubs were selected and released in 12 well tissue culture plates containing artificial diet and uncontaminated diet serving as control. The toxin was incorporated into the molten diet, vortexed and poured into a sterile container, allowed to solidify in laminar air flow. After solidification, the diet was cut into cubes of equal size and each cube was placed in a container. All the treatments showed significant differences in the mortality treated with the Bt-62 spore-crystal complexes using the different media compared with control. The highest mortality (56.66%) was shown at the wheat bran media containing Bt-62 spore-crystals followed by rice bran (48.30%)

## Bioassay of Bt62 against first instar grubs of *Holotrichia serrata* by diet incorporation method

| Treatments | Cumulative grub mortality (%) at different formulations | | |
|---|---|---|---|
| | Test 1 | Test 2 | Mean |
| Rice bran | 50.00 | 46.66 | 48.30 |
| Jaggery | 43.33 | 36.66 | 40.00 |
| Wheat bran | 66.66 | 46.66 | 56.66 |
| Sugarcane trash | 60.00 | 33.33 | 46.66 |
| T3 media | 40.00 | 46.66 | 43.33 |
| Control | 0.0 | 0.0 | 0.0 |

When diet incorporated cry8Sa1 toxin @ 20.0 ppm was tested against 2nd instar 58.3%, mortality

was observed, while no mortality was seen in untreated grubs.

### Bioassay of Cry8Sa1 toxin against second instar grubs of *Holotrichia serrata* by diet incorporation method

| Dose (µg/ml) | Grub mortality (%) | | | |
|---|---|---|---|---|
| | Test 1 | Test 2 | Test 3 | Mean |
| 20 | 50.0 | 58.33 | 66.66 | 58.33 |
| Control | 0 | 0 | 0 | 0 |

**Surface contamination method:** Similarly, bioassays also conducted on carrot and potatoes discs, FYM, root and diet. The spore-crystal suspension containing different dilutions was administered orally to grubs in the form of surface contamination of the food source. All the treatments showed significant differences in the mortality treated with the Bt-62 spore-crystal complexes.

*(P. Mahesh and B. Singaravelu)*

### Bio-ecology of Crown mealybug and its management in association with Pokkah boeng in sugarcane

**Composition and description of a mealy bug colony:** Each colony of the crown mealybug had all life stages with overlapping generations. Fresh eggs were pale yellow, elongate and laid in batches as clusters and are embedded in mealy threads of loosely compressed protracted tubular ovisacs. The prolifically emerging crawlers were yellow, highly active and move in groups. The antennae were eight segmented. The legs are strong, well-segmented and have setae with a tibial spur. The advanced nymphal instars are soft, yellow-bodied beneath the white mealy and powdery waxy coating. The waxy filaments are prominent all around the body with the protrusions along the flank more pronounced in males. There are two pairs of long waxy filaments in the caudal region flanked by another pair of filaments at the base of the abdomen. While males pass through a true pupal stage, the females moult into adult without metamorphosis. Abundant tiny male cocoons arranged as pairs in overlapping rows in inverted "V" shape, formed linear white festoons along the vertical axis on the ventral side of the leaf. The scurrying small and fragile adult males could be found active during the day. Male adults possess a pair of long white caudal filaments, white translucent wings with a pinkish body.

The relatively inactive stout females heavily coated with mealy wax filaments form the major part of a well-developed colony. The mature females spin ovisacs during the pre-ovipositional period. Single or multiple matings are observed. Egg laying is intermittent and in defined batches due to which the ovisac is extended. As the female adult matures, the size of the ovisac grows linearly and often measures more than twice the size of its body. The ovisac covers the entire body with only the head region protruding and exposed. The female body is slightly lifted at an angle with the attachment to the leaf only by the mouth parts. The females often crowd together and overlapping their long ovisacs may lead to the striking appearance of the cottony bed. The long body of the female becomes globular wide at the posterior end with the side projections of waxy filaments. The legs are prominent in all stages, but in mature females they appear shrunk in proportion to the swollen body. Feeding by females leaves a distinct black necrotic scar on leaves.

**Toxicity of insecticides:** We have also studied the toxicity of insecticides against the mealybug, *Phenacoccus saccharifolii*. *P. saccharifolli* has become a major threat to sugarcane cultivation in a few districts of Tamil Nadu. It is generally being managed by the application of insecticides. Imidacloprid has been on large scale use for managing this pest, though not recommended. Hence, it was felt necessary to generate baseline toxicity data for *P. saccharifolii* so as to identify effective insecticides. The baseline toxicity data ($LC_{50}$) of insecticides having label claim for managing the pests of sugarcane were generated for *P. saccharifolii* for the first time during the period under report. The baseline toxicity data should be developed for a particular instar and the lab-cultured population should also be used to get reliable and consistent results. We have standardized a mass rearing method through which we could furthered the generations under lab conditions. The third instar grubs were used for the bioassay. The bioassay was carried out with six different concentrations of each

insecticide, which were fixed after performing the range-finding test. There were five replications for each concentration and as many as 200 grubs were used for each concentration and thus, a total of 1200 grubs were used for each chemical. We have also standardized a novel leaf-dip method for the said bioassay. Among the insecticides tested, thiamethoxam with lowest $LC_{50}$ of less than a ppm was found to be more toxic to the mealybug.

*(T. Ramasubramanian, R. Selvakumar and K.P. Salin)*

### Relationship between the silicon content in *Saccharum* and *Erianthus* species with resistance to sugarcane borers

**Profiling of silicon in the feeding sites of sugarcane tissue borers on the progenies of red-fleshed *Saccharum robustum:*** Quantification of silicon was done from the different plant parts of red-fleshed *Saccharum robustum* progenies *viz.*, leaf, leaf sheath, midrib and rind which are preferential feeding sites of the tissue borers in sugarcane. Silicon content was higher among the plant parts in the order of leaf > leaf sheath > midrib > rind invariably in all the selected genotypes. In the red-fleshed *S. robustum* progenies, the silicon content was varied from 30.8 to 60.9 mg/g of leaf, 28.7 to 39.1 mg/g of leaf sheath, 11 to 22.65 mg/g of mid rib and 8.47 to 15.63 mg/g of rind, respectively. The silicon content was significantly higher in the genotypes GUK 14-722, GUK 14-864, GUK 14-804 and GUK 14-745.

*(M. Punithavalli, A. Vennila and C. Jayabose)*

## Contract Research Projects

### Evaluation of entomopathogenic fungi against white grub, *Holotrichhia serrata* and whitefly, *Aleurolobus barodensis* infesting sugarcane

**Experiment I: Evaluation of bio-control agents like entomopathogenic fungi (EPF) against whitefly, *Aleurolobus barodensis* Maskell in sugarcane.**

The population of the whitefly was not significantly affected due to the imposition of EPF treatments either alone or in combination (T1-T3) at the rate of 2.5 l/ha in either of the two trials. Imidacloprid significantly reduced mean population in trial 2. In general, the middle portion of the leaf harboured significantly higher whitefly population.

**Experiment II: Evaluation of bio-control agents like Entomopathogenic fungi (EPF) against white grub, *Holotrichia serrata* infesting Sugarcane**

The white grub *H. serrata* populations were not significantly different in the plots treated with EPF (Treatments 1-3) at the rate of 2.5 l/ha either alone or in combination, from that in control plots. Lesenta significantly reduced the white grub population.

*(N. Geetha and K.P. Salin)*

## Public–Private Partnership Projects

### Cloning expression and functional toxicity assay of *cry1D, cry2Af* and *vip3Bb* toxin genes from *Bacillus thuringiensis* isolate against Bt-resistant pink bollworm and other important lepidopterans

Under the collaborative project with Rasi Seeds Pvt Ltd, Attur, we have cloned cry1D, cry2Af and Vip3Bb in suitable expression vectors for conducting bioassay against Bt-resistant pink bollworm and other important lepidopterans. The expression and purification of Cry toxins will be undertaken by both ICAR-SBI and Rasi Seeds Pvt Ltd whole bioassay will be undertaken by Rasi Seeds Pvt Ltd. As the project is covered under confidentiality agreement with Rasi Seeds Pvt Ltd, the final report will be submitted after completion of the objectives and resolving any pending IP formalities arising out of the collaborative project. The project is currently running under extension and expected to conclude by June 2024.

*(B. Singaravelu, G.S. Suresha, C. Appunu, J. Srikanth and P. Mahesh (ICAR-SBI)*
*S. Mohan, M. Saravanakumar, A. Nixon Prabhu, M. Dinesh and M. Venkatachalam*
*(M/s. Rasi Seeds Pvt. Limited, Attur)*

## 5.3.3 Nematology

### Basic and applied studies of sugarcane phytonematodes and entomopathogenic nematodes

**Isolation and evaluation of entomopathogenic nematodes (EPN) from white grub endemic areas of subtropical sugarcane ecosystem**

**Molecular identification of EPN from subtropical sugarcane ecosystem:** Molecular identification of eight EPN isolates was done by analysis of genomic DNA sequences with internal transcribed spacer (ITS) specific primers. The sequences were compared with the NCBI database. Among the eight EPN, seven belongs *Heterorhabditis indica* (SBIP7, SBIP8, SBIP10, SBIP11, SBIP12, SBIUP76 & SBIUP113) and one *Steinernema surkhetense* (SBIUP96).

**NCBI Submission ITS sequences of EPN:** ITS sequences of eight EPN (*Heterorhabditis* and *Steinernema* spp.) isolated from sub-tropical sugarcane areas have been submitted to NCBI Database with accession numbers from OP985087 to OP985094.

**a) Field application of EPN through drip irrigation system and its efficacy against 1st instar of white grub (*Holotrichia serrata*) and *Galleria mellonella* larvae:** A field study was undertaken to find the delivery of novel formulation of EPN *Steinernema glaseri* through sub surface drip irrigation system. The trial was conducted in SBI main field number 24 with a ten-month old standing crop of sugarcane cv. Co 11015. Total area of the crop was 0.5 acre. The drip laterals length was 40 feet per row. EPN formulation was applied @ $10^8$ per acre. The formulation was diluted with water and injected through a venturi meter. The delivery of EPN was checked in the drip irrigation system and water samples were collected from venturi meter outlet, drip mainline outlet, different lateral at various places. The collected samples were observed for EPN. It was observed that the EPN were collected in all the laterals.

b) In another field experiment EPN *Heterorhabditis indica* (SBITND78) was delivered through subsurface drip irrigation system and its efficacy against white grub and *Galleria* larvae was studied. The trial was conducted in SBI main field number 24. Total area of the experiment was (length 12.5 m x breath 8 m) 100$m^2$. Ten laterals and each laterals with 25 drip outlet used. EPN formulation was applied @ $10^8$ per acre. Every row near the drip outlet, PVC pipes filled with soil with different height (5 cm, 10 cm, 15 cm, 20 cm, 25 cm and 30 cm) were placed. 5 larvae of 1st instar white grub and 4th instar *Galleria mellonella* larvae were placed separately in the PVC pipes. Mortality of the larvae was observed after 4th day and soil samples were collected in regular intervals for EPN observation. It was observed that more than 95% mortality of *G. mellonella* and 75% mortality of white grub was observed. Soil samples collected till 30 days and baited with Galleria larvae revealed the presence of EPN in the soil and caused 60-70% mortality of Galleria larvae.

**Mass production of *Galleria mellonella* in different diet composition**

Five different diets such as, Cattle feed (Beer extract, Godraj ruchira), Cotton seed oil cake, animal feed (Santhosha brand), Millet flour (rice, wheat, rye) were tried in combinations with glycerol or coconut oil or palm oil. The observation was recorded in different days' intervals. The larval weight, quantity of diet by single larva, egg laying were recorded. It was found that none of the media were found suitable for neonate larvae development. But while transferring 2nd instar larvae which was reared in original *Galleria* diet, five media favored the growth of the larvae till obtain pupal development.

***In vivo* mass production of EPN in *Galleria mellonella* larvae**

Six EPN isolates *H. indica* SBIP11, *H. bacteriophora* SBIH6, *S. surkhetense* SBIP3, *S. thermophillum* SBIH1, *S. siamkayai* SBITNT1 and *S. glaseri* SBILN1 was cultured on *Galleria* Larva with different larval weights (0.150g, 0.175g, 0.200g, 0.250g, 0.275g and 0.300g). It was observed that as the weight of the larvae increases there was an increase in IJs production. The average production of IJs number per *Galleria* larvae ranged between 60550 to 318450. Among the six EPN, *H. bacteriophora* SBIH6 recorded maximum.

## Liquid culturing of EPN and its bioassay against *Galleria* larvae.

Mass production of six EPN isolates *H. indica* SBITND78, *H. bacteriophora* SBITNHB, *S. surkhetense* SBIP3, *S. thermophillum* SBIH1, *S. siamkayai* SBITNT1, *S. glaseri* SBILN1 was attempted in monoxenic liquid culturing and successful nematode mass production was observed in two EPN isolates (*S. surkhetense* SBIP3 and *S. siamkayai* SBITNT1).

## Comparison of *In-vivo* and *In-vitro* cultured EPN against *Galleria* larave

Comparison of two EPN isolates (*S. surkhetense* SBIP3 and *S. siamkayai* SBITNT1) cultured on *in-vivo* and *in-vitro* methods were tested against *Galleria mellonella* larvae with different dosages (5IJs/larva, 25Ijs/larva, 50IJs/larva and 100Ijs/larva) and the mortality and IJs yield recorded. Mortality of the *Galleria* larvae was observed both in *In-vivo* and *In-vitro* cultured EPN and it ranged between 60 to 100%.

## Commercialization of ICAR - SBI EPN Biopesticide Formulation

The ICAR-SBI EPN Biopesticide formulation technology has been commercialized to two companies (Coordinated by AGRINNOVATE INDIA, New Delhi) with a license fee of Rs. Four lakhs. As per MOU, training was given to the concerned company personnels.

## Maintenance of EPN and symbiotic bacterial cultures

Seventy-eight EPN strains belongs to tropical (49) and subtropical (29) are being maintained in the culture collection and 45 symbiotic bacteria belongs to *Photorhabdus* spp. (26 Nos.) and *Xenorhabdus* spp. (19 Nos.) are also regularly sub-cultured and stored in glycerin.

*(C. Sankaranarayanan, S.K. Pandey, B. Singaravelu and P. Geetha)*

## Establishment of native entomopathogenic nematodes as potential bio-pesticide to tackle the exotic invasive pest fall armyworm menace (DST-SERB-TARE)

**Mass production and Formulation of entomopathogenic nematodes:** *In-vivo* and *in-vitro* production technology are the key factors for successfully implementing EPNs as a potential biological control agent. Mass production of native EPNs *Heterorhabditis indica* SBITNAUHI, *H. bacteriophora* SBITNAUHB1 and *Steinernema siamkayai* SBITNAUSS2 using different animal and plant protein based media were assessed. Further, the virulence of the EPN offspring reproduced from the five best solid medium were also assessed against rice grain moth *Carcyra cephalonica.* Among the ten solid media tested, *H. indica* did not multiply on wheat flour medium, meat extract medium, modified wheat flour medium. It multiplied well on NA medium with 40.2 lakh IJs per 250 ml flask. The *H. indica* IJs multiplied on NA medium recorded least LC50 (9.2 IJs) and $LT_{50}$ (13.5 h). For *Heterorhabditis bacteriophora* and *S. siamkayai* multiplication, wheat flour medium and meat extract medium were not supported. They reproduced on other eight tested media with varied multiplication rates. The *H. bacteriophora* multiplied at higher rate (37.28 lakh IJs per 250 ml flask) in NA medium and the IJs released from this media were with lesser $LC_{50}$ of 11.7 IJs and $LT_{50}$ of 21.0 h. *S. siamkayai* multiplied profusely (52.9 lakh IJs per 250 ml flask) on modified dog biscuit medium and IJs produced were with least $LC_{50}$ (8.5 IJs) and $LT_{50}$ (23.5 h). NA medium for *H. indica* and *H. bacteriophora*; and dog biscuit media for *S. siamkayai* are better for mass production of virulent populations.

Different formulations like sodium alginate beads, talc powder, water dispersible granules were prepared for *H. indica, H. bacteriophora,* and *S. siamkayai* and their survival rate was tested under 20 $^0$C and virulence against *C. cephalonica* were assessed. In alginate gel formulations, *S. siamkayai* survived longer (105 days) than *H. indica* (90 days) and *H. bacteriophora* (75 days). The infectivity also showed that all these three strains caused 100% mortality for the first 15 days and slowly declined at 75 days. The *S. siamkayai* recorded more infectivity for up to 105 days.

Survival of EPNs in talc based formulation was tested at the moisture levels of 10, 20, 30, 40, 50%. The *H. indica* showed more survival rate of 105 days than *H. bacteriophora* (90 days) and *S. siamkayai* (75 days). In talc, *H. indica* exhibited more survival rate and infectivity against

*C. cephalonica*. In water dispersible granular formulation, *S. siamkayai* and *H. indica* survived longer (up to 105 days) than *H. bacteriophora* (75 days). The *S. siamkayai* showed more infectivity of 100% against *C. cephalonica* in granular formulation.

Testing of developed formulation against the FAW under pot culture as well as field conditions: *Heterorhabditis indica* SBITNAUHI, *H. bacteriophora* SBITNAUHB1 and *Steinernema siamkayai* SBITNAUSS2 formulations were evaluated initially under pot culture conditions against FAW larvae. The higher mortality of FAW (50%) was obtained in single foliar spraying of *H. indica* at 3000 IJs/ml with 2% Glycerol + 1% Tween 20 under pot culture conditions. Further efforts were made to test the combined effect of *H. indica* SBITNAUHI, *H. bacteriophora* SBITNAUHB1 and *S. siamkayai* SBITNAUSS2 under pot culture conditions. It was revealed that foliar spraying of *H. indica* at 1500 IJs/ml + *S. siamkayai* at 1500 IJs/ml with 2% Glycerol + 1% Tween 20 caused 58.3% mortality of FAW under pot conditions. However, combined application did not allow either of EPN strain multiplications on FAW. Field studies conducted with different doses of *H. indica* revealed that foliar spraying of *H. indica* at 3000 IJs/ml with 2% Glycerol + 1% Tween 20 caused 55% mortality of FAW.

*(C. Sankaranarayanan, N. Seenivasan (TNAU, CBE) and B. Singaravelu)*

## Externally Funded Projects

### Artificial intelligence powered diagnostic kit for real-time monitoring of nematode pests of sugarcane. (TARE -DST-SERB)

This is a new project initiated during October 2022. During this period a total of 24 soil/root samples from the sugarcane rhizosphere were collected. The samples were processed by Cobb's sieving and decanting method followed by modified Baermann method. Twenty-four hour after incubation, the nematodes collected in the petri dish were kept on camera built-stereozoom microscope. The nematode images at 10x, 20x, 30x and 40x magnifications were captured. The same nematode suspension is also viewed under camera built-research compound microscope and nematode images captured at 40x and 100x magnifications. Then the nematodes were killed and fixed in 4% formaldehyde and image collection procedure was repeated on camera built-stereozoom microscope and research compound microscope in all magnifications set up as detailed above. Folders containing live/dead images of each root-knot nematode, lesion nematode, lance nematode, stunt nematode, spiral nematode and other nematodes captured at all magnifications were being maintained. The collection of soil samples and image capturing works are being continued.

The nematode images captured through varied resolution sizes and angles needs to be normalized. Various image pre-processing techniques such as logarithmic transformation, contrast stretching, histogram equalization, power-law transformation, adaptive histogram equalization, histogram matching method, fuzzy if-then method and fuzzy-genetic method are being evaluated. The best-performing image enhancement algorithm for the nematode image set will be selected based on indices entropy and blind image quality index (BIQI). The image collection and image preprocessing works are under progress.

*(C. Sankaranarayanan, D. Suryaprabha (Nehru Arts and Science College, CBE) and N. Seenivasan (TNAU, CBE)*

## All India Coordinated Research Project on Biological Control

**Pathology:** In continuation of pot culture studies with bioagents against major fungal diseases *viz.*, red rot, smut and wilt of sugarcane, three field experiments were laid out with fungal and bacterial bioagents against all the 3 diseases. In which, fungal (*Trichoderma asperellum*) and bacterial (*Paenibacillus alvei*) bioagents were selected and treated the setts individually and in combination. These biological treatments were compared with the recently CIB recommended fungicide azoxystrobin and combination of this fungicide with bacterial antagonist *P. alvei.* Invariably all the treatments were imposed by mechanized means of sett treatment using sett Treatment Device (STD). Here, wilt infected planting material of V1 – CoC 671, V2 – Co 86032, V3 – Co 11015 were selected for evaluating

wilt management and smut infected Co 97009 for smut management. With respect to red rot management, the susceptible variety CoC 671 along with red rot inoculum were used. Besides, FYM enriched with *T. harzianum* and *T. asperellum* was applied @ 1 kg/ 10′ row. Preliminary results of all the three experiments indicated that there was a significant improvement of germination and establishment was shown by combination of fungicide and bacterial bioagent followed by fungicide alone as compared to biocontrol agents alone.

*(N. Geetha and P. Malathi)*

## Management of white grubs through EPN (All India network project on white grubs and other soil arthropod pests)

**Supply of EPN cultures to AINP on white grub centers:** Five EPN *Heterorhabditis indica* SBITND78, *H. bacteriophora* SBIP5, *Steinernema surkhetense* SBIP3, *S. thermophillum* SBIH1 and *S. siamkayai* SBITNT1 were mass produced and formulated in talc and supplied to Assam Agricultural University, Jorhat for field trial against white grub on potato. Mass production of EPN is being continued for the supply to other centers as per technical programme

*(C. Sankaranarayanan and B. Singaravelu)*

## 5.4. Statistics & Economics Section

### Sugarcane based Agri-Business Incubator (SBI-ABI)

SugarcaneEdge has received Rs. 17.80 lakhs from IPTM- NAIF component-II during 2022-23. SugarcaneEdge has installed tray dryer, HPLC column, wine refractometer and other small instruments as pilot scale production and novel food products development. ICAR-SBI-ABI (SugarcaneEdge) is continuously supporting technology commercialization and incubation activities. Currently, five incubates are actively developing new products as well as licensed technology commercialization.

Cane Ice cream product was kept in the Stall for commercial sale by the entrepreneurs in the CODISSIA agri trade fair which was held during 13-16 July 2023 at Codissia complex, Coimbatore. CaneFest which was held at ICAR-SBI, Coimbatore.

*Entrepreneurs' participation in CaneFest at ICAR-SBI, Coimbatore*


*Memorandum of Agreement signed between ICAR-NAARM and SugarcaneEdge of ICAR-SBI for co-incubation and other value-added services*

The Agribusiness Incubation Society (ABIS) – Technology Business Incubator (TBI), in collaboration with a-IDEA, ICAR-NAARM, Hyderabad and SugarcaneEdge of ICAR-SBI is a knowledge partner, successfully organized the AgriUdaan Road Show 6.0 at the Directorate of Agribusiness Development, TNAU, Coimbatore. Dr. G. Hemaprabha, Director, ICAR-SBI delivered the presidential address has acknowledged the favourable environment for start-ups, providing opportunities for funding, mentoring, and support from government and incubation centers. The event saw the participation of nearly 100 stakeholders, including start-ups, investors, incubators, mentors, academicians, and bankers, contributing to the growth and upliftment of the agricultural sector.

*Testing of Soil Moisture Indicator (SMI) by Secretary DARE and DG, ICAR in the farmers meet at ICAR-CTCRI.*

SMI a widely commercialized technology by ICAR-SBI which was tested and evaluated by DG, ICAR during farmers conclave at CTCRI, Trivandrum. Recently, one of the incubators has actively demonstrating the SMI at farmers fair, meetings of FPOs and exhibitions at different parts of the country

*Visit by Shri. Alok Mehta, Hon'ble Minister for Sugarcane Industries, Govt. of Bihar to SugarcaneEdge at ICAR-SBI.*

*(P. Murali, K. Hari, G.S. Suresha and D. Puthira Prathap)*

## Economic impact of the ICAR-SBI varieties and technologies in India (ICAR-NIAP National Institute of Agricultural Economics and Policy Research)

Soil Moisture Indicator (SMI) for scheduling irrigations was developed through Farmers Participatory Action Research Programme (FPARP), funded by the Ministry of Jal Shakti, Govt of India. Soil Moisture Indicator is a device to assess the status of soil moisture and for scheduling of irrigation. SMI is handy and useful tool to monitor and regulate the irrigation scheduling. SMI is handy and useful tool to monitor and regulate the irrigation scheduling. The technology has received the second National WATER Award 2019 by Ministry of Jal Shakthi. It has also received the TERI-IWA-UNDP Water Sustainability Award 2021. The SMI technology has been licensed to 21 firms and has generated a revenue of Rs 46.58 lakhs. Over 2.2 lakh units of SMI technology has been distributed to farmers, agricultural universities, agri-departments, KVKs and sugar mills across the country.

## *Ex-ante* assessment of water saving by SMI in Tamil Nadu

Water is scarce resource in the country and sugarcane is one of the water loving and water demanding crops for realising yield and recovery potential. So, the device was developed on farmers participatory action research and experimented in the water scarce district of Tamil Nadu. The analysis was done based on data collected from 101 sample farmers to assess the extent of water saving and yield gain which is presented in the table.

### Evaluation of SMI in farmers' fields

| Item | Conventional Irrigation | Irrigation based on SMI |
|---|---|---|
| Cane yield (t/ acre/crop) | 55.8 | 60.4 |
| No. of irrigations / crop | 42 | 36 |

The *ex-ante* assessment was worked out based on sample data collected in the sugarcane crops at Tamil Nadu and Uttar Pradesh. The preliminary study revealed that additional yield as well as water saving was recorded from beneficiary farmers in the study area. Based on the sample data, the *ex-ante* assessment of water savings and additional yield improvement in sugarcane was worked out for major cane growing states as well as national level and depicted in the table.

### *Ex-ante* assessment of water savings and yield improvement with use of SMI technology in India

| Year | Estimated area under SMI (ha) | % of adoption | Estimated water saving (Lakh cubic litre) | Incremental yield with use of SMI (Lakh tonnes) | Incremental returns due to adoption of SMI technology (Rs. Crores) |
|---|---|---|---|---|---|
| 2023-24 | 0.47 | 0.013 | 51 | 0.80 | 25 |
| 2024-25 | 3.13 | 0.074 | 321 | 4.98 | 160 |
| 2025-26 | 5.39 | 0.122 | 556 | 9.31 | 306 |
| 2026-27 | 7.65 | 0.173 | 792 | 14.45 | 490 |
| 2027-28 | 8.89 | 0.217 | 925 | 16.78 | 589 |
| 2028-29 | 11.94 | 0.267 | 1,241 | 22.78 | 832 |
| 2029-30 | 15.02 | 0.311 | 1,549 | 28.25 | 1,060 |
| 2030-31 | 15.97 | 0.350 | 1,646 | 29.43 | 1,145 |
| 2031-32 | 19.03 | 0.383 | 1,953 | 34.83 | 1,393 |
| Total | 87.48 | 0.212 | 9,034 | 161.63 | 6,000 |

Soil Moisture Indicator is a promising technology developed by the ICAR-Sugarcane Breeding Institute, Coimbatore and was taken for impact evaluation. An *ex-ante* assessment of the impact of SMI on sugarcane yield, volume of irrigation and economic returns were estimated. It has been computed for Tamil Nadu, Uttar Pradesh, Madhya Pradesh, Maharashtra, Karnataka, Gujarat, Haryana, Uttarakhand and Punjab which has accounted more than 85% of the total cane area in the country. At the national level, it is expected that by 2031-32 about 38 per cent of the area under sugarcane (88 Lakh ha) would be using SMI for irrigation scheduling. This would save about 9,034 Lakh cubic litters of irrigation water and increase yield by 161 lakh tonnes to sugarcane farmers due to proper irrigation and optimum water availability in the sugarcane farms. It would help sugarcane farmers to earn an additional income of Rs. 6,000 crores by 2031-32.

The evaluation of Soil Moisture Indicator technology of Sugarcane Breeding Institute has shown that 9,034 lakh cubic litre of water could be saved by using soil moisture indicator (SMI) with the adoption rate of 38% in the country. The additional yield was realized by the farmers due to better water management. The expected additional yield of about 161 lakh tonnes of sugarcane and Rs. 6,000 crores of additional revenue could be earned by the farmers. Similarly, The SMI has potential to use major field crops and water saving and additional revenue will be much higher to major categories of farmers.

**Total surplus from the adoption of Soil Moisture Indicator (SMI) in sugarcane fields in India**

(Rs. in crores)

| Year | Consumer surplus | Producer surplus | Total surplus |
|---|---|---|---|
| 2023-24 | 0.19 | 0.21 | 0.39 |
| 2024-25 | 5.62 | 8.44 | 14.06 |
| 2025-26 | 15.88 | 29.03 | 44.92 |
| 2026-27 | 32.05 | 69.49 | 101.54 |
| 2027-28 | 43.99 | 108.53 | 152.52 |
| 2028-29 | 68.92 | 193.39 | 262.31 |
| 2029-30 | 95.01 | 295.19 | 390.20 |
| 2030-31 | 107.48 | 362.25 | 469.73 |
| 2031-32 | 135.96 | 488.92 | 624.88 |
| Total | 505.11 | 1555.44 | 2060.55 |
| NAV @ 8% | 296.05 | 889.81 | 1,185.87 |

The above table depicts the estimated consumer, producer, and total surplus due to the adoption of SMI in sugarcane fields in India. SMI has fetched a total economic surplus of Rs. 2060 crores, of which more than 75 per cent is from producer's surplus (Rs. 1555.44 crores) and 25 per cent from consumers surplus (Rs. 505.11 crores). Whereas, the discounted (at 8%) NPV of total economic surplus was about Rs. 1185 crores.

*(P. Murali, D. Puthira Prathap and K. Hari)*

## Agricultural Knowledge Management Unit (AKMU)

The Agricultural Knowledge Management Unit (AKMU) is providing online interconnectivity between the different research institutes, national centers, State Agricultural Universities. The AKMU is involved in creation of databases on sugarcane and sugar production system. It envisages the adoption of advanced methods of communication and internet technologies. It is continuously doing content up-dating and

creation of new webpages of the institute website. AKMU has Provided technical support given to E-Governance applications such as ERP system, E-Office, TMIS, SPARROW, IRS, ARMS, E-HRMS and Krishi portal *etc,*. After covid-19, AKMU actively arranging Video conferencing facility for online meeting, international conferences, national trainings, events and *etc.* AKMU is continuously upgrading IT infrastructure and accessories for easy communication by the staff. It is efficiently managing Local Area Networking (LAN), display system for showing events, AEBAS attendance system for employees. Recently, ICAR-SBI seed portal was created for easy access to farmers for buying the sugarcane-based seed materials throughout the country. Institute website has been developed in WordPress environment and it was hosted at ICAR-DC, IARI, New Delhi on 01.03.2023. Web Security audit for Institute website has been done by a CERT-IN Empanelled firm from 17.02.2023 to 23.02.2023

## 5.5 Extension Section

### P1-15/5-1 : Transfer of sugarcane technologies

### Utilization of extension methods and media for effective transfer of sugarcane technologies

#### 1. 53rd Sugarcane R&D Workshop of Tamil Nadu and Puducherry

ICAR - Sugarcane Breeding Institute had organized the 53rd Sugarcane R&D Workshop of Tamil Nadu and Puducherry at BHB Mahal, Theni, during November 3-4, 2023.

**The following topics were discussed:**

a. Review of action taken on the recommendations of the previous workshop,

b. Current Status of Mechanical harvesting in the region,

c. Current varietal position and Performance of new sugarcane varieties,

d. All India Co-ordinated Research Project on Sugarcane, Co-ordinated agronomic experiments/Adaptive Research Trial / SBI-SISMA/SBI-TNCSF Varietal trials and

e. Sugarcane seed nursery programme.

The workshop was hosted by Rajshree Sugars & Chemicals Ltd. About 300 delegates comprising scientists from ICAR-Sugarcane Breeding Institute, Coimbatore and Tamil Nadu Agricultural University, Coimbatore, Chief Executives & Cane Development personnel from various sugar factories, officers from the Department of Agriculture, Directorate of Sugar and other Cane Development organizations in Tamil Nadu & Puducherry had participated in the workshop.


*53rd Sugarcane R&D Workshop of Tamil Nadu and Puducherry*

#### 2. Trainings/Exposure visits/Personal advisories

#### 2.1. Trainings organized

a. Sponsored/Inter-state Training Programmes for Farmers and Cane Development Personnel

i. ***Refresher Course for State Public Sector/Co-op Sugar mills:*** Conducted six **'Refresher Training on Sugarcane Varieties and Technologies (RTSVT)'** for the field staff of the Co-operative and Public sector sugar mills of Tamil Nadu (Amaravathi Co-op Sugar Mills, Salem Co-op Sugar Mills, Perambalur Sugars, Kallakurichi -1 Co-op Sugar Mills, K2 Co-op Sugar Mills & Madhuranthakam Co-op Sugar Mills, Vellore Co-op Sugar Mills, Tirupattur Co-op Sugar Mills &Tiruttani Co-op Sugar Mills, Dharmapuri/ Subramaniya Siva, Arignar Anna,

National, Chengalrayan, MRK. Cheyyar Co-op Sugar Mills) on 10th, 11th , 12th , 21st , 24th & 25th July 2023, respectively. About 385 cane staff got benefitted. The training had seven technical sessions in all. The training was inaugurated by Shri C. Vijayarajkumar IAS., Principal Secretary/Commissioner of Sugar, Govt. of Tamil Nadu.

ii. Inter-state Training on 'Sugarcane Production' was conducted at Agali for ATMA farmers of Kodumudi Block, Erode : Number of participants:17; March 14-16, 2023

*Inter-state training in progress at Agali, Kerala*

iii. Sponsored Training on *'Technologies for Sustainable Sugarcane Production' (TSSP)* for the trainers of Solidaridad, New Delhi ; Number of participants: 20; Dates: 27-28 July 2023; *Padmashri* Dr Bakshi Ram , Former Director of ICAR-SBI delivered the Inaugural address online. A publication on Technologies for Sustainable Sugarcane Production' was brought out.

iv. Conducted a one-day training programme on 'Protecting the sugarcane crop', that included measures to manage Pokkah boeng disease and Crown Mealy bug on June 30, 2023 (Friday) for 55 farmers and 4 staff of MRK Co-operative Sugar Mills. Sethiathope. A technical bulletin on "Management of Crown Mealy bug and Pokkah boeng in sugarcane" was published.

v. Training on *'Improved Sugarcane Production Technologies' (ISPT):* Conducted two funded- training programmes on 'Improved Sugarcane Production Technologies (ISPT)', for the cane staff of SNJ Sugars and Products Ltd., Andhra Pradesh during 5-16 June, 2023. The programme was conducted in two phases for 40 trainees @ 20 trainees per training of five days. The training was inaugurated by Dr R. Tamizh Vendan, Registrar of Tamil Nadu Agricultural University. The training had 17 technical sessions and an Industrial/field visit to Sakthi Sugars Ltd., Appakudal. A publication entitled 'Improved Sugarcane Production Technologies (ISPT)', was released by the Director during the valedictory function of the training programme. It was found that the trainees had gained about 50% of knowledge on improved sugarcane production technologies after attending the training programme.


*ISPT Trainees at Sakthi Sugars Ltd.*

**Knowledge gain of trainees**

| | Minimum score | Maximum score | Mean scores | Knowledge gain |
|---|---|---|---|---|
| Before training | 1 | 8 | 3.9 | 49.72% |
| After training | 8 | 22 | 16.4 | |

vi. A three-day training on 'Advances in sugarcane cultivation' sponsored by Cane Development & Sugar Industry, Uttarakhand was organized for 16 sugarcane farmers from Uttarakhand during 13-15 March 2023.

vii. ICAR-Sugarcane Breeding Institute organized a *Training on 'Scientific Cultivation of Sugarcane' (TSCS)* for 11 sugarcane farmers of Palus Taluk, Sangli district, Maharashtra, during 14-15 December, 2023 (Thu-Fri). The training had twelve technical sessions in all.

*Trainers from SOLIDARIDAD, New Delhi undergoing training at ICAR-SBI*

## 2.2. One-day trainings on improved Sugarcane Cultivation

1. For 20 farmers and one staff of Mailam block, Villupuram district, TN; 19.1.23
2. For 31 farmers and 5 staff of Sangareddy district, Telangana; 20.1.23
3. For 12 farmers and one ATMA staff of Belagavi, Karnataka ; 20.2.23
4. For 20 farmers and two ATMA staff of Kodumudi, Erode, Tamil Nadu; 16.3.2023
5. For 32 farmers and two staff of Tiruvalla, Kerala, 8.6.2023
6. For 12 farmers and one staff from Maharashtra (ATMA); 21.11.23

## 2.3. Exposure Visits Conducted

1. For 71 students and six staff of SNGS Collge, Pattambi, Palakkad, Kerala; 9.1.23
2. For 62 students and four staff of Agricultural College, Sircilla, PJTSAU, Hyderabad. 10.1.23
3. For 57 students and 3 staff of Agricultural college, Palem, PJTSAU, Hyderabad; 10.1.23
4. For 100 students and 4 staff of PJTSAU, Hyderabad; 10.1.23
5. For 94 students and 6 staff of Lokmangal Agricultural College, Solapur; 11.1.2023
6. For 95 students and five staff of College of Agriculture, KAU, Padannakkad
7. For 52 students and four staff of Rani Lakshmi Bai Central Agricultural University, Jhansi, UP; 26.1.2023 (Republic day)
8. For 32 students and three staff of St.Dominic' college, Kanjirapally, Kerala; 30.1.2023
9. For 40 students and two staff of NSS college, Ottapalam, Kerala; 30.1.2023
10. For 26 students and four staff of Mar Thoma college, Chungathara, Kerala; 1.2.23
11. For 118 students and four staff of Vanavarayar Institute of Agriculture, Pollachi; 3.2.2023
12. For 55 students and two staff of Bharath Institute of Higher Education and Research (School of Agriculture); Chennai; 7.2.23
13. For 18 students and two staff of Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore; 9.2.2023
14. For 26 students and 3 staff of Sampoorna International Institute of Agricultural

College and Horticultural Technology, Karnataka.14.2.2023

15. For 20 students and two staff of Biswanath College of Agriculture, Assam Agricultural University, Assam; 15.2.23
16. For 57 students and two staff of Kalasalingam Agricultural and Horticultural College, Srivilliputtur, Tamil Nadu; 10.2.23
17. For six interns of Sree Sastha college, Kerala; 16.2.23
18. For 39 students and two staff of College of Agricultural Engineering, ANGRAU, Andhra Pradesh; 20.2.23
19. For 51 students and five staff of Bharathidasan University, Tiruchirappalli, Tamil Nadu; 2.3.23
20. For 53 students and three staff of College of Agriculture, Raichur, UASR, Karnataka; 2.3.23
21. For 6 students of PDM University, Haryana; 3.3.23
22. For 61 students and one staff of Nehru Arts and Science College, Coimbatore; 7.3.23
23. For 51 students and two staff of UAS, Dharwad; 13.3.23
24. For 10 students of Vanavarayar Institute of Agriculture, Pollachi, Tamil Nadu; 13.3.2023
25. For 67 students and two staff of College of Agriculture, UAS-Dharwad, Vijaypur; 14.3.2023
26. For 67 students and two staff (II batch) of Agricultural College, Vijayapur, UAS-D, Karnataka; 16.3.2023
27. For 39 students and two staff of CMS college of Science and Commenrce, Coimbatore, Tamil Nadu; 17.3.2023
28. For 56 students and two staff of UAS-Dharwad; 21.3.2023
29. For 58 students and two staff of College of Agriculture, UAS-Dharwad, Karnataka, 23.3.2023
30. For 61 students and two staff of UAS-Dharwad; Karnataka, 23.3.2023
31. For 56 students and five staff of PR Pote Patil College of Agriculaure, Amravati, Maharashtra; 23.3.2023
32. For 40 students and two staff of Ponnaiyah Ramajeyam Institute of Science and Technology, School of Agriculture, Thanjavur, Tamil Nadu; 23.3.2023
33. For 55 students and 2 staff of The Kavery Engineering College, Salem; 23.3.2023
34. For 150 students and 6 staff of Kailash Women's College, Mettur, Salem, Tamil Nadu; 24.3.2023
35. For 57 students and two staff of UAS-Dharwad; 27.3.2023
36. For 68 students and two staff of College of Agriculture, UAS-Dharwad, Karntaka; 30.3.2023
37. For 100 students and 10 staff of Aringnar Anna College, Krishnagiri, Tamil Nadu; 10.4.2023
38. For 33 students and four staff of Lokmangal College, Wadala, Solapur, Maharashtra; 14.4.2023
39. For 100 students and four staff of Karunya University, Coimbatore ; 3.5.2023
40. For 40 students and one staff of TNAU, Coimbatore ; 3.5.2023
41. For 141 students and five staff of APAC, GB Nagar, Kalavai, Tamil Nadu; 20.6.23
42. For 114 students and five staff of The Indian Agricultural College, Radhapuram, Tamil Nadu; 23.6.23
43. For 134 students and 3 staff of RVS Agricultural College, Thanjavur, Tamil Nadu; 27.6.23
44. For 148 students and 6 staff of College of Agricultural Technology, Theni, Tamil Nadu
45. For 107 students and six staff of Adhiyaman College of Agriculture, Hosur, Tamil Nadu; 17.7.23
46. For 45 students and three staff of Sharad college of Agriculture, Jainapur (MPKV), Rahuri, Maharashtra; 19.7.23

47. For 42 students and three staff of PRIST University, Vallam, Thanjavur; 19.7.23
48. For 151 students and four staff of AC & RI, Eachankottai, Thanjavur, Tamil Nadu (TNAU); 20.7.23
49. For 139 students and six staff of Imayam Institute of Agriculture, Thuraiyur, Tamil Nadu; 21.7.23
50. For 95 students and 4 staff of AC & RI (TNAU), Madurai; 21.7.23
51. For 42 students and six staff of AC & RI (TNAU), Madurai; 22.7.23
52. For 130 students and four staff of JSA college of Agriculture, Thittagudi, Cuddalore; Tamil Nadu; 24.7.23
53. For 67 students and two staff of TNAU, Coimbatore ; 25.7.23
54. For four PG students and one staff of AC & RI, Killikulam (TNAU), Tamil Nadu; 26.7.23
55. For 30 PG students and one staff of TNAU, Coimbatore; 3.8.23
56. For 65 students and three staff of AHS ASFT Vignan University, Guntur, Andhra Pradesh; 16.8.23
57. For 30 students and three staff of Kalasalingam Academy of Research and Education, Srivilliputtur, Tamil nadu; 27.8.23
58. For four students and one staff of TNAU, Coimbatore; 24.8.23
59. For 25 students and three staff of Mohandas College of Engineering and Technology, Trivandrum, Kerala; 5.9.23
60. For 51 students and four staff of Vivekandanda Arts and Science College for Women, Sangagiri, Salem; 21.9.23
61. For 65 students and two staff of Amrita School of Agricultural Sciences; Coimbatore; Tamil Nadu; 5.10.23
62. For 40 students and three staff of College of Agricultural Biotechnology, VNMKV Parbhani, Maharashtra; 6.10.23
63. For 19 students and two staff of KE College, Mannanam, Kerala; 9.10.23
64. For 70 students of Karunya University (Attached to Sri Avinashilingam KVK), Coimbatore; 12.10.23
65. For 41 students and two staff of Sri Krishnadevaraya College of Agricultural Sciences, Ananthapuram, Andhra Pradesh; 12.10.23
66. For 15 PG students and two staff of University of Kerala, Department of Botany, Kerala; 16.10.23
67. For 20 students and 12 staff of Calicut University, Kerala; 18.10.23
68. For 53 students and two staff of ANGRAU, Guntur, Andhra Pradesh; 18.10.23
69. For 53 students and two staff of Agricultural Colege, Mahanandi, ANGRAU, Andhra Pradesh; 19.10.23
70. For 38 students and one staff from Hanur, Chamrajanagar Dt. Karnataka; 10.11.23
71. For 20 students and two staff of Rathinam International Public School; 16.11.23

*School students at Institute museum*

## 2.4. Personal advisories/Customized technical sessions/Interaction handled

i. For two farmers of Coimbatore district; 7.2.2023

ii. For four farmers from Bareilly, UP; 10.2.23

iii. For 15 Post Graduate Students of Agricultural Extension, TNAU, Coimbatore; 15.2.2023

iv. For one farmer from Namakkal, Tamil Nadu; 15.2.23

v. For one farmer from Kangeyam, Tiruppur, Tamil Nadu; 15.2.23

vi. For one farmer from Villupuram, Tamil Nadu; 15.2.23

vii. For one farmer from Coimbatore district; Tamil Nadu; 17.2.23

viii. For one farmer from Coimbatore district, Tamil Nadu; 20.2.23

ix. For three farmers from Kolhapur, Maharashtra; 1.3.2023

x. For one farmer from Telungupalayam, Coimbatore, TN; 2.3.23

xi. For one farmer of Puttabarthi, Andhra Pradesh; 7.3.23

xii. For two farmers from Thanthai Periyar Nagar, Puducherry; 24.3.2023

xiii. For one farmer from Ganapathy, Coimbatore ; 5.4.23

xiv. For two persons from Bengaluru, Karnataka; 20.4.2023

xv. For three persons from Fertilizer Association of India; 27.4.2023

xvi. For one person from NSL Sugars Ltd.; 15.5.2023

xvii. For three CDP from Sri Chamudeeswari Sugars Ltd., KMDoddi; 15.5.23

xviii. For one teacher (retd.) from Corporation Higher secondary school, Peelamedu; 15.5.2023

xix. For two farmers of Nippani, Belgaum, Karnataka; 15.5.23

xx. For one farmer of Kovaipudur, Coimbatore, Tamil Nadu; 24.6.23

xxi. For three academicians from ADT, Baramati, Pune, Maharashtra; 5.7.23

xxii. For four farmers of Dadarwara, Narsinghpur, Madhya Pradesh; 10.7.2023

xxiii. For two CDP from Daurala Sugar works, Uttar Pradesh; 11.7.23

xxiv. For one bureaucrat (retd.) on 13.7.23

xxv. For four CDP from Madhuranthakam Co-op Sugar Mills Ltd.; 17.7.23

xxvi. For one farmer from Chetpet, 17.7.23

xxvii. For one farmer from Tiruppur; 27.7.23

xxviii. For two CDP from Mekasuta Sugars, Shreeji Sugars, Madhya Pradesh; 28.7.23

xxix. For five farmers from Maharshtra; 4.8.23

xxx. For one farmer from Kothamangalam, Paramathivelur, Tamil Nadu; 8.8.23

xxxi. For seven farmers from Vellakinaru, Coimbatore; 10.8.23

xxxii. For two farmers from Ahmednagar, Maharashtra; 10.8.23

xxxiii. For two farmers from Ulundurpet, Kallakurichi, Tamil Nadu; 10.8.23

xxxiv. For three farmers from Pune, Maharashtra; 21.8.23

xxxv. For one farmer from Sarkar Samakkulam , Coimbatore, Tamil Nadu; 22.8.23

xxxvi. For one farmer from Coimbatore ; 24.8.23

xxxvii. For one parliamentarian (former) ; 4.9.23

xxxviii. For one farmer from Vriddhachalam, Cuddalore; 14.9.23

xxxix. For two farmers of Sankari West, Salem; 22.9.23

xl. For two farmers of Shirur, Pune, Maharashtra; 17.10.23

xli. For one farmer from Belagavi ; Karnataka; 27.10.23

xlii. For one scholar from Agra, Uttar Pradesh; 1.11.23

xliii. For two farmers from Kolhapur, Maharashtra; 6.11.23

xliv. For two farmers of Sangli Dt. Maharashtra; 20.11.23


*Shri T K Rengarajan, Former Member of Parliament at Institute Museum*

## 3. Participation in Exhibitions

1. Institute had participated in the Mega exhibition on *'Azadi ka amrit mahotsav'* organized by the Ministry of Information and Broadcasting at S.N. Arangam, Coimbatore during 17-18 March, 2023.


*Mega exhibition organized as part of Azadi ka amrit mahotsav*

2. ICAR - SBI participated in **Agri-Intex 2023** (International Agricultural Exhibition) organized by Coimbatore District Small Industries Association (CODISSIA) by way of putting up a stall at its Trade Fair Complex in Coimbatore during 14-17 July, 2023.

*Registrar of Tamil Nadu Agricultural University visiting ICAR-SBI stall at Agri-Intex 2023*

3. ICAR - Sugarcane Breeding Institute participated in the **State-level Agricultural Exhibition – 2023** during 27-29 July 2023 organized by Department of Agriculture, Govt. of Tamil Nadu at Care Engineering College, Tiruchirappalli by putting up a stall.

4. ICAR-SBI participated in the exhibition organized by ICAR-NRC Banana during the 30th ICAR-NRCB Foundation Day - "Farmers' Day" on 21.08.2023.


*SMI being demonstrated during ICAR-NRCB's Foundation Day*

5. ICAR-SBI participated in the exhibition organized as part of G-20 Agriculture Ministers Meeting held from 15-17 June 2023 at Hyderabad.

6. ICAR- SBI participated in the ASC-Expo (Agricultural Science Congress) organized by NAAS, New Delhi in Kochi by putting up a stall during October 10-13, 2023.

*Dignitaries at ICAR-SBI stall at ASC-Expo in Kochi*

4. **Technology Park:** Technology Park 2023 was planted in January 2023 with 17 sugarcane varieties (Co 86032, Co 11015, Co 99004, Co 92005, Co 06022, Co 13013, Co 06030, Co 14012, Co 0212, Co 12009, Co 18009, Co 10026, Co 0232, Co 0233, Co 05011, Co 00238, Co 09004) & tissue culture plants in 90 rows.

5. **MoU with TaraBlooms:** A MoU was signed with Tarablooms in February 2023 wherein through NamFarmers which is a social media global agri platform, messages on sugarcane technologies and happenings at the Institute would be shared with the cane growers.

6. **Interaction with like-minded agencies:** Participated in the Scientific Advisory Committee meeting of MYRADA KVK, Shri Avinashilingam KVK and Dharmapuri KVK and offered suggestions for implementation of programmes.

7. **Publications: Compiled, edited and printed**

- ICAR-SBI Annual Report 2022 (English)
- ICAR-SBI News January 2023 and April 2023

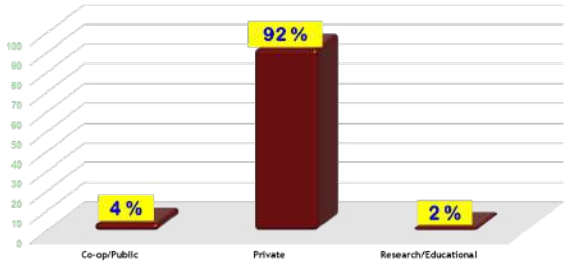
8. **National Science Day:** National Science Day was celebrated at the Institute on 28 February 2023 as an 'open day' with the participation of 1180 students from 12 schools and two colleges in Coimbatore district. The students were taken around the institute's museum and the exhibits with live specimens were explained by Scientists and Technicians apart from video shows.

9. **Use of social media for transfer of technology:** ICAR-SBI has been regularly reaching out to the stakeholders of sugarcane agriculture through social media such as Facebook (https://www.facebook.com/icar.sbi ), YouTube (http://www.youtube.com/@icar-sugarcanebreedinginst1942 ; http://www.youtube.com/caneinfo) X (@BreedingIcar). Institute technologies are being disseminated through these ICT-based channels. Six WhatsApp groups were formed with the participants of state / national level training programmes, 'Kisan mela' and farmer visitors to the Institute. Messages on eight titles were sent to the groups created and the same are also being transmitted through MYRADA KVK (225,000 farmers)

*(D. Puthira Prathap and T. Rajula Shanthy)*

## Evaluating the effectiveness of state-level sugarcane R & D workshops – A cross-state assessment

The State - level Sugarcane R&D workshops (Formerly called as Sugarcane R&D workers' meetings) is a unique outreach initiative of ICAR-Sugarcane Breeding Institute having a history of over three decades. Providing an interface between the researchers and the development personnel, these R&D workshops ensure the timely and effective transfer of the latest technologies developed at the research stations to the sugarcane growers. This project was formulated to evaluate these state-level Sugarcane R&D workshops, to know the extent to which the outcomes implied from the workshop objectives have been realized. This would also help in generating data for the benefit of the sponsors of the workshop (the sugar factories or research institutions, as the case may be), to improve the conduct of future workshops and to show their potential to the future participants as well as the policy makers *viz.*, the respective state governments. The locations of study are Tamil Nadu/Puducherry, Southern Karnataka and Northern Karnataka.




*Distribution of respondents*

During the period under report, a survey was taken up in Northern Karnataka. The questionnaires were administered to the participants of the recently concluded 19th Sugarcane R&D workshop of Northern Karnataka. Among the 25 respondents, 4% belonged to the Co-operative / Public sector factories, 92% belonged to Private sugar factories while 4% belonged to research institutions.

### The preliminary observations of the study are:

'Major topics of the workshop', 'opportunity for interacting with sugarcane scientists' and 'no registration charges' were the predominant factors that influence the decision of the respondents to attend R&D workshop, besides the nomination of employers.

- 'Varieties' was the major topic in which the respondents were most interested in the workshops.
- Majority of the respondents were 'very satisfied' with the organizational aspects of the R&D workshops.
- Respondents had rated the pre-R&D workshop correspondence to be understandable, accurate and with appropriate level of detail.
- Respondents were 'very satisfied' with the clarity of correspondence, feasibility/ practicality of workshop recommendations and the opportunity to express opinions during the workshop.
- Respondents had rated the 'Compendium of research articles and status papers', Introductory session, general interactive session and varietal display' at the R&D workshops to be 'extremely helpful'.
- Respondents had cited taking up 3-tier nursery and restricting cultivation of unreleased varieties in the factory area as major instances of action taken on the R&D workshop recommendations.
- Respondents had mentioned that the R&D workshops had a 'large' impact on one's own work and on their 'organizations'.
- 'Technical paper presentations by cane experts' and 'participation of all sugar factories in one place' were considered as the 'Strengths' of Sugarcane R&D workshops of Northern Karnataka.

*(D. Puthira Prathap and P. Murali)*

## Social impact assessment of micropropagation in sugarcane: An explanatory analysis

This is a new project initiated with the overriding objectives of studying the spread and acceptance of micropropagation technology in sugarcane, analyze the perception of cane growers and cane personnel about micropropagation, analyze the constraints faced by stakeholders in adopting

micropropagated plants and study the advantages realized in adopting micropropagated plants.

A questionnaire was developed to get response on the specific objectives from the cane growers and cane staff involved in micropropagation. Pilot study was conducted with non-sample respondents and the questionnaire was done.

Survey was conducted with 23 cane development personnel from 18 sugar mills, of which 12 were cooperative sugar mills and the rest six were private mills from 15 districts. The respondents were males 78.26% and the rest 21.74% were females; they were diploma holders in agriculture (26.09%), graduates in Agriculture (34.78%) and post graduates (39.13%); Had work experience range of 1-36 years, experience in sugar industry in the range of 1-34 years; 65.22% had attended at least one training on sugarcane in the last five years and 47.82% had attended 1-2 training programs in sugarcane tissue culture. Preliminary analysis of the data revealed that:

- Source of information about micropropagated plants for the cane staff were officials of the sugar mills concerned. They had contacted SBI, nearby Sugarcane Research Stations, Growmore or EID Parry to get further details about micropropagation.
- Most of them heard about micropropagated plants in sugarcane at least ten years back.
- Source of procuring micropropagated sugarcane plants was Sugarcane Breeding Institute for most of them, apart from EID Parry, K-I sugar mill and Growmore.
- Micropropagated plants are equated to the best quality planting material, be it for use as setts for planting or for use as bud chips for settling production.
- Qualities as seen by the cane staff in micropropagated plants include high yield, resistance to diseases and pests and good cane girth.
- Choice of varieties obtained as micropropagated plants are Co 86032, Co 11015, Co 0212.
- Micropropagated plants are either supplied to farmers through sugar mills or in certain cases, farmers get it directly.
- All the respondent cane development personnel were highly convinced about the performance of micropropagated plants.
- Farmers are advised to take bud chips from micropropagated plants of 6-8 months age for producing settlings, be it for own use or as commercial nurseries.
- Each time they discuss with and encourage farmers about the use of micropropagated plants, they say that it gives a sense of satisfaction of imparting a new technology to them.
- Advantages: Production of quality planting material, high yield, disease free plants, resistance to diseases in the subsequent stages, increased resistance to pest attack, good tillering, uniform crop growth, good crop stand, initial high vigour, more number of millable canes, long internodes with good cane girth, maintenance of genetic purity, rejuvenation of old degenerated varieties to regain its original vigour, faster multiplication of new varieties, disease free plants for use in seed nursery program, better income for seed farmers at six months itself, plants are quite sturdy and ease of planting, less mortality percentage of the plants, possibility of getting more setts / settlings in a stipulated time, good quality cane in terms of sucrose percentage thereby high recovery, maintains the high performance for 4-5 years.
- Constraints: Difficulty in convincing farmers about the importance of micropropagated plants, lack of innovative farmers to take up micropropagated plants, high cost of micropropagated plants, not available when there is high requirement, thin canes in few clumps (as reported by few), less awareness among cane growers on the benefits of micropropagated plants, needs more care compared to sett planting and its too difficult to make farmers realize this in the first attempt of using micropropagated

plants, best suited for wide row spaced cultivation only, non-availability of micropropagated plants of desired varieties, planting and establishing micropropagated plants in summer is difficult, need trained manpower for producing plants in the sugar mills, production of plants is a time consuming process.

- Suggestions: Possibility of micropropagated plants that can be harvested by 4-5 months so as to reduce the crop duration, More resistance to diseases, Increased tillering to get more setts, Availability of plants on demand at short notice with a choice of variety, More production centres with mother culture being supplied from SBI, Random monitoring of the seedlings by SBI staff in the R&D field of the mills / farmers' fields.

*(T. Rajula Shanthy, C. Jayabose and D. Neelamathi)*

## ICAR-SBI Development Action Plan for Scheduled Tribe Component (DAPSTC)

The 'Development Action Plan for Scheduled Tribe Component' (formerly TSP) is primarily concerned with ensuring Human Resource Development and enhancing the quality of life of the scheduled tribes by providing basic amenities. During the period, the project was implemented in Sathyamangalam Tiger Reserve in Erode district.

- **Conduct of needs assessment, identification of gaps and organizing a series of campaigns in the tribal settlements**

In consultation with the forest officials and officials of other line departments, an interview schedule was prepared for needs assessment, identification of gaps and possible interventions, to conduct baseline surveys. Focus groups were initially conducted in the tribal settlements of Sathyamangalam Tiger Reserve (STR) *viz.*, Uginiyam, Athiyur-Germalam, Nagalur & Bathripadugai in Kadambur hills and Ramaranai, Bejalatti, Thadasalatti, Ittarai, Maavanatham and Galithimbam in Talamalai hills.

Of these, Ramaranai, Bejalatti, Thadasalatti, Ittarai, Maavanatham, Galithimbam and Bathripadugai hamlets were selected for implementing the project. The distribution of tribal beneficiaries in Sathyamangalam Tiger Reserve is given below:

| Settlements | Tribal households | Settlements | Tribal households |
|---|---|---|---|
| Ramaranai | 23 | Galithimbam | 78 |
| Bejalatti | 83 | Ittarai | 60 |
| Thadasalatti | 40 | Bathripadugai (Kadambur) | 72 |
| Maavanatham | 94 | | |

While the Kuruba tribes live in Ramaranai, the Oorali tribes live in the other six hamlets. Unlike most of the tribals of ATR, the STR tribals have land rights. As part of STC, awareness camps were initially conducted in these settlements, on the objectives of STC and other developmental initiatives for the benefit of the tribals in the region. During the period an impact evaluation was conducted among the tribals belonging to two remote settlements of Anamalai Tiger Reserve *viz.*, Koomatti and Paalakkinaru. ITKs were documented in these settlements.

*The STC team did a 3-hour trek through dense forests to reach Paalakinaru, a remote tribal settlement in the Anamalai Tiger Reserve for impact evaluation*

*STC team at Koomatti tribal hamlet in Anamalai Tiger Reserve during Impact evaluation*

### • Launch of STC in STR and distribution of items/inputs

Subsequent to the needs assessment among the tribals as well as discussion among the forest officials of STR, an action plan was devised for possible interventions in the tribal hamlets. Accordingly, a formal 'launch programme of STC cum Tribal nutrition awareness campaign' was organized at Sathyamangalam, wherein the tribals and the village heads (Gothaali) of all the identified settlements participated.

The Director of ICAR-Sugarcane Breeding Institute and District Forest Officer, Sathyamangalam Tiger Reserve interacted with the tribals during the occasion. The DFO appreciated the efforts of ICAR-SBI in identifying 'malnutrition' as a serious issue among the tribals of STR and organizing a series of awareness campaigns to address this problem.

### • Tribal training campaigns

Following this, campaigns to impart awareness on tribal nutrition and training sessions were conducted in all the identified settlements. During these campaigns, sessions for knowledge empowerment were handled by experts and farm tools, household items, seed kits for setting up nutrition garden, radio sets, areca nut seedlings, vermicompost, liquid jaggery *etc.*, were distributed among all the tribal households. All tribals who participated in these campaigns were administered the 'Pledge against malnutrition'.

*Pledge against malnutrition*

Extension literature on setting up of nutrition gardens, millet cultivation, Leaflet on All India Radio programmes, Bee-keeping, Arecanut cultivation and Millet recipes were prepared and distributed.


*Awareness cum training campaign at Ramaranai Tribal Settlement*

### • Thrust on promoting Millet entrepreneurship among tribals

As part of the International year of Millets 2023 celebrations, seeds of finger millet, little millet and proso millet were distributed among the tribals. In order to promote 'millet entrepreneurship', training sessions were held in the tribal hamlets with experts to add value to their millet produce by making millet flour, preparing healthy and tasty millet dishes and market their products effectively. For this, 'pulverizers' along with logbooks were handed over to the tribal hamlets *viz.,* Ramaranai, Bejalatti, Thadasalatti, Ittarai, Maavanatham and Galithimbam.

### • World Forestry day

During the Nutrition awareness campaign conducted among the school children belonging to Government Tribal Residential School, Talamalai, which was held on World Forestry Day (21 March), the Director of the ICAR-SBI spoke and gave away stationery, solar-powered torchlights, millet biscuits and blankets to the students.

### • Promotion of bee-keeping to avoid human- animal conflict

Based on the needs assessment, the campaign at Bathripadugai village included a session on 'Bee-keeping'. All households of Bathripadugai settlement were supplied with Beehive boxes along with Indian honeybee (*Apis cerana indica*) and accessories, as an experimental measure, to avoid human-animal conflict, since studies from Sri Lanka have shown that the sound of Indian honey-bees scare elephants away. This enterprise would also help in increasing the income of the tribals and provide pollination support in the region.

*Bee unit distribution to minimize human-animal conflict*

*'Urali' tribal women and children at an STC awareness / training campaign in Mavanatham tribal hamlet*

*(D. Puthira Prathap, K. Mohanraj, P. Geetha and V. Sreenivasa)*

## 5.6 ICAR-Sugarcane Breeding Institute, Regional Centre, Karnal

### Breeding Superior Sugarcane Varieties of Different Maturity with Improved Cane Yield, Quality and Resistance to Biotic and Abiotic Stresses

#### Breeding elite clones suitable for NWZ

**Sugarcane variety notified for commercial cultivation:** Co 16030 (Karan 16), a mid-late maturing variety was gazette notified (SO 4222 (A) dated 25.09.2023) for cultivation in NWZ comprising the states of Delhi, Haryana, Punjab, Rajasthan, Uttrakhand and Uttar Pradesh (Central and Western parts). Co 16030 (Karan 16) is a high-yielding sugarcane variety derived from a cross Co 0238 x Co 8347 and developed at the ICAR-Sugarcane Breeding Institute, Regional Centre, Karnal (Haryana).

*Co 16030 (Karan 16), a mid-late maturing variety*

Comparative performance of Co 16030 in AICRP trials for cane yield and juice quality with the standard varieties

| Entry / standard | CCS t / ha | Cane yield (t / ha) | Sucrose (%) |
|---|---|---|---|
| Co 16030 | 11.96 | 94.97 | 17.90 |
| CoPant 97222 | 10.57 | 83.32 | 18.30 |
| CoS 767 | 9.91 | 80.71 | 17.59 |
| Co 05011 | 10.94 | 84.57 | 18.36 |
| **Percent improvement over standards** | | | |
| CoPant 97222 | 13.01 | 13.85 | -2.18 |
| CoS 767 | 20.55 | 17.60 | 1.79 |
| Co 05011 | 9.18 | 12.14 | -2.49 |

*(Mintu Ram Meena, Ravinder Kumar, G. Hemaprabha, M.L. Chhabra and S.K. Pandey)*

**Sugarcane variety identified in Varietal Identification Committee (VIC):** Co 17018 (Karan 17), a mid-late maturing variety due to its better cane and sugar yield over best check was identified in the Annual Group Meeting of AICRP on Sugarcane held at Dr. Rajendra Prasad Central Agricultural University, Pusa, Samastipur (Bihar) during October 26 - 27, 2023.

*Co 17018 (Karan 17), a mid-late maturing variety*

Comparative performance of Co 17018 in AICRP trials for cane yield and juice quality with the standard varieties

| Entry / standard | CCS t / ha | Cane yield (t /ha) | Sucrose (%) |
|---|---|---|---|
| Co 16030 | 11.77 | 91.48 | 18.38 |
| CoPant 97222 | 10.07 | 80.81 | 17.99 |
| CoS 767 | 9.91 | 81.31 | 17.48 |
| Co 05011 | 10.77 | 84.64 | 18.12 |
| **Percent improvement over standards** | | | |
| CoPant 97222 | (+) 18.19 | (+) 14.18 | (+) 2.25 |
| CoS 767 | (+) 19.10 | (+) 13.07 | (+) 5.12 |
| Co 05011 | (+) 09.76 | (+) 08.52 | (+) 1.46 |

*(Ravinder Kumar, Mintu Ram Meena, R. Karuppaiyan, Bakshi Ram, G. Hemaprabha, M.L. Chhabra, S.K. Pandey and D. Pooja)*

#### Hybridization, Progeny evaluation and selection (Season 2022-23)

**Hybridization:** A total of 55 bi-parental cross combinations were effected at NHG, ECC and Agali Centre based on the available male and female combination and a total of 16 GC

indented from National Hybridization Garden, Coimbatore during the crossing season 2023.

*(M.R. Meena)*

**Seedling selection in the ground nursery:** A total of 671 better performing clones were selected from the 11225 seedling in ground nursery, representing 85 bi-parental, 7 GC and 10 PC combinations, planted in the seedling ground nursery based on HR Brix, NMC, cane diameter, cane height and other desirable morphological traits. After assigning selection number K21-01 to K21-671, they were field transplanted under C1 evaluation in augmented design along with four standards (Co 0238, CoJ 64, Co 05011 and CoS 767).

*(M.R. Meena and Ravinder Kumar)*

**Fluff raising in mist chamber, field transplanting and winter ratooning:** The fluff of 94 bi-parental, 8 GC and 23 PC combinations of the crossing season 2022-23 was sown in the mist chamber during the second week of April, 2023. The germination and survivability of the seedlings was good with varying intensity. A total of 8280 seedlings representing nearly 125 cross combinations were field transplanted during first week of July 2023. The ground nursery was ratooned during peak winter period during last week of December.

*(Ravinder Kumar and M.R. Meena)*

**First clonal trial 2022-23:** A total of 375 clones of K20 series were evaluated for cane quality at 8$^{th}$ month. Co 15023 was the best standards with 22.4% average HR brix recorded in last week of October 2023. Fifteen entries *viz*., K20-074, K20-075, K20-105, K20-229, K20-235, K20-073, K20-275, K20-269, K20-005, K20-209, K20-232, K20-102, K20-102, K20-096 and K20-256 had numerically higher HR brix (>22.4%) than Co 15023. Six among them *viz*., K20-275, K20-269, K20-05, K20-209, K20-102 and K20-096 were found R or MR against CF13 patho-race of red rot disease.

**Red rot:** Among the 375 clones of C1 trial evaluated against CF13 isolate of red rot; 82 were found to be resistant, 121 moderately resistant, 38 moderately susceptible, 43 susceptible and 91 highly susceptible.

*(Ravinder Kumar, M.R. Meena and M.L. Chhabra)*

**Preliminary trial 2022-23:** The experiment consisting 80 test clones and four standards was evaluated for agronomic and quality parameters. For NMC ('000 ha$^{-1}$), Co 05011 (106.9) was the best standard and eight test clones had on par performance with it. K19-110 (101.13), K19-84 (98.43), K19-102 (93.62), K19-174 (92.38), K19-35 (89.68), K19-167 (87.60), K19-157 (87.70), K19-181 were promising entries for NMC population. At 8$^{th}$ month of crop stage for juice sucrose%, 9 test entries K19-234 (18.97), K19-172 (18.88), K19-175 (18.86), K19-152 (18.74), K19-39 (18.7), K19-47 (18.67), K19-240 (18.61), K19-91 (18.57) and K19- 23 (18.55) found promising over best standard CoJ 64 (18.49%). Whereas, 20 entries were promising over Co 0238 (17.81).

**Red rot:** Among the 85 preliminary clones evaluated 38 were resistance, 32 moderately resistant, six moderately susceptible, four susceptible and five highly susceptible to CF08 isolate. Similarly, against the CF13 isolate, 11 clones found to be resistant, 30 moderately resistant, four moderately susceptible, 16 susceptible and 24 highly susceptible to red rot.

*(M.R. Meena, Ravinder Kumar and M.L. Chhabra)*

## Pre-Zonal Varietal trial

During crop season 2022-23, the PZVT experiment consisting 43 test entries and four standards (Co 0238, CoJ 64, CoS 767, Co 05011) was evaluated for cane yield, juice quality and red rot reactions. Considering all the selection criteria for assigning the status of "Co" canes, three clones *viz*., K17-050 (Early), K15-525 (Early) and K15-527 (Early) whereas, K14-231(ML), K15-263 (ML), were selected for assigning the status of Co canes.

**Performance of Co status clones in PZVT experiment at ICAR-SBIRC, Karnal during 2022-23**

| Test entries/Co status | CCS t ha$^{-1}$ (10M/12M) | Cane yield t ha$^{-1}$ | Sucrose% | | | Red rot reaction | |
|---|---|---|---|---|---|---|---|
| | | | 8M | 10M | 12M | CF08 | CF13 |
| **K17-050( Co 23022) Early** (Co 86002 x CoS 88216) | 15.03 (10M) | 105.20 | 19.67 | 20.53 | 21.06 | R | MR |
| K 14-231 (Co 23023) Midlate (CoS 8436 x Co 89003) | 14.96 (12M) | 108.33 | 16.52 | 17.80 | 19.64 | MR | R |
| **K15-263 ( Co 23024) Midlate** (Co 88013 x Co 97015) | 17.05 (12M) | 125.29 | 14.41 | 16.48 | 19.32 | MR | MR |
| **K15-525 ( Co 23025) Early** (Co11015XCo94008/CoT8201/ Co10015) | 17.25 (10M) | 126.09 | 17.25 | 18.94 | 20.99 | R | MR |
| **K15-527 ( Co 23027) Early** (Co11015XCo94008/CoT8201/ Co10015) | 14.25 (12M) | 105.50 | 17.31 | 19.10 | 19.24 | R | R |
| **Standards** | | | | | | | |
| CoJ 64 | 11.76(10M) | 87.47 | 17.90 | 19.00 | 19.38 | HS | MS |
| Co 0238 | 13.66(10M) | 102.59 | 17.96 | 18.96 | 20.02 | MR | HS |
| CoS 767 | 8.02 (12M) | 62.06 | 16.61 | 16.68 | 18.19 | MR | MS |
| Co 05011 | 11.68(12M) | 91.63 | 14.99 | 16.85 | 18.31 | MR | MR |
| CD | 2.11 (10M) 2.48 (12M) | 17.85 | 0.62 | 0.60 | 0.87 | | |
| CV | 11.60(10M) 12.13(12M) | 11.60 | 2.31 | 2.12 | 1.69 | | |

*(M.R. Meena, Ravinder Kumar and M.L. Chhabra)*

**Season 2023-24:** The experiment consisting 39 test entries and four standards (CoJ 64, Co 0238, CoS 767 and Co 05011) was evaluated for agronomic and juice quality traits. For NMC ('000 ha$^{-1}$), Co 05011 (116.05) was the best standard and 27 test entries performed on par with it, among them K15-011 (130.25), WL13-815 (129.32), K18-88 (123.46),K15-231 (123.15), WL08-338 (121.30), K15-586 (120.68), K15-582 (118.21) and K15-342 (117.90) produced comparatively higher NMC over it. The general mean of the trial for HR brix at 8$^{th}$ month recorded was 19.4%. Ten entries had numerically higher HR brix% than best standard CoJ 64 (20.6%). For sucrose% in juice at 8$^{th}$ month, the performance of seven test entries *viz.*, K15-013 (18.98), K17-111 (18.93), WL 13-456 (18.91), K15-342 (18.90), K15-370 (18.85), K18-47 (18.64) and K18-34 (18.36) was comparable with the best standard CoJ 64 (18.65). Juice analysis was also carried out at 10$^{th}$ month stage. Test entries K15-013 (19.54), K15-370 (19.40), K18-47 (19.35), K15-342 (19.22) and K18-34 (19.11) found promising against best standard Co 0238 (19.11). Except K15-370 and K17-111, rest of the better performing test entries for juice quality were also R or MR against CF08 and CF13 races of red rot pathogen.

**Red rot:** Thirty nine PZVT clones were evaluated and 25 found to be resistant, 8 moderately resistant, three moderately susceptible and three susceptible with CF08 isolate, while with CF13 isolate, 12 clones exhibited resistant, 11 moderately resistant, two moderately susceptible, four susceptible and 10 highly susceptible reactions to red rot.

*(Ravinder Kumar, M.R. Meena and M.L. Chhabra)*

## Enhancement of sugarcane germplasm and development of pre-breeding material

### Evaluation of sugarcane germplasm, ISH and IGH Clones under sub-tropical conditions

**ISH trial (Plant crop):** A total of 26 ISH clones were evaluated along with four standards (Co 0238, CoJ 64, Co 05011 and CoS 767) for their drought tolerant potential**.** The drought stress was imposed by withholding irrigations during the formative stage. The average numbers of tillers ('000 $ha^{-1}$) under normal and drought condition at 120 DAP was (166.48) and (120.37) respectively and reduction was 26.12% under drought. Co 0238 was the best standard with least reduction (19.55%).

Leaf area measured after imposing of drought and entries 14-67, 14-124, 14-58, M179-15, 20-20-24, ISH 588 and ISH 524 have performed good and had less reduction for leaf area <3% under drought.

The average NMC for normal and drought stress was 0.61 and 0.49 lakhs $ha^{-1}$ respectively, with 19.2% reduction under drought condition. The best standard was Co 05011 with 2.21% reduction under drought and entries ISH 588, 14-58 and 14-195 were at par with it. At 8$^{th}$ month crop stage, cane height recorded with 23% reduction under drought and clones showed least reduction were; ISH 588, ISH 524, 14-106 and 14-90. The mean reduction under drought was 25.3% for single cane weight and it was 0.9 kg, and 0.7 kg under normal and drought respectively. Entries ISH 588, ISH 524 and 14-103 were at par with best standard Co 05011 (6.51). Pol% in juice under normal and drought stress recorded was 14.5%, 15.10% respectively, and best standard was Co 0238 with least reduction under drought conditions. The mean reduction for single cane weight under drought at 10$^{th}$ month recorded was 22.78% and Co 0238 was best standards with least reduction (19.72%). Better performing clones recorded less reduction and performed better over the best standard for single cane weight were ISH-524, 14-114, 14-90, 14-58, 14-103 and 14-124 during 10$^{th}$ month stage. The average reduction for cane height was 24% and entries *viz*., 14-90, 14-67, 14-58, M179-15, 14-474 and ISH 588 had less reduction for cane height during 10$^{th}$ month stage. For cane yield; the mean reduction of 27.7% was recorded under drought stress and Co 0238 (24.8%) was best among standards. Test clones recorded less reduction were; 14-90, 14-58, 14-67, 14-474, 14-195, 14-124, ISH 524 and ISH-588 for cane yield at harvest.

**Screening of ISH clones under salinity stress:** Five ISH clones namely 14-34, 14-83, 14-90, 14-111 and 14-161 with standard Co 0238 were planted during first fortnight of March, 2023 in 50 kg capacity cemented pots with three replications to screen them under different level of salinity stress. After 45 days of planting (DAP), chloride dominated continued saline irrigation of different EC water i.e. 4, 6 and 8 $dSm^{-1}$ were applied. Data were analyzed with CRBD design. At 110 days after salinity stress, a gradual decrease was recorded in all the studied parameters with progressive increase of salinity stress from $EC_{iw}$ – 4 $dSm^{-1}$ to $EC_{iw}$ – 8 $dSm^{-1}$. Average plant height was 127.35 cm under normal irrigated control which was reduced up to 12.3%, 19.0% and 21.80% in 4, 6 and 8 $dSm^{-1}$, respectively. ISH clones, 14-111, 14-161, 14-90 showed less reduction than average reduction and 14-34 was at par while 14-83 showed highest reduction at all the salinity treatments. Chlorophyll content reduced 9.13%, 14.13% and 19.11% under 4, 6 and 8 $dSm^{-1}$ level, respectively as compared to normal irrigated control (38.3 µg $cm^{-2}$). ISH clones, 14-161 and 14-111 recorded higher chlorophyll content among all the studied clones. Average plant population was 3 plants $clump^{-1}$ in normal irrigated control whereas 8%, 15.5% and 21% reduction was recorded under $EC_{iw}$ – 4, 6 $dSm^{-1}$ and 8 $dSm^{-1}$ salinity treatment. ISH clone, 14-161, 14-111 and 14-90 had maximum plants $clump^{-1}$ in all the treatments and showed less reduction than average reduction. $Na^+/K^+$ in leaf increased from 0.125 (control) to 0.409, 0.538 and .703 in 4 $dSm^{-1}$, 6 $dSm^{-1}$ and 8 $dSm^{-1}$, respectively. ISH clone 14-161 and 14-111 performed better than best standard Co 0238 under all the studied level of salinity stress

**Red rot:** Among the 36 ISH clones evaluated for red resistance, seven clones expressed resistant, 13 moderately resistant, seven moderately susceptible, five susceptible and four highly susceptible reactions to CF08 isolate, whereas five

clones were resistant, nine moderately resistant, five moderately susceptible, 11 susceptible and six highly susceptible to CF13 isolate.

**Insect Pests**: Thirty six sugarcane germplasms /species clones (ISH & IGH) were evaluated against early shoot borer & top borer revealed that its incidence was <10.0 per cent.

*(M.R. Meena, Ravinder Kumar, S.K. Pandey, M.L. Chhabra and D. Pooja)*

## Deciphering the mechanism of drought tolerance in sugarcane through physiological traits and root characteristics under sub-tropical conditions

**Evaluation of plant under drought stress conditions:** An experiment was conducted to study the effect of drought stress in plant crop of 17 sugarcane genotypes with two standards *viz.* Co 0238 and Co 98014. Crop was planted during first fortnight of April, 2023. Drought stress was imposed during formative phase of the crop by withholding irrigation but due to continuous rain fall (680 mm) during pre-monsoon and monsoon period drought stress could not be persist. Hence, no significant difference was recorded in physiological, morphological and yield parameters in normal irrigated and drought stress treatments in plant crop trial. Data were analyzed with factorial RBD.

Average numbers of tillers ('000 $ha^{-1}$) were 91.31 (000 $ha^{-1}$) and maximum numbers of tillers were observed in entries Co 16030 (115.3) followed by Co 18022 (115), Co 19018 (103.5), Co 21014 (100.4), Co 22020 (99.38). Overall mean plant height (cm) was 226 cm and maximum plant height was recorded in Co 98014 (250 cm) followed by Co 21012 (249 cm), Co 21013 (243 cm), Co 0238 (242 cm) and Co 16030 (238 cm). Mean SPAD value (µg $cm^{-2}$) for chlorophyll content was 43.46 µg $cm^{-2}$ and maximum SPAD values were recorded in Co 20016 (46.3) followed by Co 21012 (46.10), Co 21016 (45.0). Photosynthetic rate, transpiration rate and stomatal conductance were 22.11 µmol $CO_2$ $m^{-2}$ $s^{-1}$, 8.32 mmol $H_2O$ $m^{-2}$ $s^{-1}$ and 0.475 mmol $H_2O$ $m^{-2}s^{-1}$ respectively. Average numbers of millable canes (000 $ha^{-1}$) were 73000 $ha^{-1}$ and maximum numbers of NMC were observed in entries Co 16030 (89.79) followed by Co 18022 (83.33), Co 22020 (88.88), Co 98014 (84), Co 0238 (81), Co 20017 (80.78), Co 20015 (80), 19017 (79.62), Co 21012 (78.6).

Among juice quality parameters, overall experimental average of pol% was 19.08 at $10^{th}$ month and no significant difference was recorded in normal irrigated and drought stress treatments. Clones, Co 21012 (20.59), Co 21015 (20.31), Co 22020 (20.0), 21016 (19.71) and 20016 (19.42) showed higher pol% than mean value.

*(D. Pooja, Ravinder Kumar and S.K Pandey)*

## All India Coordinated Research Project (Sugarcane) - Subtropical zone

### Breeding

### Zonal Varietal Trial (NWZ)

**Season (2022-23):** IVT Midlate: Twelve test entries along with three standards (CoS 767, CoPant 97222, Co 05011) were evaluated for various yield contributing traits. At harvest for cane yield t $ha^{-1}$ test entries Co 19018 (124.49), Co 19017 (113.82), CoS 19234 (110.57), CoS 19235 (108.74) and CoS 19233 (107.59) found promising over best standard CoPant 97222 (99.57). Co 19018 (20.20), followed by Co 19017 (19.87), CoPb 19214 (19.80), CoPb 19182 (19.74), CoS 19234 (19.64) and CoH 19262 (19.62) were the best performer test entries for juice sucrose%.

AVT Midlate I Plant: The experiment comprising six test entries and three standards (CoS 767, CoPant 97222, Co 05011) was evaluated for various yield contributing traits. Co 05011 (96.14) was the best standard for NMC ('000 $ha^{-1}$), and two test entries *viz*., CoS 18231 (97.30) and Co 16030 (86.42) performed on par with it. Due to tall, stout, thicker and robust stature Co 18022 produced significantly higher cane yield (134.24 t $ha^{-1}$) over fellow test entries and best standard CoPant 97222 (101.2 t $ha^{-1}$). It was top performer for sugar yield (17.9 t $ha^{-1}$) as well. The sucrose% at harvest was highest in test entries CoS 18232 (19.47), CoS 18233 (19.32) and Co 18022 (18.80). Among them CoS 18232 found statistically better over best standard CoPant 97222 (18.37), but its cane yield (78.72 t $ha^{-1}$) was lower over CoPant 97222.

*(Ravinder Kumar and M.R. Meena)*

**Season (2023-24):** IVT (Early): The experiment consisting of six test entries and three standards (CoJ 64, Co 0238, Co 05009) was evaluated for cane yield and juice quality traits (till 8th month of crop stage). The NMC population ('000 ha$^{-1}$) of the experiment was 104.58 and CoJ 64 (114.04) performed as best standard. Test entries CoLk 20201 (110.80), CoLk 20202 (111.27) and CoLk 20203 (113.27) had equal performance with the best standard CoJ 64 for NMC population. For juice sucrose%, CoJ 64 (18.02) was the best standard and test entries CoH 20261 (18.43) and CoLK 20201 (18.07) had equal performance and except CoPb 20211 (16.84) rest of the entries had on par performance with CoJ 64, the best standard.

IVT (Midlate): The NMC population ('000 ha$^{-1}$) of the experiment was 98.68. Co 05011 (110.19) performed as the best among the standards. Except test entries CoLk 20204 (87.04) and CoS 20232 (87.19), the NMC population of rest of the test entries was on par with best standard Co 05011.

AVT Midlate IP: Co 05011 with 107.48 thousands NMC per ha, was found as best standard. Test entries CoS 19235 (107.95), CoLk 19204 (101.31) and Co 19017 (99.46) were the best performer test entries, which had equal performance with Co 05011. Among the test entries CoPb 19214 (45.91) produced very less millable cane.

AVT Midlate IIP: The experimental mean for NMC population was 114.12 ('000 ha$^{-1}$).Co 05011 (120.52) among the standards, while CoS 18231 (121.84), CoS 18233 (116.9) and CoS 18232 (112.27) among the test entries produced highest millable cane population.

AVT Ratoon: The NMC ('000 ha$^{-1}$), of the experiment was 111.91. Co 05011 (128.16) was the best performer among the standards and test clones. Except three test entries *viz*., CoPb 18213 (74.00), CoPb 18214 (92.98) and CoS 18233 (102.78), the performance of rest of the test entries and standards was on par with Co 05011, the highest performer standard.

*(Ravinder Kumar and M.R. Meena)*

## Evaluation and identification of climate resilient ISH and IGH genetic stocks against drought

**Evaluation for drought tolerance (II Plant Crop):** To assess the drought tolerance efficiency of the ISH clones, a total of 18 ISH entries along with three standards *viz*., Co 0238, CoJ 88 and Co 98014 were planted in alpha design with two replications. The plot size of the experiment was 6m x 2R x 0.9m and seed rate of 12 buds per meter used for planting. The better performing entries under normal condition for sucrose% at 12th month were ISH 536 (18.67%), ISH 524 (17.84%) and ISH 512 (17.54%) whereas ISH 501 (18.58%), ISH 536 (18.79%), ISH 513 (18.70%) and ISH 524 (18.33%) were better under drought condition. Entries *viz*., ISH 567 (146.45 t ha$^{-1}$), ISH 502 (121.28 t ha$^{-1}$), ISH 545 (113.34 t ha$^{-1}$ and ISH 833 (107.57 t ha$^{-1}$) were better performer for cane yield under normal and entries ISH 567 (94.58 t ha$^{-1}$), ISH 502 (88.12 t ha$^{-1}$) and ISH 545 (86.38 t ha$^{-1}$) were better performer under drought stress at 360 days after planting.

**Ratoon crop:** The NMC population under normal and drought stress was 1.02 lakhs ha$^{-1}$, 0.88 lakhs ha$^{-1}$ respectively. The single cane weight at 10th month crop in normal and drought stress was 0.7 kg and 0.5 kg respectively. The mean difference in cane yield was significant and it was 68.2 t ha$^{-1}$ and 45.7 t ha$^{-1}$ under normal and drought stress respectively.

*(M.R. Meena, Ravinder Kumar and D. Pooja)*

## Pathology

## Identification of pathotypes / races of red rot pathogen

Fourteen red rot isolates comprising eight reference pathotype (CF01, CF02, CF03, CF07, CF08, CF09, CF11, CF13) and six locally collected isolates *viz*. Cf238(Karnal), Cf238(RNG), Cf238(Faridpur), Cf89003(Karnal), Cf8436(Karnal) and Cf95422 were inoculated independently on a set of twenty one sugarcane differentials by plug method. The overall disease reactions indicated that there was a clear pathogenic variation on test host differentials. Pathogenic reaction on test hosts showed that

pathotype CF13 was more virulent followed by CF11, CF01, CF02, CF08, CF09, CF03 and CF07. Of the three Cf238 isolates of variety Co 0238, Faridpur isolate was more virulent and exhibited susceptible reaction on ten host differentials. Isolate Cf8436 (Karnal) succumbed to differential CoS 8436 with intermediate to susceptible reactions on ten host differentials, whereas, Cf89003 (Karnal) expressed susceptible reaction on nine differentials suggesting the possible emergence of another pathotype in the region. Isolate Cf95422 (CoSe 95422) found least susceptible, whereas, SES 594 showed complete resistance to all the test isolates.

## Survey of sugarcane diseases naturally occurring in the area on important sugarcane varieties

Survey for the sugarcane diseases was carried out in the reserved areas of 16 sugar mills *viz*. Karnal, Sonipat, Yamunanagar, Bhadson, Narayangarh, Shahabad, Panipat, Assandh (Haryana), Buttar Savian, Phagwara (Punjab), BCM units Balrampur, Khumbhi, Rojagaon (UP), Hasanpur, Harinagar and Bagaha(Bihar). A varietal breakdown due to red rot was noticed in ruling variety Co 0238 at many sugar mills of the zone with mild to severe incidence. Red rot incidence was also recorded in variety Co 89003 under Karnal (Traces–25.0%) and Sonipat (02-10%) area. Pokkah boeng disease was observed in most of the cultivated varieties in the zone with maximum (up to 40%) incidence in variety Co 0238 under Narayangarh sugar mill. However, in other varieties *viz*. Co 0118, Co 89003, Co 05011 and Co 15023 PB was noticed up to 13%. Further, incidence of smut was recorded up to 10% in plant crop of varieties Co 0238 and Co 89003 in Karnal and Assandh area, whereas, in ratoon crop disease expression recorded up to 20% in variety Co 0238. Mild incidence of other diseases *viz*. wilt, GSD, top rot and YLD was found in varieties Co 05011, Co 89003, CoH 160 and Co 0238.

## Evaluation of IET/Zonal varieties for resistance to red rot

Thirty six IVT entries along with eight standard varieties were evaluated for red rot resistance by plug and cotton swab methods of inoculation with CF08 and CF13 isolates. Among the six IVT early entries, CoLk 20201 expressed susceptibility to CF13 by plug and cotton swab methods, whereas, of the nine IVT (Mid-late) entries, Co 20018 and CoS 20234 entries showed susceptibility to CF08 & CF13 isolates by plug and cotton swab methods. However, remaining entries exhibited Resistant /Moderately Resistant reactions with both the isolates and methods.

## Assessment of elite ISH clones for resistance to red rot

Thirty eight ISH clones comprising 20 ISH, three IGH, fourteen commercial hybrids and one water-logging tolerant clone were evaluated for red rot resistance using CF08 and CF13 isolates. Of the test ISH clones 15 were rated resistant / moderately resistant, two moderately susceptible and three susceptible to CF08, while six clones found to be moderately resistant, four moderately susceptible and ten susceptible to CF13 isolate. Test IGH clones exhibited resistant reaction to both the isolates. Water-logging clone WL-10-85 expressed MR reaction to CF08 and susceptibility to CF13 isolates. All the commercial hybrid clones were rated resistant/ moderately resistant to CF08, while four clones (Co 0118, Co 15024, Co 98014 and Co 0124) showed susceptible reaction to CF13 isolate.

## Yellow Leaf Disease

*In vivo* incidence of yellow leaf disease (YLD) was monitored in 44 ZVT entries. Among the test entries, 35 were rated resistant / moderately resistant, four moderately susceptible and five (Co 0238, CoPb 20181, Co 05009, Co 05011and CoS 8436) susceptible to YLD.

## Efficient delivery of fungicides and other agro inputs to manage major fungal diseases in sugarcane

A trial was conducted to evaluate efficacy of two fungicides *viz*. Thiophanate methyl (TPM) and Amistar for the sett treatment of susceptible variety Co 0238 using sett treatment device for the management of red rot. Observations recorded so far revealed that fungicidal treatment(s) was quite effective in increasing the germination (%) and reducing of disease incidence over healthy and diseased controls. Further observations are in progress.

*(M.L. Chhabra)*

## Entomology

### Evaluation of Zonal varieties/genotypes for their reaction against major insect pests of sugarcane

**AVT Ratoon:** A total of nine genotypes along with one check variety were evaluated against major insect pests namely; black bug (BB), early shoot borer (ESB), top borer (TB) root borer (RB) and stalk borer (SB). All the nine genotypes, Co 17018, CoLk 17204, CoPb 17215, CoS 17233, CoS17234, CoS 17235, CoS 17236,CoH 17261 and CoH 17262 showed least susceptible (LS) reaction to BB (<25.0 individuals/20 leaves), ESB (<15.0%) and top borer (<10.0%). Two genotypes; Co 17018 and Co 05011 were least susceptible (<15%). Seven genotypes; CoLk 17204, CoPb 17215, CoS 17233, CoS17234, CoS 17235, CoS 17236 and CoH 17262 were moderately susceptible (15.1 to 30%) and one genotype, CoH 17261 was showed highly susceptible (HS) reaction to root borer (>30%).

**Reaction of sugarcane genotypes against major insect pests in ratoon**

| Variety / Genotypes | Population 20 leaves$^{-1}$ | % incidence | | | Stalk borer | | |
|---|---|---|---|---|---|---|---|
| | Black bug | ESB | Top borer | Root borer | Incidence (%) | Intensity (%) | Infestation Index |
| Co 05011 | 0.9 | 0.4 | 4.2 | 14.5 | 5.3 | 6.9 | 0.5 |
| Co 17018 | 1.1 | 1.2 | 5.3 | 13.2 | 6.5 | 6.9 | 0.4 |
| CoLk 17204 | 1.0 | 0.8 | 1.1 | 27.1 | 8.8 | 8.8 | 0.9 |
| CoPb 17215 | 1.3 | 0.3 | 4.7 | 19.2 | 6.3 | 8.0 | 0.5 |
| CoS 17233 | 1.1 | 0.3 | 6.8 | 25.1 | 9.4 | 7.5 | 1.1 |
| CoS 17234 | 1.0 | 0.2 | 1.1 | 25.9 | 2.4 | 5.1 | 0.2 |
| CoS 17235 | 1.3 | 0.7 | 5.5 | 29.1 | 6.0 | 10.0 | 0.6 |
| CoS 17236 | 1.4 | 0.0 | 0.0 | 15.5 | 1.3 | 2.8 | 0.1 |
| CoH 17261 | 1.1 | 0.0 | 4.3 | 31.2 | 1.4 | 2.8 | 0.1 |
| CoH 17262 | 1.3 | 1.9 | 2.5 | 28.1 | 18.4 | 10.6 | 1.7 |

In case of stalk borer all the nine genotypes, Co 05011, Co17018, CoLk 17204, CoPb 17215, CoS 17233, CoS 17234, CoS 17235, CoS 17236, CoH 17261 and CoH 17262 were least susceptible to stalk borer (infestation index < 2.0).

**AVT 1st plant**: A total of ten genotypes along with two check varieties were evaluated against early shoot borer (ESB), top borer (TB) root borer (RB) and stalk borer (SB). All the nine genotypes, CoS 17232, CoPb 18181, CoLk 18202, CoS 17231, CoPb 18214, CoS 18231, CoS 18232, CoS 18233, Co 18022 and CoPb 18213 showed least susceptible reaction to early shoot borer (<15.0%) and top borer (<10.0%). Four genotypes; CoLk 18202, CoS 17231, CoPb 18214 and CoS 18231were least susceptible (<15%); Six genotypes; CoS 17232, CoPb 18181, CoS 18232, CoS 18233, Co 18022 and CoPb 18213 showed moderately susceptible reaction (15.1 to 30%) to root borer.

**Reaction of sugarcane genotypes against major insect pests in AVT 1st plant**

| Variety / Genotype | Incidence (%) | | | Stalk borer | | |
|---|---|---|---|---|---|---|
| | Early shoot borer | Top borer | Root borer | Incidence (%) | Intensity (%) | Infestation Index |
| CoS 17232 | 1.7 | 7.5 | 22.3 | 18.0 | 17.8 | 2.7 |
| CoPb 18181 | 1.2 | 7.6 | 25.0 | 16.1 | 15.6 | 2.6 |
| CoLk 18202 | 0.7 | 8.7 | 7.7 | 8.1 | 11.3 | 1.0 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Co 15023 | 3.7 | 8.8 | 12.7 | 16.7 | 9.1 | 1.5 |
| CoS 17231 | 1.3 | 7.4 | 11.1 | 3.3 | 4.7 | 0.2 |
| CoPb 18214 | 3.7 | 6.5 | 12.6 | 20.8 | 12.5 | 2.9 |
| CoS 18231 | 3.0 | 5.5 | 13.7 | 6.4 | 13.1 | 0.9 |
| CoS 18232 | 10.2 | 7.9 | 22.8 | 10.2 | 8.6 | 0.9 |
| CoS 18233 | 5.2 | 6.6 | 17.1 | 8.1 | 10.1 | 1.1 |
| Co 05011 | 2.3 | 5.9 | 15.0 | 6.3 | 7.5 | 0.7 |
| Co 18022 | 1.6 | 5.3 | 17.7 | 1.1 | 2.0 | 0.1 |
| CoPb 18213 | 1.7 | 6.1 | 20.5 | 7.2 | 9.7 | 0.9 |

In case of stalk borer seven genotypes, CoLk 18202, CoS 17231, CoS 18231, CoS 18232, CoS 18233, Co 18022 and CoPb 18213 were least susceptible (infestation index < 2.0) and three genotypes, CoS 17232, CoPb 18181 and CoPb 18214 showed moderately susceptible reaction (infestation index 2.1 to 5.0).

**AVT 2nd Plant:** A total of ten genotypes along with two check varieties were evaluated against early shoot borer (ESB), top borer (TB) root borer (RB) and stalk borer (SB).

**Reaction of sugarcane genotypes against major insect pests in AVT 2nd Plant**

| Variety / Genotype | Incidence (%) | | | Stalk borer | | |
|---|---|---|---|---|---|---|
| | Early shoot borer | Top borer | Root borer | Incidence (%) | Intensity (%) | Infestation Index |
| Co 05011 | 0.6 | 5.0 | 30.3 | 17.5 | 14.4 | 2.4 |
| Co 17018 | 1.7 | 7.6 | 29.8 | 14.9 | 14.7 | 2.2 |
| CoLk 17204 | 1.5 | 5.5 | 23.2 | 8.6 | 10.8 | 0.8 |
| CoPb 17215 | 3.0 | 5.5 | 20.0 | 14.3 | 9.6 | 1.4 |
| CoS 17233 | 2.7 | 6.3 | 21.8 | 16.8 | 17.7 | 2.4 |
| CoS 17234 | 1.9 | 6.8 | 19.9 | 10.3 | 7.8 | 1.2 |
| CoS 17235 | 0.7 | 5.1 | 21.3 | 5.3 | 5.4 | 0.4 |
| CoS 17236 | 1.4 | 6.9 | 22.7 | 13.8 | 13.3 | 1.7 |
| CoH 17261 | 1.6 | 7.0 | 14.2 | 6.2 | 16.3 | 1.0 |
| CoH 17262 | 2.0 | 6.9 | 28.4 | 24.7 | 9.6 | 2.4 |

All the nine genotypes, Co 17018, CoLk 17204, CoPb 17215, CoS 17233, CoS 17234, CoS 17235, CoS 17236, CoH 17261 and CoH 17262 were least susceptible to early shoot borer (<15.0%) and top borer (<10.0%). One genotypes, CoH 17261 was least susceptible (<15%); Eight genotypes; Co 17018, CoLk 17204, CoPb 17215, CoS 17233, CoS 17234, CoS 17235, CoS 17236 and CoH 17262 exhibited moderately susceptible reaction (15.1-30%) to root borer. In case of stalk borer, Six genotypes, CoLk 17204, CoPb 17215, CoS 17234, CoS 17235, CoS 17236 and CoH 17261 were least susceptible (infestation index < 2.0) and three genotypes, Co 17018, CoS 17233 and CoH 17262 showed moderately susceptible reaction (infestation index 2.1 to 5.0).

## Assessment of yield losses caused by borer pests of sugarcane under changing climate scenario

Field experiments were conducted in two blocks; treated (applied all the control measures) as well as untreated and the incidence of major borer pests namely early shoot borer, top borer, stalk borer and root borer was recorded.

**Borer Incidence**

| Experiments | Incidence (%) | | | Stalk borer | | |
|---|---|---|---|---|---|---|
| | ESB | TB | RB | Incidence (%) | Intensity (%) | Infestation Index |
| Treated | 9.5 | 28.8 | 4.8 | 36.8 | 11.3 | 4.2 |
| Untreated | 12.2 | 35.2 | 35.8 | 30.4 | 13.6 | 4.1 |

The incidence of early shoot borer, top borer, stalk borer and root borer was 9.5, 28.8, 36.8 and 4.8 per cent in treated block and 12.2, 35.2, 30.4 and 35.8 per cent in untreated block, respectively. In respect of stalk borer infestation index was 4.2 and 4.1 in treated and untreated block, respectively.

**Impact of borer incidence on Juice quality**

| Experiments | Brix | % Pol | Purity |
|---|---|---|---|
| Healthy | 22.7 | 88.59 | 93.95 |
| Unhealthy | 21.8 | 82.72 | 92.25 |

The cane juice samples were obtained at 12$^{th}$ months and qualitative analysis was done to find out the impact of borers infestation of juice quality traits; *viz*., brix, pol and purity in juice. The brix, pol and purity in juice were 22.7, 88.59, 93.95 in treated block and 21.8, 82.72, 92.250 in untreated block respectively.

was carried out in the reserved areas of 04 sugar mills of Haryana namely; Karnal, Asandh, Panipat and Narayangarh, nine sugar mills of Uttar Pradesh *viz*., Sabitgarh, Sheohara, Rani Nangal, Chandanpur, Deoband, Khatauli, Milak Narayanpur, Unn, Ramkola and Laxar sugar mills in Uttarakhand. Early shoot borer, top borer, root borer, stalk borer; pyrilla, black bug and termites were listed as key pests of sugarcane in Haryana. Gurdaspur borer, pink borer and blister mite were identified as minor pests of sugarcane in Haryana, UP and UK. Pyrilla, army worm, grass hopper, white fly, yellow mites, mealy bug and trips were recorded as occasional pests of sugarcane under the zone. The incidence of early shoot borer and pink borer was below 15.00%. Whereas top borer, stalk borer and root borer incidence varied from 0.0 to 65.0, 0.0 to 70.0, 0.0 to 44.0; 0.0 to 31.0, 0.0 to 27.0, 0.0 to 21.0 and 0.0 to 16.0, 0.0 to 34.0, 0.0 to 27.0% in Haryana , Uttar Pradesh and Uttarakhand, respectively. Black bug incidence varied from traces 0 to 05.0, 14.0 and 06.0, individuals tillers$^{-1}$ in Haryana, western Uttar Pradesh and Uttarakhand, respectively. White grub incidence varied from 0 to T, T to 2.0 grubs m$^{-2}$ and T to 2.0 grubs m$^{-2}$ mostly in sandy soils in Haryana, western Uttar Pradesh and Uttarakhand, respectively. The incidence of pyrilla, mealy bug whorl weevil and yellow mite was negligible in the zone.

**Impact of borer incidence on Yield Parameters**

| Experiments | Height (m) | Girth (cm) | Weight (kg) | NMC ha$^{-1}$ | Yield (t ha$^{-1}$) |
|---|---|---|---|---|---|
| Healthy | 2.3 | 2.9 | 1.6 | 57042.9 | 91.3 |
| Unhealthy | 2.2 | 2.8 | 1.5 | 56990.4 | 85.5 |

The yield parameters, cane height, girth, weight and number of millable canes and yield t ha$^{-1}$ were also recorded. Cane height, girth, weight and number of millable canes and yield t ha$^{-1}$ were 2.3 m, 2.9 cm, 1.6 kg, 57042.9 and 91.3 t ha$^{-1}$ in treated plot and 2.2 m, 2.8 cm, 1.5 kg, 56990.4 and 85.5 t ha$^{-1}$ in untreated block respectively.

## Survey and surveillance of sugarcane insect- pests

To identify the key insect pests' of sugarcane under North Western Zone, insect pests' survey

**Current status of major insect pests of sugarcane North Western Zone**

| Area | Population / Incidence | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | ESB (%) | PB (%) | TB (%) | SB | RB (%) | BB tiller$^{-1}$ | WW whorl$^{-1}$ | PH whorl$^{-1}$ | BM (%) | WG m$^{-2}$ |
| Haryana | 0-9 | 0-12 | 0-65 | 0-31 | 0-16 | 0-5 | 0-2 | 0-15 | 0-60 | 0-T |
| U P | 0-7 | 0-11 | 0-70 | 0-27 | 0-34 | 0-3 | 0-2 | 0-17 | 0-70 | 0-2 |
| UK | 0-11 | 0-13 | 0-44 | 0-21 | 0-27 | 0-6 | 0-1 | 0-21 | 0-72 | 0-2 |

BB= Black bug, WW= Whorl weevil, PH= Plant hopper, WG=White grubs, BM=Blister mite, ESB= Early shoot borer, PB=Pink borer, TB =Top borer, RB= Root borer, SB= Stalk borer, T-Trace

## Monitoring of insect pests and bio agent's in sugarcane agro- ecosystem.

A non-replicated experiment with sugarcane variety, Co 15023 was carried out and monitored the incidences of major insect pests and their bio agents of sugarcane at regular interval. The incidence of early shoot borer and pink borer was below ETL (<15.0).

**Prevalence of Insect pests of sugarcane and their bio- agents**

| Insect-pests | Incidence Population$^{-1}$ | Bio-agents | Parasitisation (%) |
|---|---|---|---|
| Pink borer | 7.0% | - | - |
| Early shoot borer | 1.3% | - | - |
| Top borer | 18.6% | *Isotima javensis* | 2.0 (Larvae) |
| | | *Stenobracon deesae* | 1.0 (Larvae) |
| Root borer | 14.3% | - | - |
| Termite | 4.4% | - | - |
| Black bug | 03.0/tiller (Nymph & Adult)/cane | - | - |
| Stalk borer | Incidence - 24.8%<br>Intensity - 11.5%<br>Infestation index -2.8 | *Cotesia flavipes* | 3.0 (Larvae) |
| Pyrilla | 0.2 /20 leaves | *Epiricania melanoleuca* | 1.6 (Nymph and adults) |
| | | *Tetrasticus pyrillae.* | 1.3 (eggs) |

Top borer and root borer incidence was 18.6 and 14.3 per cent, respectively. Stalk borer incidence, intensity and infestation index were 24.8%, 11.5% and 2.8, respectively. It was observed that black bug, an insect pest of sugarcane ratoon, infested the planted sugarcane crop also during July to October. The mean population of black bug was 2.9/tiller. Pyrilla population was 0.2 individual/20 leaf. The incidence of termite was noted at 4.4 per cent. Among the bio agents, *Epiricania melanoleuca*, identified as an effective parasitoid of pyrilla nymphs and adults effected 1.6 per cent parasitisation. *Tetrasticus pyrillae*, an egg parasitoid of pyrilla, parasitized 3.3 per cent egg masses. *Isotima javensis* and *Stenobracon deesae* parasitisation of top borer larvae was 2.0 and 1.0 per cent respectively. *Cotesia flavipes* was identified as a larval cum pre pupal parasitoid of stalk borer which parasitized 3.0 per cent stalk borer larvae during the month of September to March.

*(S.K. Pandey, K.P. Salin and P. Mahesh)*

## Identification, characterization and verification of new sugarcane varieties for DUS testing

Maintenance of reference varieties (RV) of sugarcane: A collection of 171 sub-tropical sugarcane reference varieties were maintained in field under the disease free conditions and accommodated in a plot of size 6m L x 0.9 m spacing between rows x 2 rows per variety at ICAR-Sugarcane Breeding Institute-Regional Centre, Karnal. Verification of Distinctness, Uniformity, and Stability (DUS) descriptors of these reference varieties was conducted as integral part of characterization based on DUS criteria. The following category DUS reference varieties are being maintained at the Centre:

BO series-17 varieties; CoP series-7; CoB series-1; CoBln series 8; CoH series 12; CoJ series 5; CoPb series 4; CoLk series 9; CoPant series 9; CoS series 50; CoSe series 14; CoPk 1; UP series 6 varieties, Co varieties 23.

**Re-characterization of reference varieties:** DUS traits of 171 RV maintained at ICAR-SBIRC, Karnal were verified/re-characterized during 2023-24 and the database of all the verified DUS reference varieties is submitted to the PPV&FR Authority in tabulation format.

**DUS testing for new sugarcane variety:** Second year DUS test of Co 13035 along with its reference varieties (CoPant 97222 and CoS 90269) and a total of one hundred and sixty settlings derived from single bud setts of each varieties, were transplanted into RBD design with two replications in the DUS testing field. The plot size of 4 Rows x 6 m length x 0.9 m row to row spacing was maintained. Observations on twenty seven morphological traits were recorded from the candidate as well as reference varieties. The result of 2nd year trial shows that the candidate variety Co 13035 was distinct from each other as well as from the reference varieties and the population of these varieties was uniform in both the years. The claimed /essential characters recorded from the entries had shown stable performance in second year as well.

Application for registration of two new varieties namely, Co 15023 and Co 16030 has been submitted to the PPV&FR authority.

*(M.R. Meena and Ravinder Kumar)*

## ICAR-Seed Project, Sugarcane (RFS, Karnal)

The breeder seed crop was planted in 8.5 acres area at the Centre and in nearly 50 acres at FPSP farms. A total of 24398.64 quintals of breeder seed was produced and supplied to various stakeholders. From the sale of the seed material Rs 18.19 lakhs was earned as revenue. Among the varieties Co 15023 (12135.6 quintals) and Co 0118 (11767.1 quintals) were supplied in large quantity. The on-farm seed production was 3223.23 quintals whereas FPSP seed production was 21175.41 quintals.

**Details of seed production and sale (in quintals) during crop season 2022-23**

| States | Co 0118 | Co 0238 | Co 13035 | Co 15023 | Co 16030 | Total |
|---|---|---|---|---|---|---|
| On farm seed production and sale | | | | | | |
| Spring 2023 | 161.50 | 126.90 | 85.1 | 1374.40 | - | 1748.51 |
| Autumn 2023 | 219.51 | 71.90 | | 1118.75 | 64.56 | 1474.72 |
| Total A | 381.01 | 198.80 | 85.10 | 2493.15 | 64.56 | 3223.23 |
| C) Revenue generated (Rs) | | | | | | 1395560 |
| Farmers Participatory Seed Production and sale | | | | | | |
| Spring 2023 | 9929.14 | 146.9 | - | 8999.9 | - | 19075.91 |
| Autumn 2023 | 1456.95 | - | - | 642.55 | - | 2099.50 |
| Total B | 11386.09 | 146.9 | - | 9642.45 | - | 21175.41 |
| D) Institute's share (Rs) | | | | | | 423508 |
| Total A+B | 11767.10 | 345.7 | 85.10 | 12135.60 | 64.56 | 24398.64 |
| Total Revenue (C+D) | | | | | | Rs. 1819068 |

**Settling production and sale:** Apart from using of the settlings in the planting of breeder seed crop of the Centre in 4 acres of area, a total of 13066 numbers (Co 15023 = 6408 Nos; Co 0118 = 6658 Nos) worth Rs 39198/- were sold to the various stakeholders.

**Total Revenue generated:** In total a sum of Rs 1858266/- was generated as revenue from the sale of planting material.

**Production of tissue culture plantlets:** The tissue culture plantlets of varieties Co 0118, Co 0238 and Co 15023 were produced through meristem culture. The plantlets were field transplanted as nucleus seed crop during September to October 2023.

*(Ravinder Kumar and M.R. Meena)*

## Healthy seed production and mechanization of sugarcane agriculture - A farmers participatory initiative (RKVY Haryana)

Supplied 1257.6 quintals of seed cane of varieties Co 15023 (804.96 quintals), Co 0118 (225.42 quintals), Co 0238 (178.7 quintals) and Co 16030 (48.52 quintals) to 51 stakeholders of Haryana state mainly farmers and sugar mills for the production of seedling material. Besides 4808 settlings of Co 15023 and 6658 of Co 0118 were also provided to six farmers of Haryana for production of quality seed.

*Winter hardening of ready-to-transplant settlings in multilayered racks using plant growth chamber*

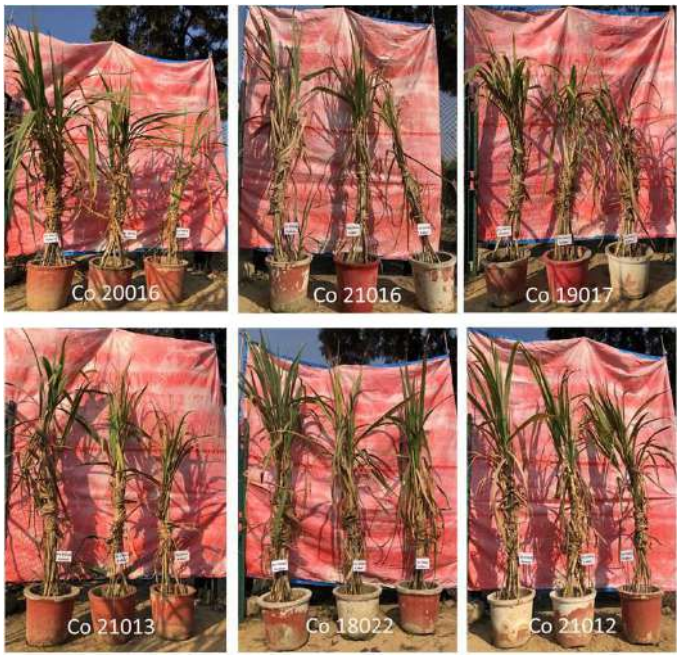
Utilizing settling production facility and plant growth chamber nearly 50000 settlings were produced during peak winter (temp at which sugarcane species do not grow). After 10 days, the cavity trays containing ready to transplant stage settlings were shifted to the multilayered racks designed for the purpose for winter hardening.

*(Ravinder Kumar, M.R. Meena, M.L Chhabra, D. Pooja and S.K Pandey)*

## Identification of salt tolerant sugarcane clones for commercial cultivation in Haryana (RKVY Haryana)

**Screening of Co-canes under salinity stress:** A CRBD experiment was conducted on thirteen genotypes *viz.*, Co 17018, Co 18021, Co 18022, Co 19017, Co 20016, Co 20017, Co 20018, Co 20019, Co 21012, Co 21013, Co 21014, Co 21015 and Co 21016 with standard Co 0238 in 50 kg

capacity cemented pots under variable regimes of irrigation water salinity i.e. Control (best available water), $EC_{iw}$ - 6 and 8 dS/m. Co-canes were planted during second fortnight of March, 2023 and continued saline irrigation was given after 45 days of germination. Data for growth, physiological parameters and $Na^+/K^+$ ratio were recorded.




*Performance of Co-canes under different alinity regimes*

A gradual increase was recorded in $Na^+/K^+$ ratio of leaf under salinity stress in all the studied clones. In leaves, $Na^+/K^+$ ratio increased from 0.115 (control) to 0.385 and 0.625 under 6 $dSm^{-1}$ and 8 $dSm^{-1}$, respectively. Among the studied clones, Co 17018 showed highest photosynthetic rate of 22.05, 17.91, 14.68 µmol $CO_2$ $m^{-2}$ $s^{-1}$ under control, $EC_{iw}$ – 6 and 8 dS/m. The average reduction in A was 38.5 and 58.3% under $EC_{iw}$ – 6 and 8 dS/m, respectively in comparison to control. Whereas highest reduction in Pn was noted in Co 20017. Significant reduction was recorded in chlorophyll content (SPAD readings) and genotype Co 17018, Co 18022, Co 21016, Co 21012 and Co 21013 had higher values than the other studied Co-canes under stress condition. At maturity stage, average plant height was 173.05 cm under normal irrigated control whereas 17.38 and 28.76% reduction were recorded in 6 and 8 dS/m, respectively. Likewise, NMC reduced 18.5%, and 29% under 6 and 8 dS/m, respectively. Genotypes, Co 17018, Co 18022, Co 21016, Co 21012 and Co 21013 showed less reduction than average reduction and performed better under the studied level of salinity stress whereas Co 20016 was at par with standard Co 0238.

*(D. Pooja, Ravinder Kumar, M.R. Meena, M.L. Chhabra and S.K. Pandey)*

## Improving water use efficiency and economizing water use in sugarcane cultivation in India (ISMA-funded)

A new contract research project on "Improving water use efficiency and economizing water use in sugarcane cultivation in subtropical India" funded by Indian sugar mill association of India, New Delhi with total outlay Rs. 7,93000 was sanctioned to evaluate the best water saving agro-technique for sugarcane and also to assess the irrigation water requirement of the most prominent cropping system in subtropical India. For this study, variety Co 0118 was planted in seven treatments in RBD on 14.04.2023. Micro irrigation system installed for further study. Results obtained from the study revealed that among all the treatment drip irrigation system significantly saved water in sugarcane cultivation followed by skip furrow method while highest water was consumed in flat method. In rice crop, almost two times higher water was consumed than sugarcane under subtropical condition.

*Micro-irrigated sugarcane crop at SBI-RC, Karnal*

*(D. Pooja and Ravinder Kumar)*

## Unraveling the molecular mechanism of early maturing responsive genes in sugarcane through transcriptome analysis

Transcript quantification for estimating the abundance of each gene was carried out using RSEM v1.2.25. A comprehensive analysis of differential expressed gene was conducted at the 8, 10 and 12-month stage in Co 15023 and Co 0124 both in leaf and stem, resulting in identification of 1335 DEGs. Heat maps were constructed and to understand the molecular function of the DEGs, Blast2GO was used. FASTA sequences of the DEGs were searched against NCBI non-redundant (Nr) protein database using BLASTx with the taxonomy filter, Viridiplantae, and E-value of 1.0E-3. DEGs to the biological pathways was performed using the KEGG database. Cluster of Orthologous Groups (COG) annotation was done using EggNOG (Evolutionary genealogy of genes: Non-supervised Orthologous Groups) based orthology assignments. Total of 165 DEG were exclusively found at 8-month stage of the crop. A total of 79 DEG were involved in sucrose synthesis pathway. Further, gene expression analysis revealed that, 60 DEG were upregulated were specifically expressed in leaf tissue, out of which 11 were unique to leaf whereas 24 were unique to stem tissue. Quantitative real-time PCR analysis was done to validate candidate DEGs obtained from Illumina RNA-seq. Primers were designed using NCBI primer-BLAST. RT-PCR was performed with the same set of RNA samples with triplicates that were used for transcriptome analysis. The expression of P-247363, P-131977, P-986494 and P- 1389104 were at par with the control genes SPSA and SPSB for sucrose metabolism. A total of 18078 SSR markers were predicted using the MISA tools, representing 12% mono-, 13% Di-, 60% tri- and 9% tetra- repeats. Differential gene expression analysis was also conducted to investigate genes involved in sugar transport during various stages. In stem tissue, a total of 204 genes were found to be differentially expressed, while in leaf tissue, 156 genes were identified. Among these, 19, 38, and 22 genes showed differential expression in the 8$^{th}$, 10$^{th}$, and 12$^{th}$ month of stem tissue, respectively. Similarly, in leaf tissue, 22, 34, and 28 genes exhibited differential expression in the 8$^{th}$, 10$^{th}$, and 12$^{th}$ month, respectively.

*(M.R. Meena)*

## 5.7. ICAR-SBI Research Centre, Kannur

### Breeding superior sugarcane varieties of different maturity with improved cane yield, quality and resistance to biotic and abiotic stresses

#### Breeding varieties resistant to waterlogging

Two clones attained 'Co' status based on their overall performance for yield and quality parameters. Clone WL 15-1177(WL10- 102 x CPCL41-111) identified as Co 22017 based on the performance at ICAR-SBI Coimbatore. Clone WL 10-85 (WL 04-95 x CP 80-182) identified as Co 22020-early based on the performance at ICAR-SBIRC Karnal.

Three clones WL 18-597, WL 18-755 and WL 18-855 are evaluated in the Pre-Zonal Varietal Trial and have 20.5%, 19.4% and 18.7% sucrose at 10$^{th}$ month respectively.

The final clonal evaluation included 19 trial entries and three standards (Co 86032, Co 99006 and Co 62175) in RBD with three replications. The clones were evaluated for various yield (NMC., Cane thickness, Cane Height, Single cane Weight and Cane yield) and quality (HR Brix 8M, Brix at 10M and sucrose% 10M) parameters. All the clones have thickness more than 2.5 cm. HR brix at 8$^{th}$ month was more than 20% for 11 test entries and 7 entries had more brix than the best standard. Single cane weight of WL19-571, WL19-395, WL 19-385 and WL 19-347 was higher than all the three standards. The clone WL 19-359 was attained cane height of more than 3 m. Brix% at 10 month was more than 20% for 15 entries and the clone WL 19-216 recorded the highest Brix of 22.1%. Sucrose% at 10M of the entries ranged from 19 to 20.7. Clones WL 19-216 and WL 19-241 recorded the highest sucrose% of 20.7 and 20.4% respectively. Clone WL 19-359 recorded highest cane yield of 88 kg/plot followed by the clone WL 19-751(85 kg/plot). Clones WL 19-216, WL 19-241 and WL19 351 had higher CCS yield /plot compared to three standards. All the test clones showed moderate resistance to red rot pathogen. Based on overall performance clones WL 19-216, WL 19-241 and WL19-351are selected for Pre-Zonal Varietal Trail.

In the second clonal trial 42 clones were evaluated for yield and quality traits along with three standards (Co 86032, Co 99006 and Co 62175) in RBD with three replications. The NMC ranged from 12 to 39, cane thickness from 2.3 to 2.9 cm, SCW from 0.8 to 1.6 kg, cane height from 110 to 260 cm, Brix at 10$^{th}$ month ranged from 16.8 to 21.2%, sucrose from 13 to 19.8%, yield from 12 to 47 kg and CCS yield per plot ranged from 2.0 to 7.1 kg. Clones WL 20-1108, WL 20-705, WL 20-654, WL 20-1315, WL 20-752, WL 20-1065, WL 20-1076, WL 20-975, WL 20-1453 and WL 20-941 have superior CCS yield per plot compared to the best standard. Based on the performance 19 clones were advanced to the final clonal trial.

In the first clonal trial 270 clones were evaluated for NMC, cane thickness and HR brix at 8$^{th}$ month. NMC ranged from 2 to 51 per plot, cane thickness from 2.2 to 3.6 cm and HR brix from 11.3 to 23.7%. About 41% of the clones recorded brix above 20%. Based on the performance 45 clones were advanced to second clonal trial.

In the preclonal trial 640 seedlings of 13 crosses were evaluated for NMC cane thickness and HR brix at 8$^{th}$ month. NMC ranged from 1 to 9 per clump cane thickness from 1.1 to 3.4 and HR brix from 11 to 24%. Based on the performance 250 clones were advanced to the first clonal trial.

During the flowering season 20 crosses were done utilizing waterlogging resistant clones, Indian hybrids and foreign hybrids. Progenies obtained in the crosses were planted in polybags.

WL clones are evaluated for their performance under subtropical conditions at Balrampur Chinni Mills UP(15clones) and ICAR-SBIRC Karnal (11 clones).

Around 119 potential clones of waterlogging resistance which are maintained over the years were evaluated for yield and quality traits. The yield and quality traits were compared with the standard check varieties Co 86032, Co 62175 and Co 99006. All the evaluated clones were either resistant(R) or moderately resistant (MR) to red red pathogen. The NMC ranged from 10 to 49 with an average of 24.5. Clone 88 WL 2137 had the highest NMC. The average cane thickness was

2.4 and 62 clones have thickness above 2.5 cm. Single cane weight (SCW) of the clones ranged from 0.6- 2.3 cm and the clone WL 18-586 had the highest SCW. Brix% at 10th month ranged from 14 (99 WL 632) to 24.75 (WL 04-95) and 69 clones had the brix% over and above the average value of 19.6. Sucrose content at 10th month ranged from 10 (99 WL 632) to 22.4% (WL 04-95). WL 04-95, WL 17-785, WL 10-24, WL 15-808, WL 06-332, WL 17-2248, WL 10-102 and WL 03-741 recorded sucrose content above 21%. CCS yield in kg per plot ranged from 0.9 to 8.2. Clones WL 18-586, WL 10-49, WL 17-854, WL 15-1177, WL 10-24, WL 15-1463, 98 WL 1357, WL 01-69, WL 08-270, WL 16-498., WL 18-749 and WL 10118 recorded high CCS yield in kg per plot compared with the standard Co 99006.

*(M. Nisha, K. Chandran, V. Krishnapriya, R. Gopi, B. Mahendran and V.G. Dhanya)*

## Enhancement of sugarcane germplasm and development of pre-breeding material

### Utilisation of germplasm resources for developing new genetic stocks

A final clonal trial was conducted with 16 clones of different back cross progenies of inter-specific crosses. GUK 19-1395, GUK 19-1421, GUK 19-1763, GUK 19-1796 and GUK 19-1814 showed significantly higher CCS yield at the 11th month and are identified for PZVT. All the selected clones are the progenies of red-fleshed *S. robustum* clones and three of them had sucrose 20% or above. In the second clonal trial, 30 clones were evaluated with two checks. Eight clones (GUK 20-383, GUK 20-401, GUK 20-419,GUK 20-74,GUK 20-125,GUK 20-258,GUK 20-473 and GUK 20-96) were found promising for CCS yield and out of which four are from the red fleshed *S. robustum* background. Five clones (GUK 20-125, GUK 20-267, GUK 20-279, GUK 20-473 and GUK 20-611 from the red – flesh *S. robustum* background showed early high brix(>21% at 7th month).

289 selected progenies of various14 back crosses of inter and intraspecific crosses evaluated for cane thickness, brix at bottom, middle and top and NMC and tillering along with two check varieties. The NMC ranged from 5-50, HR brix at the bottom of the cane ranged from 4.2-22.5%, at the middle 4-22.73% and the top 6-22.6% and cane thickness 1.2-2.3 cm. These progenies include 5 $BC_1$ progenies of GUK 14-130 and 43 progenies of GUK 14-30 (both clones are $F_1$ of red fleshed *S. robustum* with light red flesh colour). In the progenies of GUK 14-30, the flesh colour range was from 0-4 (in 0-5 scale) and in progenies of GUK 14-30 it was 0-5 and four of them are exactly having the flesh colour of the *S. robustum* parent (NG -77-84) and with higher brix (>11.4%) compared to 8% brix in NG 77-84. The anthocyanin pigmentation was estimated and it ranged from 0.425µg to 6.74µg/gm fresh tissue. The HR brix data shows that there is an improvement in HR brix% in the progenies 9-19.2% progenies of GUK 14-30 and 10-16.2% in progenies of GUK 14-130 against 8% in *S. robustum* parental clone with red flesh colour. However, none of the red-fleshed *S. robustum* clones and the $BC_1$ progenies flowered this year.

1183 seedlings derived from 11 crosses were evaluated in the ground nursery and 250 seedlings were selected for the first clonal trial. The progenies of the cross GUK 18-440 x Co 09008 had the highest average brix (20%) at 9th month.

*(K. Chandran, M. Nisha, B. Mahendran, R. Gopi and V.G. Dhanya)*

## Maintenance of world collection of sugarcane germplasm

### Maintenance and evaluation of germplasm

**Maintenance:** The world collection of sugarcane germplasm comprising 3379 clones are maintained in the field gene bank by annual re-planting. The flowering of the germplasm clones was monitored and found that *S. officinarum* collection showed poor flowering compared to the previous year. The flowering ranged from 4.6% (*S. officinarum* ) to 88% (IND allied Genera). The flowering percentage of other sets of clones were *S. spontaneum* (Exotic collection) 80%, Exotic hybrids 30.4.6%, Allied genera (exotic collection) 74.3%, *S. robustum* 18%, Indian hybrids 31.33%, *S. sinense* 6.6% *S. barberi* 11.9%, and *S. spontaneum* (IND) 25.5%. A set of 70 non-flowering clones of *S. officinarum* planted in two replication to maintain as a perennial/ratoon crop to study the flowering under this conditions.

*(K. Chandran and M. Nisha)*

**Studies on seed germination in *S spontaneum*:** True seeds from 20 accessions of *S. spontaneum* were collected to analyse the germinability and seedling vigour index under normal atmospheric conditions. The seeds exhibited physical dormancy (due to seed coat characteristics). Seeds were further exposed to different mechanical and chemical dormancy breaking methods. The results indicated that $KNO_3$ can be used as a chemical supplement to fasten the seed germination in *S. spontaneum.*

## Monitoring of diseases, pest and quarantine

**Monitoring of disease and quarantine:** Diseases recorded in germplasm clones during 2023 were ring spot, brown spot, wilt, stalk rot, smut, freckle(SCBV) *etc.* A maximum ring spot disease scale of 4 was recorded in Awela Green Sport, Cebu Light Purple, Fiji 30, 51 NG 95, Penang, Sarawak unknown of *S. officinarum*, 57 NG 234 ST, IJ 76-337, IJ 76 -426, NG 77 159, NG 77 213, NG 77 215 and NG 77 216 *S. robustum*, Co 1026 of Indian hybrid and B 41-248, CP 63-313, CP 73-351 of foreign hybrids. Many clones of *S. spontaneum*, *S. barberi*, and *S. robustum* were found either free or recorded very low incidence of ring spot.

A Maximum rust incidence was recorded in IND 81-20, IND 81-82, IND 81-83 of *S. spontaneum*, nine Indian hybrids, F 31-436(7), LF 70-313(7) of foreign hybrids. Only orange rust (*P. keunhii*) was recorded in *S. spontaneum*, *S. officinarum* clone IJ 76-501 and also in Indian hybrid clones. However, brown rust was recorded in foreign hybrid clones such as PR 1039 and PR 1040 with a maximum disease scale of 7.

Brown spot was recorded in IND 81-109, IND 81-156 and IND 81-161 of *S. spontaneum* with maximum disease rating of five in IND 81-109. Smut whips were noticed in IJ 36-432, Zwart Cheribon of *S. officinarum*, 56-400, 56-420, of foreign hybrids, Co 848, Co 850, Co 898, Co 905, Co 961, Co 1223, Co 1241, Co 62093, IC 224, and Mys Strip of Indian hybrids. Very few clones such as 57 NG 140 and 28 NG 10 of *S. officinarum* recorded Stalk rot. Freckle and chlorosis due to SCBV was found in Listada, Castilla, China, Guam A, Irang Malang, Hawai Original 36, Hawai Original 38 and Pilimoi 60 of *S. officinarum*.

*(R. Gopi)*

**Monitoring for pests incidence, biological control of the pests:** Sugarcane germplasm maintained at SBIRC, Kannur was monitored for occurrence of pests and their natural enemies. Insect pests *viz*., Internode borer (INB), *Chilosacchariphagus indicus*; Pink borer, *Sesamia inferens*; Sugarcane planthopper, *Pyrilla perpusilla* and leaf (web) mite, *Schizotetranychus krungthepensis* were found to be occurring at various ranges. In addition to that the sporadic infestation of woolly aphids, *Ceratovacuna lanigera*, armyworms, rice skipper, mealy bugs, scale insects, and sugarcane aphid, *Melanaphis sacchari* were noticed during the monitoring period.

INB incidence was noticed in less than 1% of the accessions across all crop assemblages. The soil based application of insecticide Fipronil 0.3% GR was undertaken at the time of sett planting as well as spot application for the management of pink borer. Pink borer incidence was noticed in less than 4% of the accessions across all crop assemblages with mean percent infestation of 6.78% on a dead heart basis. Pyrilla population was effectively suppressed by introduced ecto-parasiotoid, *Epiricania melanoleuca* and natural pathogenicity from entomopathogenic fungi. The activity of egg parasitoid, *Parachrysocharis javensis* was recorded throughout the season and exhibited good control over the egg population. The nymphal parasitoid, *Dryinus pyrillae.* was also recorded but at a low level. The web mite infestation was noticed in the potted plants and spraying of 0.5% neem oil was undertaken as a control measure.

Isolated incidence of fall armyworm, *Spodoptera frugiperda* and loreyi leaf worm, *Mythimna loreyi* noticed during the month of March-April. The woolly aphid infestation was noticed on the *S. sinense* accession, AGAUL, and a patch of WL clones. All the heavily infested leaves with aphid colonies have been clipped and burned to prevent the spread. Since 20-30% parasitism from *Encarsia flavoscutellum*, the high-level activity of predators like *Micromus igorotus*, *Dipha aphidivora* and syrphids was recorded, chemical control was avoided and only soap solution spray was undertaken. The isolated incidence of sugarcane aphid, *M. sacchari* with colonies

showing mummification from the parasitoid, *Aphelinus sp*. was noticed. There was also activity of predators like syrphids and ladybird beetle, *Pseudaspidimerus* sp. effectively preying on sugarcane aphid colonies recorded.

Red fleshed *S. robustum* accession NG 77-132 was found to be free from INB incidence consequently for four years at the field level and identified as INB resistant source for the pre-breeding program

*(B. Mahendran)*

## *In vitro* conservation of germplasm

111 *S. officinarum* clones were cultured *in vitro* using shoot tip and are maintained through sub culturing.

**Cryopreservation**: The encapsulated meristem from *S. officinarum* was regenerated successfully and studied the effect under cryopreservation. After immersion in liquid nitrogen for 10 minutes the meristem were cultured *in vitro* but failed to grow. Pollen grains from 4 *S. spontaneum* clones and eight Co canes were treated with cryoprotectant mannitol after reducing the moisture up to 50% pollen viability and immersed in liquid nitrogen. The cryopreserved pollen showed stainability but failed to germinate in the pollen germination medium. But all failed to germinate.

**Induction of variation in ornamental type *S. officinarum* through hybridization:** 35 selected progenies of three crosses were evaluated in a clonal trial.

GUK 21-511

GUK 21-368

GUK 21-368 (striped cane green/yellow, GUK 21-383 (yellow rind and thin cane, GUK 21-408 (black purple rind), GUK 21-413 (green rind), GUK 21-479 (yellow rind), GUK 21-511 (dark purple/light purple striped rind with thin layer of wax and GUK 21-544 (purple rind with weather mark) were found promising for ornamental purpose.

**Induction of variation through *in vitro* callus culture:** The regenerated eight somaclones were planted in the field and characterized morphologically and for yield and quality traits. In all the regenerant studied, variations were observed for morphological traits in comparison with the parental clone. In 51 NG 131 the tumescent striped cane was completely transformed to yellowish green rind with much elongated internodes. The growth crack present in the 51 NG 131 was completely lost and the yellowish rind had additional ornamentation of red blotches. The tumescent-shaped internode changed to a conoidal internode. In NG 77-314 only one plant could be regenerated that was showing variation to the leaf colour (less purple coloured leaves). In IJ 76-559 the rind colour and the texture exhibited by the weather marks was remaining as such in the somalones. In NG 77-92 the clone with dark purple stripes on purple coloured rind, two types of plants were observed among the somaclones, one with rind stripes and one without rind stripes but with uniform purple coloured rind. All the regenerants of 51 NG 131 showed close similarities between them but were quite distinct from the mother plant in lacking unique traits. These clones did not had the deep cracks and had uniform yellow colour with ornamentation of red blotches Similarly, the two regenerants from NG 77-952 were very close for most of the traits except one cloned had stripes and other was with uniform colour for the rind. The regenerant from IJ 76314 and IJ 76-559 also showed variation from mother plant. The somaclones TC1 of 51 NG 131, TC 6 of NG 77-92 and, TC 8 of IJ 76-314 were identified as promising in the initial evaluation.

**Commercial production of tissue culture plantlets:** The commercial production of tissue

culture seedlings at ICAR-SBIRC, Kannur has been initiated. Under this, the variety Co 86032 has been selected for mass multiplication. As on date, we have achieved shoot induction in 66 propagules in the M3 stage.

*(K. Chandran, M. Nisha and V.G. Dhanya)*

## Molecular characterization

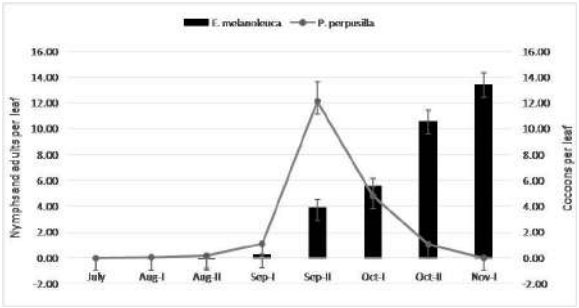
DNA fingerprints were developed for 757 *Saccharum officcinarum* clones available in the collection is using three mSSCIR primers and the DNA fingerprinting with other primers are in progress. Nineteen *Saccharum spontaneum* clones of Indian collection (IND collection) were genotyped using 6 SSR primers (NKS 28, NKS 25, NKS 23, SMC334BS, SMC 336BS and mSSCIR 24). Pairwise genetic similarity coefficients calculated based on the Jaccard coefficient ranged from 0 to 26%. Maximum similarity was between IND 89-718 and IND 85-567. Complete dissimilarity was observed among various clones though all these clones were collected from different regions of India only IND 84-437 showed complete dissimilarity with IND 81-6, IND 81-118, IND 81-122 and IND 85-531. IND 81-147 showed complete dissimilarity IND 84-378, IND 84-398, IND 84-420, IND 84-450, IND 85-567 and IND 89-718. IND 82-244 showed no similarity with IND 89-718.

*(K. Chandran and M. Nisha)*

### Studies on Sugarcane Pests and Their Management

## Evaluation of seasonal dynamics and biological control of sugarcane pyrilla, *Pyrilla perpusilla*, in crop island scenario

The successful colonisation and establishment of ectoparasitoid, *Epiricania melanoleuca* at the Centre, exerted a good initial impact and effectively suppressed the pyrilla population in the cropping season of 2021-22. The post-colonisation impact and sustenance of *E. Melanoleuca* in the crop island scenario was assessed in the current season crop (2023). Initially, a low level of pyrilla incidence was noticed in the first fortnight of June with the recorded activity of adults and sporadic egg masses. With the arrival of monsoon rain, a gradual increase in the population of pyrilla coupled with the initial appearance of *E. Melanoleuca* was noticed in July. The build-up of the pyrilla population with 0.19 ± 0.01 (mean± SE) nymphs and adults per leaf and a low level of *E. melanoleuca* cocoons (mean ± SE = 0.04 ± 0.001) was recorded in the 2nd fortnight of August. *P. perpusilla* population reached its peak (12.12 ± 1.51) in the 2nd fortnight of September with the favourable weather condition. At the same time, increased parasitization from *E. Melanoleuca* was also recorded with 3.91 ± 0.60 cocoons per leaf. The number of *E. melanoleuca* cocoons per leaf surpassed the pyrilla population in 1st fortnight of October and exhibited remarkable control over pyrilla. Thereafter, a steady increase in parasitization from *E. Melanoleuca* was observed with the mean number of cocoons reaching 13.46 ± 0.88 per leaf during 1st fortnight of November when pyrilla population was completely suppressed.




*Population levels of E. melanoleuca and P. perpusilla in the crop year 2023*

The ectoparasitoid, *E. Melanoleuca* was able to bring pyrilla population under control within two months period. The pyrilla biocontrol was also well synergised by the natural pathogenicity from *Hirsutella citriformis* manifesting epizootics in October at the field level. Moreover, the activity of egg parasitoid, *Parachrysocharis javensis* was noticed throughout cropping season with mean parasitizaton percentage of 66.42%, and a low level of parasitization by *Dryinus pyrillae* on nymphs was also recorded.

*(B. Mahendran, R. Gopi and P. Mahesh)*

## Standardization of true seed production technique through developing homozygous parental lines and apomixes Inbreeding

297 progenies from 9 selfs 4th and 5th generation were evaluated in ground nursery. 119 self progenies from eight exotic hybrids and three WL clones of first to 5th generation selfing were evaluated for yield and quality traits along with the parents.

*(G. Hemaprabha, A. Anna Durai, K. Chandran, T. Lakshmi Pathy and V. Vinu)*

## Value addition and product diversification in sugarcane

Six technologies identified for commercialization is submitted for certification. Shelf life of sugarcane juice was studied by carbonation and cooling (refrigerated conditions). The carbonated sugarcane juice retained the freshness for three days under ambient temperature and one week under refrigerated conditions.

*(K. Chandran, R. Gopi, M. Nisha, B. Mahendran and V.G. Dhanya)*

## 5.8 ICAR-SBI Research Centre, Agali

### Enhancement of sugarcane germplasm and development of pre-breeding materials

### Germplasm maintenance, hybridization and off-season nursery at Agali

**Germplasm maintenance:** A total of 1394 germplasm lines including Co canes, Co allied clones, exotic hybrids, inter-specific and inter-generic hybrids, active collection of *Saccharum officinarum, S. barberi, S. sinense, S. robustum, Erianthus* spp., *Sclerostachya* and *Narenga* are clonally maintained in the field.

**Flowering during 2023 season:** Out of 1394 germplasm lines, 797 accessions flowered during 2023 crossing season. The flowering intensity across the clones during 2023 season is 57.17%. Among the 205 *S. officinarum* clones maintained at National Distant Hybridization Facility (NDHF), Agali, 37 clones (18.05%) flowered during 2023 season. Six clones of *S. sinense*, four clones of *S. robustum* and two clones of *S. barberi* flowered during the season. Intensity of flowering in Co canes and Co-allied clones is 76.53% (375). Anthesis (opening of spikelets) began from 20th September, 2023 and lasted up to 10th December, 2023. *S. officinarum* clones *viz*., Mongetgayam, Naz, Otaheite, LF 89-2064, Suphan-50 and Sugar doctor were the early flowering clones flowered during 3rd week of September 2023.

**Hybridization**: During 2023 crossing season, a total of 226 crosses were made at NDHF at Agali. This year 18 AICRP (S) centres (Anakapalle, Cuddalore, Gurdaspur, Lucknow, Kapurthala, Karnal, Mandya, Motipur, Navasari, Padegaon, Pantnagar, Perumalapalle, Pune, Pusa, Sankeshwar, Seorahi, Shahjahanpur, and Rudrur) visited the center and utilized the facility. A total of 94 crosses were effected for the participating centers.

**First Clonal trial:** 42 clones were selected from 178 base population in 1st clonal stage based on Brix% of 22% and better cane parameters. Most of the selections were from crosses involving Co canes with ISH/IGH and Co-allied clones.

**Second clonal trial:** 24 Four clones were selected from the second clonal stage based on the superior cane parameters and juice sucrose% of >21% at harvest and promoted to PZVT stage. The clones will be included in 2024 PZVT Trial.

**Off Season Nursery:** ICAR-NRC Banana, Trichy, under the project 'Improvement of banana through conventional breeding' planted twelve females (Saba, Cuba, Karpuravalli, Udhayam, Nendran, NRC-17, Poovan, IITA-75, 2390-2, SH 3640, GNM, and TMB-9) and five males (Pisang Lilly, Cv. Rose, Hybrid-1, Hybrid-2 and Calcutta-4) for effecting crosses. Previous season, around 200 crosses were effected at the Centre.

*(V. Sreenivasa, R.T. Maruthi and A. Anna Durai)*

### DUS Testing Project-Sugarcane (Agali Centre)

**Maintenance of reference varieties:** A total of 244 Reference Varieties (RV's) were maintained through clonal propagation at Co-operating Centre (ICAR-SBI RC, Agali). Single bud derived settlings of all RVs were raised in polybags during January 2023 and the settlings were transplanted in the main field on 11th February 2023. Each RV was planted in two rows (6 m long) with spacing of 0.9 m. All the recommended cultural practices were followed to a disease-free crop at the Centre.

**Multiplication of seed cane of candidate varieties:** During 2023 season, the Centre received seed canes of 2 new varieties (NV's) namely, Phule-11082 (CoM 11082) and Phule Sugarcane 15012 (MS 17082) from CSRS, Padegaon for conduct of DUS test at Agali Centre. The seed canes of these varieties were multiplied during the reported period.

**Conduct of DUS test for NV's:** During 2022-23 season, at Agali Centre DUS test was conducted for 5 new varieties namely, CoA 14321, CoA 14323, CoM 0265, Co 11015 and Co 10026. First year DUS test for two NVs namely, (i) CoA 14321 along with closely resembling RVs namely, CoG 93076, Co 97009, (ii) CoA 14323 (NV) along with closely resembling RVs such as CoC 773, Co 7527 and one extant variety CoM 0265 along with closely resembling RV Co 87044, CoN 07072 and zonal standards (CoA 92081, CoV 92102) was conducted at the Centre. Second year DUS test for two new varieties namely, Co 11015 and Co 10026 along with closely resembling RVs namely,

Co 85002, Co 85019 for Co 11015 and CoN 95132, Co 7508 for Co 10026 and zonal standards (Co 86032, CoC 671) was conducted at the Centre.

**Results of DUS test:**

i. The candidate variety Co 11015 (NV) was distinct from the RV's (Co 85002 and Co 85019) in respect of DUS traits *viz*. plant growth habit, shape of ligule, colour of dewlap, leaf blade curvature, internode colour not exposed to sun, internode shape, rind surface appearance and bud shape.

ii. The candidate variety Co 10026 (NV) was distinct from the RV's (Co 7508 and CoN 95132) in respect of DUS traits *viz*., colour of dewlap, leaf blade curvature, adherence of leaf sheath, internode zig-zag alignment, rind surface appearance, shape of bud, bud groove, bud cushion and bud tip relation to growth ring.

iii. The candidate variety CoA 14321 (NV) was distinct from the RV's (CoG 93076 and Co 97009) in respect of DUS traits *viz*. plant growth habit, hairiness, shape of ligule, inner auricle, internode zig-zag alignment, rind surface appearance and waxiness.

iv. The candidate variety CoA 14323 (NV) was distinct from the RV's (CoC 773 and Co 7527) in respect of DUS traits *viz*., growth habit, ligule, inner auricle, leaf sheath curvature, inter node shape, inter node zig-zag alignment and growth crack.

v. The candidate variety CoM 0265 (EV) was distinct from the RV's (Co 87044 and CoN 07072) in respect of DUS traits *viz*., hairiness, ligule, inner auricle, colour of dewlap, leaf blade curvature, adherence of leaf sheath, internode shape, zig-zag alignment, growth crack, shape of bud, bud groove and bud tip relation to growth ring.

*(V. Sreenivasa, R.T. Maruthi and R. Karuppaiyan)*

# 06
# Education & Training

## 6.1 Education:

### M.Sc./Ph.D. programme

- Ms. K. Nalayeni (Guide: Dr. A. Ramesh Sundar) was awarded Ph.D. degree by Bharathiar University w.e.f. 04 January 2023 for her thesis work entitled "Molecular profiling of host resistance determinants and pathogenicity – associated factors during interaction of sugarcane with *Sporisorium scitamineum*".

- Ms. Jini Narayanan (Guide: Dr. R. Manimekalai) was awarded Ph.D. degree by Bharathidasan University w.e.f. 23 March 2023 for her thesis work entitled "Physiological and transcriptome analysis in sugarcane, allied species and genera under oxidative stress".

- Shri. C. Naveen Prasanth (Guide: Dr. R. Viswanathan) was awarded Ph.D. degree by Bharathiar University w.e.f. 07 June 2023 for his thesis work entitled "Deciphering the high evolutionary potential pathogenicity gene cluster in *Colletotrichum falcatum* infecting sugarcane – a NGS based pathogenome study".

### Project work / Training programme for students:

- *UG/PG Project work:* During 2023, 52 Post Graduate and 4 Under Graduate students studying wide array of degree programmes *viz.*, Biotechnology, Biochemistry, Botany, Microbiology, Food science, Zoology, Life science, Bioinformatics and Genetics in various colleges /Universities of Tamil Nadu and Kerala completed 3-6 months Project work in various disciplines of the Institute.

- *Exposure Training:* In total, 214 students opted for exposure training in the Bio technology aspects of plant breeding and genetics, tissue culture, cytogenetics microbiology, plant pathology, entomology, crop physiology and nematology. Out of this, a batch comprising 17 students from Government College of Technology completed their exposure training with the financial support granted by Department of Technical Education, Chennai.

- A total revenue of Rs.12,20,000/- was realized through the fees paid by the project students and exposure trainees.

- Special lectures were delivered to the students undergoing Project / Exposure training and a *Quiz* programme was conducted to provide a broad view about the Institute research activities on 06$^{th}$ and 30$^{th}$ June 2023.

- *Deputation abroad:* Dr. R. Valarmathi DST -SERB International Research Experience (SIRE) Fellowship Program (GoI) at School of Plant, Environmental and Soil Science, Louisiana State Agriculture Centre, Louisiana, USA, from 08.12.23 to 07.06.24.

### Training Programmes organized:

### At Coimbatore

1. A One-day workshop on "Recent advances and challenges in genome editing Technology for Crop Improvement and future Agriculture" was organised on 10$^{th}$ February 2023 under SERB-DST Core Research Grant scheme.

2. An orientation cum training on sugarcane breeding and other aspects of sugarcane was offered for 21 days (w.e.f 13.02.2023) to Dr. Santhoshkumar Pujer, Asst. Professor, S.Nijalingappa Sugar Institute, Belagavi, Karnataka.

3. A One-day training programme on "High throughput sampling using optical properties (understanding & Application) was organised on 17$^{th}$ February 2023.

4. A One-day training was conducted on "Quality Seed production" to the seed production farmers in four villages nearby

Kothari Sugars and Chemicals Pvt Ltd, Sathamangalam on 20th February 2023.

5. A Two-day training programme on "Quality seed production through micropropagation in sugarcane" was organized under NFSM during 9–10, March 2023 for 21 cane staff from 16 sugar mills and two tissue culture lab-in charges from Tamil Nadu.

6. A Three-day training programme on "Advances in Sugarcane cultivation" was organized for 20 sugarcane farmers from Uttarakhand during 13-15, March 2023.

7. A One-Day Exposure Visit and Entrepreneurship Meet was organized on 1st June 2023 at ICAR-SBIRC, Kannur by ICAR-SBI Research Centre, Kannur in collaboration with Research Innovation Network Kerala (RINK) – a Kerala Start Up Mission.

8. Two Five-days training programme on "Improved Sugarcane Production Technologies" was organized for the Cane Staff of SNJ Sugars & Products Ltd., Chittoor, Andhra Pradesh during 5-9, June 2023 and 12-16, June 2023.

9. Six one-day Refresher training on "Sugarcane varieties and Technologies" (RTSVT) was organized for the field staff of the Co-operative and Public sector sugar mills of Tamil Nadu on 10, 11, 12, 21, 24 & 25th July 2023.

10. An awareness and training campaign was organized at ICAR-SBIRC, Agali for tribal women of Attappady hills on 19th July 2023 under STC.

11. A one-day funded-training programme on 'Technologies for Sustainable Sugarcane Production - TSSP' was organized for the trainers of Solidaridad, New Delhi during 27-28, July 2023.

12. A training cum awareness programme for creating awareness to the farmers and other stakeholders about 'the provisions of the Protection of Plant Varieties and Farmers' Rights Act 2001' was organized on 31st July 2023.

13. Dr. N. Aswini, Scientist from ICAR-NIBSM underwent three months Professional Attachment Training in Bioinformatics at ICAR-SBI from 26th September to 27th November, 2023.

14. A one-day Brainstorming Workshop on "Trends in the Application of artificial intelligence for Sustainable agriculture" was organised in collaboration with Natioal Academy of Biological Sciences (NABS) and NAAS chapter, Coimbatore in hybrid mode on 29th November 2023. A total of 180 participants representing ICAR, State Universities, private research organization, Industry and Government departments attended the workshop.

15. ICAR-SBI organized a two-day training on 'Scientific Cultivation of Sugarcane' (TSCS) for the sugarcane farmers of Sangli district, Maharashtra during 14-15, December 2023.

### At Karnal

1. Scientists at ICAR-SBIRC, Karnal, imparted training to the farmers and cane development officials on "Latest Technologies of sugarcane cultivation" at Kaithal Sugar Mills, Kaithal (Haryana) on 13th February 2023.

2. Imparted training to cane development officials on "Management of Insect Pests and Diseases of Sugarcane" at Naraingarh Sugar Mills Ltd., Naraingarh (Haryana) on 15th February 2023.

3. A one-day training programme on "Seed health improvement: A success key for healthy crop, better recovery and profitable sugarcane farming" was organized for the farmers and sugar mill officials from Bihar, Haryana, Punjab, Uttarakhand and Uttar Pradesh on 08th August 2023.


*Training on seed health*

4. Imparted training on Production of healthy seed Co varieties to cane development officials at Saraswati Sugar Mills, Yamunanagar, Haryana on 04th September 2023.

5. Imparted training on Identification and management of Insect & Disease pests to the staff of Naraingarh Sugar Mills, Naraingarh, Haryana on 05th September, 2023

6. Imparted training to the farmers and sugar mill officials on "Importance of healthy seed production of Sugarcane" at village Algokhoti Distt. Tarantaran (Punjab) organized by Rana Sugars Ltd. Buttar Siviyan on 27th September 2023.

7. Imparted training to 400 farmers in the training programme organized by the Golden Sandhar Mills Ltd., Phagwara (Punjab) on 28th September 2023.

8. Imparted training to 220 farmers and cane staff of Harinagar Sugar Mills, Harinagar (Bihar) on 13th October, 2023.

9. Imparted training to the 250 farmers and cane staff at Tirupati Sugars Ltd. Bagaha (Bihar) on 14th October, 2023.

## 6.2 Training and Capacity building:

1. Dr. M. Nisha, Senior Scientist, attended an online senior certificate course on "Agricultural statistics and computing" for the period of six months from 23rd August 2022 to 25th January 2023 organized by ICAR-IASRI, New Delhi.

2. Shri. R. Raja, Senior Technical Assistant, Shri. U. Dinesh, Senior technician, Shri. K. Manivannan, Technical officer, Smt. T. Kavitha, Senior Technician and Dr. (Smt). P. Harunipriya, Senior Technical Assistant, attended a two weeks short course/online training programme on "Good Agricultural Practices (GAPs) for enhancing resource – use efficiency and farm productivity" during 20 January–03 February, 2023, organized by ICAR-IARI, New Delhi.

3. Smt. M. Lalitha Rani, Private Secretary and Shri.Vasudev V Galagali, UDC, attended an online training programme on E-Governance Applications in ICAR for Administrative Personnel" during 6–10, February 2023 organized by ISARI, New Delhi.

4. Dr. P.T. Prathima, Senior Scientist, Dr. R. Arun Kumar, Senior Scientist and Dr. T. Ramasubramanian, Principal Scientist attended NABL assessor training course at ICAR-NIVEDI, Bangalore during 6-10, February 2023.

5. Dr. H.K. Mahadeva Swamy, Scientist, attended an international workshop on "Phenotyping for drought tolerance" during 27th February – 3rd March, 2023 organized at ICAR-National Research Centre for Banana, Trichy.

6. Dr. G.S. Suresha, Senior Scientist, attended an online international workshop cum training on Plant Microbiomes: Theory and Application organized by ICAR-IARI and Netherlands Institute of Ecology and Leiden University during 20th February to 3rd March 2023.

7. Dr. P. Murali, Senior Scientist, attended an online impact assessment training cum workshop organized by ICAR-NIAP during 6-7, March 2023.

8. Dr. K. Lakshmi, Senior Scientist, attended virtual workshop on 'Intellectual property protection for Biotechnological research' held on 15th March 2023 at ICAR-NIBSM, Raipur.

9. Dr. C. Appunu, Senior Scientist, Dr. K. Lakshmi, Senior Scientist, Dr. R. Arunkumar, Senior scientist and Dr. S. Sheelamary, Scientist attended virtual training programme on "Multivariate data analysis" during 20 – 27, March 2023 organized by ICAR-NAARM, Hyderabad.

10. Scientific, Technical and Administrative staff of the Institute attended online courses "Y-Break Yoga at Workplace, Orientation Module on Mission LIFE and Stay Safe in Cyber Space" in the iGOT Karmayogi Platform during the month of June 2023.

11. Dr. G.S. Suresha, Senior Scientist, attended National webinar on 'Techno economic analysis on selected Green technologies for the production of value-added products from Agro-Industrial materials" on 16thAugust 2023 organized by CSIR-NIIST.

12. Dr. T. Kasthuri Thilagam, Senior Scientist and Dr. B. Mahendran, Scientist, attended ICAR-NAARM training programme on 'Analysis of Experimental Data using R' held in Hyderabad, during 21-25, August 2023.

13. Dr. G. S. Suresha, Senior Scientist, and Dr. P. Murali, Senior Scientist, attended Sensitization Workshop held at Pusa, New Delhi during 21-22, September 2023

14. Dr. V. Jayakumar, Principal Scientist, Dr. K. Nithya, Senior Scientist, Dr. Amaresh, Senior Technical Officer, Ms. Rabisha, Technical Assistant, attended an online training programme on 'Next Generation Sequencing & Data Analysis' organised by ICAR-NAARM, Hyderabad, during 16-20, October 2023.

15. Dr. S. Anusha, scientist attended an online training programme on 'Analysis of experimental data using R' organized by ICAR-NAARM, during 20-24, November 2023.

16. Dr. T. Rajula Shanthy, Principal scientist, attended a DST sponsored training programme on 'Research for societal growth through social responsibility' during 20-24, November 2023 organized by Amrita school of business.

17. Dr. K. Devakumar, Senior Scientist and Mr. S. Manoharan, Chief Technical Officer, Library, attended a one-day regional training cum awareness workshop on L-Gate@Cera for Southern Region held on 5th December 2023 at Tamil Nadu Agricultural University, Coimbatore.

18. Dr. V. Jayakumar, Principal scientist, attended an online training programme on 'Metagenomics data analysis' conducted at ICAR-IASRI, New Delhi during 11-13, December 2023.

# 07
# Awards & Recognition

Alagupalamuthirsolai, M received the "Best Paper award" in the 8th National conference on Agricultural Scientific Tamil Society on 25-26 February 2023 at TNJFU, Nagapattinam.

Alagupalamuthirsolai, M received the Best oral presentation award in the "International conference on Recent Innovations and Technological Advancement in Agriculture, Horticulture, Agricultural Engineering, Sericulture, Food science, Biotechnology and Rural Entrepreneurship 2023" held during 11-12th August, 2023 at The Indian Agriculture college, Radhapuram, Tirunelveli, Tamil Nadu, India

Appunu, C et al. received "Noel Deerr Gold Medal Award 2023" in 81st Annual Convention of the Sugar Technologists Association of India (STAI) and International Expo 2023 held during 06-08, September 2023 at Thiruvananthapuram, Kerala.

Appunu, C., Swathik Clarancia, P., Valarmathi, R., Arun Kumar, R., Gomathi, R., Suresha, G.S and Hemaprabha, G received Best oral paper presentation award for Over expression of Aldehyde dehydrogenase enhances drought tolerance in transgenic sugarcane at 13th NABS National Conference on Current Perspectives for Sustainable Development in Life Sciences, Environment and Agriculture during 23-25 January 2023, Periyar University, Salem.

Arumuganathan, T received the "Best Short Oral Presentation Award" for the paper "Agricultural sprayer drone technology demonstration for input management in sugarcane cultivation" presented during the "in National Seminar on "Research Imperatives for Sustaining Sugarcane, Sugar and Ethanol Production" held on 25th August, 2023 at ICAR-Sugarcane Breeding Institute, Coimbatore, Tamil Nadu, India.

Arun Kumar, R received an award for oral presentation in National Level Conference "AGMET 2022 - Advances in Agrometeorological Interventions for Climate Resilient Agriculture" held during 15- 17, February 2023, organized by Association of Agrometeorologists, Gujarat and Tamil Nadu Agricultural University, Coimbatore.

Arun Kumar, R received the "Best Paper Award" during the 8th National Conference on Agricultural scientific Tamil" 25-26th February, 2023 at TNJFU, Nagapattinam.

Chandran, K received "Best short oral presentation award" for the research paper "Freeze preservation of Sugarcane juice with natural additives in National Seminar on "Research Imperatives for Sustaining Sugarcane, Sugar and Ethanol Production" held on 25th August, 2023 at ICAR-Sugarcane Breeding Institute, Coimbatore, Tamil Nadu, India.

Chandran, K received "Best short oral presentation award" for the research paper "Yield and quality evaluation of selected $F_1$ progenies from polycross on *Saccharum robustum f. sanguineum"*. At National Seminar on Research Imperatives for Sustaining Sugarcane, Sugar and Ethanol Production (SugarSem-2023), held on 25th August 2023, at ICAR-Sugarcane Breeding Institute Coimbatore, Tamil Nadu.

Divya, G.P., Hari, K., Suresha, G.S., Murali, P., Antony Leo, Kalaiselvi, K and Malini, P received Best Short Oral award for the paper Value addition of sugarcane juice concentrate with root extracts of Nannari (*Hemidesmus indicus*) and Vetiver (*Chrysopogon zizanioides*) in National Seminar on "Research Imperatives for Sustaining Sugarcane, Sugar and Ethanol Production" held on 25th August, 2023 at ICAR-Sugarcane Breeding Institute, Coimbatore, Tamil Nadu, India.

Geetha, P received "Certificate of Appreciation" during the 5th International Agriculture Conference on "Global Insights on Research And Development In Agriculture, Horticulture

And Allied Sciences" GH Raisoni University, Saikheda Just Agriculture Education Group and AEEFWS, Chandigarh ; 05-07 October, 2023.

Geetha, P received "Best Book Award" in Tamil, In 9th National Tamil conference on Agricultural Science held at TNAU, Coimbatore from 16 to 17 December, 2023.

Gomathi, R was conferred with "Dr. E. K. Janaki Ammal Memorial NABS award for the year 2021" during the 13th National conference "Current Perspectives for Sustainable Development in Life Sciences, Environment and Agriculture" held at Periyar University on 25th January 2023.

Gomathi, R was conferred with "Fellow of the National Academy of Biological Sciences (FNABS-2020)" by National Academy of Biological Sciences (NABS), Chennai during the 13th National conference on "Current Perspectives for Sustainable Development in Life Sciences, Environment and Agriculture" held at Periyar University on 25th January 2023.

Hari, K served as External expert in the Technical Advisory Committee for the research BIRAC E-YUVA fellowship scholar at Tamil Nadu Agricultural University.

Hemaprabha, G received "Best woman Scientist" award from Holy Cross College, Tiruchirappalli in commemoration of the centennial celebration & International Women's Day on 10th March 2023.

Jain, G., Aaliya, B., Antony Leo., Suresha, G.S., Hari, K., Murali, P., Kalaiselvi, K and Malini, P received Best Short Oral award for the paper entailed "Development of novel process for cane syrup/liquid jaggery preparation from sugarcane juice through physico mechanical separation and vacuum concentration" in National Seminar on "Research Imperatives for Sustaining Sugarcane, Sugar and Ethanol Production" held on 25th August, 2023 at ICAR-Sugarcane Breeding Institute, Coimbatore, Tamil Nadu, India.

Kasthuri Thilagam, V acted as external expert for valuing the paper for the recruitment of lab technician for ICAR- Krishi Vigyan Kendra, Karamadai, Coimbatore on 07th January, 2023.

Kasthuri Thilagam, V received "Special Research Award-2022" from soil conservation society of India, New Delhi.

Krishnapriya, V et al. received the "Best Short Oral Paper Presentation" for the paper entitled "Structural attributes of leaf rolling in commercial hybrids and germplasm clones of sugarcane" in the National Seminar on Research Imperatives for Sustaining Sugarcane, Sugar and Ethanol Production (SugarSem-2023) held on 25th August 2023, ICAR-Sugarcane Breeding Institute Coimbatore, Tamil Nadu, India.

Lakshmi, K received Best Poster award for the paper entitled "Targeted genome editing in sugarcane: CRISPR/ Cas9-mediated lignin modification towards improved lignocellulosic biofuel production" in National Seminar on "Research Imperatives for Sustaining Sugarcane, Sugar and Ethanol Production" held on 25th August, 2023 at ICAR-Sugarcane Breeding Institute, Coimbatore, Tamil Nadu, India.

Lavanya, R., Suresha, G.S., Hari, K., Murali, P and Bakshi Ram received Best Short Oral award for the paper entitle "Cane Jam: An innovative value-added product of sugarcane for entrepreneurship", in National Seminar on "Research Imperatives for Sustaining Sugarcane, Sugar and Ethanol Production" held on 25th August, 2023 at ICAR-Sugarcane Breeding Institute, Coimbatore, Tamil Nadu, India.

Mahesh, P., Singaravelu, B., Srikanth, J., Hari, K., Salin, K.P., Appunu, C., Suresha, G.S., Sankaranarayanan, C and Nirmala, R received Best oral paper award for the research paper titled "A low-cost technology for mass production of *Bacillus thuringiensis* on agro-industry by-products against white grub *Holotrichia serrata*" Presented at the 13th National Academy of Biological Science conference on Current Perspectives for Sustainable Development in Life Science, Environment and Agriculture, held from January 23-25, 2023, Periyar University, Salem, Tamil Nadu, India.

Malathi, P was awarded "STAI Silver Medal" 2022 during "81st Stai Annual Convention and International Sugar Expo 2023", held during 6-8 September, 2023 at Travancore International

Convention Centre, Thiruvananthapuram, Kerala.

Mohanraj, K received First Prize for oral presentation in the 6th Rencontres de Quy Nhon: International Biology Conference 2023 held during 20-22 September, 2023 at The International Centre for Interdisciplinary Science and Education (ICISE), Quy Nhon, Vietnam.

Murali, P served as external expert for career advancement scheme (CAS) for the post of Professor in the discipline of agricultural economics on 2nd July 2023 at TNAU, Coimbatore.

Pooja, D received "Reviewer Excellence Award" from Legume Research Journal.

Pooja, D, Ravinder Kumar and Meena, M.R received "Best oral presentation award" for the research paper entitled "Screening of sugarcane germplasm for salt tolerance using growth, physiological and ionic traits". In: International Conference on Climate Resilient Agriculture for Food Security and Sustainability, CCS HAU, held from 17 – 19 February, 2023.

Punithavalli, M, received "Fellow of Plant Protection Association of India" at the International Conference on Plant Health Management (ICPHM 2023) – Innovation and Sustainability, held from 15-18 November, 2023, Hyderabad, India.

Puthira Prathap, D has been selected for *TANSA – 2021* (Tamil Nadu Scientist Award), by the Tamil Nadu State Council for Science and Technology (TNSCST), Govt. of Tamil Nadu under the 'Social Sciences' category.

Puthira Prathap , D served as Chief Editor, *Journal of Extension Education (ISSN: 0971-3123).*

Puthira Prathap , D served as Chief Editor, *Journal of Sugarcane Research (ISSN: 2249-927X).*

Puthira Prathap, D served as External Examiner, Conduct of PhD *Viva-voce* on 20th January 2023, at Department of Agrl. Extension Education, College of Agriculture, UAS, Dharwad, Karnataka.

Puthira Prathap, D served as Member of the Evaluation Committee for evaluating various award applications of Scientists and Institutions of TNAU, 22.05.2023.

Puthira Prathap D, contributed 'Foreword' for *Karumbu kural* publication (Tamil) [2023]. Chennai: Sri Sastha Prints. p168.

Puthira Prathap, D and Sankaranarayanan, C received "*Gold Medal of Appreciation*" by Agricultural Scientific Tamil Society, New Delhi in 8th National Conference on Agricultural Scientific Tamil, held at Tamil Nadu Dr. Jayalalitha Fisheries University, Nagapattinam on 25th February 2023.

Puthira Prathap, D served as External expert, Approved assessment committee for upgradation from JRF to SRF of Tamil Nadu Agricultural University on 26th July 2023.

Puthira Prathap, D served as External Panel member, Committee for selection of SMS (Animal Science) of ICAR-KVK, Erode, on 6th February 2023.

Rajula Shanthy, T received Recognition Award from the Society of Extension Education, Agra for the outstanding contribution in the field of Transfer of Technology and Extension Management in Agricultural Sciences during the 1st International Extension Education Congress organized at Regional Agricultural Research Institute, Jaipur during 18-20 December, 2023.

Rajula Shanthy, T received Certificate of Appreciation from the Society of Extension Education, Agra for the contribution in organizing, and serving as Co-chairperson of Technical Session in the 1st International Extension Education Congress at Regional Agricultural Research Institute, Jaipur during 18-20 December, 2023.

Ramasubramanian, T and Prathima, P.T were recognized as NABL Assessors for registering / managing NABL accredited laboratories.

Sankaranarayanan, C., Puthira Prathap, D and Singaravelu, B received the "*Best Scientist Awards*"

from Agricultural Scientific Tamil Society, New Delhi during the inaugural ceremony of the National Conference on Agricultural Scientific Tamil held on 16th December 2023 at Tamil Nadu Agricultural University, Coimbatore.

Suganya, A received Distinguished Scientist Award during the 8th National Conference on Agricultural scientific Tamil" 25-26th February, 2023 at TNJFU, Nagapattinam.

Suganya, A , received "Best presentation/paper" award in 8th National Conference on Agricultural scientific Tamil" 25-26 February, 2023 at TNJFU, Nagapattinam.

Suganya, A, received Best book chapter contributor award during the 8th National Conference on Agricultural scientific Tamil" 25-26 February, 2023 at TNJFU, Nagapattinam.

Suresha, G.S., Hari, K., Murali, P., Lavanya, R and Antony Leo received ICAR technology recognition (ICAR-AE-SBI-Product 2023-008) for the "Technology for production of novel frozen sugarcane juice products" on 16th July, 2023.


*Hemaprabha, G, Director, ICAR-SBI receiving "Best woman Scientist" award at Holy Cross College, Tiruchirappalli.*

# 08
# Linkages & Collaboration in India Including Externally Funded Projects

The Institute has established linkages with ICAR Institutes like IARI, NBPGR, NRCPB, NBAIR, IISR, Sugarcane Research Centres of SAUs under AICRP, International Centre for Genetic Engineering and Biotechnology (ICGEB), Ministry of Consumer Affairs, Food and Public Distribution, Ministry of Agriculture-and Farmers Welfare, GoI, Ministry of Food Processing Industries, DST, DBT/GoI, BARC, Directorate of Sugarcane Development, TNPL (a Govt. of Tamil Nadu Undertaking), MSSRF, Chennai and sugar industry in critical areas in emerging technologies for deriving maximum benefit.

| Project Title and Scientists involved | Source of Funding | Total Outlay (Rs. In Lakhs) |
|---|---|---|
| Identification, characterization and verification of new sugarcane varieties for DUS testing at Coimbatore - S. Alarmelu, R. Karuppaiyan and C. Jayabose | PPV&FRA | 5.87 |
| Unraveling the molecular mechanism of early maturing responsive genes in sugarcane through transcriptome analysis – M.R. Meena | DST-SERB | 31.25 |
| Novel application of sugarcane vacuolar targeting technology for recombinant protein – C. Appunu and G.S. Suresha | TRANALAB | 22.8 |
| CRISPR / CAS mediated targeted editing for virus resistance in sugarcane – C. Appunu, R. Viswanathan and R. Valarmathi | DST-SERB-CRG | 38.86 |
| Identification of salt tolerant sugarcane clones for commercial cultivation in Haryana – D. Pooja, S.K. Pandey, Ravinder Kumar, M.R. Meena and M.L. Chhabra | RKVY, Haryana | 242.00 |
| Development and application of diagnostics to viruses and phyto plasmas infecting sugarcane – K. Nithya and D. Neelamathi | ICAR-CRP | 75.82 |
| Intellectual Property Management and Technology Transfer/ Commercialization–Institute Technology Management Unit (ITMU) (National Agricultural Innovation Fund Scheme (NAIF) - ComponentI, IP &TM, ICAR) – K. Hari, G. Hemaprabha, A. Ramesh Sundar, B. Singaravelu, K. Mohanraj, K. Rathnavel (CICR RS, Coimbatore), C. Palaniswami, R.M. Shanthi and P. Murali | NAIF | 6.20 |
| Network project "Production systems, Agribusiness and Institutions" NAIF-Component 1: Impact assessment of agricultural technology – P. Murali, D. Puthira Prathap and K. Hari | ICAR-NIAP | 15.00 |

| Project Title and Scientists involved | Source of Funding | Total Outlay (Rs. In Lakhs) |
|---|---|---|
| Identification, characterization and verification of new sugarcane varieties for DUS testing – M.R. Meena and Ravinder Kumar | PPV&FRA | 7.00 |
| ICAR Seed project– Seed production in agricultural crops and fisheries–sugarcane (RFS, Karnal) – Ravinder Kumar and M.R. Meena | ICAR | 11.00 |
| Healthy seed production and mechanization of sugarcane agriculture-A farmer's participatory initiative – Ravinder Kumar, M.R. Meena, M.L. Chhabra, S.K. Pandey and D. Pooja | RKVY, Haryana | 87.32 |
| DUS testing of sugarcane (Agali) – V.Sreenivasa, R. Karuppaiyan and R.T. Maruthi | PPV&FRA | 5.87 |
| Sugarcane based Agri-Business Incubator (ABI)(National Agricultural Innovation Fund Scheme (NAIF) – Component II, IP & TM, ICAR) – P. Murali, K. Hari, A.J. Prabakaran, G.S. Suresha and D. Puthira Prathap | NAIF | 89.5 |
| CRISPR–Crop Network–Targeted importance of stress tolerance, nutritional quality and yield of crops by using genome editing – R. Manimekalai, V.P. Sobhakumari and C. Appunu | NASF | 66.10 |
| Deciphering the genetic basis of root-system architecture developing climate resilient sugarcane (BRNS) – R. Valarmathi and C. Appunu | GoI – DAE – BRNS | 25.336 |
| Mechanized priming of planting material and technology popularization for revival of sugarcane productivity in Tamil Nadu (RKVY) – P. Malathi, A. Ramesh Sundar, R. Selvakumar, T. Rajula Shanthy, A. Vennila, T. Ramasubramanian and Ravindra Naik (CIAE RS, CBE) | RKVY, Tamil Nadu | 27.75 |
| Decoding the molecular events of PAMP-triggered immunity (PTI) by unlocking the interactome of the PAMP-CfEPL1 of *Colletotrichum falcatum* during interaction with sugarcane – A.Ramesh Sundar, G.S. Suresha and P. Malathi | DST-SERB | 49.5 |
| Development of onsite field diagnostics to sugarcane grassy shoot disease Candidatus phytoplasma sacchari by RPA-LFD method to ensure healhy seed chain and sustain sugar production – K. Nithya, R. Viswanathan, Susheel Kumar Sharma (IARI, New Delhi) | DST-SERB-CRG | 61.62 |
| Artificial intelligence powered diagnostic kit for real-time monitoring of nematode pests of sugarcane - C. Sankaranarayanan (Mentor), D. Suryaprabha (AP, Nehru Arts and Science College, Coimbatore) and N. Seenivasan (TNAU, CBE) | DST-SERB-TARE | 18.3 |

| Project Title and Scientists involved | Source of Funding | Total Outlay (Rs. In Lakhs) |
|---|---|---|
| Identification of climate resilient drought tolerant sugarcane varieties suitable for Haryana state – M.R. Meena, S.K. Pandey, Ravinder Kumar, D. Pooja and M.L. Chhabra | RKVY, Haryana | 198.00 |
| Improving tillering and yield in sugarcane through creating novel alleles of strigolactone biosynthesis gene MAX4-1 using CRISPR / CAS9 – R. Valarmathi, C. Appunu, K. Mohanraj | DST-SERB | 40.00 |
| Targeted genome editing in sugarcane: CRISPR/Cas9-mediated lignin modification towards lignocellulosic biofuel production – K. Lakshmi | DST-SERB | 44.53 |
| Identification and characterization of SWEET genes associated with sugar content and disease susceptibility in sugarcane – P.T. Prathima, A. Selvi, R. Manimekalai and K. Lakshmi | DST-SERB | 31.00 |
| Agriculture Drone Project under Sub Mission on Agricultural Mechanization: Drone Technology Demonstration – T. Arumuganathan | ICAR-ATARI, Hyderabad | 35.00 |
| Cloning expression and functional toxicity assay of *cry1D*, *cry2Af* and *vip3Bb* toxin genes from *Bacillus thuringiensis* isolate against Bt-resistant pink bollworm and other important lepidopterans - B. Singaravelu, G.S. Suresha, C. Appunu, J. Srikanth and P. Mahesh (ICAR-SBI) S. Mohan, M. Saravanakumar, A. Nixon Prabhu, M. Dinesh, M. Venkatachalam (M/s. Rasi Seeds Pvt. Limited, Attur) | M/s Rasi Seeds Pvt Ltd,. Attur | 18.05 |
| Enhancing Sugar Productivity in Tamil Nadu through Institute-Industry Approach (SISMA-TN funded-SWEET BLOOM 2.0) - G. Hemaprabha, C. Appunu, S. Karthigeyan, A. Annadurai, R. Karuppaiyan, K. Mohanraj, V. Sreenivasa, Maruthi R.T, Adhini S.Pazhany, K. Elayaraja, S. Sheelamary, K. Gopalareddy, V. Vinu, H. K. Mahadeva Swamy, D. Neelamathi, C. Jayabose, R. Valarmathi | SISMA | 53.00 |
| Identification of suitable location specific sugarcane varieties for commercial cultivation under different agro-climatic situations in India – G. Hemaprabha, K. Mohanraj and V. Sreenivasa | ISMA | 750.00 |
| Improving water use efficiency and economizing water use in sugarcane cultivation in India<br>Location: ICAR-SBIRC, Karnal – D. Pooja | ISMA | 6.435 |
| Improving water use efficiency and economizing water use in sugarcane cultivation in India<br>Location: ICAR-SBI, Coimbatore – P. Geetha and S. Anusha | ISMA | 6.435 |

## International Cooperation

Dr. P. Govindaraj was deputed as external expert to Sugar Research Institute of Fiji (SRIF), as Agricultural Expert to sugar industries in Fiji under the Government of Fiji for a period of two years from August 2022 till the month of October 2023, under ITEC programme of Ministry of External Affairs.

09

# All India Coordinated Research Project on Sugarcane - AICRP (S)

The All India Coordinated Research Project on Sugarcane was started in 1971. A National Hybridization Garden was established in the Institute to facilitate the national breeding programs. The following are the research areas under this project:

- Fluff supply to various sugarcane research institutes / centres.
- Evaluation of 'Co' canes for different sugarcane growing regions and acting as the coordinating unit for the identification of 'Co' and other Co- regional selections.
- To gather information on general and specific combining ability of biparental crosses.
- Collaboration for development of national varieties.
- Collaborative research on Agronomy, Soil science, Plant Physiology, Entomology and Plant Pathology.

Dr. G. Hemaprabha, Director is the Principal Investigator of Crop Improvement.

# 10
# Publications

## Research papers


Alarmelu, S., Jayabose, C., Anusheela, V., Aravindhan, K. and Karuppaiyan, R. 2022. Genetic diversity analysis in tropical sugarcane genotypes using morphometric traits. *Sugar Tech* 25(2):430-439.

Arun Kumar, R., Hemaprabha, G., Vasantha, S., Arumuganathan, T., Hari, K., Senthilkumar, T., Sadvatha, R.H., Ambrose, D.C.P., Manikandan, C., Lakshmi, K., Suresha, G.S, Govindaraj, P., Sreenivasa, V., Palaniswami, C., Gomathi, R., Appunu, C., Mahesh, P., Yogambal, C., Krishnapriya, V., Tayade, A.S. and Alagupalamuthirsolai, M. 2023. Rapid assessment of rind hardness in sugarcane and its association with biochemical traits. *International Journal of Environment and Climate Change* 13(8):2019-2031.

Arun Kumar, R., Vasantha, S., Gomathi, R., Hemaprabha, G., Alarmelu, S., Srinivasa, V., Vengavasi, K., Alagupalamuthirsolai, M., Hari, K., Palaniswami, C., Moharaj, K., Appunu, C., Geetha, P., Tayade, A.S., Anusha, S., Vinu, V., Valarmathi, R., Pooja, D. and Meena, M.R. 2023. Rapid and non-destructive methodology for measuring canopy coverage at an early stage and its correlation with physiological and morphological traits and yield in sugarcane. *Agriculture* 13:1481. 10.3390/agriculture13081481

Arun Kumar, R., Vasantha, S., Hemaprabha, G., Alarmelu, S., Mohanraj, K., Sreenivasa, V., Gomathi, R., Palaniswami, C., Krishnapriya, V., Anusha, S. and Alagupalamuthirsolai, M. 2023. Comparison of stalk volume by water displacement method and calculation method for stalk weight determination and its relevance to single cane weight in sugarcane clones. *International Journal of Environment and Climate Change* 13(8):2282-2291.

Chandran K., Nisha, M., Gopi, R., Mahendran, B., Dilsha Chandran, Mahesh, P., Arun kumar, R., Krishnapriya, V., Gomathi, R., Malathi, P., Viswanathan, R. and Hemaprabha, G. 2023. Sugarcane genetic resources for challenged agriculture. *Sugar Tech*. https://doi.org/10.1007/s12355-023-01313-9

Channappa Mahadevaiah, Palanisamy Vignesh, Chinnasamy Appunu, Ramanathan Valarmathi, Pooja Dhansu, Ashwani Kumar, Selvarajan Dharshini, Thelakat Sasikumar Sarath Padmanabhan, Jayanarayanan Ashwin Narayan, Kannan Selvamuthu, Venkatarayappa Sreenivasa, Huskur Kumaraswamy Mahadeva Swamy, Vazhakkannadi Vinu, Arun Kumar Raja, Giriyapura Shivalingamurthy Suresha, Govindakurup Hemaprabha and Ravinder Kumar 2023. Physiological characterization of *Tripidium arundinaceum* and Sugarcane (*Saccharum* spp.) germplasm for salinity stress tolerance at the formative stage. *Sustainability* 15:6962. https://doi.org/10.3390/su15086962

Elayaraja, K. and Shanthi, R.M. 2021. Identification of principal traits for ratooning ability associated with cane yield and juice quality in sugarcane genotypes from advanced varietal evaluation trial. *Journal of Sugarcane Research* 11(1):66-73.

Gomathi, R., Chandran, K., Arun Kumar R., Alagupalamuthirsolai, M. and Krishnapriya, V. 2022. Impact of waterlogging stress on juice quality in sugarcane cultivated in tropical India. *Journal of Sugarcane Research* 12:85-91. 10.37580/JSR.2022.1.12.85-91

Gopi R., Chandran, K., Ramesh Sundar, A., Nisha M., Mahendran, B., Keerthana, Sony Jayaraman and Viswanathan, R. 2023. Occurrence of false floral smut in sugarcane inflorescence and associated weather variables. *Sugar Tech* 25(6):1411-

1418 https://doi.org/10.1007/s12355-023-01304-w

Gopi, R., Chandran, K., M. Nisha, M., Mahendran, B., Viswanathan, R. Nithya, K. and Keerthana. 2023. New record of occurrence of *Athelia rolfsii* (Syn. *Sclerotium rolfsii*) in seedlings of sugarcane. *Indian Phytopathology* 76(1):339-343. URL: http://dx.doi.org/10.1007/s42360-022-00587-5.

Gopi, R., Chandran, K., Viswanathan, R., Mahendran, B., Nisha, M., Gireesan, P.P., Sony Jayaraman and Mayalekshmi. 2023. Diseases and reaction of clones of *Saccharum spontaneum* and *Erianthus* spp. of the world collection of sugarcane germplasm. *Australasian Plant Pathology*. 52:407–417. https://doi.org/10.1007/s13313-023-00928-6

Jayabose, C., Anusheela V., Hemadarshini, M., Valarmathi, R., Neelamathi, D., Prabakaran, M. and Prithika, P. 2024. Study on regeneration ability of *Saccharum sp* clones for optimizing cryopreservation techniques and identification of suitable explant for long-term storage. *Sugar Tech*. 26(396-407).

Jayabose, C., Anusheela V., Karthigeyan, S., Govindaraj, P. and Rema Devi, A. K. 2022. Genetic analysis in *Saccharum spontaneum* accessions of Maharashtra collection. 2022. *Electronic Journal of Plant Breeding* 13(1): 216-224.

Jayabose, C., Anusheela, V., Kaleeswari, A. and Neelamathi, D. 2022. Meristem tip culture in *Phragmites australis* and genetic fidelity study. *Electronic Journal of Plant Breeding* 13(3): 1092-1098.

Juby, B., Meenakshi Ganesan, N., Ganesan, K.N., Sivakumar S.D., Chandrasekhar C.N. and Sobhakumari, V.P. 2023. Stomatal studies on colchicine treated Bajra Napier hybrids (*Pennisetum glaucum* x *P. purpureum*). *Agricultural Science Digest* Doi: 10.18805/ag.D-5743

Juby, B., Meenakshi Ganesan, N., Ganesan, K.N., Sivakumar, S.D., Chandrasekhar C.N. and Sobhakumari, V.P. 2023. Studies on colchicine induced changes in bajra napier hybrid (*Pennisetum glaucum* x *P. purpureum*) *Electronic journal of Plant Breeding* 14(1):1-2. https://doi.org/10.37992/2023.1401.019

Kasthuri Thilagam, V., Manivannan, S. and Khola, O.P.S. 2023. Deriving land management practices for reduced nutrient movement from an agricultural watershed using the AGNPS model. *Sustainability* 15 (5):4001. https://doi.org/10.3390/su15054001

Krishnapriya, V., Karpagam, E., Vasantha, S., Arun Kumar, R., Anusha, S., Vinu, V., Alagupalamuthirsolai, M. and Gomathi R. 2024. Deficiency, critical threshold, and sufficiency levels for hydroponic supplementation of major nutrients for evaluating sugarcane under controlled conditions. *Journal of Soil Science and Plant Nutrition*. https://doi.org/10.1007/s42729-023-01604-w

Kumar, R., Dhansu. P., Kulshreshtha. N., Meena, M.R., Mahadevaswamy, H.K., Appunu, C., Chhabra, M.L. and Pandey, S.K. 2023. Identification of salinity tolerant stable sugarcane cultivars using AMMI, GGE and some other stability parameters under multi environments of salinity stress. *Sustainability* 15(2):1119. https://doi.org/10.3390/su15021119

Kungumaselvan, T., Theodore, R.K., Senthilkumar, M., Puthira Prathap, D., Vanitha, G. and Duraisamy, M.R. 2022. Knowledge Level of Farmers in Accessing Agricultural Information through Smartphone. *Asian Journal of Agricultural Extension, Economics &* Sociology. pp. 1123-1130.

Lakshmi, K., Keerthana, K., Sheelamary, S., Selvi, A., Maiyilsamy, V and Manimekalai, R. 2022. Cloning and characterization of Patatin like Protein (PLP) a Phospholipase gene involved in salinity stress induced lipid signaling. *Journal of Sugarcane Research*.12(2). https://doi.org/10.37580/JSR.2022.2.12.162-171

Mahesh, P., Singaravelu, B., Srikanth, J., Chandran, K. and Salin, K.P. 2023. Resistance

of Indian hybrid accessions of sugarcane to internode borer *Chilo sacchariphagus indicus* (Lepidoptera: Crambidae) Experimental Agriculture (in press).

Manikantan, M.R., Pandiselvam, R., Arumuganathan, T., Indu Rani, C. and Varadharaju. N. 2022. Low-density polyethylene based nanocomposite packaging films for the preservation of sugarcane juice. *Journal of Food Science and Technology* 59(4):1629-1636.

Manikantan, M.R., Pandiselvam, R., Arumuganathan,T., Varadharaju, N., Sruthi, N.U. and Amin Mousavi Khaneghah. 2022. Development of linear low-density polyethylene nanocomposite films for storage of sugarcane juice. *Journal of Food Process Engineering*. DOI: 10.1111/jfpe.13988

Manimekalai, R., Selvi, A., Jini Narayanan, Ram Vannish, R. Shalini, Gayathri, S. and Rabisha V.P. 2023. Comparative physiological and transcriptome analysis in cultivated and wild sugarcane species in response to hydrogen peroxide-induced oxidative stress. *BMC Genomics* 24:155. https://doi.org/10.1186/s12864-023-09218

Manimekalai, R., Lakshmi, K., Karthigeyan, S., Selvi, A., Gomathi, R. 2023. Cloning of oxidative stress tolerant gene NAC 1 from *Erianthus arundinaceus* and development of transformation vector for sugarcane. *Journal of Sugarcane Research* 4:1-18.

Meena, M.R., Govindaraj, P., Rajesh Kumar, Arun Kumar, Ravinder Kumar, Chhabra, M.L., Pandey, S.K. and Hemaprabha, G. 2022. Genetic variability for fodder quality traits among high biomass energy cane feed stocks under rainfed conditions. *Journal of Sugarcane Research* 12:112-120. https://doi.org/10.37580/JSR.2022.1.12. 112-120

Nandita Banerjee, Khan, M.S., Swapna, M., Yadav, S., Tiwari, G., Jena, S.N., Patel, J.D., Manimekalai, R., Kumar, S. Dattamajuder, S.K., Kapur, R., Koebernick, J.C. and Singh. R.K. 2023. QTL mapping and identification of candidate genes linked to red rot resistance in sugarcane. *3 Biotech*. Doi. 10.1007/s13205-023-03481-7

Narayanan, J., Lakshmi, K., Ram Vannish, Karthigeyan, S., Selvi, A., Gomathi, R. and Manimekalai, R. 2022. Cloning of NAC 1 gene from *Erianthus arundinaceus* and development of transformation vector for sugarcane. Journal of Sugarcane Research 12:52-62. https://doi.org/10.37580/JSR.2022.1.12.52-62

Narayanan, J., Manimekalai, R., Selvi, A. Gomathi, R. And Arun, R. 2022. Physiological, Biochemical and Molecular Responses to Oxidative Stress in *Saccharum spontaneum*. *Sugar Tech* (2022). https://doi.org/10.1007/s12355-022-01189-1

Nisha, M., Chandran, K., Gireesan, P.P., Krishnapriya, V., Mayalekshmi, Gopi, R. and B. Mahendran. 2023. Evaluation of sugarcane clones for yield, quality and adaptive characters under waterlogged condition. *Indian Journal of Genetics and Plant Breeding* 83(2):282-286.

Nisha, M., Chandran, K., Gopi, R., Mahendran, B. and Gireesan, P.P. 2021. Status of sugarcane cultivation in Kerala vis-a-vis product diversification options. *Journal of Sugarcane Research* 11:130-136.

Nithya, K., Parameswari, B., Adhini S. Pazhany, Annadurai, A., Nithyanantham, R. and Viswanathan, R. 2023. Identification of sugarcane yellow leaf virus resistance in *Saccharum* parental hybrids in India. *Journal of Sugarcane Research* 11:205-211.

Nithya, K., Parameswari, B., Kumar, S., Annadurai, A., Nithyanantham, R., Mahadevaswamy, H.K. and Viswanathan, R. 2023. Prospecting true ScYLV resistance in *Saccharum* hybrid parental population in India by symptom phenotyping and viral titre quantification. *3 Biotech* 13(5):125. DOI: 10.1007/s13205-023-03541-y

Nithya, K., Raja Muthuramalingam T., Parameswari, B. and Viswanathan, R. 2023. Micro structuring and host tissue patterning of sugarcane grassy shoot phytoplasma

through scanning electron microscopy. *Indian Phytopathology* 76:323-326. https://doi.org/10.1007/s42360-022-00591-9

Nithya, K., Vishnu Vardhan, J., Balasaravanan, S., Kaverinathan, K., Visalatchi, D. and Viswanathan, R. 2023. First report of maize yellow mosaic virus (MaYMV) infecting maize in India. *Indian Phytopathology* 76:327-331. https://doi.org/10.1007/s42360-023-00603-2

Panwar, P., Machiwal, D., Kumari, V., Kumar, S., Dogra, P., Manivannan, S., Bhatnagar, P.R., Tomar, J.M.S., Kaushal, R., Jinger, D., Pradip Kumar Sarkar, L.K. Baishya, Devi, NP., Vijaysinha Kakade, Gaurav Singh, Nongmaithem Raju Singh, S. Gojendro Singh, Abhishek Patel, Renjith, P.S., Sharmistha Pal., Bhatt, V.K., Sharma, N.K., Khola, O.P.S., Radhakrishnan K.S., Kasthuri Thilagam, V., Bhutia, P.L., Kouberi Nath, Rekha Das, Dhiman Daschaudhuri, Arun Kumar, Panwar, G.S., Dwivedi, S.V., Sanjeev Kumar and Singh, B. K. 2023. Sustainable water harvesting for improving food security and livelihoods of smallholders under different climatic conditions of India. *Sustainability* 15(12):9230. https://doi.org/10.3390/su15129230

Parameswari, B., Sharma, S.K., Karthikaiselvi, L., Baby Wangkhem, Nithya, K., Viswanathan, R., Rao,G.P., Celia Chalam, V. and Anitha, K. 2023. A simplified Isothermal Recombinase Polymerase Amplification Assay for detection of *Sugarcane bacilliform virus* Infection. *Sugar Tech* (2023). https://doi.org/10.1007/s12355-023-01258-z

Pooja D., Ravinder Kumar, Chhabra, M.L., Pandey, S.K., Ashish Kr. Singh. and Karuppaiyan, R. 2023. Different Treatments for Sugarcane Juice Preservation. *Foods* 12:1-12.

Prathima, P.T., Singode, A., Thalambedu, L.P., Athiappan, S., Krishnasamy, M., Purakkal, S.V., Govind, H., Furtado, A. and Henry, R. 2023. Long read transcriptome sequencing of a sugarcane hybrid and its progenitors, *Saccharum officinarum* and *S. spontaneum*. *Frontiers in Plant Science 14*. https://doi.org/10.3389/fpls.2023.1199748

Punithavalli, M. 2023. Spatial distribution of proteinase inhibitors among diverse groups of sugarcane and their interaction with sugarcane borers. *Indian Journal of Entomology* 84(3):693-696. DoI No: 10.5958/0974-8172.2021.00101.2.

Rajula Shanthy, T., Komal, P.S., Chauhan J.K. 2023. Intercropping in sugarcane by growers of Kolhapur district, Maharashtra: A performance analysis. *Indian Research Journal of Extension Education* 23(4):126-133.

Ramasubramanian, M., Ramesh, R., Anuratha, A., Radhakrishnan, V., Selvamurugan, M., Jagadeesan, R., ... and Puthira Prathap, D. 2022. Redefining the Roles of Extension Scientists in KVKs: Innovative Experiments during COVID Pandemic in KVK, Thiruvarur, Tamil Nadu, India. *Asian Journal of Agricultural Extension, Economics & Sociology 40*(9):183-195.

Sadhana. V., Senguttuvan. K., Murugan. M., Yogambal. C., Ramasubramanian. T., Caroline Nirmala. R. and Jayakanthan. M. 2023. First record of Rugose Spiralling Whitefly, *Aleurodicus rugioperculatus* Martin (Hemiptera: Aleyrodidae), its occurrence and infestation in the cotton ecosystem of Tamil Nadu India. *International Journal of Tropical Insect Science*. https://doi.org/10.1007/s42690-024-01181-0

Sagadevan, K., Babu, D., Janakiraman, V., Palaniswamy, H., Kasirajan, L., Gomathi, R. and Ramkumar, T.R. 2022. A short review on sugarcane: its domestication, molecular manipulations and future perspectives. *Genetic Resources and Crop Evolution* 69:2623–2643. https://doi.org/10.1007/s10722-022-01430-6

Saurabh, S., Raj Morya, Durgesh Kumar, J., Keerthana, S., Kim, S., Manimekalai, R., Pereira, A.P.A. and Verma, J.P. 2023. Innovations and advances in enzymatic deconstruction of biomass and their sustainability analysis: A review. *Journal Renewable and Sustainable Energy Reviews*. https://doi.org/10.1016/j.rser.2023.1139

Selvakumar, R., Lakshmi Pathy, T., Gopalareddy, K. and Viswanathan R. 2022. Cut leaf assay: A rapid method for screening rust resistance in sugarcane. *Journal of Sugarcane Research* 12: 215-217.

Selvakumar, R., Remya, M., Akshay Ravi, R.B. and Viswanathan, R. 2023. First report of *Exserohilum rostratum* causing sugarcane leaf spot in India. *Sugar Tech.* DOI:10.1007/s12355-023-01281-0

Sheelamary, S., Lakshmi, K. and Boomiraj, K. 2023. Climate Smart Agriculture and Food Security. *Vigyan Varta* 4(8):31-35.

Singh, S.G., Vennila, A., Singh, R., Bharti, V.S., Shukla, S.P. and Purushothaman, C.S. 2023. Standing carbon stock of Thane Creek mangrove ecosystem: An integrated approach using allometry and remote sensing techniques. *Regional Studies in Marine Science*. https://doi.org/10.1016/j.rsma.2023.103207

Sobhakumari, V.P. and Govindaraj, P. 2022. Chromosomal polymorphism in *Saccharum spontaneum*: numerical variation in accessions from Eastern India. *Cytologia* 87(4):375–381.

Sobhakumari, V.P., Mohanraj K., Mohanaprabha, M. and Mathumathi, R. 2021. Establishment of GISH and multi-color GISH techniques to simultaneously discriminate different genomes in *Erianthus procerus* x *Saccharum officinarum*. *Journal of Sugarcane Research* 11:172-179. https://doi.org/10.37580/JSR.2021.2.11.172-179

Srikanth, J., Singaravelu, B., Crickmore, N., Mahesh, P., Sankaranarayanan, C., Suresha, G.S., Appunu, C., Nirmala, R., Om Prakash, M. and Athira, K.M. 2023. Laboratory evaluation of a scarabid-specific isolate of *Bacillus thuringiensis* against white grub *Holotrichia serrata*. *BioControl* 68(6). https://doi.org/10.1007/s10526-023-10220-7

Srinivasan R., Chandrakala, M., Kasthuri Thilagam, V., Maddileti, N. and Abhilash, P.C. 2022. A farm-scale approach to soil resource inventory for crop productivity and land restoration in KRP dam catchment, Tamil Nadu, India. *Climate Change and Environmental Sustainability* 10(1):52-69. DOI: 10.5958/2320-642X.2022.00006.0

Suganya, A., Govindaraj, P., Selvi, A. and Viswanathan, R. 2023. Red rot resistance in interspecific hybrids of sugarcane derived from diverse cytotypes of *Saccharum spontaneum* L. (wild relative of sugarcane). Accepted in Journal of Sugarcane Research.

Suresha, G.S. and Hari, K. 2023. Comparative evaluation of xylan extraction methods and product characterization from sugarcane bagasse. *Journal of Sugarcane Research* 11:158-171.

Sushma, K., Shanthi, M., Murugan, S., Vellaikumar, D., Uma and Ramasubramanian, T. 2023. Sublethal effects of chitosan-o-arginine, a chitosan based insecticidal compound against green lacewing *Chrysoperla zastrowi sillemi* (esben-petersen). *International Journal of Environment and Climate Change* 13(10):2378-2385.

Swathik Clarancia, P., Valarmathi, R., Suresh, G.S., Hemaprabha, G. and Appunu, C. 2023. Isolation and characterization of drought responsive Aldehyde dehydrogenase (ALDH) gene from drought tolerant wild relative of sugarcane, *Erianthus arundinaceus*. *Journal of Sugarcane Research* 11:158-171.

Swathik Clarancia, Peter, Murugan Naveenarani, Jayanarayanan Ashwin Narayan, Sakthivel Surya Krishna, Prathima Perumal Thirugnanasambandam, Ramanathan Valarmathi, Giriyapur Shivalingamurthy Suresha, Raju Gomathi, Raja Arun Kumar, Markandan Manickavasagam, Ramalingam Jegadeesan, Muthukrishnan Arun, Govindakurup Hemaprabha, and Chinnaswamy Appunu. 2023. Genome-Wide identification, characterization and expression analysis of Plant Nuclear Factor (NF-Y) gene family transcription factors in *Saccharum* spp. *Genes* 14 (6). p.1147.

Tayade, A.S., Geetha, P., Anusha. S. and Puthira Prathap, D. 2023. Production efficiency and Agro-Economic analysis of Sugarcane + Blackgram intercropping system under Tropical Indian condition. *AATCC Review* 11(3):283-288.

Tayade, A.S., Geetha, P., Anusha, S., Palaniswami, C. and Govindaraj, P. 2022. Agronomic evaluation of sugarcane (*Saccharum* spp. hybrid) genotypes for its cane yield and quality under different fertilizer levels. *Journal of Sugarcane Research* 12(2). https://doi.org/10.37580/JSR.2022.2.12.186-191

Tayade, A.S., Vasantha, S., Anusha, S., Arun Kumar, R., Hemaprabha, G., Geetha, P., Krishnapriya, V., Sammi Reddy, K., Rajan Bhatt, Manzer H. Siddiqui and Mahipal Singh Kesawat. 2023. Water-efficient genotypes along with conservation measures significantly reduce the green and blue water footprints in sugarcane (*Saccharum* spp.) *Scientific Reports* 13:13229. https://doi.org/10.1038/s41598-023-40223-4

Valarmathi, R., Mahadeva Swamy, H.K. Appunu, C, Suresha, G.S., Mohanraj, K., Hemaprabha, G., Mahadevaiah, C. and Ulaganathan, V. 2023. Comparative transcriptome profiling to unravel the key molecular signalling pathways and drought adaptive plasticity in shoot borne root system of sugarcane *Scientific Reports* 13:012853https://doi.org/10.1038/s41598-023-39970-1

Valarmathi, R., Mahadevaswamy, H.K., Ulaganathana, V., Appunu, C., Hemaprabha, G. and Sathishraj, R. 2022. Low cost high throughput image based root phenotyping pipeline for evaluation of sugarcane root system architecture under drought stress. *Journal of Sugarcane Research* 11:24-36.

Vasantha, S., Raja, A.K., Vengavasi, K., Tayade, A.S., Shareef, A. and Hemaprabha, G. 2023. Sugarcane stalk traits for high throughput phenotyping in restricted irrigation regimes. *Sugar Tech* 4:788-796. https://doi.org/10.1007/s12355-023-01242-7

Venkatasubramanian, V., Puthira Prathap, D., Murali, P., and Arumuganathan, T. 2023. Strengthening Technology Delivery System through Empowerment of Village Organizations. *International Journal of Social Science* 12 (2):65-70.

Vennila, A., Malathi, P., Augustin, R., Kasthuri Thilagam, V., Palaniswami, C. and Viswanathan, R. 2023. Efficient and economical way of improving sugarcane settling vigour by mechanized priming of single bud setts with nutrients. *Sugar Tech* 25(6):1328-1338. https://doi.org/10.1007/s12355-023-01293-w

Vinu, V., Lakshmi Pathy, T., Adhini, S., Pazhany, and Karthigeyan, S. 2022. Cluster and principal component analyses for assessment of genetic diversity in *Saccharum spontaneum*. *Journal of Sugarcane Research* 12:41-51.

Viswanathan, R., Nithya, K., Vishnuvardhan, J., Balasaravanan, S., Kaverinathan, K. and Visalatchi, D. 2023. Sorghum (*Sorghum bicolor*) a new host to sugarcane yellow leaf and mosaic viruses in India. *Indian Phytopathology* 76:867-877. https://doi.org/10.1007/s42360-023-00662-5

## Books/Compendia/Training manuals

Gomathi, R., Alagupalamuthirsolai, M., Arun Kumar, R., Krishnapriya, V., Balasubramanian, S., Karuppaiyan, R. and Hemaprabha, G. 2023. High Throughput sampling using optical properties (understanding and application). Plant Physiology section, ICAR-SBI, Coimbatore. p. 120. ISBN: 978-93-85267-38-3.

Gomathi, R., Arun Kumar, R., Krishnapriya, V., Alagupalamuthirsolai, M., Pooja, D. and Vasantha, S. 2023. Laboratory techniques in sugarcane physiology. Plant Physiology section, ICAR-SBI, Coimbatore. p. 123. ISBN: 978-93-85267-37-6.

Gomathi, R., Malathi, P., Alarmelu, S., Appunu, C., Arun Kumar, R., Alagupalamuthirsolai, M., Krishnapriya, V., Sreenivasa, V., Solomon, S., Rao, G.P and Hemaprabha, G. 2023. Proceedings of the national seminar

on research imperatives for sustaining sugarcane, sugar and ethanol production (SugarSem-2023), 25 August 2023, ICAR-SBI, Coimbatore. p. 163. ISBN: 978-93-85267-40-6.

Puthira Prathap, D. 2023. Proceedings and recommendations of the 52nd Sugarcane R&D workshop of Tamil Nadu and Puducherry. Sugarcane Breeding Institute, Coimbatore. p. 16.

Puthira Prathap, D. and Murali, P. (Eds). 2023. Improved Sugarcane Production Technologies. ICAR - Sugarcane Breeding Institute, Coimbatore. p. 240.

Puthira Prathap, D. and Murali, P. (Eds). 2022. Compendium of Research Articles and Status Papers of 52nd Sugarcane R&D workshop of Tamil Nadu and Puducherry. ICAR - Sugarcane Breeding Institute, Coimbatore. p. 282.

Puthira Prathap, D. and Murali, P. (Eds). 2022. Compendium of Research Articles and Status Papers of 19th Sugarcane R&D workshop of Northern Karnataka. ICAR - Sugarcane Breeding Institute, Coimbatore. p. 192.

Puthira Prathap, D., Mohanraj, K. and Hemaprabha, G. (Eds). 2023. Technologies for Sustainable Sugarcane Production. ICAR - Sugarcane Breeding Institute, Coimbatore. p.204. ISBN: 978-93-85267-39-0 (ICAR-SBI Training series: 2023/E/02).

Puthira Prathap, D., Mohanraj, K., Geetha, P. and Sreenivasa, V. Eds. 2023. Beekeeping handbook (Tamil – தேனீ வளர்ப்பு - ஒரு கையேடு. ICAR-SBI-STC publication series- STC/2022-03/Ta/02/Bee. p. 22.

Seenivasan, N., Sankaranarayanan, C. and Subramanian K.S. 2023. The Use of humic acid in nematode management. Cambridge Scholars Publishing, UK. p.149. ISBN: 978-1-5275-1180-4.

## Chapters in Books/Training manuals

Annadurai, A. and Karuppaiyan. R. 2023. Potential parents for developing climate resilient sugarcane varieties in India: A Breeding Perspectives. In: Agro-industrial Perspectives on Sugarcane Production under Environment Stress. Springer. pp. 57-83. https://link.springer.com/chapter/10.1007/978-981-19-3955-6_4

Anusha, S. and Geetha, P. 2023. Cane Agronomy. In: Advances in sugarcane cultivation. Rajula Shanthy and Hemaprabha, G. (Eds). ICAR-Sugarcane Breeding Institute, Coimbatore. pp. 26-44.

Anusha, S. and Geetha, P. 2023. Sugarcane Ratoon Management. In: Advances in sugarcane cultivation. Rajula Shanthy and Hemaprabha, G. (Eds). ICAR-Sugarcane Breeding Institute, Coimbatore. pp. 138-142.

Anusha, S. and Geetha, P. 2023. Weed and ratoon management in sugarcane. In: Improved sugarcane production technologies. Puthira Prathap, D. and P. Murali (Eds). ICAR-Sugarcane Breeding Institute, Coimbatore. pp.78-103.

Arumuganathan, T. 2023. Mechanized sugarcane cultivation including usage of drones. In: Technologies for sustainable sugarcane production. Prathap, D. Puthira, Mohanraj, K., & Hemaprabha, G. (Eds). ICAR-SBI Training Series: 2023/E/02, ICAR-Sugarcane Breeding Institute, Coimbatore. pp: 70-93. ISBN: 978-93-85267-39-0.

Arun Kumar, R., Vasantha, S., Tayade, A.S., Anusha, S., Krishnapriya, V., Sreenivasa, V., Gomathi, R., Palaniswami, C. and Hemaprabha, G. 2023. Sugarcane clones for higher water productivity and yield sustainability under deficit irrigation. In: Wakchaure, G.C, Singh, A.K. Aliza Pradhan, and Reddy, K.S. (Eds) Climate Change & abiotic stresses management solutions for enhancing water productivity, production quality and doubling farmer's income in scarcity zones. Training Manual, ICAR-National Institute of Abiotic Stress Management, Malegaon Kh, Baramati, Pune, Maharashtra, India. pp. 49-54.

Ashwin, N.M.R., Amalamol, D., Lakshana, K.V., Kumar, M.S., Sundar, A.R., Malathi, P.

and Viswanathan, R. 2023. Role of Cerato-Platanins in Inducing PAMP-Triggered Immunity in Plants. In: Bastas, K.K., Kumar, A. and Sivakumar, U. (Eds). Microbial Biocontrol: Molecular Perspective in Plant Disease Management. Microorganisms for Sustainability, vol 49. Springer, Singapore. https://doi.org/10.1007/978-981-99-3947-3_2

Geetha, P., Tayade, A. S., Rajula Shanthy, T., Palaniswami, C. and Anusha, S. 2023. Sugarcane based farming system. In: Advances in sugarcane cultivation. Rajula Shanthy and Hemaprabha, G. (Eds). ICAR-SBI, Coimbatore. pp. 106-113.

Geetha. P. 2023. Agronomy of sugarcane. In: Training manual on quality seed production through micropropagation in sugarcane. Neelamathi, D., Jayabose, C. and Hemaprabha, G. (Eds). ICAR-SBI, Coimbatore. Extension publication 332(2023). pp. 61-70.

Geetha. P. 2023. Cane Agronomy. In Improved sugarcane production technologies. Puthira prathap, D. and Murali, P. (Eds). ICAR-SBI, Coimbatore. Extension publication.pp. 55-65.

Gomathi, R., Arun Kumar, R., Krishnapriya, V. and Alagupalamuthirsolai, M. 2023. Abiotic stress management in Sugarcane. In. Advances in sugarcane cultivation. Rajula Shanthy, T. and Hemaprabha, G. (Eds). ICAR-SBI, Coimbatore. Extension Publication 331:100-105.

Gomathi, R., Arun Kumar, R., Krishnapriya, V. and Alagupalamuthirsolai, M. 2023. Management of Post-Harvest deterioration and flowering in sugarcane. In: Improved Sugarcane Production Technologies. Puthira Prathap, D. and Murali, P. (Eds). Published by Hemaprabha, G. The Director, ICAR-SBI, Coimbatore, pp. 114-129.

Gomathi, R., Pooja, D., Arun Kumar, R., Krishnapriya, V., Elayaraja, K., Alagupalamuthirsolai, M. and Hemaprabha, G. 2023. Co 14012 - A climate resilient superior variety for tropical & sub-tropical India. In: 81st STAI Annual Convention and International Sugar Expo 2023 Edited and Published by The President STAI Association of India, New Delhi. pp: 67-78. ISBN-81 -85871-02-7

Hari, K., Suresha, G.S. and Murali, P. 2023. Commercialized Technologies from ICAR Sugarcane Breeding Institute and value-added products from sugarcane. Prathap, D. Puthira, Mohanraj, K., & Hemaprabha, G. (Eds). Technologies for Sustainable Sugarcane Production. ICAR – Sugarcane Breeding Institute (ICAR–SBI Training series :2023/E/02) ISBN: 978-93-85267–39-0. pp. 170-204.

Jayakumar, V. 2023. Nanotechnology approaches for sugarcane disease management. In: Prathap, D. Puthira, Mohanraj, K. and Hemaprabha, G. (Eds). Technologies for sustainable sugarcane production. ICAR-Sugarcane Breeding Institute (ICAR- SBI training series: 2023/E/02). pp: 148-152.

Mahesh, P., Srikanth, J., Singaravelu, B., Salin, K.P., Puthira Prathap, D., Mahendran, B. and Nirmala, R. 2023. *Saccharum spontaneum* inankalil sethil poochi Melanaspis glomerata (Homoptera: Diaspididae) edirpputhanmai mathipittaiyu [Tamil] [Screening of *Saccharum spontaneum* for resistance to *Melanaspis glomerata* (Homoptera: Diaspididae)]. In: Velan Poochial, Anandi, P., Lekhapriyanka, S., Usharani, P. and Merlin Kamala, I. (Eds). Tamil Nadu Agricultural University, Coimbatore, India. pp. 71-73. ISBN 978-93-91853-42-6

Mahesh, P., Srikanth, J., Singaravelu, B., Salin, K.P., Puthira Prathap, D., Mahendran, B. and Nirmala, R. 2023. Karimbin moola marabou pairigalil karumbu ilaitholaippan (Aphanisticus Coleoptera: Buprestidae): Oru pudia aayuvu [Tamil] [*Aphanisticus aeneus* Coleoptera: Buprestidae: new occurrence in sugarcane]. In: Velan Poochial, Anandi, P., Lekhapriyanka, S., Usharani, P. and Merlin Kamala, I. (Eds). Tamil Nadu Agricultural University, Coimbatore, India. pp. 97-100. ISBN 978-93-91853-42-6

Malathi, P. 2023. Integrated Disease Management in Sugarcane. In: Improved Sugarcane Production Technologies. (Prathap, D. Puthira. & Murali, P. (Eds). ICAR-Sugarcane Breeding Institute, (ICAR-SBI Training Series: 2023/E/1). pp. 146-157.

Malathi, P. and A. Ramesh Sundar. 2023. Integrated Disease Management in Sugarcane. In: Technologies for Sustainable Sugarcane Production. Prathap, D. Puthira, Mohanraj, K. and Hemaprabha, G. (Eds). ICAR-Sugarcane Breeding Institute (ICAR-SBI Training Series: 2023/E/2), (ISBN: 978-93-85267-39-0). pp. 134-147.

Meena, M.R., Tabish Akhtar, Appunu, C., Arun Kumar, R., Vasantha, S., Pooja, D., Ravinder Kumar and Pandey, S.K. 2023. Impact of Salinity Stress on Sugarcane Yield and Quality: Management.

Palaniswami, C., V. Kasthuri Thilagam. and Vennila, A. 2023. Application of remote sensing and decision support system in sugarcane agriculture. In: Technologies for sugarcane production. Prathap, D. Puthira, Mohanraj, K., & Hemaprabha, G. (Eds). ICAR-Sugarcane Breeding Institute, Coimbatore. (ICAR-SBI Training Series: 2023/E/02) pp: 94-103. ISBN: 978-93-85267-39-0.

Palaniswami, C., Vennila, A. and V. Kasthuri Thilagam. 2023. Irrigation management in sugarcane cultivation. In: Improved sugarcane production technologies. Prathap, D. Puthira, Mohanraj, K., & Hemaprabha, G. (Eds). ICAR-SBI, Coimbatore. pp: 66-77.

Puthira Prathap, D. and Murali, P. 2023. ICT Sources of Sugarcane Information. In: Puthira Prathap, D. and Mohanraj, K (Eds) (2023). Improved Sugarcane Production Technologies. ICAR-SBI, Coimbatore. pp. 203 – 211.

Puthira Prathap, D., Mohanraj, K. and Murali, P. 2023. Sugarcane Information Sources and Search Strategies. In: Puthira Prathap, D. and Mohanraj, K. and Hemaprabha, G. (Eds). Technologies for Sustainable Sugarcane Production. ICAR-SBI, Coimbatore. pp. 153 – 169. ISBN: 978-93-85267-39-0 (ICAR-SBI Training series: 2023/E/02).

Sankaranarayanan, C. 2023. Sugarcane nematode complex: Polyspecific Paradise. In. Nematode problems of crops and their management in south Asia. Walia, R.K. and Khan, M. R. (Eds), Cambridge Scholars Publishing, UK. pp. 281-294.

Suganya, A. and Neelamathi, D. 2023. A practical manual for micropropagation of sugarcane. TNAU.

Tayade, A. S., Geetha, P., Anusha, S., Arunkumar, R. and Vasantha, S. 2023. Agro-technologies to sustain sugarcane productivity under abiotic stresses. In Agro-industrial perspectives on sugarcane production under environmental stress. Springer Nature Singapore. pp. 231-266.

Vennila, A., Kasthuri Thilagam V. and Palaniswami, C. 2023. Precision water and nutrient management in sugarcane. In: Technologies for sugarcane production. Puthira Prathap, D., Mohanraj, K. and Hemaprabha, G. (Eds). ICAR-Sugarcane Breeding Institute, Coimbatore. pp. 52-69. ISBN: 978-93-85267-39-0. (ICAR_SBI Training Series: 2023/E/02).

Vennila, A., Kasthuri Thilagam V. and Palaniswami, C. 2023. Precision nutrient management in sugarcane. In: Improved sugarcane production technologies. Puthira Prathap, D. and Murali, P. ICAR-SBI, Coimbatore. pp. 104-113.

Vennila, A., Palaniswami, C. and Kasthuri Thilagam, V. 2023. Integrated nutrient management for achieving sustainable sugarcane production. In: Advances in sugarcane cultivation. Rajula Shanthy, T. and Hemaprabha, G. (Eds). ICAR-Sugarcane Breeding Institute, Coimbatore. Extension Publication No. 331. pp. 74-83.

Viswanathan, R., Geetha, N., Anna Durai, A., Thirugnanasambandam, P.P., Appunu, C., Parameswari, B., Nithya, K., Ramasubramanian, T. and Selvi, A., 2022. Genomic Designing for Biotic Stress

Resistance in Sugarcane. In Genomic Designing for Biotic Stress Resistant Technical Crops. Cham: Springer International Publishing. pp. 337-439.

## Technical / Popular articles / Extension publications / Pamphlets

Anusha, S., Krishnapriya, V., Vinu, V., Geetha, P. and Arun Kumar, R. 2023. *Rottboellia cochinchinensis*: A noxious grass weed. *Krishi Science* 4(10):38-41. ISSN: 2583-4150.

Arumuganathan, T. 2023. Mechanization in sugarcane farming. In: Improved Sugarcane Production Technologies Puthira Prathap, D. and Murali, P. (Eds) ICAR-SBI, Coimbatore, pp. 130-145.

Arumuganathan, T., Mohan, S. and Balakrishnan, T. 2023. Karumbil drone moolam marunthu thelippu vilakkam (Demonstration of agricultural sprayer drone in sugarcane). Bannariamman Kuzhumam Newsletter 14(2):22-23.

Arun Kumar, R., Vasantha,. S, Hemaprabha. G., Tayade, A.S., Anusha, S., Krishnapriya, V., Sreenivasa, V., Gomathi, R., Palaniswami, C., Arumuganathan, T. and Alagupalamuthirsolai, M. 2022. Kam sinchaayi ke halathon mein uchch jal uthpadaktha aur uthpadan ki nirantharatha ke liye ganne ke krinthak. *Ganna Prakash* 7(7):74-79.

Geetha, P., Tayade, A. S., Rajula Shanthy, T., Palaniswami, C. and Anusha, S. 2022. Possibilities of natural farming in eco-friendly sugarcane production (in Hindi). *Ganna Prakash* 7(7):27-28.

Gomathi, R., Karuppaiyan, R., Arumuganathan, T., Murali, P., Arun Kumar, R., Suresh, G.S., Geetha, P., Alagupalamuthirsolai, M., Dinesh, U., Raja, R., Amsaveni, P., Manivannan, K. and Hemaprabha, G. 2023. In. Iniya – Podi Vellam (Karumbin ootasathu niraintha thayaarippu) migundha potassium satthu nirainthathu nachhu thanmai atrathu. Published by ICAR-SBI, Coimbatore. Extension Publication. 1-6.

Gomathi, R., Karuppaiyan, R., Arumuganathan, T., Murali, P., Arun Kumar, R., Suresh, G.S., Geetha,P., Alagupalamuthirsolai, M., Dinesh, U., Raja, R., Amsaveni, P., Manivannan, K. and Hemaprabha, G. 2023. In. Iniya – Powder Jaggery (A Nutritive product of sugarcane) Potassium-Rich and Toxic Free. Published by ICAR-SBI, Coimbatore. Extension Publication. 1-6.

Hari, K. 2023. Biofertilizers and commercialized technologies from ICAR-SBI, In: Training manual on Improved sugarcane production technologies. Puthira Prathap, D. and Murali, P. (Eds) ICAR-SBI, Coimbatore, pp. 212-225.

Hari, K. 2023. Biofertilizers in sugarcane production. In: Advances in sugarcane cultivation, Extension Publication No. 331 (2023), ICAR-SBI, Coimbatore. pp. 84-86.

Karuppaiyan, R., Alarmelu, S., Jayabose, C., Sreenivasa, V., Hemaprabha, G., Anusheela, V. and Amudha, P. 2023. Protection of Plant Varieties and Farmers Right Act (Tamil). Extension publication No. 334/2023. ICAR-SBI, Coimbatore.

Kasthuri Thilagam V., Vennila, A. and Palaniswami, C. 2023. Soil and water sampling procedure (Tamil). Extension publication No. 336/2023/T. ICAR-SBI, Coimbatore.

Krishnapriya, V., Arun Kumar, R., Vasantha, S., Hari, K., Arumuganathan, T., Suresha, G.S., Annadurai, A., Chandran, K., Nisha, M., Pooja, D., Alagupalamuthirsolai, M. and Gomathi, R. 2022. Ganna uthpadaktha mein sudhaar ke liye jad lakshansamishti ka avasar. *Ganna Prakash* 7(7):67-71.

Mahesh, P., Puthira Prathap, D., Singaravelu, B., Srikanth, J., Aishwarya, B., Yuvasri, S., Mohanraj, K., Geetha, P., Srinivasa, V. and Hemaprabha, G. 2023. Makkachola pairil padaipulu thaakkudalai kattupaduthum moraigal [Tamil] [Fall armyworm in maize and its management]. ICAR-SBI-STC Publication Series, STC/2022-23/Ta/02. ICAR-SBI, Coimbatore, India. p. 6.

Mahesh, P., Puthira Prathap, D., Singaravelu, B., Srikanth, J., Mohanraj, K., Geetha, P. and Sreenivasa V. 2023. Makka Chola payiril Padaipuzhu thakkthalai kattupadhuthum Muraigal. ICAR-SBI- STC/2022-2023/ Ta/02.

Mahesh, P., Singaravelu, B., Srikanth, J., Sankaranarayan, C., Salin, K.P. and Nirmala, R. 2023. Karumpu chakupatiyil verppulu melanmai [Tamil] [White grub management in sugarcane]. ICAR-SBI-STC Publication Series, STC/2022-23/Ta/02. ICAR-SBI, Coimbatore, India. p. 6.

Malathi, P., R. Viswanathan, A. Ramesh Sundar, Ravindra Naik, T. Rajula Shanthy, A. Vennila and T. Ramasubramanian. 2023. Sugarcane Sett Treatment Device (User Manual in English). Extension Publication No. 338.p. 6, ICAR-SBI, Coimbatore. (Under NADP-RKVY).

Malathi, P., Rajula Shanthy, T., Vennila, A., Ramasubramanian, T., Ravindra Naik, and Ramesh Sundar, A. 2023. Role of sett treatment device on the integrated management of pokkah boeng in sugarcane (Tamil). Extension Publication No. 333. p. 4. ICAR-SBI, Coimbatore. (Under NADP-RKVY).

Malathi, P., Rajula Shanthy, T., Vennila, A., Ramasubramanian, T., Ravindra Naik, and Ramesh Sundar, A. 2023. Technology on mechanized sett treatment to protect sugarcane (Tamil). Extn. Publication No.335. p. 4, SBI, Coimbatore. (Under NADP-RKVY).

Malathi, P., Viswanathan, R., Ramesh Sundar, A., Ravindra Naik, Rajula Shanthy, T., Vennila, A. and Ramasubramanian, T. 2023. Sugarcane Sett Treatment Device (User Manual in English). Extension Publication No. 340.p. 6, ICAR-SBI, Coimbatore. (Under NADP-RKVY).

Meena, M.R., Tabish Akhtar, Appunu, C., Arun Kumar, R., Vasantha, S., Pooja, D., Ravinder Kumar and Pandey, S.K. 2023. Impact of Salinity Stress on Sugarcane Yield and Quality: Management Approaches for Higher Cane Sugar Productivity. pp. 39-56 DOI - 10.1007/978-981-19-3955-6_3

Murali, P., Hari, K., Suresha, G.S., Puthira Prathap, D., Hemaprabha, G., Anusha, S., Vinu, V., Adhini, S.P. and Sreenoop, S. 2023. SugarcaneEdge: Agri Business Incubation Centre (in Malayalam), ABI Publication No. SBI-ABI/2023/M/01. ICAR-SBI, Coimbatore.

Murali, P., Hari, K., Suresha, G.S., Puthira Prathap, D., Hemaprabha, G. and Antony Leo, C. 2023. Pamphlet On Sugarcane Edge: Sugarcane Based Agri Business Incubation Centre (English). Publication No. SBI-ABI/E/01.

Murali, P., Puthira Prathap, D. and Elayaraja, K. 2023. Role of sugarcane economy in Indian Agriculture (Tamil). Sakthi Sugars Newsletter February, 10. pp. 30-36.

Nisha, M., Chandran, K., Gopi, R., Mahendran, B. and Dhanya, V.G. 2023. Sugarcane cultivation and value added products from sugarcane juice (Malayalam). *Krishiyankanam* 6(4):34-40.

Puthira Prathap, D. 2022. From the Editor's Desk. *Journal of Extension Education* 34(2): 6789. https://doi.org/10.26725 JEE.2022.2.34.6789

Puthira Prathap, D. 2022. From the Editor's Desk. *Journal of Extension Education* 34(1): 6739. https://doi.org/10.26725/ JEE.2022.1.34.6739

Puthira Prathap, D., Mohanraj K., Geetha, P. and Sreenivasa V., (Eds). 2022. Millet cultivation. ICAR-SBI, Coimbatore. p. 20.

Puthira Prathap, D., Mohanraj K., Geetha, P. and Sreenivasa V., (Eds). 2023. Beekeeping handbook. ICAR-SBI, Coimbatore. (Scheduled Tribe Component). p. 32.

Puthira Prathap, D., Mohanraj K., Geetha, P. and Sreenivasa V., Eds. 2023. ICAR – Sugarcane Breeding Institute organizes campaigns to emphasize the importance of millets, among the tribals of Sathyamangalam Tiger Reserve! *ICAR-SBI News* 45 (2). pp. 3-4.

Puthira Prathap, D. 2023. Co-0238, the wonder cane variety, (E-publication) ICAR-SBI/ Social_Media/e-instructional material series/Co0238/2022.

Rajula Shanthy, T. 2023. Sugarcane breeding to produce new varieties. Agriculture Information connection growers, buyers and experts. pp. 224-227.

Rajula Shanthy, T., Jayabose, C. and Malakappa B. Medegar 2023. Triumphing against all odds of life: The story of a tribal lady. SBI News 42(4): p. 2.

Suganya, A., Govindaraj, P., Selvi, A., Hemaprabha, G. and Bakshi Ram. 2022. Cytotype 2n=72 derived interspecific hybrid- AS 04-2097 (INGR20070) of *S. spontaneum* L. tolerance to drought. *Ganna Prakash*, 7:53-54.

Suganya, A.., Govindaraj, P., Selvi, A., Hemaprabha, G. and Bakshi Ram. 2021. A climate resilient interspecific hybrid - AS 04-1687 (IC0636675:INGR20110) tolerance to drought, waterlogging and salinity. *Ganna Prakash* 6:7-9.

Suresha, G.S, Lavanya, R., Mural, P., Hari, K., Bakshi Ram, Antony Leo and Puthira Prathap, D. 2023. *Cane Jam* (Hindi) 7(7):25-26.

Suresha, G.S., Hari, K. and Murali, P. 2023. Value added products from sugarcane. In: Training manual on Improved sugarcane production technologies. Puthira Prathap, D. and Murali, P. (Eds) ICAR-SBI, Coimbatore, pp. 212-225.

Suresha, G.S., Hari, K. and Murali, P. 2023. Value added products from sugarcane. In: Advances in sugarcane cultivation, Extension Publication No. 331 (2023), ICAR-SBI, Coimbatore. pp. 123-134-86.

Vennila, A., Kasthuri Thilagam, V. and Palaniswami, C. 2023. Foliar spraying of iron using drone for sugarcane in calcareous soils. *Kisan World* 50(3):5-7.

Vennila, A., Kasthuri Thilagam, V. and Palaniswami, C. 2023. Soil and water sampling procedure for sustainable sugarcane production. Extension Publication No. 337/2023/E. ICAR-SBI, Coimbatore.

Vinu, V., Krishnapriya, V., Adhini, S. P., Anusha, S. and Karthigeyan, S. 2023. Exploring the gold mine of genetic resources to improve abiotic stress tolerance in sugarcane. *Just Agriculture* 3(5):146-153. ISSN: 2582-8223.

Vinu, V., Krishnapriya, V., Adhini, S. P., Anusha, S. and Karthigeyan. S. 2023. Exploring the gold mine of genetic resources to improve abiotic stress tolerance in sugarcane (in Hindi) *Ganna Prakash* 7(7):61-66.

## Presentations in Conference/Symposia/ Seminars/Workshops/Others

Afseena, A. and Prathima. P.T. 2023. A comparative analysis of SWEET transporters from sugarcane hybrid and its progenitor species. In: International Seminar and Workshop on CRISPR/Cas-based Plant Functional Genomics and Computational Modeling held from January Jan 18-21, 2023, CSIR-NEIST, Jorhat, Assam, India.

Afseena., A., Prathima, P.T., and Namrata, P.M. 2023. A comparative study on sugar-related transcripts in sugarcane hybrid, Co 11015, and progenitor species *S. officinarum* and *S. spontaneum*. In: XVI Agricultural Science Congress and ASC Expo; Kochi, Kerala held on October 10-13, 2023

Afseena., A., Prathima, P.T., Rabisha, V., Vannish, R. and Swaliha, B. 2023 Cloning and characterization of SWEETs towards improving sugar content in sugarcane through gene editing.In: National seminar on Research Imperatives for Sustaining sugarcane, Sugar and Ethanol production held on 25th August 2023 at ICAR-SBI, Coimbatore p. 50.

Alarmelu, S. 2023. Harnessing sugarcane germplasm for genetic enhancement: challenges and opportunities. In: National seminar on Research Imperatives for Sustaining sugarcane, Sugar and Ethanol production held on 25th August 2023 at ICAR-SBI, Coimbatore pp. 4-13.

Alarmelu, S., Vasantha, S., Sheela Mary, S., Arunkumar., R. and Anusheela, V. 2023. Evaluation of drought tolerance in sugarcane backcross hybrids using the membership function value of drought tolerance (MFVD) In: National seminar on Research Imperatives for Sustaining sugarcane, Sugar and Ethanol production held on 25th August 2023 at ICAR-SBI, Coimbatore. p. 44.

Anjali, S., Abi, A., Neha Sara, S., Suresha, G, S., Hari, K., Murali, P., Elayaraja, K., Malini, P and Kalaiselvi, K. 2023 Isolation and characterization polyphenol enriched fraction from sugarcane juice. In: Proceedings of the National Seminar on Research Imperatives for Sustaining Sugarcane, Sugar and Ethanol Production (SugarSem-2023), held on 25th August 2023, ICAR-Sugarcane Breeding Institute Coimbatore, Tamil Nadu, India. pp. 156 – 157.

Appunu, C., Swathik Clarancia, P., Valarmathi, R., Arun Kumar, R., Gomathi, R., Suresha, G. S. and Hemaprabha, G. 2023. Over-expression of Aldehyde dehydrogenase enhances drought tolerance in transgenic sugarcane. In: Proceedings of 13th NABS National Conference on Current Perspectives for Sustainable Development in Life Sciences, Environment and Agriculture during 23-25 January 2023, Periyar University, Salem.

Ariharasutharsan, G., Pooja, D., Negi, Vinoth, P., Malarvizhi, A., Senthilrajan, P., Appunu, C, Ashish K Srivastava and Valarmathi, R. 2023. Image based high-throughput root system architecture analysis of in-vitro derived gamma ray induced mutants in sugarcane mutants in sugarcane. In: Proceedings of the National Seminar on Research Imperatives for Sustaining Sugarcane, Sugar and Ethanol Production (SugarSem-2023), held on 25th August 2023, ICAR-Sugarcane Breeding Institute Coimbatore, Tamil Nadu, India. p. 54.

Arumuganathan, T. 2023. Agricultural sprayer drone technology demonstration for input management in sugarcane cultivation. In: Proceedings of the National Seminar on Research Imperatives for Sustaining Sugarcane, Sugar and Ethanol Production (SugarSem-2023), held on 25th August 2023, ICAR-Sugarcane Breeding Institute Coimbatore, Tamil Nadu, India. pp. 158-159.

Arumuganathan, T., Singh, A.K., Tayade, A.S., Senthilkumar, T., Anusha, S. and Bakshi Ram. 2023. Field Performance of different mechanical planters for mechanized sugarcane planting under tropical conditions. In: Souvenir-cum-Abstracts of 2nd International conference on "Prospects and Challenges of Environment and Biological Sciences in Food Production System for Livelihood Security of Farmers (ICFPLS-2023). Chaudhary, V.P., Sunder, J., Verma, N., Nirmal, Bohra, P., Singh, P.K., Kumar Vijay, Kumari Sweeti, Katiyar Hari Om, Chakurkar, E.B. and Prasad, G. (Eds) held during 18-20, September 2023 at ICAR-CIARI, Port Blair, Andaman Nicobar Islands, India. p. 29.

Arun Kumar, R., Vasantha, S., Hemaprabha, G., Tayade, A.S., Anusha, S., Geetha, P., Krishnapriya, V., Sreenivasa, V., Gomathi, R., Palaniswami, C. and Alagupalamuthirsolai, M. 2023. Water-productive sugarcane clones for climate-resilient sugarcane production. In: Proceedings of the National Conference on Research Imperatives for Sustaining Sugarcane, Sugar and Ethanol Production Sugar-Sem 2023. Gomathi, R., Malathi, P., Alarmelu, S., Appunu, C. *et.al*.(Eds). ICAR-Sugarcane Breeding Institute, Coimbatore, SSRD, Coimbatore and SSRP, New Delhi. p. 73.

Arya, M., Geetha, P., Hari, K and Malathi A. 2023 Development of improved sugarcane planting material by priming with bioinoculants. In: Proceedings of the National Seminar on Research Imperatives for Sustaining Sugarcane, Sugar and Ethanol Production (SugarSem-2023), held on 25th August 2023, ICAR-Sugarcane Breeding Institute Coimbatore, Tamil Nadu, India. p. 79.

Bhuvaneshwari, V., Kaverinathan, K., Nithyanantham, R. and Malathi, P. 2023. Role of *Trichoderma* based nanomaterial in enhancing defense enzymes against red rot in sugarcane. In: Proceedings of the National Seminar on Research Imperatives for Sustaining Sugarcane, Sugar and Ethanol Production (SugarSem-2023), held on 25th August 2023, ICAR-Sugarcane Breeding Institute Coimbatore, Tamil Nadu, India. p. 111.

Chandran, K. 2023. Product diversification option for sustainable sugarcane agriculture (Lead Paper). In: Proceedings of the National Seminar on Research Imperatives for Sustaining Sugarcane, Sugar and Ethanol Production (SugarSem-2023), held on 25th August 2023, ICAR-Sugarcane Breeding Institute Coimbatore, Tamil Nadu, India. pp: 121-128.

Chandran, K., Dilsha, C., Nisha, M., Mahendran, B. and Gopi, R. 2023. Induced somaclonal variation for rind colour and internode shape in *S. officinarum* clones. In: Proceedings of the National Seminar on Research Imperatives for Sustaining Sugarcane, Sugar and Ethanol Production (SugarSem-2023), held on 25th August 2023, ICAR-Sugarcane Breeding Institute Coimbatore, Tamil Nadu, India. p. 61

Chandran, K., Keerthi, C., Dhanya, V.G., Nisha, M., Mahendran, B. and Gopi, R. 2023. Freeze preservation of Sugarcane juice with natural additives. In: Proceedings of the National Seminar on Research Imperatives for Sustaining Sugarcane, Sugar and Ethanol Production (SugarSem-2023), held on 25th August 2023, ICAR-Sugarcane Breeding Institute Coimbatore, Tamil Nadu, India. p. 152

Chandran, K., Keerthi, C., Hasnath, P.K., Nisha, M., Mahendran, B. and Gopi, R. 2023. Nutri Cookies and Cakes sweetened with sugarcane raw sugar (Jaggery). In: book of abstracts. XVI Agricultural Science Congress and ASC expo. Transformation of agri-food system for achieving sustainable developmental goals. NAAS, New Delhi and ICAR CMFRI, Kochi, held during 10-13 October 2023, Kochi India. p. 122.

Chandran, K., M.Nisha, Nisha, M., Mahendran, B., Gopi, R. and Arun Kumar, R. 2023. Yield and quality evaluation of selected F1 progenies from polycross on *Saccharum robustum* f. *sanguineum*. In: Proceedings of the National Seminar on Research Imperatives for Sustaining Sugarcane, Sugar and Ethanol Production (SugarSem-2023), held on 25th August 2023, ICAR-Sugarcane Breeding Institute Coimbatore, Tamil Nadu, India. p. 58.

Deva Kumar, K., Lakshmi, K., Prathima, P.T., Ram Vannish, Rabisha. V.P. and Selvi, A. 2023. Cloning and sequencing of ANGUSTIFOLIA3 (AN3) and GRAS gene from sugarcane cultivars. In: Proceedings of the National Seminar on Research Imperatives for Sustaining Sugarcane, Sugar and Ethanol Production (SugarSem-2023), held on 25th August 2023, ICAR-Sugarcane Breeding Institute Coimbatore, Tamil Nadu, India. pp: 163.

Dhanya, V.G., Amaresh, Neelamathi, D., Shanthi, R.M. and Hemaprabha, G. 2023. Seed setting in sugarcane: potential impacts of climate change. In: Proceedings of the National Seminar on Research Imperatives for Sustaining Sugarcane, Sugar and Ethanol Production (SugarSem-2023), held on 25th August 2023, ICAR-Sugarcane Breeding Institute Coimbatore, Tamil Nadu, India. P. 149.

Divya, Pai, G., Hari, K., Suresha, G.S., Murali, P., Antony Leo, Kalaiselvi, K. and Malini, P. 2023. Value addition of sugarcane juice concentrate with root extracts of Nannari (*Hemidesmus indicus*) and Vetiver (*Chrysopogon zizanioides*). In: Proceedings of the National Seminar on Research Imperatives for Sustaining Sugarcane, Sugar and Ethanol Production (SugarSem-2023), held on 25th August 2023, ICAR-Sugarcane Breeding Institute Coimbatore, Tamil Nadu, India. p. 158.

Elamathi E., P. Malathi, A. Ramesh Sundar and R. Viswanathan. 2023. Antagonistic suppression of red rot pathogen in sugarcane evidenced by expression of antifungal metabolites during ditrophic and tritrophic interactions. In: Proceedings of the National Seminar on Research Imperatives for Sustaining Sugarcane, Sugar and Ethanol Production (SugarSem-2023), held on 25th August 2023, ICAR-Sugarcane Breeding Institute Coimbatore, Tamil Nadu, India. p. 115.

Elayaraja, K., Mohanraj, K., Shanthi, R.M., Alarmelu, S., Govindaraj, P., Gomathi, R., Arun Kumar, R., Prabakaran, A.J. and Hemaprabha, G. 2023. Genetic diversity analysis of interspecific and intergeneric hybrids of Sugarcane through Principal Component Analysis. In: National seminar on Research Imperatives for Sustaining sugarcane, Sugar and Ethanol production held on 25th August 2023 at ICAR-SBI, Coimbatore p. 18.

Geetha P., Anusha, S. and Kannan, K. 2023. Sustainability of organic sugarcane cultivation in tropical India. In: International Conference on Global Insights on Research and Development in Agriculture, Horticulture and Allied Sciences during 05-07 October, 2023, G. H. Raisoni University, Nagpur. pp. 1-5.

Geetha P., Tayade, A.S. Arun Kumar, R. and Palaniswami. C. 2023. Impact of climatic variables on sugarcane yield over a decade in Tamil Nadu. In: National Level Conference "AGMET 2022" Advances in Agrometeorological Interventions for Climate Resilient Agriculture. TNAU, Coimbatore.

Geetha P., Tayade, A.S., Rajula Shanthy, T., Palaniswami, C. and Anusha, S. 2023. Auditing of energy use and economics of sugarcane based cropping system in tropical india. In: National seminar on Research Imperatives for sustaining sugarcane research, sugar and Ethanol production. 25th Aug, 2023, ICAR-SBI, Coimbatore. p. 77.

Geetha P., Tayade, A.S., Vennila, A. and Hari, K. 2023. Conservation Agriculture in sugarcane based cropping System in Tropical India: Impact on cane yield and productivity In: 2nd International conference on Prospects and Challenges of Environment and Biological Sciences in Food Production System for Livelihood Security of Farmers (ICFPLS–2023) hed during September 18–20, 2023 ICAR-CIARI, Port Blair, Andaman & Nicobar Islands, India. p. 84. (Online).

Geetha, P, *et al*. 2023. Natural farming for sustainable sugarcane production. In: 9th National Tamil conference on Agricultural Science, TNAU, Coimbatore held during Dec 16-17, 2023. pp. 230-234.

Gomathi, R., Arun Kumar, R., Krishnapriya, V., Alagupalamuthirsolai, M., Annadurai, A. and Hemaprabha, G. 2023. Climate-resilient drought tolerant sugarcane clones for Peninsular Zone of India. In: Proceedings of the National Conference on Research Imperatives for Sustaining Sugarcane, Sugar and Ethanol Production Sugar-Sem 2023. Gomathi, R., Malathi, P., Alarmelu, S., Appunu, C. *et.al*.(Eds). ICAR-Sugarcane Breeding Institute, Coimbatore, SSRD, Coimbatore and SSRP, New Delhi. p. 87.

Gomathi, R., Krishnapriya, V., Arun Kumar, R. and Alagupalamuthirsolai. M. 2023. Climate-smart practices for sustaining sugarcane productivity under changing climate. In: Proceedings of the National Conference on Research Imperatives for Sustaining Sugarcane, Sugar and Ethanol Production Sugar-Sem 2023. Gomathi, R., Malathi, P., Alarmelu, S., Appunu, C. *et.al*. (Eds). ICAR-Sugarcane Breeding Institute, Coimbatore, SSRD, Coimbatore and SSRP, New Delhi. p. 65.

Gomathi, R., Krishnapriya, V., Arun Kumar, R., Pooja, D. and Elayaraja, K. 2023. Yield and quality of tropical and sub-tropical sugarcane varieties at two different agro-climatic zones of India. In: Proceedings of 13th NABS National Conference on Current Perspectives for Sustainable

Development in Life Sciences, Environment and Agriculture during 23-25 January 2023, Periyar University, Salem p. 62.

Gopi, R., Chandran, K., Nisha, M., Mahendran, B. and Sony Jayaraman. 2023. New diseases in sugarcane germplasm at Kannur authored by in the XVI Agricultural Science Congress by the National Academy of Agricultural Sciences (NAAS), New Delhi and hosted by ICAR-Central Marine Fisheries Research Institute (ICAR-CMFRI) during 10-13 October, 2023 at Kochi, India. P. 96

Gopi, R., Chandran, K., Ramesh Sundar, A., Viswanathan, R., Jayakumar, V., Nisha, M. Mahendran, B. and Sony Jayaraman. 2023. Status of smut in the sugarcane germplasm at Kannur. In: Proceedings of the National Seminar on Research Imperatives for Sustaining Sugarcane, Sugar and Ethanol Production (SugarSem-2023), held on 25th August 2023, ICAR-Sugarcane Breeding Institute Coimbatore, Tamil Nadu, India. p. 98.

Gopi, R., Chandran, K., Viswanathan, R., Mahendran, B. Nisha, M., Gireesan P.P., Sony Jayaraman. and Mayalekshmi. 2023. Diseases and reaction of clones of wild species of sugarcane germplasm. In the proceedings of National Symposium on Plant Health Management: Current Trends and Novel Mitigation Strategies 11 – 12 September 2023 held at Central Tuber Crops Research Institute Thiruvananthapuram – 695 017, Kerala, India. pp. 74-75.

Hari, K., Suresha, G.S. and Murali, P. 2023. Exploring newer opportunities in sugarcane through product diversification and value addition. In: Proceedings of the National Seminar on Research Imperatives for Sustaining Sugarcane, Sugar and Ethanol Production (SugarSem-2023), held on 25th August 2023, ICAR-Sugarcane Breeding Institute Coimbatore, Tamil Nadu, India. p. 129.

Hari, K., Suresha, G.S., and Murali, P. 2023. Commercialized technologies from ICAR Sugarcane Breeding Institute Coimbatore and Value added products from sugarcane In: Technologies for sustainable sugarcane production. Puthira Prathap, D., Mohanraj, K. and Hemaprabha, G. (Eds). ICAR- Sugarcane Breeding Institute, Coimbatore-641007 pp. 170-204.

Hari, K., Suresha, G.S., Senthil, C. and Govindaraj, P. 2023. Hydrothermal liquefaction of energycane biomass. In: Proceedings of the National Seminar on Research Imperatives for Sustaining Sugarcane, Sugar and Ethanol Production (SugarSem-2023), held on 25 August 2023, ICAR-Sugarcane Breeding Institute Coimbatore, Tamil Nadu, India. pp. 143 – 144.

Hemaprabha, G. 2023. Interventions for improving sugarcane yields in Tamil Nadu. Lead paper presented in the 53rd Sugarcane Research and Development Workshop of Tamil Nadu and Puducherry held during 3-4 November, 2023, Theni.

Hemaprabha. G. 2023. Performance of promising varieties. Presented in 53rd Sugarcane Research and Development Workshop of Tamil Nadu and Puducherry held during 3-4 November, 2023, Theni.

Hemaprabha. G. 2023. Sugarcane cultivation for product diversification and changing climate. 7th Memorial Lecture of Sri Goli Narasimha Rao held on 7th September, 2023, RARS Anakapalle.

Hemaprabha. G. 2023. Sugarcane scenario in the country and the role of ICAR-Sugarcane Breeding Institute. In: Improved Sugarcane production Technologies. Puthira Prathap, Murali, P. (Eds). ICAR- Sugarcane Breeding Institute, Coimbatore. pp. 1-10.

Hemaprabha G. 2023. Sugarcane germplasm utilization for breeding climate resilient varieties. In: Proceedings of International Symposium on Modernization and Innovation of Sugarcane Breeding organized by Sugarcane Research Institute, Guangxi Academy of Agricultural Sciences held during 4-8 December 2023, Nanning, China.

Hemaprabha, G. 2023. Mechanical harvesting of Sugarcane crop. Lead paper presented in the Farmers- Scientists Interaction Meeting held during Farmers' Day on 24th March, 2023, Annamalai University.

Hemaprabha, G. 2023. Changing philosophy of genetic improvement in sugarcane to address varied challenges and opportunities. 81st STAI Convention held during 6-8 September, 2023, Thiruvanthapuram, Kerala.

Hemaprabha, G., Mohanraj, K., Alarmelu, S and Lakshmi Pathy, T. 2023. Generations of Sugarcane Breeding in India. Presented in the XXXI ISSCT Congress held during 20-23, February 2023, Hyderabad.

Henry, R., Furtado, A. and Prathima, P.T. 2023. Unraveling the complex sugarcane transcriptome, In: PAG Australia sugarcane workshop, held during 20-22nd September 2023.

Jain, G., Aaliya, B., Antony Leo, Suresha, G, S., Hari, K., Murali, P., Kalaiselvi K and Malini P. 2023. Development of novel process for cane syrup/liquid jaggery preparation from sugarcane juice through physico-mechanical separation and vacuum concentration. In: Proceedings of the National Seminar on Research Imperatives for Sustaining Sugarcane, Sugar and Ethanol Production (SugarSem-2023), held on 25th August 2023, ICAR-Sugarcane Breeding Institute Coimbatore, Tamil Nadu, India. p. 90.

Janiga, P.K, Nithya, K. and Viswanathan, R. 2023. High fidelity and Efficient Rolling circle amplification method for detection and characterization of SCBV. In: Proceedings of the National Seminar on Research Imperatives for Sustaining Sugarcane, Sugar and Ethanol Production (SugarSem-2023), held on 25th August 2023, ICAR-Sugarcane Breeding Institute Coimbatore, Tamil Nadu, India. p. 112.

Janiga, P.K, Nithya, K. and Viswanathan, R. 2023. Simple and efficient whole genome amplification method for Sugarcane Bacilliform Virus (SCBV) In: Proceedings of International Conference on Plant Health Management ICPHM 2023 - Innovation and Sustainability. p. 209.

Janiga, P.K., Nithya, K. and Viswanathan, R. 2023. Deducing the genome of Sugarcane bacilliform virus (SCBV) to develop an infective clone for sugarcane In: Souvenir and Abstracts IBBACI-2023. p. 203.

Juhiya, C.B. and Chandran, K. 2023. Optimization of wine making from sugarcane juice blended with grape and banana fruits. In: Proceedings of the National Seminar on Research Imperatives for Sustaining Sugarcane, Sugar and Ethanol Production (SugarSem-2023), held on 25th August 2023, ICAR-Sugarcane Breeding Institute Coimbatore, Tamil Nadu, India. p. 148.

Kasthuri Thilagam, V. and Manivannan, S. 2023. Assessment of Soil Carbon Stock at the Influence Zones of Soil and Water Conservation Engineering Structures at the Watershed Level. In the Book of Abstracts, International Conference on "Sustainable Natural Resource Management under Global Climate Change". Manivannan, S., Rajput, T.B.S., Sanjay Arora, Kasthuri Thilagam, V., Nandlal Kushwaha, Mukesh Kumar, Patel, R.A.S. and Manjushree Singh, (Eds). held during November 07-10, 2023, Soil Conservation Society of India, New Delhi, India. pp. 407-408.

Kasthuri Thilagam, V. and Manivannan, S. 2023. Soil and water conservation planning for a hill watershed using geospatial technologies. In: Proceedings of National Seminar on Hydrology with special reference to Hydrological Solutions for Sustainable Development. Rama Rao, P. and Selvakumar, R. (Eds) Organized by Association of Hydrologists of India Jointly with PSG Institute of Advanced Studies, Coimbatore during 01- 02 December 2023. pp. 90-91.

Kaverinathan, K., P. Malathi, A. Ramesh Sundar and R. Viswanathan. 2023. Expression analysis of pathogenicity related proteins

of Colletotrichum falcatum in response to host resistance and pathogen virulence. In: Proceedings of the National Seminar on Research Imperatives for Sustaining Sugarcane, Sugar and Ethanol Production (SugarSem-2023), held on 25 August 2023, ICAR-Sugarcane Breeding Institute Coimbatore, Tamil Nadu, India. p. 115.

Krishnapriya V., Vasantha, S., Arun Kumar, R., Aswathy, G., Anusha, S., Sreenivasa, V., Alarmelu, S., Mohanraj, K., Hemaprabha, G., Arumuganathan, T., Alagupalamuthirsolai, M. and Gomathi, R. 2023. Structural attributes of leaf rolling in commercial hybrids and germplasm clones of sugarcane. In: Proceedings of the National Conference on Research Imperatives for Sustaining Sugarcane, Sugar and Ethanol Production Sugar-Sem 2023. Gomathi, R., Malathi, P., Alarmelu, S., Appunu, C. *et.al*.(Eds). ICAR-Sugarcane Breeding Institute, Coimbatore, SSRD, Coimbatore and SSRP, New Delhi. p. 78.

Krishnapriya, V., Arun Kumar R., Anusha, S., Vinu, V., Vasantha, S., Gomathi, R. and Alagupalamuthirsolai, M. 2023. Physiological markers for nutrient efficient sugarcane genotypes under soil and hydroponic conditions. Souvenir cum Abstract book of the National Conference of Plant Physiology "Physiological and Molecular Approaches for Climate Smart Agriculture. p. 32.

Lakshmi, K., Rabisha, V., Keerthana, K., Sheelamary, S., Selvi, A., Vasantha, S. and Karthigeyan, S. 2022. Deep Sequencing of Suppression Subtractive Hybridization Identifies Differentially Expressed Transcripts of *Saccharum spontaneum* Exposed to Salinity Stress. In: 7th IAPSIT International Sugar Conference (SUGARCON) Sustainability of the Sugar and Integrated Industries: Issues and Initiatives.

Lavanya, R., Suresha, G.S., Hari, K., Murali, P and Bakshi, Ram. 2023. Cane Jam: An innovative value-added product of sugarcane for entrepreneurship. In: Proceedings of the National Seminar on Research Imperatives for Sustaining Sugarcane, Sugar and Ethanol Production (SugarSem-2023), held on 25th August 2023, ICAR-Sugarcane Breeding Institute Coimbatore, Tamil Nadu, India. p. 160.

Lexy Sara Liju, Antony Leo, Suresha, G.S., Murali, P., Hari, K., Kalaiselvi, K., Malini, P. and Sreenoob, S. 2023. Development of process for preparation of jellies and gummies from sugarcane juice. In: Proceedings of the National Seminar on Research Imperatives for Sustaining Sugarcane, Sugar and Ethanol Production (SugarSem-2023), held on 25th August 2023, ICAR-Sugarcane Breeding Institute Coimbatore, Tamil Nadu, India. p. 161.

Madhumathi, R., Ashok Kumar, K., Chandra Kumar, N., Dhyanesh, A. and Arumuganathan, T. 2023. Regression methods for soil nutrient prediction and crop recommendation system in the context of precision agriculture. In: Souvenir-cum-Abstracts of 2nd International conference on "Prospects and Challenges of Environment and Biological Sciences in Food Production System for Livelihood Security of Farmers (ICFPLS-2023). Chaudhary, V.P., Sunder, J., Verma, N., Nirmal, Bohra, P., Singh, P.K., Kumar Vijay, Kumari Sweeti, Katiyar Hari Om, Chakurkar, E.B. and Prasad, G. (Eds) held during 18-20, September 2023 at ICAR-CIARI, Port Blair, Andaman Nicobar Islands, India. p. 22.

Madhumathi, R., Jegan, B., Naveenganesh, M., Raghavendar, S. and Arumuganathan. T. 2023. AI based system for irrigation and fertigation automation. In: Souvenir-cum-Abstracts of 2nd International conference on "Prospects and Challenges of Environment and Biological Sciences in Food Production System for Livelihood Security of Farmers (ICFPLS-2023). Chaudhary, V.P., Sunder, J., Verma, N., Nirmal, Bohra, P., Singh, P.K., Kumar Vijay, Kumari Sweeti, Katiyar Hari Om, Chakurkar, E.B. and Prasad, G. (Eds) held during 18-20, September 2023 at

ICAR-CIARI, Port Blair, Andaman Nicobar Islands, India, pp. 183-184.

Mahesh P., Singaravelu B., Srikanth J., Hari K., Salin K.P., Appunu, C., Suresha G., Sankaranarayanan, C., Nirmala, R. and Iswarya, B. 2023. Low-cost technology for mass production of a white grub specific strain of *Bacillus thuringiensis* on agro-industry byproducts. In: Proceedings of the National Seminar on Research Imperatives for Sustaining Sugarcane, Sugar and Ethanol Production (SugarSem-2023), held on 25th August 2023, ICAR-Sugarcane Breeding Institute Coimbatore, Tamil Nadu, India. p. 102.

Mahesh, P., Singaravelu, B., Srikanth, J., Hari, K., Salin, K.P. Appunu, C., Suresha, G.S., Sankaranarayanan, C. and Nirmala, R. 2023. A low-cost technology for mass production of *Bacillus thuringiensis* on agro-industry by-products against white grub *Holotrichia serrata.* In: Proceedings of 13th NABS National Conference on Current Perspectives for Sustainable Development in Life Sciences, Environment and Agriculture during 23-25 January 2023, Periyar University, Salem. p. 54.

Mahesh, P., Singaravelu, B., Suresha, G.S., Srikanth, J., Sankaranarayanan, C., Hari, K. and Appunu. C. 2023 A low-cost technology for mass production of *Bacillus thuringiensis* on agro-industry by-products against white grub *Holotrichia serrata*. In: Proceedings of 13th NABS National Conference on Current Perspectives for Sustainable Development in Life Sciences, Environment and Agriculture during 23-25 January 2023, Periyar University, Salem. p. 239.

Malarvizhi. A., Vinoth, P., Ariharasutharsan, G., Senthilrajan, P., Appunu, C and Valarmathi, R. 2023. Exploring the drought and salinity stress adaptive morpho-anatomical phenes in leaf and roots of wild sugarcane germplasm compared to the commercial genotypes.In: Proceedings of the National Seminar on Research Imperatives for Sustaining Sugarcane, Sugar and Ethanol Production (SugarSem-2023), held on 25th August 2023, ICAR-Sugarcane Breeding Institute Coimbatore, Tamil Nadu, India. p. 55.

Malathi, P., Kaverinathan, K., Parvathy, A.J. and Ramesh Sundar, A. 2023. Bio-formulation of Substrates with fungal and bacterial antagonists for effective settling production and its efficacy against primary source of Red rot disease in Sugarcane. In: Proceedings of the National Seminar on Research Imperatives for Sustaining Sugarcane, Sugar and Ethanol Production (SugarSem-2023), held on 25th August 2023, ICAR-Sugarcane Breeding Institute Coimbatore, Tamil Nadu, India. p. 96.

Malathi, P., Kaverinathan, K., Ramesh Sundar, A. and Viswanathan, R. 2022. Application of Omics tools to identify potential target sites for the management of red rot pathogen *Colletotrichum falcatum* in sugarcane. Proceedings of XXXIst ISSCT Congress organized by The Sugar Technologists Association of India during 20 - 23 February 2023 at International Convention Centre (HICC), Hyderabad, India. p. 61.

Malathi, P., Ramesh Sundar, A., Selvakumar, R., Jayakumar, V., Nithya, K., Vennila, A., Ramasubramanian, T. and Rajula Shanthy, T., Viswanathan, R. Shweta Singh, Ravindra Naik, Veena, S.S., Jeeva, M.L. Maheshkumar, T. Ravichandran, V., Priti Sonavane, Sriram S., Thangavelu, R. and Loganathan, M. 2023. Mechanized priming of planting materials in sugarcane and other vegetatively propagated crops: An innovative approach for healthy nursery and disease management. In: Proceedings of National Symposium on Plant Health Management: Current Trends and Novel Mitigation Strategies" organized by Indian Phytopathological Society – SZ at CTCRI, Thiruvananthapuram during 11-12 September, 2023. pp. 99-100.

Malathi, P., Viswanathan, R., Ramesh Sundar, A., Ravindra Naik, Rajula Shanthy, T., Vennila, A. and Ramasubramanian, T. 2023.

Mechanized priming of sugarcane planting materials - an efficient and economic way of delivering agro inputs for healthy nursery and main field crop. In: Proceedings of 52nd Annual Convention of SISSTA at Chennai during 29-30th September 2023. pp: 198-203.

Malathi, P., Viswanathan, R., Ramesh Sundar, A., Ravindra Naik, Selvakumar, R., A. Vennila, A., Ramasubramanian, T., Rajula Shanthy, T. and Puthira Prathap, D. 2023. Management of pokkah boeng in sugarcane and role of sett treatment device in managing sugarcane diseases in 53nd Sugarcane Research and Development Workshop of Tamil Nadu and Puducherry at Theni during 03-04 November 2023.

Manimekalai, R., Viswanathan, C., Vanchinathan, Soham Ray, and Shivani. 2023. Optimization of multiplex SgRNA/Cas9 cloning cassette for sugarcane. In: The International conference on food and nutritional security (iFANS-2023) to be held during Jan 6-9, 2023 at National Agri-Food Biotechnology Institute (NABI) Mohali. P-023 114.

Meena, M.R., Ravinder Kumar, Pandey, S.K., Chhabra, M.L. and Pooja Dhansu. 2023. Evaluation of ISH and IGH clones of *Saccharum* for drought tolerance in Sub-tropical climate. In: Proceedings of the National Seminar on Research Imperatives for Sustaining Sugarcane, Sugar and Ethanol Production (SugarSem-2023), held on 25th August 2023, ICAR-Sugarcane Breeding Institute Coimbatore, Tamil Nadu, India. p. 40.

Mohanraj K., Meena, M.R., Suganya, A., Sobhakumari, V.P., Mahadevaswamy, H.K. and Hemaprabha, G. 2023. Development of climate resilient sugarcane: Utilization of wild relative *Erianthus procerus* in the 6th International biology Conference 2023 held during 20-22 September at The International Centre for Interdisciplinary Science and Education (ICISE), Quy Nhon, Vietnam. P. 16.

Murali, P. 2023. Sugarcane based agripreneurship at Agri udaan 6.0 at TNAU, Coimbatore on 11 July 2023.

Murali, P., Niranjan, S., Hari, K. and Suresha, G.S. 2023. Marching towards E20 from E10: Pitfalls and prospects. In: Proceedings of the National Seminar on Research Imperatives for Sustaining Sugarcane, Sugar and Ethanol Production (SugarSem-2023), held on 25th August 2023, ICAR-Sugarcane Breeding Institute Coimbatore, Tamil Nadu, India. p. 145.

Naveen Prasanth, Malathi, P., Ramesh Sundar, A. and Viswanathan, R. 2022. Dynamics and varying pathogenicity of red rot pathogen *Colletotrichum falcatum* during its interaction with sugarcane. In: Proceedings of XXXIst ISSCT Congress organized by The Sugar Technologists Association of India during 20-23 February 2023 at International Convention Centre (HICC), Hyderabad, India. pp. 61-62.

Nisha, M., Winnie Maria, Chandran, K., Gopi, R. and Mahendran, B. 2023. "Standardization of the method of ice cream preparation from sugarcane juice Syrup. In: Proceedings of the National Seminar on Research Imperatives for Sustaining Sugarcane, Sugar and Ethanol Production (SugarSem-2023), held on 25th August 2023, ICAR-Sugarcane Breeding Institute Coimbatore, Tamil Nadu, India. p. 149.

Nithya, K., Jayakumar, V. and Anna Durai, A. 2023. Management of sugarcane true seed borne diseases In: Proceedings of National Seminar on "Research Imperatives for Sustaining Sugarcane, Sugar and Ethanol Production" (SugarSem 2023) p. 103.

Nithya, K., Vishnuvardhan, J., Kaverinathan, K., Nithyanantham, R., and Viswanathan, R. 2023. Loop mediated isothermal amplification assay for the detection of sugarcane grassy shoot phytoplasma In: Proceedings of National Symposium on Plant Health Management: Current Trends and Novel Mitigation Strategies p. 100.

Nithya, K., Vishnuvardhan, J., Kaverinathan, K., Nithyanantham, R., and Viswanathan, R. 2023. New viruses infecting sugarcane and new host spectrum of sugarcane viruses in

India In: Proceedings of VIROCON- 2023, Advancements in Global Virus Research Towards One Health p. 83.

Nithya, K., Vishnuvardhan, J., Kaverinathan, K., Nithyanantham, R., and Viswanathan, R. 2023. Research advancements in sugarcane grassy shoot disease diagnosis and management in India. In: Proceedings of the National Seminar on Research Imperatives for Sustaining Sugarcane, Sugar and Ethanol Production (SugarSem-2023), held on 25th August 2023, ICAR-Sugarcane Breeding Institute Coimbatore, Tamil Nadu, India. p. 47.

Pooja, D., Ravinder Kumar, Meena, M.R. 2023. Screening of sugarcane germplasm for salt tolerance using growth, physiological and ionic traits. In: International Conference on Climate Resilient Agriculture for Food Security and Sustainability, CCS HAU, held from 17th – 19th, February 2023. P. 37.

Prathima, P.T. and Robert Henry. 2023. Understanding the sub-genomic contribution of progenitor species in the modern sugarcane hybrids through long read sequencing. In: International Conference on Biochemical and Biotechnological Approaches for Crop Improvement' (IBBACI), New Delhi, held from October 30th -1st November, 2023.

Prathima, P.T., Lakshmi, K.., Manimekalai, R., Devakumar K. .and Selvi, A. 2023. Sugar transporters contributing to sugar content in sugarcane hybrid Co 11015 and its progenitor 4. species.In: Proceedings of the National Seminar on Research Imperatives for Sustaining Sugarcane, Sugar and Ethanol Production (SugarSem-2023), held on 25th August 2023, ICAR-Sugarcane Breeding Institute Coimbatore, Tamil Nadu, India. P. 162.

Punithavalli, M., Govindaraj, P., Salin, K.P and Yuvashri, S. 2023. Delineating the mechanism of resistance operating in the energy canes against sugarcane tissue borers. International Conference on Plant Health Management (ICPHM 2023) – Innovation and Sustainability, held on 15 to 18 November, 2023, organized by Plant Protection Association of India, Hyderabad, India. p. 100.

Punithavalli, M., Jebamalaimary, A. and Salin, K.P. 2023. Profiling of antibiosis factors in *Erianthus arundinaceus* and their defensive role against sugarcane shoot borer, *Chilo infuscatellus* (Crambidae: Lepidoptera). International Conference on Plant Health Management (ICPHM 2023) – Innovation and Sustainability, held from 15-18 November, 2023, organized by Plant Protection Association of India, Hyderabad, India. p. 115.

Punithavalli, M., Nirmala Devi, P. and Yuvan Sankar Padian, M. 2023. Response of elite sugarcane varieties for resistance to tissue borer pests. National Seminar on Research Imperatives for Sustaining Sugarcane, Sugar and Ethanol Production, held on 25th August, 2023 at Sugarcane Breeding Institute, Coimbatore, Tamil Nadu, India. p. 254.

Puthira Prathap, D. 2023. Cross-district comparison of Internet Usage among young sugarcane farmers of Tamil Nadu'. In: Proceedings of the National Seminar on Research Imperatives for Sustaining Sugarcane, Sugar and Ethanol Production (SugarSem-2023), held on 25th August 2023, ICAR-Sugarcane Breeding Institute Coimbatore, Tamil Nadu, India. p. 74.

Puthira Prathap, D. 2023. Professional ethics and principled leadership. In: Training Programme on *'Leadership Skills and Management Techniques'* organized by MANAGE, Hyderabad and TNAU, Coimbatore during 21-25 August 2023.

Puthira Prathap, D. 2023. Systematic Literature Search for Extension Research. In: the online training programme on "Faculty Development Program" for the benefit of the Faculty, Extension Professionals, Scholars and other relevant stakeholders organised by the MANAGE and TNAU during 13-16 June, 2023.

Raja, R., Kanjana, D., Arumuganathan, T., Prakash, A.H. and Prasad, Y.G. 2023. Unmanned aerial vehicle based chemical topping agent application for canopy management in cotton. In: Proceedings on Ninth Asian Cotton Research and Development Network (ACRDN) Meeting & International Conference organized by Indian Society for Cotton Improvement (ISCI) in collaboration with International Cotton Advisory Committee (ICAC), Washington DC, ICAR-Central Institute for Research on Cotton Technology (CIRCOT), Mumbai, ICAR-Central Institute for Cotton Research (CICR), Nagpur and Indian Fibre Society, Mumbai, held at ICAR-CIRCOT, Mumbai, Maharashtra during 06-08 December, 2023.

Raja, R., Kanjana, D., Prakash, A.H. Arumuganathan, T. and Prasad, Y.G. 2023. Role of unmanned aerial vehicles in cotton precision farming. In: Proceedings of the Workshop on Future Prospects of Cotton Farming in Tamil Nadu, organised by Cotton Research Station (CRS), Tamil Nadu Agricultural University, Veppanthattai held at CRS, Veppanthattai held on 30th January 2023. pp. 30-34.

Rajula Shanthy, T. 2023. Technology and variety adoption in sugarcane industry in India In: Proceedings of International Symposium on modernisation and innovation of sugarcane breeding organized by Sugarcane Research Institute, Guangxi Academy of Agricultural Sciences at Nanning, China during 4-8 December 2023.

Rajula Shanthy, T. 2023. The Achievements and activities of Sugarcane Breeding Institute during the DST sponsored training on Research for societal good through social responsibility' conducted at Amrita Vishwa Vidyapeetham during 20-24 November 2023.

Rajula Shanthy, T. and Gurumurthy, D. 2023. Sugarcane trash conservation practices to increase cane yield: A socioeconomic analysis. In the National Seminar on Research imperatives for sustaining sugarcane, sugar and ethanol production at ICAR-SBI on 25 August 2023.

Rajula Shanthy, T., Jayabose, C. and Malakappa B. Medegar 2023. Impact of need based technological interventions in tribal villages. In: the first International Extension Education Congress on 'Rural transformation and sustainable agri-food system through community based organization oriented extension strategy held at Jaipur during 18-20 December 2023.

Sankaranarayanan, C. 2023. Management of white grubs through entomopathogenic nematodes (EPN). Attended and presented in 24th Group Meeting of All India Network Project on white grubs and other Soil arthropod pests at Rajasthan Agricultural Research Institute, Durgapura, Jaipur, Rajasthan from 13-14 July 2023.

Sankaranarayanan, C., Pandey, S.K., Singaravelu, B., Geetha, P and Rajeskumar, M. 2023. Field application of entomopathogenic nematodes (EPN) through drip irrigation system and its efficacy against white grub, *Holotrichia serrata* and *Galleria mellonella* larvae. In: Proceedings of the National Seminar on Research Imperatives for Sustaining Sugarcane, Sugar and Ethanol Production (SugarSem-2023), held on 25th August 2023, ICAR-Sugarcane Breeding Institute Coimbatore, Tamil Nadu, India. p. 110.

Selvakumar, R., Gopalareddy, K., Lakshmi Pathy T., and Viswanathan R. 2022. Sugarcane clones and their field reactions to *Puccinia* rusts in Peninsular region of India. P 98-99. In: Proceedings of the National Seminar on Research Imperatives for Sustaining Sugarcane, Sugar and Ethanol Production (SugarSem-2023), held on 25th August 2023, ICAR-Sugarcane Breeding Institute Coimbatore, Tamil Nadu, India. p. 162.

Selvi, A., Manimekalai, R., Lakshmi, K., Prathima, P.T., Devakumar, K., Rabisha, V., M. Ramvannish, M and Preethika, M. 2023. Sugarcane Dehydrins – Expression profiling, cloning and deducing their

regulatory role in drought stress tolerance in sugarcane cultivars. In: National seminar on Research Imperatives for Sustaining sugarcane,Sugar and Ethanol production held on 25th August 2023 at ICAR-SBI, Coimbatore. P. 163.

Sheelamary, S., Karthigeyan, S., Sobhakumari, V.P., Dhanapal, M. Karthick, M. and Vinith. 2023. Evaluation of New *Saccharum* hybrids developed through different cytotypes of *S.spontaneum.* In: National seminar on Research Imperatives for Sustaining sugarcane,Sugar and Ethanol production held on 25th August 2023 at ICAR-SBI, Coimbatore. P. 24.

Shwetha, MA., Gopika Arun, N., Suresha, G.S., Hari, K., Murali, P., Elayaraja, K., Malini, P. and Kalaiselvi, K. 2023 Development of process for sugarcane fibre fortified cookies. In: Proceedings of the National Seminar on Research Imperatives for Sustaining Sugarcane, Sugar and Ethanol Production (SugarSem-2023), held on 25th August 2023, ICAR-Sugarcane Breeding Institute Coimbatore, Tamil Nadu, India. p. 159.

Singaravelu, B., Suresha, G.S., Om Prakash, M., Athira, K.M., Appunu, C., Mahesh, P., Sankaranarayanan, C., Shu, C. and Zhang, J. 2023. Cloning and functional validation of the crystal toxin genes of *Bacillus thuringiensis* isolate toxic to sugarcane internode borer *Chilo sacchariphagus indicus* (Kapur) (Lepidoptera: Crambidae). In: Proceedings of the National Seminar on Research Imperatives for Sustaining Sugarcane, Sugar and Ethanol Production (SugarSem-2023), held on 25th August 2023, ICAR-Sugarcane Breeding Institute Coimbatore, Tamil Nadu, India. p. 97.

Siva, M., Sendhilvel, V., Thangeswari, S., Malathi, P., Karthikeyan, D., Sassikumar, N. and Saravanan, A. 2023. Scenario of sugarcane Pokkah boeng disease in Tamil Nadu. In: Proceedings of the National Seminar on Research Imperatives for Sustaining Sugarcane, Sugar and Ethanol Production (SugarSem-2023), held on 25th August 2023, ICAR-Sugarcane Breeding Institute Coimbatore, Tamil Nadu, India. p. 101.

Sobhakumari, V.P. 2023. Molecular cytogenetic analysis to unravel the genome architecture of modern sugarcane cultivars. In: Book of Abstracts, XVI Agricultural Science Congress and ASC Expo, Transformation of Agri-food systems for achieving sustainable development goals. National Academy of Agricultural Sciences, New Delhi and ICAR-CMFRI, Kochi, 10-13 Oct., 2023. p. 216.

Sobhakumari, V.P. and Mohanraj, K. 2023. Accelerating the development of climate resilient sugarcane varieties by incorporating molecular cytogenetic techniques. SISSTA Proceedings – 2023-52nd Annual Convention 29-30t September 2023 held at Feathers-A Radha Hotel, Chennai, Tamil Nadu. pp. 63-72

Sobhakumari, V.P. and Mohanraj, K. 2023. Characterization of back cross progenies of *Erianthus procerus* x *Saccharum officinarum* using *Erianthus* specific repetitive sequences and genomic *in situ* hybridization. In: Proceedings of the National Seminar on Research Imperatives for Sustaining Sugarcane, Sugar and Ethanol Production (SugarSem-2023), held on 25th August 2023, ICAR-Sugarcane Breeding Institute Coimbatore, Tamil Nadu, India. p. 17.

Sreenithya, C., Arathy K., Hari, K., Suresha, G, S., Murali, P., Malini, P and Kalaiselvi, K. 2023 Development of process for preparation of sugarcane juice based candy. In: Proceedings of the National Seminar on Research Imperatives for Sustaining Sugarcane, Sugar and Ethanol Production (SugarSem-2023), held on 25th August 2023, ICAR-Sugarcane Breeding Institute Coimbatore, Tamil Nadu, India. p. 157.

Suganya A., Govindaraj, P., Karuppaiyan, R. and Murali, P. 2023. Wide hybrids of sugarcane as a sustainable source for renewable energy and land restoration: perspectives and prospects. Proc. ICFLS.2023.

Suganya, A. 2023. Flowering in the *in vitro* reinvigorated clones of *Saccharum officinarum L.* In: National seminar on Research

Imperatives for Sustaining sugarcane, Sugar and Ethanol production held on 25 August 2023 at ICAR-SBI, Coimbatore. p. 30.

Suganya, A. 2023. *In vitro* regeneration of caryopsis of sugarcane crosses (in Tamil). In: Proceedings of the 8th national conference on Agricultural Scientific Tamil Society. MuthamilSelvan *et al*. (Eds).

Suganya, A. 2023.Cytological and Molecular analysis of anther derived plants of *S. spontaneum* (In tamil). In: Proceedings of the 8th national conference on Agricultural Scientific Tamil Society. MuthamilSelvan *et al*. (Eds).

Suganya, A. and A. Selvi, V. Rabisha, M. Ramvannish. 2023. Molecular affinity in typical and atypical clones of *Saccharum officinarum* L. *In:* National seminar on Research Imperatives for Sustaining sugarcane, Sugar and Ethanol production held on 25th August 2023 at ICAR-SBI, Coimbatore P 33

Suganya, A. and A. Selvi. 2022. Molecular analysis of *Saccharum spontaneum* L. derived progenies with different chromosome transmission pattern (n+n, n+2n and 2n+n) using SSR markers. Sugarcon 2022.

Suganya, A. and Selvi, A. 2023. AS 04- 2097 (ICO 635053: INGR -20070): A genetic stock for drought tolerance (In tamil). In: Proceedings of the 8th national conference on Agricultural Scientific Tamil Society. MuthamilSelvan *et al*. (Eds).

Suganya, A. and Selvi, A. 2023. Flowering in the reinvigorated plants of *S. officinarum* and utilization. (In tamil). In: Proceedings of the 8th national conference on Agricultural Scientific Tamil Society. MuthamilSelvan *et al*. (Eds).

Suganya, A. and Selvi, A. 2023. Hybridity of interspecific hybrids with 2n+n transmission with molecular markers (In tamil). In: Proceedings of the 8th national conference on Agricultural Scientific Tamil Society. MuthamilSelvan *et al*. (Eds).

Suganya, A. and Selvi, A. 2023. Molecular analysis of hybrids derived with different cytotypes of *S. spontaneum*(in Tamil). In: Proceedings of the 8th national conference on Agricultural Scientific Tamil Society. MuthamilSelvan *et al*. (Eds).

Suganya, A. Internode micromorphology of '*Saccharum* complex' members. In: National seminar on Research Imperatives for Sustaining sugarcane,Sugar and Ethanol production held on 25th August 2023 at ICAR-SBI, Coimbatore P. 31.

Suganya, A., Govindaraj, P. and Selvi, A. 2023. Cluster analysis of typical and atypical clones of *S. officinarum* using SSR markers (In tamil). In: Proceedings of the 8th national conference on Agricultural Scientific Tamil Society. MuthamilSelvan *et al*. (Eds).

Suganya, A., Govindaraj, P., Karuppaiyan, R. and Murali. P. 2023. Energy canes of *Saccharum spontaneum* derived progenies for climate resilient village (In tamil). In: Proceedings of the 8th national conference on Agricultural Scientific Tamil Society. MuthamilSelvan *et al*. (Eds).

Suganya, A., Selvi, A. and Lakshmi, K. 2023. AS 04-1687 (INGR 20110): A superior genetic stock with multitolerance to drought, waterlogging and salinity (In tamil). In: Proceedings of the 8th national conference on Agricultural Scientific Tamil Society. MuthamilSelvan *et al*. (Eds).

Suresha, G.S., Chandran, K., Hari, K., Sreenivasa, V and Hemaprabha, G. 2023. Functional characterization of bioactive compounds from the stem extracts of red fleshed *Saccharum robustum* genotypes and their polycross progenies from Indian sugarcane germplasm. In: Proceedings of the National Seminar on Research Imperatives for Sustaining Sugarcane, Sugar and Ethanol Production (SugarSem-2023), held on 25th August 2023, ICAR-Sugarcane Breeding Institute Coimbatore, Tamil Nadu, India. pp. 146 – 147.

Valarmathi, R., Ariharasutharsan, G., Pooja, D., Negi, Vinoth, P., Malarvizhi, A., Senthilrajan, P., Appunu, C., Gomathi, R., Mohanraj, K. and Ashish K Srivastava. 2023. Gamma irradiation induced chlorophyll mutants through *in vitro* mutagenesis in sugarcane. In: Proceedings of the National Seminar on Research Imperatives for Sustaining Sugarcane, Sugar and Ethanol Production (SugarSem-2023), held on 25th August 2023, ICAR-Sugarcane Breeding Institute Coimbatore, Tamil Nadu, India. p. 52.

Vennila, A., Anusha, S., Palaniswami, C. and Malathi, P. 2023. Sugarcane settling transplanting technology for improving yield and profit maximization. In: Proceedings of 81st STAI Annual Convention and International Sugar Expo 2022 held from 06-08 September, Travancore International Convention Centre, Thiruvananthapuram, Kerala, pp: 27-35.

Vinoth, P, Ariharasutharsan, G., Malarvizhi, A., Senthilrajan, P., Appunu, C., Mohanraj, K. and Valarmathi, R. Comparative gene expression profiling of Teosinte Branched 1 (TB1) and More Axillary Branching genes (MAX) involved in negative regulation of shoot branching in sugarcane. In: Proceedings of the National Seminar on Research Imperatives for Sustaining Sugarcane, Sugar and Ethanol Production (SugarSem-2023), held on 25th August 2023, ICAR-Sugarcane Breeding Institute Coimbatore, Tamil Nadu, India. p. 51.

Vinu, V., Lakshmi Pathy, T., Mahadevaswamy, H.K., Valarmathi, R., Arun Kumar, R., Krishnapriya, V. and Sreenivasa, V. 2023. Identifying highly drought tolerant *Saccharum spontaneum* accessions from world sugarcane germplasm collection. In: Proceedings of the National Seminar on Research Imperatives for Sustaining Sugarcane, Sugar and Ethanol Production (SugarSem-2023), held on 25th August 2023, ICAR-Sugarcane Breeding Institute Coimbatore, Tamil Nadu, India. p. 20.

Vishnu Vardhan, J., Nithya, K., Kaverinathan, K. and Viswanathan, R. 2023. Expression and Ni-NTA based partial purification of SCYLV-CP under yeast expression vector for pAB production. In: Proceedings of National Symposium on Plant Health Management: Current Trends and Novel Mitigation Strategies p. 59.

Vishnu Vardhan, J., Nithya, K., Kaverinathan, K. and Viswanathan, R. 2023. Natural cross infection of sugarcane mosaic viruses in new hosts. In: Proceedings of the National Seminar on Research Imperatives for Sustaining Sugarcane, Sugar and Ethanol Production (SugarSem-2023), held on 25 August 2023, ICAR-Sugarcane Breeding Institute Coimbatore, Tamil Nadu, India. p. 117.

Vishnu Vardhan, J., Nithya, K., Kaverinathan, K. and Viswanathan, R. 2023. Identification and Characterization of Sugarcane Viruses in New Host Spectrum in India In: Proceedings of International Conference on Plant Health Management ICPHM 2023 - Innovation and Sustainability p. 307.

# 11
# Research Projects

1. Breeding superior sugarcane varieties of different maturity with improved cane yield, quality and resistance to biotic and abiotic stresses
2. Enhancement of sugarcane germplasm and development of pre-breeding material
3. Sugarcane genomics and molecular markers
4. Gene discovery and genetic transformation in sugarcane
5. Development of cropping systems and improved agronomic practices to enhance sugarcane productivity
6. Enhancing physiological efficiency of sugarcane
7. Natural resource management for enhancing productivity and sustainable sugarcane production
8. Host resistance, interactomics, pathogen variability, diagnosis and disease management in sugarcane
9. Studies on sugarcane pest and their management
10. Basic and applied studies of sugarcane phytonematodes and entomopathogenic nematodes
11. Economic and statistical studies in sugarcane and sugar production system
12. Transfer of sugarcane technologies
13. Standardization of true seed production technique through developing homozygous parental lines and apomixes
14. Value addition and product diversification in sugarcane
15. All India Coordinated Research Project (Sugarcane)
16. All India Coordinated Research Project on Biological Control
17. All India Coordinated Research Project on Seed (Crops)
18. All India Network Porject on White grubs and other soil arthropod pests

# 12

# Consultancy Services, Intellectual Property, Technology Management & Commercialization

Two ITMC meetings were conducted to take decisions on different aspects pertains to technology disclosures, patent applications and commercialization of technologies developed by ICAR-SBI. The procedures for Indian and global license terms were finalized for (1) true seed (fluff), (2) sugarcane varieties (3) freeze dried sugarcane juice and (4) Powder jaggery based fortified cookies and cakes.

- World IP day 2023 was organised on 26th April 2023 with a theme titled Women and IP – Accelerating innovation and creativity.
- Member secretary, ITMC participated in the ICAR-Industry Stakeholder Consultation meet of Agrinnovate India Ltd, New Delhi on 6th March 2023 at Bharat Ratna C. Subramaniam NASC Complex, New Delhi.
- Technologies of ICAR-SBI were displayed in G20 exhibition of Agriculture Minister's Meeting of G-20 countries on 15–17 June, 2023 at Novotel Convention Centre, Hyderabad, which was visited by large number of Indian and foreign delegates.
- Hon'ble Governor of Tamil Nadu Thiru. R. N. Ravi introduced the ICAR-SBI EPN Biopesticide Formulation to Tamil Nadu Agri entrepreneurs at Agricultural Scientific-Tamil Addressees Meet on 04th November 2023 at Raj Bhavan, Chennai.
- ICAR has certified the technology "Technology for production of novel frozen sugarcane juice products" by Suresha, G.S., Hari, K., Murali, P., Lavanya, R. and Antony Leo, ICAR-AE-SBI-Product 2023-008 dated 16-07-2023.
- Submitted two new varieties Co 14012 (Avani) & Co 16030 (Karan 16) and two extant varieties namely Co 12009 (Sankalp) & Co 15023 (Karan 15) with PPV&FRA, New Delhi.
- Trademark granted for ICAR-SBI logo No. 5317060 dated 30-10-2023. NBA Form 2 Transfer of research results to a third party with foreign participation for commercialization was pertains to energycane was perused.
- Submitted one genetic stock Co 12014 (SBI/2023/Co 12014/318) for registration with NBPGR, New Delhi. One design application submitted with The Registrar (Designs), The Patent office, Kolkata for "Parasitoid Release Station", No. 396729-001 dated 05-10-2023.
- Two new technology disclosures *viz*., (1) Technology for powder jaggery based fortified cookies and cakes by K. Chandran, R. Gopi, M. Nisha, B. Mahendran, C. Keerthi, and G. Hemaprabha were received and (2) Technology titled 'Novel Coleopteran active toxin gene(s) from Indigenous Bacillus thuringiensis isolate Bt 41 and its use thereof". These genes have toxicity to Coconut Rhinocerous beetle, Cotton stem weevil and White grub. These technologies are being processed for commercialization.
- Licensed Soil Moisture Indicator technology to Ms Tech Source Solutions, Bengaluru, Karnataka for Rs. 0.75 lakhs. This technology has also realized revenue as royalty of Rs. 6,13,080/-.
- SBIEC14006-An Energycane with High biomass production was licensed to two

firms M/s Sai Wardha Power Generation Private Limited, Hyderabad, Telangana and M/s VS Lignite Power Private Limited, Hyderabad, Telangana which has realized Rs. 6,00,000/-.

- Licensed liquid jaggery technology to Ms 5KEXIM Solutions Private Limited, Coimbatore, Tamil Nadu, which has realized a revenue of Rs. 10,000/-. Production of Cane Dietary Fibre Food Products was licensed to M/s VattamAgro& Dairy Industries, Pvt Ltd, Chennai, Tamil Nadu for Rs. 25,000/-.
- Licensed ICAR-SBI EPN Biopesticide formulation to three firms *viz*., (1) Curative Microbes Pvt. Ltd. Junagadh, Gujarat (2) Symbiotics Biologicals Rajkot, Gujarat and (3) K K Agrotech Pune Maharashtra for Rs. 6,00,000/-.
- Signed MoUs for (i). Evaluation of Bannari Bio-products in sugarcane (27 months) with Bannari Amman Sugars Ltd, Sathyamangalam, Tamil Nadu on 02.01.2023. (ii). Evaluation of sugarcane clones - (4 years) with M/s Tirupati Sugars Ltd., Bagaha, West Champaran Dist, Bihar. (iii). To use the "Nam Farmers.com" a social media for communicating with farmers, Agri- stakeholders for knowledge, content dissemination and extension purposes (Up to 2028) with Tara Blooms Private Limited, Coimbatore on 10.02.2023. (iv). Identification of location specific sugarcane varieties in both tropical and sub-tropical regions of the country (5 years) with Indian Sugar Mills Association, New Delhi on 26.06.2023. (v). Collaboration for promotion of students' training / PG research / Teaching (Three years) with Tamil Nadu Agricultural University, Coimbatore on 30.06.2023.
- A total of eight MoUs signed during the period and the commercialization activity has realised Rs. 19,23,080/- through licensing and royalty and paid a GST of Rs. 3,46,154/-.

*(K. Hari, G.Hemaprabha, K. Mohanraj, B. Singaravelu, K. Rathnavel (CICR RS, Coimbatore), R.M., Shanthi, C. Palaniswami and P. Murali)*


*Introduction of ICAR-SBI EPN Biopesticide formulation by the Hon'ble Governor of Tamil Nadu*

*Licensing liquid jaggery technology to Ms 5KEXIM Solutions Private Limited*

*Licensing ICAR-SBI EPN Biopesticide formulation to Symbiotics Biologicals Rajkot, Gujarat*


*Display of ICAR-SBI technologies in G20 Exhibition, Hyderabad*

*World IP Day- 2023*

# 13
# Meetings, Workshops & Events Organized

## Republic Day celebration

Republic Day was celebrated on 26 January 2023. Dr. G. Hemaprabha, Director of the Institute hoisted the National flag and addressed the staff.

*Republic Day celebration at ICAR-SBI*

## International Year of Millets

Launch programme of the International Year of Millets 2023 was inaugurated by Smt. Sangeetha Yadhav Maurya, MP, Rajya Sabha on 09 January 2023 and sowing of seven millets (Pearl millet, Finger millet, Foxtail millet, Kodo millet, Barnyard millet, little millet, Proso millet) in the field was done by the Director and the staffs of the Institute.

*Launch programme of the International Year of Millets 2023 at ICAR-SBI*

## Tribal nutrition awareness campaign

A nutrition awareness campaign was conducted in two tribal hamlets of Anamalai Tiger Reserve, Pollachi on 2-3 February 2023 as well as follow-up visits at Paalakkinaru and Koomatti to get feedback on distribution of seeds, farm tools and other household items issued in the STC awareness campaigns conducted during 2021-22. Millet biscuits were distributed and the virtues of including millets for a balanced diet were explained to them. Tribal nutrition awareness campaign among the school children and tribal women was organized in Talamalai and Ramarani villages in Satyamangalam tiger reserve on 21st March 2023.

*Nutrition awareness campaign at Thadasalatti tribal hamlet in Sathyamangalam Tiger Reserve*

## National Science Day

National Science Day was celebrated on 28th February 2023 under the theme 'Global Science for Global Well-being'. Nearly, 1000 school and college students from Tamil Nadu and Kerala participated and acquired knowledge on application of biotechnological tools in crop improvement through demonstrations.

*National Science Day Celebrations*

## International Women's Day

International Women's Day was celebrated on 8 March 2023 and the chief guest, Mrs. Latha Sundaram, Founder & Managing Trustee of Aram Foundation Charitable Trust presided over the function.

*International Women's Day Celebration*

## Field Day and Seed Day

The Field Day and Seed Day of the Institute was organized on 15 March 2023 in the Seyur village wherein field visits and interaction among the scientists with progressive farmers from Tamil Nadu and Uttarakhand was arranged.

## World Intellectual day

World Intellectual day was celebrated on theme "Women and IP: Accelerating Innovation and Creativity" and lectures by Mrs. Rajalakshmi (Advocate) on "IPR in law" and Dr. S. Alarmelu, Principal Scientist, on "Biodiversity and innovate conservation of sugarcane genetic resources" were delivered on 26th April 2023.

## RINK Demo Day

Online programme on RINK Demo Day was organized jointly by ICAR-SBIRC, Kannur and Kerala Start-Up Mission on 26th April 2023 to showcase ten sugarcane products and interact with entrepreneurs.

## Brainstorming session

A brainstorming session on "Sugarcane scenario: Research and Industry perspective" was held on 10th May 2023. Dr. T.R. Sharma, DDG (CS), ICAR, Dr. R.K. Singh, ADG (CC) ICAR, Dr. D.K. Yadava, ADG (Seeds), ICAR, Dr. R. Viswanathan, Director, ICAR- IISR, Dr. M. Manickam, Chairman and Managing Director of Sakthi Sugars Ltd, Shri M. Silvester, Vice-President of the South Indian Sugar Mills Association–TN (SISMA-TN) & Whole time

Director of Kothari Sugars participated in the programme.

## Entrepreneurship meet

One day exposure visit and Entrepreneurship meet at ICAR-SBIRC, Kannur in collaboration with Kerala Start up Mission, on 01st June 2023.

## MoU signing ceremony

The MoU signing ceremony between ICAR-SBI and ISMA on 'Identification of location specific and climate resilient varieties with high yield and quality potential for both tropical and sub-tropical regions of the country' held at the Institute on 27th June 2023

## International Yoga Day

International Yoga Day was celebrated at the institute on 21st June 2023. Dr. K.P. Salin, PS delivered a talk on "Y Break @ Workplace".

## AGRI-UDAAN 6.0

ICAR-SBI contributed as Knowledge Partner at AGRI-UDAAN 6.0 Food and Agribusiness Accelerator Roadshow held at Tamil Nadu Agricultural University, Coimbatore on 28th July 2023.

## Independence Day Celebration

Independence Day was celebrated in the Institute on 15th August 2023. Dr. G. Hemaprabha, Director, ICAR-SBI hoisted the national flag and addressed the staff.

*Independence Day Celebration at ICAR-SBI*

## Seminar

National Seminar on "Research Imperatives for sustaining sugarcane, Sugar and Ethanol production"– *SugarSem*-2023 was organized on the eve of celebrating 25th Anniversary of SSRP jointly with SSRD on 25th August 2023 at ICAR-Sugarcane Breeding Institute.

## Hindi Pakhwada

Various competitions were conducted under Hindi Pakhwada at the Institute and centres during 14-29 September 2023 and Hindi Day was celebrated on 26th September 2023.

## Vigilance Awareness Week

Vigilance Awareness Week was observed from 30th October – 5th November at the Institute. As a part of observance of Vigilance Awareness week, activities such as pledge on vigilance awareness (30th October 2023), essay competition on the theme of "Say no to corruption - Commit to the Nation" was conducted.

## National Unity Day

In connection to the celebration of birth anniversary of Sardar Vallabhbhai Patel as 'Rashtriya Ekta Diwas' (National Unity Day), a

Pledge taking ceremony was held on 31th October 2023 and an event of 'Walk for Unity' was organized for all staff of the Institute.

## Training

A one day training programme on "Seed health improvement: A success key for healthy crop, better recovery and profitable sugarcane farming" was organized on 08th August 2023. Nearly 120 participants including farmers and sugar mill officials of selected sugar mills of Bihar, Haryana, Punjab, Uttarakhand and Uttar Pradesh attended the program.

## World Soil Day

World soil Day 2023 was observed on 5th December 2023 at Annur Block, Coimbatore. A total of 100 participants attended the function. The demonstration on collection of representative soil samples for sugarcane nutrient management was also explained and 30 Soil Health card were distributed. On the eve of World Soil Day, 12th Dr. B. Ramamoorthy Memorial Lecture was delivered by Dr. C. Palaniswami, Principal scientist on 05th December 2023 at Tamil Nadu Agricultural University, organised by ISSS, Coimbatore chapter.

*World Soil Day celebration*

## Swachh Bharat Abhiyan

All staff of the Institute participated in the Pledge taking ceremony on 14th December 2023 in connection to 'SwachhtaPakhwada Campaign'

## Activities under *'Azadi Ka Amrit Mahotsav'*

As a part of Azadi Ka Amrit Mahotsav (AKAM) the following activities were organized at ICAR-SBI during 2023.

| Lecture Title / Conference/ Other activities | Delivered / Organised by | Date | Mode |
|---|---|---|---|
| A lecture on "Varietal requirements to meet sugar and energy demands for Atmanirbhar Bharat" | Dr. Bakshi Ram, the Padma Shri Awardee 2023 and Former Director | 10 May 2023 | Physical |
| A lecture on "Reviving Water Bodies" under the theme "Water", | Thiru. R. Manikandan (Co-ordinator of *Kovai Kulangal Padhukaapu Amaippu*) | 26 May 2023 | Physical |
| Tree plantation campaign under the theme of 'Life' on the eve of World Environment Day and planted 75 saplings of Indian Gooseberry | ICAR-SBI, Coimbatore | 05 June 2023 | Physical |
| "Run for Unity" under Azadi ka Amrit Mahotsav | ICAR-SBIRC, Kannur | 13 June 2023 | Physical |
| A talk on 'Getting organic certification for wild harvest' for tribal women belonging to Agali in Attappady hills and Demonstration on Panjakavya preparation and its application procedure | Smt.D.V.IrenePriyadarshini, Asst. Director of Agriculture – Seed Certification (Seed Analyst) | 19 July 2023 | Physical |

| | | | |
|---|---|---|---|
| An Inter- school Quiz competition was organized for students from eight schools in Kannur District | ICAR-SBIRC, Kannur | 7 August 2023 | Physical |
| Drawing competition was organized for the children of ICAR-SBI's staff on the theme "Cultural Pride" | ICAR-SBI, Coimbatore | 10 August 2023 | Physical |
| Essay competition in Tamil was organized for the students of Shah Fulchand Virchand Govt. Higher Secondary School, Seeranaickenpalayam, on the theme 'Culture Pride' | ICAR-SBI, Coimbatore | 11 August 2023 | Physical |

*Essay Competition at ICAR-SBI*


*Lecture on "Reviving Water Bodies"*


*Tree planting campaign of World Environment Day*


*Lecture and demonstration of technologies in Agali*


*Brainstorming session on "Sugarcane scenario: Research and Industry perspective; 10 May 2023"*

# 14
# Committees

## Institute Research Committee Meeting

Institute Research Committee meeting for the year 2023 was held during 19-23 June 2023 to review the progress of ongoing research projects and finalize the technical program for 2024.

## Institute Management Committee Meeting

100th Institute Management Committee Meeting of ICAR-Sugarcane Breeding Institute was held on 28 June 2023.

*Institute Management Committee Meeting in progress; 28 June 2023*

## Research Advisory Committee

The XXIXth Meeting of Research Advisory Committee of ICAR-Sugarcane Breeding Institute, Coimbatore for the year 2022-2023 was held on 18th and 19th December, 2023.

Dr. S.K. Sharma, Ex. Vice Chancellor, HPKV served as the Chairperson. The following members of the committee participated in the meeting both online/offline: Dr. J. Singh, Ex Director, UP Council of Sugarcane Research, Dr. R. Srinivasan, Ex. Principal Scientist, NIPB, Dr. A.R. Sharma, Director Research, RLBCAU, Prof. B.L. Jalali, Ex-Dir. Research, CCSHAU ,Dr. S.S. Singh, Director Extension, RBLCAU, Dr. Narendra Mohan, Director National Sugar Institute, Dr. S.K. Yadava, ADG Seeds and Commercial Crops, ICAR, Dr. G. Hemaprabha, Director, ICAR-SBI, Dr. A. Ramesh Sundar, Member Secretary & Principal Scientist (Plant Pathology), Heads of Divisions, Sections and Research Centres of ICAR-SBI.

### Recommendations of RAC

#### Crop Improvement

1. Drought being one of the top most priority traits in important States like Maharashtra, targeted breeding for imparting drought tolerance is to be accelerated through pre-breeding and development of varieties/ genetic stocks with drought tolerance, besides other important traits like sucrose, red rot, top borer *etc.*,

2. Strengthening cryo-preservation facilities for the cost-effective long-term conservation of the valuable germplasm.

3. Co-0238, the wonder variety that transformed sugarcane agriculture and brought sugar revolution in the country needs a suitable replacement variety to address to the problems of red rot and top borer in the sub-tropics and is a priority research area.

4. ICAR-SBI being the custodian of world collection of sugarcane germplasm should intensify efforts to identify prioritized trait specific germplasm and its utilization.

5. Use of new tools of biotechnology to be integrated in the breeding programmes and prioritization of research on genome editing technology for 1 or 2 genes for practical applications.

## Crop Production

1. Sugarcane -based farming system is a good approach to increase the overall farm productivity. The complementarity between different enterprises and overall economics should be worked out in a scientific manner for a targeted farm size say for one hectare or acre.

2. Complete farm mechanization (planting to harvesting) is the immediate need of the present times to reduce the dependency on manual labour and increasing the profitability. Inter-Institutional collaboration with ICAR-CIAE, ICAR-IISR *etc.* and with technologically premier Institutes like IITs is to be initiated.

3. Low productivity of ratoon in sugarcane as compared to the plant crop is a major concern to reduce the cost of cultivation. Efforts are needed to minimize this gap by identifying a suitable variety as well as management practices.

4. Drone and Artificial Intelligence-based technologies are to be developed / standardized for phenotyping, weed management, application of micronutrients, pesticides/fungicides *etc.*

5. More concerted efforts on interdisciplinary research to combine drought resilience with improved water use efficiency for increased sugarcane production considering predicted climate change.

## Crop Protection

Focused programme on red rot is a priority and work to continue with synergy between Breeders, Pathologists and Biotechnologists - techniques of precision – convergency of new tools of selection

1. A disease management advisory on Pokkah Boeng in sugarcane is to be issued.

2. Studies on pest disease dynamics comprising survey. surveillance, epidemiology *etc.,* in sugarcane to continue for the emerging pest and the pathogens from a climate change perspective, and to strengthen domestic and international quarantine.

## Social Sciences

1. Short films on progressive farmers and the technologies developed are to be displayed in the Institute website.

2. Technology demonstration by core scientists with the help of Social Scientists using FPOs platforms.

3. Merging of Agricultural Extension and Agricultural Economics as Social Sciences Section.

*RAC meeting in progress; 18 December 2023*

# 15
# Participation in Conferences, Meetings, Workshops, Symposia & Seminars

| S.No | Title | Date | Participant(s) |
|---|---|---|---|
| 1. | Online lecture by Dr. N. Kalaiselvi, Secretary DSIR & DG, CSIR | 12 January 2023 | All Scientific and Technical staff |
| 2. | Zonal Breeders and Plant Protection Scientists Meet of AICRP 2023 at IISR, Lucknow-Physical & virtual mode | 20 January 2023 | The Director and all Plant breeders and Plant pathologists of the Institute |
| 3. | 13th NABS National Conference on Current Perspectives for Sustainable Development in Life Science, Environment and Agriculture, held at Periyar University, Salem, Tamilnadu | 23-25 January 2023 | Dr. R. Gomathi<br>Dr. C. Appunu<br>Dr. P. Mahesh |
| 4. | Meeting on developing suitable insurance products and adaptation and mitigation measures for sugarcane under climate change scenario held at TNAU with officials of Agricultural Insurance Company of India | 04 February 2023 | Dr. R. Arun Kumar<br>Dr. P. Murali |
| 5. | International conference "Agri Technova 23" held at American College, Madurai | 17-18 February 2023 | Dr. P. Murali |
| 6. | International conference on Climate Resilient Agriculture for Food Security and Sustainability at CCS Haryana Agricultural University, Hisar | 17-19 February 2023 | Dr. Pooja |
| 7. | XXXI IISCT Congress held at Hyderabad | 20-23 February 2023 | Dr. G. Hemaprabha<br>Dr. P. Malathi,<br>Dr. S. Alarmelu |
| 8. | Online meeting on Current status and future plans of Agrinnovate India Ltd" by CEO of Agrinnovate India | 20 February 2023 | Dr. K. Hari |
| 9. | Webinar on Making India a Global Hub for "Shree Anna" chaired by Hon'ble Union Minister of State for Agriculture and Farmers' welfare, Shri. Kailash Chaudary | 24 February 2023 | The Director and all staff of the Institute |
| 10. | Annual conference of VCs & Directors of ICAR Institutes held at Pusa, New Delhi | 04-05 March 2023 | Dr. G. Hemaprabha |
| 11. | ICAR-Industry Stakeholders Consultation Meet organized by Agrinnovate India Ltd at NASC Complex, New Delhi | 06 March 2023 | Dr. G. Hemaprabha<br>Dr. K. Hari |

| | | | |
|---|---|---|---|
| 12. | Online meeting with CEO and other officials of Agrinnovate and ADG IPTM nominee | 07 March 2023 | Dr. G. Hemaprabha<br>Dr. K. Hari |
| 13. | Farmers- Scientists Interaction Meeting held during Farmers' Day at Annamalai University | 24 March 2023 | Dr. G. Hemaprabha<br>Dr. A. Ramesh Sundar |
| 14. | FOCARS112 - online meeting by ICAR-NAARM, Hyderabad | 11 April 2023 | Dr. G. Hemaprabha |
| 15. | Ring Demo Day on Technology Showcase of ICAR-SBI which was organized by Kerala STARTUP mission | 26 April 2023 | Dr. P. Murali |
| 16. | 90th Meeting of the Central Sub-Committee on Crop Standards, Notification and Release of Varieties for Agricultural Crops held under the Chairmanship of Deputy Director General (C.S), ICAR through video conferencing | 02 May 2023 | Dr. G. Hemaprabha |
| 17. | Meeting on "Aligning the Activities of Various Disciplines under Different Subject Matter Divisions" and "Certifying Products / Technologies / Process / Methodology/ Model/ Protocol/Policy *etc*." chaired by Secretary (DARE) & DG (ICAR)- virtual mode | 03 May 2023 | The Director and all the scientists of the Institute |
| 18. | "Annual Breeder Seed Review meeting and 38th AGM of AICRP on Seed (Crops)" held at Tamil Nadu Agricultural University, Coimbatore | 09–10 May 2023 | Dr. A. Anna Durai<br>Dr. K. Mohanraj |
| 19. | Interaction meeting through online mode with all In-charges of AICRP(S) centers held at ICAR-IISR, Lucknow | 15 May 2023 | Dr. G. Hemaprabha |
| 20. | Interaction Meeting of ISMA with the Hon'ble Director General, ICAR | 16 May 2023 | Dr. G. Hemaprabha |
| 21. | Meeting of the Conveners of the Regional Chapters of NAAS | 03 June 2023 | Dr. G. Hemaprabha |
| 22. | National Training Conclave-2023 held at Convention Centre, ITPO, Pragati Maidan, New Delhi | 11 June 2023 | Dr. P. Malathi |
| 23. | Participation in G20 Exhibition held at Hyderabad during G20-Agricultural Ministerial Meeting to represent ICAR-Sugarcane Breeding Institute | 15-17 June 2023 | Dr. G. Hemaprabha<br>Dr. K. Hari<br>Dr. C. Appunu<br>Dr. Ravinder Kumar |
| 24. | Quarterly Rajbhasha (Hindi) meeting at the centre | 28 June 2023 | Scientists and Technical officials of ICAR-SBIRC, Karnal |
| 25. | Online meeting of State Level Sanctioning Committee (SLSC) of RKVY Cafeteria Scheme & Krishonatti Yojana (KY) | 05 July 2023 | Dr. M.L. Chhabra<br>Dr. M.R. Meena |

| | | | |
|---|---|---|---|
| 26. | 24th Group Meeting on All India Network Project on white grubs and other Soil arthropod pests at Rajasthan | 13-14 July 2023 | Dr. C. Sankaranarayanan<br>Dr. B. Singaravelu |
| 27. | 95th Foundation cum Technology Day of ICAR at NAAS Complex New Delhi. | 16-18 July 2023 | Dr. G. Hemaprabha |
| 28. | Online Meeting on "ICAR-CSR Guidelines" chaired by Secretary, DARE | 01 August 2023 | Dr. G. Hemaprabha |
| 29. | International HIROS Partners' Workshop and Farmers session at ICAR-CSSRI, Karnal | 9-11 August 2023 | Dr. M.L. Chhabra<br>Dr. Ravinder Kumar |
| 30. | National Seminar on "Research Imperatives for Sustaining Sugarcane, Sugar and Ethanol Production, at ICAR-Sugarcane Breeding Institute, Coimbatore, Tamil Nadu, India | 25 August, 2023 | All the Scientists |
| 31. | National Symposium on Plant Health Management: Current Trends and Novel Mitigation Strategies, organized by ICAR-Central Tuber Crops Research Institute, Thiruvananthapuram and Indian Phyto pathological Society (Southern Zone) Thiruvananthapuram | 11 September 2023 | Dr. A. Ramesh Sundar<br>Dr. P. Malathi<br>Dr. K. Nithya<br>Dr. R. Gopi<br>Shri. K. Kaverinathan<br>Shri. J. Vishnu Vardhan |
| 32. | 7th Memorial Lecture of Sri Goli Narasimha Rao at RARS Anakapalle on "Sugarcane cultivation for product diversification and changing climate" | 16 September 2023 | Dr. G. Hemaprabha |
| 33. | Meeting of Board of Directors of Punjab State Federation of Co-operative Sugar Mills Ltd. at Mohali (Punjab) | 16 September 2023 | Dr. M.L. Chhabra |
| 34. | 2nd International Conference on Prospects and Challenges of Environment and Biological Sciences in Food production system for livelihood security of Farmers (ICFPLS 2023) organized by ICAR-CIAR, in Port Blair, Andaman and Nicobar Islands, India | 8-20 September 2023 | Dr. A. Suganya<br>Dr. T. Arumuganathan<br>Dr. P. Geetha (online mode) |
| 35. | The 6th Rencontres de Quy Nhon: International Biology Conference 2023, held at the International Centre for Interdisciplinary Science and Education (ICISE), Quy Nhon in Vietnam | 20-22 September 2023 | Dr. K. Mohanraj |
| 36. | India Sugar & Bioenergy Conference 2023 held at New Delhi | 21-22 September 2023 | Dr. G. Hemaprabha |
| 37. | Policy Dialogue Workshop on "Strengthening Capacities of the Government of Andhra Pradesh to support Farmers to adopt sustainable agri-food systems"- at Vijayawada, Andhra Pradesh through Video conferencing | 25-27 September 2023 | Dr. C. Palaniswami |

| | | | |
|---|---|---|---|
| 38. | 3rd Edition of Conference on Technologies held at Chennai organized by CTO Forum of Tamil Nadu Technology Development & Promotion Centres | 28 September 2023 | Dr. P. Malathi<br>Dr. P. Murali |
| 39. | 52nd Annual Convention of SISSTA at Chennai | 29 September 2023 | Dr. G. Hemaprabha<br>Dr. A. Anna Durai<br>Dr. V.P. Sobhakumari<br>Dr. P. Malathi |
| 40. | 5th International conference on Global insights in research and development in Agriculture, Horticulture and Allied sciences through online. | 05 October 2023 | Dr. P. Geetha |
| 41. | International Conference on "Nature for Sustainable Development" organized by Bangladesh Academy of Sciences, held at the National Science & Technology Complex, Agargaon, Dhaka – 1207, Bangladesh | 07-08 October 2023 | Dr. R. Manimekalai |
| 42. | XVI Agricultural Science Congress and ASC Expo organized by the National Academy of Agricultural Sciences (NAAS), New Delhi hosted by ICAR-CMFRI, Kochi | 10-13 October 2023 | Dr. G. Hemaprabha<br>Dr. K. Chandran<br>Dr. V.P. Sobhakumari<br>Dr. P. Murali<br>Dr. G.S. Suresha<br>Dr. K. Lakshmi<br>Dr. M. Nisha<br>Dr. R. Gopi<br>Dr. B. Mahendran<br>Dr. V.G. Dhanya |
| 43. | AICRP – Annual Group Meet held in Rajendra Prasad Central Agricultural University, Pusa, Samastipur, Bihar | 26-27 October 2023 | Dr. G. Hemaprabha<br>Dr. A. Ramesh Sundar<br>Dr. K. Kannan<br>Dr. R. M. Shanthi<br>Dr .K. P. Salin<br>Dr. A. Anna Durai<br>Dr. P. Geetha |
| 44. | International conference on Biochemical and Biotechnological approaches for Crop Improvement (IBBACI)- 2023 organized by Society for Plant Biochemistry and Biotechnology in collaboration with ICAR-Indian Agricultural Research Institute (IARI), New Delhi, ICAR-National Institute for Plant Biotechnology (NIPB), New Delhi and CSIR- National Botanical Research Institute (NBRI), Lucknow | 30 October - 01 November 2023 | Dr. R. Manimekalai<br>Dr. P. T. Prathima<br>Smt. K.V. Lakshana,<br>Smt. P.K. Janiga<br>Smt. M. Remya |
| 45. | AGM of AICRP on Sugarcane at Dr. RPCAU, Pusa, Samastipur, Bihar | 03 November 2023 | Dr. M.L. Chhabra<br>Dr. Ravinder Kumar |
| 46. | Regional Committee Meeting- VI (online) held at ICAR- CSWRI, Avikanagar (Rajasthan) | 03 November 2023 | Dr. M. L. Chhabra |

| | | | |
|---|---|---|---|
| 47. | 53rd Sugarcane Research and Development Workshop of Tamil Nadu and Puducherry held in Theni | 03-04 November 2023 | Dr. G. Hemaprabha<br>Dr. R. M. Shanthi<br>Dr. A. RameshSundar<br>Dr. C. Palaniswami,<br>Dr. B. Singaravelu,<br>Dr. P. Malathi<br>Dr. D. Puthira Prathap<br>Dr. S. Karthigeyan<br>Dr. C. Appunu |
| 48. | Governor Programme on "Think to Dare" &'Agricultural Scientific - Tamil Meet' held in Raj Bhavan, Chennai.<br>ICAR-SBI EPN Bioformulation technology and 'Iniya' (Power Jaggery) introduced by the Hon'ble Governor to the Tamil Nadu Agripreneurs and Farmers | 04 November 2023 | Dr. C. Sankaranarayanan<br>Dr. R. Gomathi |
| 49. | 78th six monthly TOLIC meeting at ICAR- NDRI, Karnal | 07 November 2023 | Dr. M.L. Chhabra<br>Dr. Ravinder Kumar<br>Pramod Kumar |
| 50. | International Conference on Plant Health Management (ICPHM 2023) – Innovation and Sustainability, held at Hyderabad, India. | 15-18 November 2023 | Dr. M. Punithavalli<br>Dr. K. Nithya |
| 51. | DST sponsored training on Research for societal good through social responsibility' conducted at Amrita School of Business, Amrita Vishwa Vidyapeetham | 20-24 November 2023 | Dr. T. Rajula Shanthy |
| 52. | Trends in the Application of Artificial Intelligence for Sustainable Agriculture" organized by ICAR-Sugarcane Breeding Institute in collaboration with National Academy of Biological Sciences (NABS), Chennai and NAAS Chapter (Coimbatore) | 29 November 2023 | Dr. V. Jayakumar |
| 53. | 26th RCM III meeting (Virtual) held at Krishi Bhavan, New Delhi | 01 December 2023 | Dr. A. Anna Durai |
| 54. | VIROCON- 2023, Advancements in Global Virus Research Towards One Health, held at ICAR-NRC, Banana, Trichy | 01-03 December 2023 | Dr. K. Nithya |
| 55. | International symposium on "Modernisation and Innovation of Sugarcane Breeding" held at Sugarcane Research Institute (SRI) of Guangxi Academy of Agricultural Sciences, Guangxi, China | 04-08 December 2023 | Dr. G. Hemaprabha<br>Dr. T. Rajula Shanthy |
| 56. | First International Extension Education Congress on 'Rural transformation and sustainable agri-food system through community based organization oriented extension strategy held at Jaipur | 18-20 December 2023 | Dr. T. Rajula Shanthy |

| | | | |
|---|---|---|---|
| 57. | National Conference of Plant Physiology "Physiological and Molecular Approaches for Climate Smart Agriculture", organised by Indian Society for Plant Physiology, New Delhi | 09-11 December 2023 | Dr. V. Krishnapriya |
| 58. | All India National Level Seminar on "Implications of Bio Sensors and Nano Sensors in Agro Ecosystem" organized by Institution of Engineers (India), Coimbatore Local Centre and Department of Electronics and Instrumentation Engineering, Hindusthan College of Engineering and Technology (HCET), Coimbatore held at HCET, Coimbatore | 18 April 2023 | Dr. T. Arumuganathan |
| 59. | International Conference on "Sustainable Natural Resource Management under Global Climate Change" organized by Soil conservation Society of India at New Delhi. | 7-10 November 2023 | Dr. V. Kasthuri Thilagam |
| 60. | All India Seminar on "Advanced instrumentation for Assessment of Soil Health Indicators, Pollution and Greenhouse Gas Emission from Soil" organised by Institution of Engineers (India), Coimbatore Local Centre and Department of Electronics and Instrumentation Engineering, Hindusthan Institute of Technology (HIT), Coimbatore held at HIT, Coimbatore | 16 November 2023 | Dr. T. Arumuganathan |
| 61. | National Seminar on Hydrology with special reference to Hydrological Solutions for Sustainable Development Organized by Association of Hydrologists of India Jointly with PSG Institute of Advanced Studies, Coimbatore | 1-2 December 2023 | Dr. V. Kasthuri Thilagam |


*Participation of ICAR-SBI in Governor Programme on "Think to Dare" &' Agricultural Scientific Tamil- Meet' held in Raj Bhavan, Chennai*

# 16
# Distinguished Visitors

- Dr. Thomas Dumont, Dr. Mathilde Mellinand Dr. Jea Yves Horarau from eRcane, Ile dala Reunion-France visited ICAR–Sugarcane Breeding Institute, Coimbatore during 13–17, February 2023 to interact with the scientists involved in cane breeding.

*Scientists from Reunion in a Sugarcane Field in Erode district*

- Dr. T.R. Sharma DDG(CS), Dr. R.K. Singh, ADG (CC), Dr. D.K. Yadava ADG (Seed) visited the ICAR–Sugarcane Breeding Institute on 10th May 2023 and inaugurated the new administrative building and participated in a Brainstorming session on "Sugarcane Scenario: Research and Industry Perspective".

*Dr T R Sharma DDG (CS), ICAR at ICAR-SBI*

- Dr. Nandkumar Kunchge, Director, K.J. Somaiya Institute of Applied Agricultural Research, Karnataka visited the Institute during 10-11, August 2023.

- Prof. Fredy Altpeter, University of Florida, visited the Institute on 21st August 2023 and delivered a lecture on "Embracing the challenge: Editing the highly polyploid sugarcane genome"


*Prof Fredy Altpeter delivering a lecture at ICAR-SBI*

- Former MP of Rajya Sabha Mr. T.K. Rangarajan, visited the Institute on 04th September 2023

- Hon'ble Minister for Sugarcane Industries, Govt. of Bihar Shri. Alok Kumar Mehta along with a team 4 Officials visited the Institute on 15th December 2023.


*Visit by Shri. Alok Mehta, Hon'ble Minister for Sugarcane Industries, Govt. of Bihar to ICAR-SBI on 15th December 2023*

# 17
# Personnel

| Name | Designation & Discipline | E-mail ID |
|---|---|---|
| G. Hemaprabha Ph.D. | Director | G.Hemaprabha@icar.gov.in |
| **Division of Crop Improvement** | | |
| P. Govindaraj Ph.D. | Pr. Scientist (Plant Breeding) & Head | P.Govindaraj@icar.gov.in |
| A.J. Prabakaran Ph.D. | Pr. Scientist (Plant Breeding) | prabakaran.aj@icar.gov.in |
| R.M. Shanthi Ph.D. | Pr. Scientist (Plant Breeding) | RM.Shanthi@icar.gov.in |
| D. Neelamathi Ph.D. | Pr. Scientist (Seed Technology) | D.Neelamathi@icar.gov.in |
| S. Alarmelu Ph.D. | Pr. Scientist (Plant Breeding) | S.Alarmelu@icar.gov.in |
| A. Selvi Ph.D. | Pr. Scientist (Plant Biotechnology) | A.Selvi@icar.gov.in |
| V.P. Sobhakumari Ph.D. | Pr. Scientist (Gen. & Cyto.) | vp.sobhakumari@icar.gov.in |
| A. Suganya Ph.D. | Pr. Scientist (Economic Botany) | A.suganya@icar.gov.in |
| S. Karthigeyan Ph.D. | Pr. Scientist ( Plant Breeding) | karthikeyan.s@icar.gov.in |
| A. Anna Durai Ph.D. | Pr. Scientist (Plant Breeding) | A.Annadurai@icar.gov.in |
| R. Manimekalai Ph.D. | Pr. Scientist (Plant Biotechnology) | R.manimekalai@icar.gov.in |
| R. Karuppaiyan Ph.D. | Pr. Scientist (Plant Breeding) | Karuppaiyan.R@icar.gov.in |
| C. Jayabose Ph.D. | Pr. Scientist (Genetics) | C.jayabose@icar.gov.in |
| K. Devakumar Ph.D. | Sr. Scientist (Plant Biotechnology) | Devakumar.k@icar.gov.in |
| K. Mohanraj Ph.D. | Sr. Scientist (Plant Breeding) | k.mohanraj@icar.gov.in |
| C. Appunu Ph.D. | Sr. Scientist (Plant Breeding) | C.appunu@icar.gov.in |
| K. Lakshmi Ph.D. | Sr. Scientist (Plant Biotechnology) | k.lakshmi@icar.gov.in |
| P.T. Prathima Ph.D. | Sr. Scientist (Plant Biotechnology) | Prathima.Pt@icar.gov.in |
| V. Sreenivasa Ph.D. | Sr. Scientist (Plant Breeding) | V.Sreenivasa@icar.gov.in |
| K. Elayaraja Ph.D. | Sr. Scientist (Plant Breeding) | Elayaraja.K@icar.gov.in |
| R.T. Maruthi Ph.D. | Sr. Scientist (Plant Breeding) | maruthi.rt@icar.gov.in |
| Adhini S. Pazhany M.Sc | Scientist (Plant Breeding) | Adhini.Sp@icar.gov.in |
| S. Sheelamary Ph.D. | Scientist (Plant Breeding) | Sheela.Mary@icar.gov.in |
| K. Gopalareddy Ph.D. | Scientist (Plant Breeding) | gopalareddy.k@icar.gov.in |

| | | |
|---|---|---|
| R. Valarmathi Ph.D. | Scientist (Eco. Bot. and PGR) | valarmathi.r@icar.gov.in |
| H.K. Mahadeva Swamy Ph.D. | Scientist (Plant Breeding) | Mahadevaswamy.HK@icar.gov.in |
| T. Lakshmi Pathy M.Sc. | Scientist (Plant Breeding) | Lakshmipathy.T@icar.gov.in |
| R. Gobu Ph.D. | Scientist (Plant Breeding) | gobu.r@icar.gov.in |
| Shweta Kumari Ph.D. | Scientist (Bio-Informatics) | Shweta.kumari1@icar.gov.in |
| Amaresh | Senior Technical Officer | amaresh@icar.gov.in |
| L. Elango | Technical Officer | L.Elango@icar.gov.in |
| S. Mathesh | Technical Officer | S.Mathesh@icar.gov.in |
| R. Raja | Senior Technical Assistant | R.Raja@icar.gov.in |
| V. Raffee Viola | Senior Technical Assistant | Raffee.viola@icar.gov.in |
| K. Selvamuthu | Senior Technical Assistant | Selvamuthu.K@icar.gov.in |
| M. Pradheep Kumar | Senior Technical Assistant | Pradheep.Kumar@icar.gov.in |
| V.P. Rabisha | Senior Technical Assistant | VP.rabisha@icar.gov.in |
| K. Dhanapal | Senior Technical Assistant | K.Dhanapal@icar.gov.in |
| R. Narayanaswamy | Senior Technician | R.Narayanasamy@icar.gov.in |
| M. Karthick | Technical Assistant | M.Karthick@icar.gov.in |
| M. Kannaian | Senior Technician | M.Kannaian@icar.gov.in |
| S. Mutharasu | Senior Technician | Mutharasu.S@icar.gov.in |
| K. Muraleekrishnan | Technician | muralee@icar.gov.in |
| N. Murugesan | Skilled Support Staff | Murugesan.N@icar.gov.in |
| R. Thimmappan | Skilled Support Staff | Thimmappan.R@icar.gov.in |
| M. Mallika | Skilled Support Staff | Mallika.M@icar.gov.in |
| M. Subramanian | Skilled Supp ort Staff | m.subramanian@icar.gov.in |
| R. Velumani | Skilled Support Staff | r.velumani@icar.gov.in |
| S. Manickaraj | Skilled Support Staff | s.manickaraj@icar.gov.in |
| G. Suresh | Skilled Support Staff | g.suresh1@icar.gov.in |
| **Division of Crop Production** | | |
| K. Kannan Ph.D. | Pr. Scientist (Agronomy) & Head | Kannan.K@icar.gov.in |
| C. Palaniswami Ph.D. | Pr. Scientist (Soil science) | Palaniswami.C@icar.gov.in |
| K. Hari Ph.D. | Pr. Scientist (Microbiology) | K.Hari@icar.gov.in |
| R. Gomathi Ph.D. | Pr. Scientist (Plant Physiol.) | R.Gomathi@icar.gov.in |
| A. Vennila Ph.D. | Pr. Scientist (Soil Science) | Vennila.A@icar.gov.in |
| T. Arumuganathan Ph.D. | Pr. Scientist (Farm Machinery & Power) | T.Arumuganathan@icar.gov.in |

| | | |
|---|---|---|
| R. Arun Kumar Ph.D. | Sr. Scientist (Plant Physiol.) | R.Arun@icar.gov.in |
| G.S. Suresha Ph.D. | Sr. Scientist (Biochemistry) | GS.Suresha@icar.gov.in |
| V. Kasthuri Thilagam Ph.D. | Sr. Scientist (Soil Science) | Kasthuri.V@icar.gov.in |
| P. Geetha Ph.D. | Sr. Scientist (Agronomy) | Geetha.P@icar.gov.in |
| M. Alagupalamuthirsolai Ph.D. | Sr. Scientist (Plant Physiology) | Alagu.M@icar.gov.in |
| S. Anusha Ph.D. | Scientist (Agronomy) | anusha.s@icar.gov.in |
| V. Krishnapriya Ph.D. | Scientist (Plant Physiology) | k.vengavasi@icar.gov.in |
| P. Harunipriya | Senior Technical Assistant | Harunipriya.P@icar.gov.in |
| G. Aswathy | Senior Technical Assistant | G.Aswathy@icar.gov.in |
| T. Kavitha | Senior Technician | Kavitha.T@icar.gov.in |
| S. Jothimani | Senior Technician | Jothimani.S@icar.gov.in |
| I. Saravanakumar | Technician | Saravanakumar.I@icar.gov.in |
| P. Kannan | Skilled Support Staff | p.Kannan@icar.gov.in |
| Eswari | Skilled Support Staff | eswari@icar.gov.in |
| K. Saraswathi | Skilled Support Staff | k.saraswathi@icar.gov.in |
| **Division of Crop Protection** | | |
| A. Ramesh Sundar Ph.D. | Pr. Scientist (Pl. Patho.) & Head | A.Rameshsundar@icar.gov.in |
| K.P. Salin Ph.D. | Pr. Scientist (Ag. Ento.) | Kp.salin@icar.gov.in |
| N. Geetha Ph.D. | Pr. Scientist (Ag. Ento.) | Geetha.N@icar.gov.in |
| C. Sankaranarayanan Ph.D. | Pr. Scientist (Nematol.) | Sankarnarayanan.C@icar.gov.in |
| B. Singaravelu Ph.D. | Pr. Scientist (Ag. Ento.) | Singaravelu.B@icar.gov.in |
| P. Malathi Ph.D. | Pr. Scientist (Pl. Patho.) | Malathi.P@icar.gov.in |
| R. Selvakumar Ph. D. | Pr. Scientist (Pl. Patho.) | R.Selvakumar@icar.gov.in |
| V. Jayakumar Ph.D. | Pr. Scientist (Pl. Patho.) | V.Jayakumar@icar.gov.in |
| T. Ramasubramanian Ph.D. | Pr. Scientist (Ag. Ento.) | T.Ramasubramanian@icar.gov.in |
| R. Ramesh Ph.D. | Pr. Scientist (Pl. Patho.) | r.ramesh@icar.gov.in |
| R. Gopi Ph.D. | Sr. Scientist (Pl.Patho.) | R.Gopi@icar.gov.in |
| A. Jeevalatha Ph.D. | Sr. Scientist (Pl.Patho.) | A.Jeevalatha@icar.gov.in |
| M. Punithavalli Ph.D. | Sr. Scientist (Ag. Ento.) | M.Punithavalli@icar.gov.in |
| P. Mahesh Ph.D. | Sr. Scientist (Ag. Ento.) | P.Mahesh@icar.gov.in |
| K. Nithya Ph.D. | Sr. Scientist (Pl. Patho.) | Nithya.K@icar.gov.in |
| K. Kaverinathan | Senior Technical Assistant | Kaverinathan.K@icar.gov.in |

| | | |
|---|---|---|
| C. Yogambal | Senior Technical Assistant | Yogambal.C@icar.gov.in |
| M. Rajesh Kumar | Technical Assistant | M.Rajeshkumar@icar.gov.in |
| R. Nithiyanantham | Senior Technician | R.Nithiyanantham@icar.gov.in |
| A. Kala | Senior Technician | Kala.A@icar.gov.in |
| R. Monikandan | Technician | Monikandan.R@icar.gov.in |
| C. Shanmugaraj | Skilled Support Staff | Shanmugaraj.C@icar.gov.in |
| L. Tholasiammal | Skilled Support Staff | Tholasiammal.L@icar.gov.in |
| R. Easwari | Skilled Support Staff | Easwari.R@icar.gov.in |
| R. Lakshmi | Skilled Support Staff | Lakshmi.Raman@icar.gov.in |
| S. Balan | Skilled Support Staff | Balan.S@icar.gov.in |
| V.R. Nagarajan | Skilled Support Staff | vr.nagarajan@icar.gov.in |
| S. Dhanabhagyam | Skilled Support Staff | s.dhanabhagyam@icar.gov.in |
| **Statistics and Economics Section** | | |
| P. Murali Ph.D. | Sr. Scientist (Agrl. Econ) | P.Murali@icar.gov.in |
| Vinayaka Ph.D. | Scientist (Agrl. Statistics) | vinayaka@icar.gov.in |
| S. Karuppasamy | Technical Officer | S.Karuppasamy@icar.gov.in |
| M. Shobhanbabu | Skilled Support Staff | Shobhanbabu.M@icar.gov.in |
| **Extension Section** | | |
| D. Puthira Prathap Ph.D. | Pr. Scientist (Agrl. Extn.) | dp.prathap@icar.gov.in |
| T. Rajula Shanthy Ph.D. | Pr. Scientist (Agrl. Extn.) | Rajula.shanthy@icar.gov.in |
| Malakappa B. Medegar | Senior Technician | MB.Medegar@icar.gov.in |
| R. Sekar | Skilled Support Staff | Sekar.R@icar.gov.in |
| **SBIRC, Karnal** | | |
| M.L. Chhabra Ph.D. | Pr. Scientist (Pl. Patho.) & Officer i/c | ml.chhabra@icar.gov.in |
| Ravinder Kumar Ph.D. | Sr. Scientist (Plant Breeding) | ravinder.kumar6@icar.gov.in |
| Mintu Ram Meena Ph.D. | Sr. Scientist (Plant Breeding) | mr.meena@icar.gov.in |
| Pooja Ph.D. | Sr. Scientist (Plant Physiology) | pooja@icar.gov.in |
| Pramodkumar | Asst. Chief Technical Officer | Pramod.Kumar7@icar.gov.in |
| Vijay kumar | Technical Officer | Vijaya.Kumar@icar.gov.in |
| Rajesh Kumar | Senior Technical Assistant | Rajesh.Kumar11@icar.gov.in |
| Ramesh Chand | Senior Technician | Ramesh.Chand21@icar.gov.in |
| Om Parkash | Skilled Support Staff | Om.Parkash @icar.gov.in |
| Fate Singh | Skilled Support Staff | Fate.Singh @icar.gov.in |

| | | |
|---|---|---|
| Rambir | Skilled Support Staff | Ranbir@icar.gov.in |
| **SBIRC, Kannur** | | |
| M. Nisha Ph.D. | Sr. Scientist (Plant Breeding) & Officer i/c | Nisha.M@icar.gov.in |
| K. Chandran Ph.D. | Pr. Scientist (Plant Breeding) | K.Chandran@icar.gov.in |
| B. Mahendran Ph.D. | Scientist (Ag. Ento.) | mahendran.b@icar.gov.in |
| Dhanya V.G, Ph.D. | Scientist (Seed Science and Technology) | dhanya.vg@icar.gov.in |
| Nici Ashok | Technical Officer | Nici.Ashok@icar.gov.in |
| P. Seema | Skilled Support Staff | Seema.P@icar.gov.in |
| **SBIRC, Agali** | | |
| K. Praveen Kumar | Technician | K.Praveenkumar@icar.gov.in |
| **PME Cell** | | |
| R. Nirmala | Chief Technical Officer | R.Nirmala@icar.gov.in |
| S. Kandasamy | Skilled Support Staff | Kandasamy@icar.gov.in |
| **Estate** | | |
| P. Sivaraj | Technical Officer | P.Sivaraj@icar.gov.in |
| P. Amshaveni | Technical Officer (Civil) | P. Amsaveni@icar.gov.in |
| A. Shanmugavel | Skilled Support Staff | Shanmugavel.A@icar.gov.in |
| K. Rajeevan | Skilled Support Staff | Rajeevan.K@icar.gov.in |
| R. Aribabu | Skilled Support Staff | Aribabu.R@icar.gov.in |
| R. Gopalakrishnan | Skilled Support Staff | Gopalakrishnan.R@icar.gov.in |
| L. Enjerappan | Skilled Support Staff | Enjerappan.L@icar.gov.in |
| R. Jogappan | Skilled Support Staff | Jogappan.R@icar.gov.in |
| R. Selvaraj | Skilled Support Staff | r.selvaraj@icar.gov.in |
| K. Shanmugaraj | Skilled Support Staff | k.shanmugaraj@icar.gov.in |
| C. Nagarajan | Skilled Support Staff | c.nagarajan@icar.gov.in |
| A. Muthusamy | Skilled Support Staff | a.muthusamy@icar.gov.in |
| **Farm** | | |
| K. Manivannan | Technical Officer | K.Manivannan@icar.gov.in |
| M. Gnanavel | Technical Officer | M.Gnanavel@icar.gov.in |
| U. Dinesh | Technical Assistant | U.Dinesh@icar.gov.in |
| R. Rajamani | Skilled Support Staff | Rajamani.R@icar.gov.in |
| C. Sundaral | Skilled Support Staff | Sundaral.C@icar.gov.in |

| | | |
|---|---|---|
| T. Lakshmi | Skilled Support Staff | Lakshmi.T@icar.gov.in |
| M. Chandran | Skilled Support Staff | Chandran.M@icar.gov.in |
| M. Nagamani | Skilled Support Staff | Nagamani.M@icar.gov.in |
| R. Palaniammal | Skilled Support Staff | Palaniammal.R@icar.gov.in |
| N.K. Nagarajan | Skilled Support Staff | Nagarajan.NK@icar.gov.in |
| T. Rajendran | Skilled Support Staff | Rajendran.T@icar.gov.in |
| M. Selvam | Skilled Support Staff | Selvam.M@icar.gov.in |
| A. Karuppusamy | Skilled Support Staff | a.karuppusamy@icar.gov.in |
| K. Rangasamy | Skilled Support Staff | k.rangasamy@icar.gov.in |
| M. Natarajan | Skilled Support Staff | m.natarajan@icar.gov.in |
| R. Chandran | Skilled Support Staff | r.chandran1@icar.gov.in |
| **Library** | | |
| S. Manoharan | Chief Technical Officer | S.Manoharan@icar.gov.in |
| V. Indirani | Skilled Support Staff | Indirani.V@icar.gov.in |
| **DPC** | | |
| S. Maheshwari | Assistant Chief Technical Ofiicer (Hindi Translator) | S. Maheshwari @icar.gov.in |
| **Administration** | | |
| Devassy. P. V | Administrative Officer | Devassy.PV@icar.gov.in |
| S.B. Baburaj | Senior Finance & Accounts Officer | SB.Baburaj@ icar.gov.in |
| V. Ashakumari | Assistant Administrative Officer | Ashakumari.V1@icar.gov.in |
| B.V. Santhosh | Assistant Administrative Officer | BV.Santhosh@icar.gov.in |
| P. Sivakumar | Assistant Administrative Officer | Sivakumar.P@icar.gov.in |
| J. Emily Florence Daisy Rani | Assistant | Emily.Daniel@icar.gov.in |
| K. Kanageswari | Assistant | K. Kanageswari@icar.gov.in |
| Kratika Sharma | Assistant | Kratika.Sharma@icar.gov.in |
| Vasudev V.Galagali | Assistant | Vasudev.Galagali@icar.gov.in |
| K. Maruthi | Upper Division Clerk | K.Maruthi@icar.gov.in |
| M. Jainub | Upper Division Clerk | Jainub.M@icar.gov.in |
| S.T. Subramanyan | Upper Division Clerk | St.Subramanyan@icar.gov.in |
| N. Priyadharsini | Upper Division Clerk | N.Priyadharsini@icar.gov.in |
| A. Sathasivam | Lower Division Clerk | sathasivam.A@icar.gov.in |
| A. Sindhu | Lower Division Clerk | Sindhu.A@icar.gov.in |

| | | |
|---|---|---|
| S.K. Anumalaviga | Lower Division Clerk | Anumalaviga.SK@icar.gov.in |
| R. Mahalakshmi | Lower Division Clerk | Mahalakshmi.R@icar.gov.in |
| M. Balachandran | Lower Division Clerk | Balachandran.M@icar.gov.in |
| M. Lalitha Rani | Private Secretary | M.Lalitharani@icar.gov.in |
| P. Bhuvanamuzhuthudaiyal | Private Secretary | P.Bhuvana@icar.gov.in |
| P. Ajayan | Private Secretary | Ajayan.P@icar.gov.in |
| M. Manickam | Skilled Support Staff | Manickam.M@icar.gov.in |
| T. Rajan | Skilled Support Staff | t.rajan@icar.gov.in |
| S. Shanmugam | Skilled Support Staff | Shanmugam.S@icar.gov.in |
| C. Vasanthamani | Skilled Support Staff | Vasanthamani.C@icar.gov.in |
| M. Thangaraj | Skilled Support Staff | Thangaraj.M@icar.gov.in |
| P. Chinnaswamy | Skilled Support Staff | chinnasamy.p@icar.gov.in |

NOTES

Azadi Ka Amrit Mahotsav


भा. कृ. अ. प. - गन्ना प्रजनन संस्थान
कोयंबत्तूर – 641 007

**ICAR- SUGARCANE BREEDING INSTITUTE**
**Coimbatore - 641 007**