



SBI News

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Tamil Nadu, India



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MANAGEMENT OF VARIETAL DEGENERATION CAUSED BY YELLOW LEAF DISEASE IN SUGARCANE

Background

In the late 1980s, yellow leaf disease (YLD) was reported for first time in Hawaii, during 1999 in India from the Institute. That time it was referred to as yellow leaf syndrome. Currently, the disease is found in most of the sugarcane growing countries. When YLD was recorded in 1999, it was considered as a minor disease in India; however, within few years its widespread occurrence was recorded in different states. Later, the disease attained epidemic status and due to that largescale crop losses were recorded. In sugarcane, YLD symptoms are characterized

by prominent yellowing of midribs on the lower surface, spread of yellowing to leaf lamina from midrib, death of yellowish lamina and midrib starting from leaf tip downwards along the midrib and a bunchy top of the spindle due to shortening of internodes in maturing canes (Fig. 1, 2). Usually, within 6-8 months of crop growth, the disease symptoms appear in the field. However, if virus titre is more, symptom expression can be seen much before during 5th month onwards. Severely affected ratoon crops exhibit symptoms by 3rd month onwards. Further, progressive drought conditions aggravate disease expression and



Fig. 1. Characteristic yellowing of midrib and adjoining lamina in the spindle leaves of YLD affected sugarcane



Fig. 2 'Bunchy top' symptoms in the severe YLD affected canes of the popular cv Co 86032 in the field

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disease severity during early crop growth phases. Sugarcane yellow leaf virus (ScYLV) is associated with the disease. The virus specifically colonizes phloem tissues and is transmitted mainly through infected seed canes. Plant to plant transmission of the virus is done by *Melanaphis sacchari*, sugarcane aphid in the field. The disease is responsible for varietal degeneration on different varieties either alone or with other viruses, thereby yield potential of the varieties is significantly reduced. This paper addresses impact of the disease to sugarcane production, varietal degeneration and disease management for sustainable crop productivity.

Impact to sugarcane cultivation

Canes of the affected crop do not dry as in the cases of fungal diseases like red rot or wilt, rather cane growth is reduced drastically. Major growth parameters affected in the YLD-affected crop are bud germination, tillering, number of canes per clump, cane thickness, internode elongation, number of internodes, leaf growth and leaf area index. YLD-affected crops recorded a reduced flowering and reduction in inflorescence (arrows) growth. Colonization of the virus in phloem causes disruption of photosynthates movement and other physiological disorders in the affected plants. The virus infected plants record poor photosynthesis during the grand growth phase of the crop, thereby affecting cane growth during the active plant growth phase. YLD-affected plants record a significantly low photosynthetic rate in terms of $\mu\text{mol CO}_2 \text{ m}^{-2} \text{ s}^{-1}$ than the healthy plants. Similarly, upon SCYLV-infection, reductions in transpiration rate and chlorophyll content are recorded. Usually, YLD-affected plants record significant reductions in chlorophyll content in the range of 21.3 - 34.7 % in different varieties, indicating a low efficiency in photosynthesis. In general, ratoon crops show a severe impact caused by the virus which is multi-fold of plant crops' in terms of cane yield and other growth parameters.

The virus infection causes varietal degeneration depending on the varieties and in some varieties infection of other viruses like Sugarcane mosaic virus (SCMV) and Sugarcane streak mosaic virus (SCSMV) causing mosaic and ratoon stunting (RSD) bacterium *Leifsonia xyli* subsp. *xyli* show a synergistic activity by which the variety degenerates very fast than their separate infections. Recent studies on the degenerated variety CoJ 64 due to systemic infections of all these three viruses showed significant reductions in sett germination, plant growth and exhibited a poor vigour during all stages of crop growth. Symptomatic plants recorded reductions in different physiological and yield parameters such as photosynthetic rate, stomatal conductance, transpiration rate, chlorophyll fluorescence ratio, leaf chlorophyll content and juice yield by 49.3 - 49.4%, 47.48 - 54.7%, 40.03 - 42.52%, 28.48 - 31.57%, 34.31 - 38.82% and 30.13 - 36.04%, respectively. Further studies on real time PCR assays found a threshold limit for

virus titre in causing symptom development and varietal degeneration in sugarcane. This study evidenced a progressive increase in virus titre over the generations in causing deleterious effect in cane growth. Similar studies revealed that RSD bacterial infection favoured YLD severity in many sugarcane varieties and suggested that infections by ScYLV and RSD cause more rapid varietal degeneration leading to poor performance of the varieties (Fig.3). Such impact has been found in varieties like Co 419, Co 997, CoS 767, CoS 8436 and many other subtropical varieties. When the xylem limiting bacterium and phloem limiting ScYLV infect together, the vascular system is totally deranged in the affected plant and degeneration takes place rapidly.



Fig. 3 Severe degeneration due to RSD and YLD in the cv CoS 8436 shows shortening of internodes and cane girth with typical RSD symptoms on the nodes

Impact of YLD on the popular variety Co 86032

The popular variety of the tropical region, Co 86032 was released for commercial cultivation during 2000 and it is still under cultivation for more than two decades in the tropical states, currently occupying ~50% total cane area in the region. However, the variety got degenerated under field conditions due to repeated use of the same seed. The increased virus titre caused severe expression of YLD and extensive losses to crop cultivation in the field. Severe outbreak of the disease is witnessed as extensive foliage drying by 7th month onwards. By this, the farmers lose 3-4 months of cane growth hence the impact caused by the virus is huge under field conditions (Fig. 4). The author has recorded severe expression of the disease from 2002 onwards in different states and epidemic occurrences of the disease from 2005. Hence, the sugar industry was advised on the emerging issue of the disease and advocated healthy seed nursery programme to manage the disease. The industry was appraised on the seriousness of the disease due to degeneration, which is new to sugar industry since the industry faced such serious crop losses with fungal diseases like red rot, smut and wilt. In the experiments conducted at ICAR-SBI on the impact of YLD on cane growth and yield in the variety under field conditions revealed that the variety recorded a loss of 36.31 % in germination, 29.17% in



Fig. 4 Severe foliage drying and poor growth due to YLD in a degenerated crop in the field (cv Co 86032)

number of millable canes (NMC) and 81.06% in flowering due to virus infection. When the economical parameters were analysed, a significant reductions of 42.3% in stalk weight and 31.17% in juice yield were recorded (Fig. 5).



Fig. 5 Rejuvenated canes (left) with vigorous growth as compared to stunted/degenerated canes of YLD affected (right) cv Co 86032

Varietal degeneration

Major fungal diseases such as red rot and smut are managed through deploying disease resistant varieties. Due to vegetative propagation the viral pathogens along with other non-fungal pathogens causing RSD and GSD gradually increase in their load in the canes over the generations and such a high population of different pathogens leading to 'varietal degeneration'. In the past, impact of non-fungal diseases was ignored due to lack of precise diagnostic techniques and clarity in symptoms caused by different viral diseases in sugarcane. Due to this, longevity of many elite sugarcane varieties was reduced in the past. Degeneration of the popular cv Co 86032 due to YLD is reflected in the

severe epidemic occurrence of the disease wherein a large scale destruction of foliage and premature drying of the crop is noticed across the states in the entire tropical region in India. The loss is estimated to be about Rs 3000/- crores every year in the country. Although many high yielding varieties were released for cultivation, sugarcane yield remained static over the decades from 1970 onwards. This is due to varietal degeneration caused by non-fungal pathogens that systemically infect the stalks and slowly causes decline in cane vigour. Since seed replacements have not happened at regular pace, the degenerated seed was used in the absence of quality seed and due to that expected additional yield could not be attained in the new varieties under field conditions. Also, the non-fungal diseases do not show any symptoms on seed canes and very often, these diseases do not exhibit any apparent symptoms hence the seed crop is assumed healthy. Although sensitive diagnostics were developed they could not be applied under field conditions.

Healthy seed programme

Heat treatment of seed canes by aerated steam or moist hot air has been practised in the country over the decades to inactivate the seed borne pathogens. This treatment addressed grassy shoot and ratoon stunting diseases to certain extent. Although the treatment was not completely effective against these pathogens, partial amelioration in seed cane programme was considered as success in the previous decades. Moreover, in the three tier seed nursery programme with heat treatment of seed canes, replacement of seed was suggested after a plant and two ratoons. But such advice was not implemented in toto. Further, heat treatment is ineffective against viral pathogens hence the intended benefits of heat treatment have not realized under field conditions. After heat treatment, practically seed canes harboured the non-pathogens hence physical elimination of the pathogens through meristem culture was advocated. Ever since YLD became a serious disease in India, efforts were made to standardize mass multiplication of sugarcane varieties through meristem culture to supply healthy seed to sugar industry to rejuvenate the degenerated variety Co 86032 at ICAR-SBI, Coimbatore. At the same time, molecular diagnostic assays were standardized to precisely detect the viruses in the *in vitro* seedlings before rooting. The assays (RT-PCR/ PCR) have been standardized to ensure that the tissue culture derived planting materials are totally free from ScYLV, SCMV, SCSMV and grassy shoot phytoplasma. Indexing of tissue culture derived seedlings for the designated viruses and phytoplasma is mandatory to ensure freedom of the plantlets to raise healthy crop and to prevent spread of the disease through the seedlings. Further, virus indexing service has been provided to tissue culture production units spread in the country to produce and supply only disease-free planting materials. In addition, the efficiency of meristem-derived tissue culture plants on virus elimination was demonstrated through RT-

qPCR (real time) assay by relative standard curve method at the institute. In this assay, Ct mean of *in vitro* plantlets ranged from 32.06 to 38.52 whereas in the asymptomatic plants but virus-infected, it was in the range of 19.54 - 27.04. The study conducted at SBI clearly established that the recommended virus disease management strategy works well to eliminate the virus from infected sugarcane and it is advantageous to produce virus-free planting materials.

Impact of healthy seed nurseries

Since seed cane serves as the source for disease transmission for most of the pathogens in sugarcane, to manage the diseases, major emphasis is given to seed health. Similarly, after epidemic occurrences of YLD, disease-free nursery programmes were initiated to manage the disease in the field. Ever since YLD became a serious threat to sugarcane cultivation, ICAR-SBI has given more emphasis on healthy seed programme to address varietal degeneration by elimination of systemic virus infections through tissue culture combined with molecular diagnosis. Virus-free seedlings are recommended in place of breeder seed in the three-tier seed nursery programme adopted in sugarcane. To augment supply large-scale virus-free planting materials, single bud settlings are raised in protrays under shade-net and this procedure aids in faster multiplication of virus-free seed canes. Large scale adoption of such nurseries in different districts in Tamil Nadu and other states resulted in significant increase in cane yield as compared to the conventional seed. Monitoring of YLD-free fields revealed that the disease-free fields always maintained a vigorous crop stand (Fig. 6) and the farmers realized an average increase of 37.5-50 tonnes/ ha in cane yield in the region. It was also found that by successful adoption of healthy nursery, upto 250 tonnes of cane yield was achieved in



Fig. 6 Healthy and vigorously growing ScYLV-free Co 86032 crop under farmers' field in Namakkal Dt

Vellode village in Erode district (Fig. 7). Since productivity in ratoon crops is severely affected by YLD, adoption of YLD-free nurseries benefits increased ratoon productivity in sugarcane and scope of multi-ratooning will be a feasibility in India and other countries. Management of varietal degeneration caused by YLD will improve land productivity and sustain sugarcane productivity in the country.



Fig. 7 Virus-free canes of Co 86032 show robust growth of more than 2 kg single cane weight at the time of harvest (the field recorded 250 tonnes per ha, Erode Dt).

Summary

YLD has been a threat to sugarcane cultivation in India and many other countries. In India, the author has made detailed works starting from the first report, developed diagnostics, established disease epidemiology, devised new disease screening method to identify the resistant germplasm and varieties and effectively managed the disease through meristem culture combined with molecular diagnosis. Above all, pathologists, breeders and extension personnel were trained to identify the disease and to take up disease management measures and this has made more awareness about the disease in all the states. In spite of sustained efforts to bring awareness on varietal degeneration caused by the disease, still there is a slackness among the farmers and industry and this severely affects cane productivity across the states and varieties. Hence to increase the crop productivity, concerted efforts have to be taken up in the field to manage the disease and achieve the potential yield of varieties. Wherever healthy seed nursery programmes are implemented, an increase of 20-35 t/ha cane yield was recorded which indicates the disease can be effectively controlled through clean seed programme aided by virus indexing in the planting materials. This success story has to be implemented in large areas to increase farmers' profitability and sustain the crop cultivation. Overall, the research efforts made at SBI have resulted in deeper understanding of the disease, associated virus, and effective disease management strategies and they have helped to sustain sugarcane cultivation and prolonging field life of elite varieties in the country.

(R. Viswanathan,
ICAR-Sugarcane Breeding Institute, Coimbatore)

Developmental activities in selected tribal villages

Surveys were conducted in Coimbatore district and four villages viz., Neelampathi, Ookaiyanoor, Ookapatti and Mottiyoor in Periyanaickenpalayam range were selected as beneficiary villages. The four villages have over 140 acres of cultivated area. Most of the area in these tribal villages are rainfed and the crops grown include ragi, castor, beans, cowpea, horsegram, red gram, blackgram, kudhiraivaali, saamai, thinai and in limited areas paddy, vegetables, banana and coconut are cultivated.

Focus group discussions were conducted in all these four villages with the village head, tribal villagers and women (Fig. 8). Participatory rural appraisal techniques like transect walk, social maps, participant observation, gender analysis, venn diagram and the like were conducted to get first-hand information on these villages. Problem-cause diagram helped us to prioritise the felt needs of the tribal villagers and accordingly, action plan was charted out. Consequent to the discussions with the tribal villagers and their demands for seeds, visits were made to TNAU and discussed with Dean, College of Horticulture, Head, Department of Vegetables, Head, Department of Pulses, Head, Department of Millets, Manager, Central Farm, Manager, Orchard and enquiries were made with Head, KVK, Santhiyur and Head, Centre for Excellence in Minor Millets, Bhavani. Visits were also made to various private firms, plant nurseries and SPIC unit in Coimbatore.



Fig. 8. Scientists of ICAR-SBI interacting with tribal people of Neelampathi

Awareness programs organized in tribal villages

- Conducted a training program on 'Nutrient management in coconut cultivation' for 108 tribal people of Neelampathi, Ookaiyanoor, Ookapatti and Mottiyoor tribal villages on 30 September 2020. They

Scientific participation

Title	Date	Participant (s)
11 th International Conference on Computing, communication and networking technologies organised by Indian Institute of Technology (IIT), Kharagpur, India in association with IEEE Kharagpur Section held at IIT, Kharagpur	1-3 July 2020	Dr. T. Arumuganathan



Fig. 9. Distribution of vegetable seeds (30 September 2020)



Fig. 10. Distribution of coconut seedlings (30 September 2020)

were supplied with coconut seedlings and vegetable seeds (Fig. 9-10).

(T. Rajula Shanthi, C. Jayabose, R. Arun Kumar, C. Sankalanarayanan, R. Karuppayyan, M.B. Medegar, Kannaian)

Training programs attended

- Dr. C. Palaniswami & Dr. K. Hari: MDP on Implementation of access and benefit sharing regulations in agriculture research: Awareness cum sensitization workshop during 7-10 July 2020.
- Dr. S. Alarmelu: Training programme on Stress management during 7-10 July 2020.
- Dr. P. Malathi: Training programme on Design thinking in research project formulation and implementation during 25-29 August 2020.
- Dr. P. Murali: Webinar on IPR in Agricultural Research & Education in India during 12-28 September 2020.

Title	Date	Participant (s)
IPS Webinar on Innovative strategies to reduce aflatoxin contamination in foods by Dr. R. Velazhahan, Associate Professor, Department of Plant Sciences, College of Agricultural and Marine Sciences, Sultan Qaboos University, Muscat, Sultanate of Oman, on the celebration of International Plant Health 2020 Indian Phytopathological Society (South Zone)	9 July 2020	Dr. R. Gopi
IPS Webinar on Recent developments in plant pathogen detection, discovery and diagnostics for deploying effective managements against emerging diseases by Dr R Selvarajan, Principal scientist (Plant virology), ICAR-NRCB, Trichy. on the celebration of International Plant Health 2020 Indian Phytopathological Society (South Zone)	9 July 2020	Dr. R. Gopi
National E-Conference on Communication, computation, control and automation CCCA-2020 organized by the Department of Electronics and Communication Engineering, Sri Ramakrishna Institute of Technology, Coimbatore	17 July 2020	Dr. T. Arumuganathan
Webinar on Frontline extension in agriculture delivered by Dr. S. Prabhu Kumar, Former Director, ICAR-ATARI Zone I, Ludhiana & Zone VIII, Bangalore, organised by Kumaraguru Institute of Agriculture, Erode	18 July 2020	Dr. T. Arumuganathan
International E-Conference on Covid-19 global impacts organized by African - British Journals	20-21 July 2020	Dr. T. Arumuganathan
National webinar on Integrated water management: A paradigm shift for higher productivity in agriculture organized by Faculty of Agriculture, Department of Agronomy, Annamalai University, Chidambaram	30 July 2020	Dr. P. Geetha
International Plant Biology (Conference 2020) at Washington DC, USA	27-31 July 2020	Dr. K. Lakshmi
Webinar on Organic farming: Need of the hour organized by K.K. Wagh College of Agriculture, Nashik, Maharashtra	6 August 2020	Dr. T. Arumuganathan
Green Sugar Summit 2020 on Making Indian sugar sector world class in green	6 -7 August 2020	Dr. Bakshi Ram
Zoom meeting on NABL Accreditation of ICAR laboratories	13 August 2020	Dr. C. Palaniswami
NPFGGM Review Meeting	18-19 August 2020	Dr. C. Appunu
General Board Meeting of TNAU, Coimbatore	18 August 2020	Dr. Bakshi Ram
Nation webinar on Abiotic stress in agriculture: Geospatial characterization and management options organized by ICAR-National Institute of Abiotic Stress Management, Baramati	27 August 2020	Dr. P. Geetha Dr. S. Anusha
Executive Development Programme organized by National Sugar Institute, Kanpur during (Online)	24-28 August 2020	Dr. Bakshi Ram
Webinar on Weed science: Challenges in the California rice ecosystems organized by Bioingene.com	28 August 2020	Dr. S. Anusha
Webinar on Response surface methodology - An introduction and its applications in research organised by ICAR – Central Institute of Agricultural Engineering, Regional Centre, Coimbatore	28 August 2020	Dr. T. Arumuganathan

Title	Date	Participant (s)
National webinar on Relevance of modelling in nutrient and water management organized by Faculty of Agriculture, Department of Soil Science and Agricultural Chemistry, Annamalai University	4 September 2020	Dr. P. Geetha
Meeting on Intellectual property rights in agricultural research and education in India organized by National Agricultural Higher Education Project & Intellectual Property and Technology Management Unit (ITMU), New Delhi	12-28 September 2020	Dr. P. Murali
Workshop on IPR & Technology commercialization: Status and opportunities in ICAR by ZTMU, IIMR, Hyderabad and IP&TM, ICAR, New Delhi	15 September 2020	Dr. K. Hari
International webinar on Plant physiology paradigms towards agricultural sustainability under climate change organized by Bihar Agricultural University Sabour, Bhagalpur	15 September 2020	Dr. R. Valarmathi Dr. H.K. Mahadevaswamy Dr. C. Appunu
Online Review Meeting on Progress on ZTMC activities in ICAR Crop Institutes in the Southern Indian zone ICAR-IIMR, Hyderabad and IP&TM, ICAR, New Delhi	6 September 2020	Dr. K. Hari
Webinar on Mechanisation in value addition of banana and generation of wealth from banana pseudo stem waste organised by ICAR-Central Institute of Agricultural Engineering, Regional Centre, Coimbatore	18 September 2020	Dr. T. Arumuganathan
Brainstorming session on Sugarcane based ethanol production for sustainable fuel ethanol blending programme by NAAS and ICAR- Sugarcane Breeding Institute, Coimbatore	18 September 2020	All scientists of ICAR-SBI
Webinar on Current opinion on horticultural mechanisation in India organised by ICAR-Central Institute of Agricultural Engineering, Regional Centre, Coimbatore	25 September 2020	Dr. T. Arumuganathan
Workshop/Lecture on Gandhian Philosophy to commemorate the 150 th Birth Anniversary of Mahatma Gandhi by Dr. R.C. Agarwal, DDG (Edn.) and Dr. A.K. Vyas, ADG (HRM), ICAR	29 September 2020	All Scientists of ICAR-SBI
Webinar on Gandhian philosophy in the back drop of agricultural transformation to commemorate the 150 th Birth Anniversary of Mahatma Gandhi organised by ICAR-SBI	30 September 2020	All Scientists of ICAR-SBI
One-day National webinar on Halophytes for alleviating salinity stress in agriculture: potentials and problems organised by ICAR-National Institute of Abiotic Stress Management, Baramati	30 September 2020	Dr. K. Hari Dr. P. Geetha Dr. S. Anusha

OTHER ACTIVITIES



Fig. 11. Independence Day celebration (15 August 2020)

Independence day

- Independence Day was celebrated in the Institute on 15 August 2020. Dr. Bakshi Ram, Director, ICAR-SBI hoisted the National flag and addressed the staff (Fig. 11).

Hindi Day celebration

- Hindi Day was celebrated on 29 September 2020 (Fig. 12). Various competitions were conducted and the winners were awarded. The Hindi magazine 'Ganna Prakash' was released during the Hindi Day by Dr. Bakshi Ram, Director, ICAR-SBI.



Fig. 12. Hindi Day celebration (29 September 2020)

International deputation

Dr. K. Lakshmi was awarded bioenergy award for cutting edge research (b-acer) fellowship for a period of seven months from 27.01.2020 to 21.08.2020 at University of Florida, Institute of food and Agricultural Sciences , USA.

Commercialization of technologies

- Licenced liquid jaggery production technology to Cropnrich Agri Private Limited, Wayanad on 01 September 2020.
- Licenced EPN formulation for white grub control to T. Stanes and Co Ltd on 02 September 2020.

Events

- Organized 'Brainstorming Session on Sugarcane based ethanol production for sustainable fuel ethanol blending programme' (online) on 18 September 2020 sponsored by NAAS, New Delhi under Chairmanship of Dr. Mangala Rai, Former President NAAS and DG, ICAR & Secretary DARE, Co-Chaired by Dr. T. Mohapatra, President, NAAS and DG, ICAR & Secretary DARE. Dr Bakshi Ram, Director, ICAR-Sugarcane Breeding Institute, Coimbatore served as the Convener of the session.
- Green Sugar Summit 2020 was held during 6-7 August 2020 and Session III: Session on Cane Management was held on 6 August 2020.
- NAAS India meeting was held on 13 August 2020 in Director's cell .

Institute Research Council meeting

The Institute Research Council meeting was conducted during 20-25 July 2020. The progress of the ongoing research projects was reviewed and suggestions were offered. Thirteen sub-projects were concluded and 15 new sub-projects were approved for the coming year.

Meetings

- Senior Officers Committee meeting held on 04.07.2020 and 05.08.2020.
- IJSC meeting held on 25.09.2020.
- Grievance Committee meeting held on 27.07.2020, 18.08.2020 and 14.09.2020.
- Women Cell meeting held on 19.08.2020.
- Selection Committee meeting for engaging Ex-Servicemen security guards on contract basis held on 26.09.2020.
- Independence Day was celebrated on 15.08.2020.

Promotions

- Smt. K. Usha, Assistant promoted as Assistant Administrative Officer w.e.f. 03.08.2020.
- Smt. J. Emily Florence Daisy Rani, Assistant was granted 3rd MACP in Level 7 of 7th CPC Pay Matrix w.e.f. 19.03.2020.

Transfers

- Dr. V. Venkatasubramanian, Principal Scientist was relieved from this Institute w.e.f. 21.07.2020 (AN) on his appointment as Director, ATARI, Bengaluru.

Retirements

- Smt. R. Vanithamuthumaheswari, AAO retired from service on superannuation on 31.07.2020 (AN).
- Dr. N. Thiraviam, CTO retired from service on superannuation on 31.07.2020 (AN).

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