To commemorate the Centenary of Sugarcane Breeding Institute, Coimbatore, the Institute and the Society for Sugarcane Research and Development, Coimbatore, jointly organized the ‘International Symposium on New Paradigms in Sugarcane Research (ISNPSR-2012)’ during 15-18 October 2012 at Coimbatore.

The main objective of the symposium was to provide a global platform for the sugarcane researchers working in different countries to interact and share their perceptions and concerns on current challenges in sugarcane agriculture and to review the progress of research in different countries in sugarcane. The symposium was held for three days at Hotel Le Meridien, Coimbatore during 15-17 October 2012 followed by a post symposium visit to the Institute and a sugar factory on 18 October 2012.

The symposium received an overwhelming response from researchers from India and abroad with 414 delegates from 11 countries participating in the meet. Apart from 249 Indian delegates, 51 delegates from Australia, Brazil, Peoples Republic of China, France, Kenya, Nigeria, South Africa, Thailand, Vietnam etc., participated in the meeting. Seventy eight delegates representing the sugar industry and 36 students also participated in the meeting. Dr. Swapan Kumar Dutta, Deputy Director General, Crop Science, (ICAR), New Delhi inaugurated the symposium on 15-10-2012.
Dr. N. V. Nair, Director, Sugarcane Breeding Institute (SBI), and Chairman, Organizing Committee, delivered the introductory lecture, in which he highlighted the genesis and structure of the four-day symposium. Dr. K. Ramasamy, Vice Chancellor, Tamil Nadu Agricultural University, Coimbatore delivered the key note address. Dr. N. Gopalakrishnan, Asstant Director General, Commercial Crops (ICAR), New Delhi, Dr. M. Manickam, President, South India Sugar Mills Association-TN, and Vice Chairman, Sakthi Sugars, Coimbatore and Dr. G.S.C. Rao, President, Sugar Technologists Association of India, New Delhi also spoke on the occasion. Mr. K. Nagendran, Vice President, SSRD & Special Director, Thiru Arooran Sugars, Chennai welcomed the delegates and Dr. R. Viswanathan, Head, Division of Crop Protection, SBI and Organizing Secretary of Symposium proposed the vote of thanks.

Ten technical sessions were held concurrently during the three days. Each day there were one or two plenary sessions wherein eminent speakers presented the current status of research in different areas. There were four plenary sessions with eight plenary lectures. A plenary session was held on 15th in which two plenary lectures were delivered. Similarly two plenary sessions were held on 16.10.12 with four plenary lectures and one plenary session was held on 17.10.12 with two plenary lectures.

Eminent scientists Dr. Frikke Botha, Dr. Phillip Jackson and Dr. Prakash Laksman from BSES, Australia, Dr John Manners, CSIRO, Australia, Dr. N. V. Nair, SBI, Coimbatore, Dr. Tomas Ayala-Silva, USDA, USA and Dr. M. M. Pandey, ICAR, New Delhi delivered plenary lectures on contemporary topics. In addition, an eminent sugar technologist, Mr. P. Ramababu from Chennai, highlighted the perspectives of Indian Sugar Industry in a plenary lecture. A total of 352 research articles and abstracts including 38 from foreign countries were received for the symposium. These papers were presented in ten technical sessions.
PLENARY LECTURES

Dr. Frikkie Botha, Research Manager of the Variety Improvement programme at BSES Limited, Australia having rich experience with SASRI, South Africa delivered a detailed talk on the Regulation of sucrose accumulation in sugarcane. He highlighted use of recombinant DNA technologies to achieve a breakthrough in increasing sugar content in sugarcane. He critically evaluated our current understanding of metabolic flux in sugarcane and emphasized future steps that are needed to increase the flux of carbon into sucrose storage pool. His illuminating talk added glitter to the symposium after the inauguration ceremony. This maiden presentation in the symposium was a motivating talk to the delegates.

Shri. P. Ramababu, Sugar industry expert, Chennai, India, represented the Indian Sugar Industry and spoke on the perspectives in Indian sugar Industry. He shared his experience in Indian sugar industry and narrated its decade-wise growth. He opined that sugarcane is an alternate energy crop and mentioned challenges like increased cost of production, slow progress of mechanization in cane cultivation, shrinking natural resources, rapid urbanization etc. However he was optimistic about the growth and prospects of Indian sugar industry and complimented century old SBI for its contribution to the growth of sugar industry in India and elsewhere and offered best wishes for the success of the symposium.

Dr. Phillip Jackson, CSIRO Plant Industry, Brisbane, Australia spoke on developing sugarcane varieties for sugar and energy production. He said that in view of sugarcane being used for sugar as well as energy, economic models are being used to assess the relative benefits to the client industry and developed assumptions on costs and revenues. The results are used to suggest how breeding programmes should change in response to increasing industrial use of sugarcane for both sucrose and energy products.

Dr. M. M. Pandey, Deputy Director General (Agricultural Engineering), ICAR, New Delhi spoke on ‘Mechanization of Sugarcane Agriculture’. He emphasized the need for combination of efficient mechanization and high yielding varieties to meet the increasing sugar demands. Mechanization is essential to achieve the timeliness in agricultural operations and to reduce drudgery to the farm workers. He highlighted the economics and employment as the key challenges for mechanization. He concluded that mechanization package had to be eco-friendly and overcome the strenuous and hazardous sugarcane farming operations in a safe and comfortable manner to increase the productivity and to facilitate custom hiring/contract farming.
Dr. N.V. Nair, Director Sugarcane Breeding Institute, Coimbatore spoke on ‘Sugarcane genetic resources—status, potential and role in sugarcane improvement’. He highlighted the world sugarcane germplasm collection, conservation, utilization, role of wild species as sources for important characters and as trait specific germplasm including their potential for biomass and bioenergy. He commented that the large variability represented across the *Saccharum* species and related genera and the absence of any serious crossability barriers within the *Saccharum* complex offer enormous possibilities in creating genetic recombinations that will meet the future varietal needs for sugar and energy sectors.

Dr. Tomas Ayala-Sylva, USDA-ARS, Miami, Florida, USA spoke on ‘World *Saccharum* collection at the USDA Subtropical research station, National Germplasm repository, Miami. He spoke on the Genebank devoted to conservation of subtropical and tropical fruits, sugarcane and related grasses and ornamental plants maintained at Miami, USA since 1980. This repository maintains about 1200 *Saccharum* and 50 *Miscanthus* collections free of viruses, their distribution for basic researches and to promote the preservation of sugarcane genetic resources for future generations. He also highlighted practical aspects of maintaining such a large collection of germplasm materials.

Dr. John Manners, CSIRO Plant Industry, Brisbane, Australia. presented on “An integrated pipeline for functional genomics research in sugarcane”. He lucidly narrated how the recent advances in DNA sequencing would generate knowledge on gene function through forward and reverse genetics in spite of the complexity of sugarcane genome. Understanding the unique biological attributes of sugarcane through functional genomics would provide innovative plant improvement applications that can underpin future food, bioenergy and biomaterial industries.

Dr Prakash Lakshmanan, BSES Ltd, Brisbane, Australia spoke on “Transgenic sugarcane: The global scenario”. Though sugarcane transgenic technology is well established and practical in several sugar producing countries, several technical hurdles on multi-gene transgenesis, commercially viable transgenic events, precise transgene integration and controlled expression of transgenes are yet to be demonstrated in sugarcane. He highlighted the progress in sugarcane transgenesis and opportunities and challenges of developing and delivering commercial transgenic sugarcane based on the information available in the public domain. His talk was an update on sugarcane transgenics to all the delegates.
The lead paper on “A quantitative genetic approach to sugarcane improvement” of Dr. Xiamming Wei, BSES, Australia was presented by Dr. Philip Jackson, CSIRO, Australia. He gave a detailed account of application of quantitative genetics in sugarcane improvement followed in BSES. He emphasized on the need to define objectives of any breeding program in clear terms to maximize genetic gain and weightage given to a component trait based on their economic importance. Critical examination of costs and income and associated traits in the Australian sugar production systems indicated sugar content as the major trait of economic importance. Along with it, cane yield and fibre content were included in the breeding objectives. Sugarcane improvement programme in Australia is also based on well defined selection indices.

A large number of clones with improved quality, ratooning ability, high biomass, high fibre and resistance to smut and red rot diseases have been isolated for utilizing in commercial breeding programmes. *Erianthus arundinaceus*, known for its robust growth, excellent ratoonability and resistance to many biotic and abiotic stresses is also being used in genetic base broadening programmes at SBI, Coimbatore.

### RECOMMENDATIONS

1. Selection of sugarcane seedlings should be liberal and emphasis may be given on rejection of poor seedlings rather than selection for superior seedlings.
2. Evaluation of clones at earlier stages of selection for absolutely essential traits like ratoonability and red rot resistance.
3. Planting of seedlings in longer rows to reduce the proportion of border positioned seedlings.
4. Selection in seedlings ratoon nursery early in the season (October) for effective isolation of early maturing varieties under sub-tropical conditions in India.
5. Utilization of pollen stored at -18°C and 20% moisture for hybridization upto 30 days to overcome the problem of non-synchronization in flowering time of sugarcane parents.
SESSION II : Resource management: Soil, nutrient and stress management

In Chair : Dr. S. Solomon, Director, IISR Lucknow, India & Dr. Yang-rui Li, President, GXAAS, Nanning, China
Conveners : Dr. T. K. Srivastava, IISR, Lucknow and Dr. A. Bhaskaran, SBI, Coimbatore

Two lead papers by Dr. Prakash Lakshmanan, BSES, Australia and Dr. S. Solomon, IISR, Lucknow and nine oral papers were presented in this session. Dr. Prakash in his lead paper on ‘Sugarcane for water limited environments: Challenges and opportunities’ highlighted the sugarcane genetic improvement programme for water stress tolerance and water use efficiency. Assessment of sugarcane traits for improving productivity using APSIM and the performance of 131 genetically diverse clones under water stress environments were elaborated. The methodologies for studying the G x E interaction under water stress were of benefit to the delegates.

Dr. S. Solomon in his lead lecture on ‘Productivity enhancement options in sugarcane: Cost effective and input-efficient technologies for developing countries’ gave viable productivity enhancement options that can improve the average cane yield to about 75 t/ha in addition to conserving the natural resources. These technologies are suitable for small farmers, who represent about 75% of sugarcane growers in India.

Nine oral papers covering a wide spectrum of resource management options ranging from use of GIS and remote sensing, management of soil sickness, organic recycling, new chemicals, efficient agronomic practices and productive cropping systems were presented, all aiming at sustaining soil health, enhancing sugarcane production and farm productivity while conserving the natural resources.

Dr. T. K. Srivastava of IISR, Lucknow highlighted the positive effect of sugar industry based bio-manure in combination with the biofertilizer Gluconacetobacter diazotrophicus and inorganic fertilizers in enhancing sugarcane plant and ratoon yields in long term and sustaining the soil health even after eight ratoons. Timely interventions in crop husbandry and management are emphasized as vital in sustaining the sugarcane and sugar production.

A new remote sensing and GIS based approach for identifying and mapping yellow leaf infected cane area developed by SBI was presented. The results on the YLD prediction accuracy confirmed its validity. The presentations on simultaneously raising wheat and sugarcane in sub-tropical India and the FIRB method of planting sugarcane in standing wheat crop emphasized time saving and avoiding the productivity decline. The presentation on crop geometry of sugarcane based intercropping highlighted the advantages of 150 cm wide row planting and intercropping soybean and black gram. The paper on the inhibitory effect of distillery effluents on soil fungal growth stressed upon the optimization of quantity and frequency of its application as a source of nutrient.

Dr. D.G. Hapase shared his research experience and offered his remarks on the presentations.
The lead speakers were Dr. Li Tao Yang from China, Dr. Joao C. Baspalhok Filho from Brazil and Dr. E.H. Kwon-Ndung from Nigeria.

Dr. Li Tao Yang in her presentation reported that the chlorophyll content, rate of photosynthesis and stomatal conductance decreased with increasing duration of cold. Cold injury index and photosynthetic parameters could be used as indices for cold tolerance in sugarcane.

The beneficial effects of plant growth rhizobacteria (PGPR) such as *Glucanoacetobacter*, *Azospirillum*, Tri-Azo, etc and association of PGPR with sugarcane clones were presented by Dr. Joao C. Baspalhok Filho from Brazil. Dr. E.H. Kwon-Ndung presented the sugarcane scenario in Nigeria. He said that the country imports sugar at present and the efforts are taken to promote sugarcane development. Progress in varietal development programme using the fluff of biparental and polycrosses was also presented.

There were five oral presentations on various issues related to varietal needs. The importance of cold tolerant varieties for the subtropical regions was stressed. The possibility of identifying sugarcane situation specific integrated nutrient management incorporating organic manures, inorganic fertilizers and bio fertilizers, integrated weed management strategies, problem soil management strategies for compacted soils, saline and sodic soils etc. must be identified and disseminated to achieve the potential production of sugarcane.

1. Region specific and site specific package of resource management technologies including manipulation of crop geometry, tillage, planting methods, cropping system management, intercropping, time and method of planting, site and

2. Research should focus on improving the use efficiency of natural resources thereby deriving the maximum benefits without their depletion.

3. New approaches and technologies viz., remote sensing and GIS, growth promoting and stress managing chemicals should be harnessed to improve the natural resources use efficiency, cane productivity and profitability and sustainable soil health.

16 October 2012

**SESSION III : Sugarcane Varieties for Varied Uses and Situations**

**In Chair** : Dr. N. Gopalakrishnan, ADG (CC), ICAR, New Delhi & Dr. Li Tao Yang, Guanxi University, Nanning, China.

**Conveners** : Dr. Bakshi Ram, SBI Regional Centre, Karnal & Dr. S. Alarmelu, SBI, Coimbatore

The lead speakers were Dr. Li Tao Yang from China, Dr. Joao C. Baspalhok Filho from Brazil and Dr. E. H. Kwon-Ndung from Nigeria.

**Salient points presented and discussed**

Dr. Li Tao Yang in her presentation reported that the chlorophyll content, rate of photosynthesis and stomatal conductance decreased with increasing duration of cold. Cold injury index and photosynthetic parameters could be used as indices for cold tolerance in sugarcane.
varieties with water use efficiency through carbon isotope discrimination was mentioned. The need to evolve sugarcane varieties with photo-thermo sensitivity in addition to yield and quality for sustaining sucrose recovery for longer periods was also highlighted.

The achievements made in sugarcane varietal development were discussed in some of the presentations. There was a progressive increase in the sucrose content of Co canes evolved since 1912 to 2012 at SBI, Coimbatore. This genetic gain was attributed to choice of proper parents followed by efficient selection. New genetic stocks with high sucrose content and early sucrose accumulation have been developed, such as INGR 09-053 capable of accumulating as much as 22% sucrose at 10th month, with 12% improvement over the best quality standard CoC 671. An analysis of district wise variation in sugarcane production and productivity indicated a lower poverty index in higher sugarcane producing districts. A total of 32 posters pertaining to the session were presented.

SESSION IV : Resource Management: Mechanization and Irrigation management

In chair : Dr. M. M. Pandey, DDG (Engg), ICAR, New Delhi & Dr. P.R. Singh, Head, Agricultural Engineering, IISR, Lucknow
Convener : Dr S.J.K. Annamalai, CIAE Regional Centre, Coimbatore

Nine papers were presented in the oral session of which two were on sub-surface drip irrigation including economic analysis, one on study on soil compaction in view of mechanization and the rest were on sugarcane mechanization equipment. The salient highlights of the presentations are as follows:

CIAE regional centre, Coimbatore in collaboration with SBI Coimbatore has developed a tractor operated two row sugarcane settling planter, which is cost effective and labour saving.
A lead paper, six oral presentations and ten posters were presented in the session. The lead paper was presented by Dr. M.N. Premachandran, SBI, Coimbatore wherein he highlighted the importance of cytoplasmic diversity and its role in imparting abiotic and biotic stresses. He also clarified that there was difference between cytoplasmic substitution between *Erianthus* and *S. spontaneum*. Three oral papers dealt on the utilization of *Erianthus* and *S. spontaneum*. There is obvious focus on utilization of *Erianthus* in base broadening efforts in view of use of sugarcane as energy cane. The importance of

A tractor operated culti harrow which is time and energy saving, has been developed at IISR, Lucknow. It saves 4-5 l diesel and 1.5 to 2 h time /ha as compared to tractor drawn cultivator and harrow. The number of tractor passes is also reduced.

A hand tool for pruning the sugarcane main shoots for increasing tillers has been developed at TNAU, Coimbatore which greatly reduces drudgery and saves approximately 60 per cent labour. A tractor front mounted whole cane sugarcane harvester has been developed by IISR, Lucknow that cuts sugarcane at base and used even in narrow spaced planting. There is a great scope for low cost whole cane harvester in the country.

**SESSION V : Genetic Resources**

**In Chair** : Dr. Thomas Ayala-Sylva of USDA, USA & Dr. M.N. Premachandran, SBI, Coimbatore

**Conveners** : Dr. K. Chandran, SBIRC, Kannur & Dr. P. Govindaraj, SBI, Coimbatore.

A presentation from IISR Lucknow on the equipment developed for ratoon management and planting along with seeding of the companion crops in flat and raised beds holds good promise.

Small scale sugarcane processing technologies developed in Nigeria was presented.

The paper on impact on soil physical health due to use of heavy equipment indicated the increase in bulk density below 15-30 cm soil depth.

In the study on water soluble fertilizers under sub surface drip fertigation system, it was found that water soluble fertilizers gave better yield in combination with conventional fertilizers. In another paper, laying of subsurface drip pipe line was found better in paired rows when placed in between rows in cane geometry of 120+ 40 cm.

**RECOMMENDATIONS**

1. Popularization of the tractor operated culti harrow of IISR in the areas with light and medium soils and evaluating it in heavy soils
2. Evaluation of the whole cane sugarcane harvester developed by IISR
3. Long term study on soil compaction due to mechanization for further understanding
developing core and mini core collections for efficient utilization and conservation of sugarcane germplasm and the procedure of developing core collection was discussed. Phenotyping and genotyping of genetic resources selected from the World collection from Miami indicated maximum diversity within S. spontaneum group followed by S. officinarum. Various molecular cytological tools available for unraveling complex cytogenetics of Saccharum including GISH, PRINS and C banding were presented. Similarly the use of various cytotypes of S. spontaneum in breeding programme showed stable chromosomes transfer with 2n=64 cytotypes and differences in the number of chromosomal deletions were observed in the progenies derived from S. spontaneum 2n= 72 and 2n=80 types.

SESSION VI : Diseases and Pest Management in Sugarcane

In Chair : Dr O.K. Sinha, Project Coordinator (Sugarcane), IISR, Lucknow
Dr R. Viswanathan, Head, Crop Protection, SBI, Coimbatore

Conveners : Dr G.P. Rao, IARI, New Delhi and Dr J Srikanth, SBI, Coimbatore

Dr O.K. Sinha in his lead lecture gave a scenario of diseases affecting sugarcane and cautioned about the minor diseases becoming major ones in course of time, while red rot still remained as epidemic due to cultivation of old susceptible varieties despite deployment of resistant varieties and healthy seed production. He remarked on the occurrence of smut, brown rust, yellow leaf, pokkah boeng and eye spots in alarming proportions in a few Indian states.

Dr A.R. Prasad of IICT, Hyderabad elaborated on pheromone application technology for the management of sugarcane borers including the chemistry of pheromones, types of lures and traps and the usefulness of this technology in sugarcane borers management based on field studies.

The major points from the oral presentations were on the epidemiology and resistance behavior of sugarcane varieties against orange rust in Sao Paulo, Brazil, recent researches on diagnosis, epidemiology and management of white leaf and grassy shoot caused by phytoplasma in Thailand and India, evolution and behavior of red rot pathogen under different conditions in India, management aspects of red rot in Tamil Nadu, management of different important diseases of sugarcane with Trichoderma species and the mechanism of systemic acquired resistance (SAR) and its application for disease management in sugarcane.
There were three lead lectures and five oral presentations in this session. Dr. Angelique D'hont in her lead paper on ‘Evolutionary dynamics of homeologous chromosome segments within the highly polyploid sugarcane genome’ explained the genomic contribution of the *Saccharum officinarum* and *S. spontaneum* as well as sugarcane cultivar R570 and suggested that the presence of broad sets of functional homeologous alleles in its genome, which could explain its unique efficiency particularly in its high phenotypic plasticity and wide adaptations of sugarcane cultivars.

RECOMMENDATIONS

1. Healthy seed cane production through heat therapy followed by meristem culture for elimination of important pathogens that are sensitive to heat
2. The reliable and sensitive molecular diagnostic tools should be used for disease indexing of tissue culture raised plants.
3. Strict vigil should be kept on minor diseases like orange and brown rust, yellow leaf disease, pokkah boeng and eye spot which have at times assumed serious proportions.
4. Major diseases like red rot, grassy shoot, smut and wilt should be monitored from assuming alarming proportions.
5. Systemic acquired resistance and biological control may be given due consideration to prevent superior varieties from becoming susceptible to diseases.
6. Woolly aphid pest needs to be monitored to prevent its resurgence.
7. Studies on the role of kairomones as enhancers of parasitoid efficiency need to be pursued to utilize them in biological control of borers.
Two lead lectures were presented, one by Dr. Menossi, Brazil on ‘The FAPESP bioenergy research program in Brazil’ and the other by Dr. Fukuhara, Japan on ‘Advantages of sugarcane A-molasses in fermentation and distillation waste water quality’. There were eight oral presentations on different areas viz., computational synthetic biology for biomass energy, expression analysis of genes in sugarcane, including ten new transcripts, which were not reported earlier, involved during early events of sugarcane red rot interaction in sugarcane resistance response, adaptability of *Erianthus arundinaceus* to different moisture regimes wherein a relative increase in expression of HSP 70 and DREB 2 was observed consequent to moisture stress.

**RECOMMENDATIONS**

Molecular marker techniques have been successfully used for genetic diversity studies, gene mapping and quantitative trait loci (QTL) identification, DNA fingerprinting of varieties and marker assisted selection in sugarcane. The next step is to sequence the sugarcane genome, along with the complete set of genes, regulatory elements and their position on the chromosome. Genes identified thus will be useful to correlate with traits of interest using segregating populations and for promoter isolation that can be used to develop transgenics with enhanced levels of gene expression.

**SESSION VIII : Bioenergy and sucrose metabolism**

**In the Chair :** Dr. Steve Brumbley, University of North Texas, USA and Dr Marcelo Menossi Teixeira, University of Campinas, Brazil

**Conveners :** Dr. Amaresh Chandra, IISR, Lucknow and Dr. K. Hari, SBI, Coimbatore

Dr. Aitken, CSIRO, Australia, in her lead paper on ‘Sequencing the sugarcane genome: an Australian perspective,’ explained the work done by Australian group on genome sequence in sugarcane. Dr. Shailesh V. Joshi, SASRI, South Africa in his lead paper on ‘Marker assisted breeding in sugarcane: a South African perspective’ discussed about the association mapping approach in MAS for varietal development in South African sugarcane varieties. This approach was also utilized in marker assisted selection in sugarcane for varietal development in South Africa.

Oral presentations included a novel method on cDNA-SCOT for gene differential expression in sugarcane, association mapping for identification of associated markers on sugarcane particularly sucrose, NMC and stalk borer resistance, identification of two molecular markers linked with smut resistance in sugarcane, identification of differentially expressed genes involving molecular modeling and docking studies of soluble acid invertase, chemical ripener to improve sucrose synthesis and accumulation. *Erianthus arundinaceus* for fibre and biofuel, sugarcane for antioxidants and biomass related traits in energy sorghum. All the presentations had good interactions with the participants.
Three lead papers were presented. The first one on 'PHA accumulation in Sugarcane' was presented by Dr. Stevens M. Brumbley, Department of Biological sciences, The University of North Texas, USA, wherein he highlighted on genetic improvement of sugarcane for biofactory concepts. Developing sugarcane as a biofactory to produce a range of industrial biopolymers including $\rho$-hydroxybenzoic acid, polyhydroxybutyrate, polyhydroxybutyrate / polyhydroxyalkanoate copolymer and alternative sugars were explained along with the possibilities for producing the therapeutic compounds. He elaborated his work on polyhydroxyalkanoate copolymer production in sugarcane plastids and peroxisomes. Fifteen plants with high PHA production could be obtained after screening of more than 10,000 transgenics. The methodologies followed for using sugarcane as a platform for the production bioplastics was quite interesting.

RECOMMENDATIONS

During the deliberations, Dr Menossi, Brazil expressed that the 'Bioenergy programme' of Brazil has collaboration with many countries and India can also be a part of this programme. India has the potential to play an active role in this programme.

Dr Brumbley, USA expressed that India could initiate collaborative programmes in the area of metabolic engineering and biomass energy.

SESSION IX : Genomics and Transgenics –II

In Chair : Dr. John Manners, Chief of CSIRO Plant Industry & Dr. Graham Bonnett, Program Leader, CSIRO, Plant Industry, Australia

Conveners : Dr. N. Subramonian and Dr. C. Appunu, SBI, Coimbatore.
The second lead paper was delivered by Dr. Graham Bonnett, CSIRO, Australia. In the talk on 'Reproductive biology and composition of sugarcane-establishing the baseline for regulatory assessment of GM cultivars' he provided a framework of suggestions for regulating the assessment of sugarcane transgenics. He stressed the importance of sugarcane transgenic technology for increasing the productivity whilst ensuring environmental health. Understanding the ecology and reproductive biology of sugarcane was essential in order to identify and manage potential risks of genetically modified sugarcane. He also elaborated the need for measurement of nutritional components in the sugarcane stalk in GM and non-GM crops as this data is lacking at present in the case of sugarcane, unlike in that for sexually propagated transgenic crops.

Dr. Hugo Bruno Correa Molinari, Embrapa Agroenergia, Brazil presented the third lead lecture on “Production of drought tolerant transgenic sugarcane plants expressing the AtDREB2A gene”. He gave an outline of Brazilian sugarcane agro-ecological zoning and the drought prone areas and on development of transgenics with AtDREB2A and their screening for water deficit stress tolerance.

Two papers on transgenics and one on proteomic analysis of sugarcane-Colletotrichum falcatum interaction were presented. The highlights of these presentations was the proteomic analysis being the first study on understanding the changes in the proteome profile of resistant and susceptible sugarcane cultivar in response to C. falcatum pathogen challenge using 2-DE analysis that showed the suitability of proteomics based analysis in deciphering host pathogen interaction. The other papers highlighted expression and purification of a heterologous protein from transgenic sugarcane juice using beta-glucuronidase (GUS) as a model under the control of a constitutive promoter and a strong vacuole localizing motif and the identification and characterization of a novel constitutive ubiquitin promoter from Porteresia coarctata, through random amplification of genomic ends (RAGE) that conferred higher expression of transgenes in sugarcane compared to that of maize Ubi1 and CaMV35s promoters.

Dr. Hugo Bruno Molinari

Dr.N.Subramonian

RECOMMENDATIONS

The presentations and posters pertaining to the session IX covered various aspects of transgenics in sugarcane for different applications and enhancing the sugarcane production under stressed environmental conditions. The information shared in this session has raised the hope of improving/enhancing the sugarcane productivity of the existing genotypes/varieties, especially under biotic and abiotic stress conditions, and the use of sugarcane as a platform for the production of other valuable molecules of commercial importance.
This session was chaired by Dr. M. Manickam. In his introductory remarks, the Chairman complemented that the close association between SBI and Indian sugar industries for nearly 100 years has contributed to the phenomenal growth in sugarcane area, production, productivity and sugar production. He expressed that the symposium has deliberated on the opportunities and challenges posed by the recent innovations in sugarcane agriculture viz., crop geometry, mechanized cane cultivation and harvest, healthy planting materials through tissue culture propagation, better management of diseases and pests and micro irrigation. He expressed concern over the lack of awareness and adoption of these technologies by industries and farmers. Dr. Manickam also said that the country needs to adopt laser leveling, satellite mapping and crop management and GPS mapping of fields to implement optimal irrigation and targeted fertilizer application. He added that the industry is ready to support SBI, by sponsoring joint programmes.

Two lead papers viz., ‘Four decades of contribution of the Serra do Ouro to agro industry of sugarcane from Brazil’ by Dr J.M. Santos, RIDESA, Brazil (presented by Dr Carlos Bespalhok), ‘Beyond hundred years: emerging challenges of sugarcane production and Research & Development strategies for 2050’ by Dr M.C.Gopinathan, India were presented. Dr Santos observed that in Brazil, Serra do ouro germplasm bank, located in an area suitable for natural and profuse flowering of sugarcane, has contributed to the development of several improved sugarcane varieties, which occupy over 60 % of the cane area in Brazil.
Expressing concern over the dwindling yield levels across the globe, Dr. M. C. Gopinathan in his lead paper mentioned that the significant improvement in sugarcane yields in 1960s to 1980s could not be sustained after 1980s. Sugarcane yield growth rates in Brazil and India must be more than double from historical yield growth rates in order to meet global demands for food and energy needs. Informing the gathering that with an average growth of 2.71% and per capita consumption of 27 kg/year the global sugar demand in 2050 is estimated to be of 210 MT, from the present 160 MT, he suggested that sugar production needs to grow at a faster rate in the coming decades to meet the diversified demands of sugar for the large growing population. Eight papers were presented by speakers from Brazil, Nigeria, Thailand, China and India. This was followed by an ‘interactive session’ with the expert panel of the session.

**RECOMMENDATIONS**

1. Collaborative efforts are needed from Industry, Research institutions and growers in meeting the new challenges in cane research and development.
2. While varieties such as Co 62175, Co 957 and Co 997 are still being used for commercial cultivation in Nigeria, the country has to adopt a regulatory mechanism for local sugarcane/sugar development in the near future, in order to make sugarcane production sustainable in the long run.
3. In future, Research and Development in the Industry sector has to be customer driven and should be taken up in a Public-Private-Farmer partnership mode.

**POSTER SESSIONS**

About 251 posters were displayed during the symposium. Session VI attracted maximum of 63 posters and was followed by the Session II with 56 posters. The posters were displayed with colour illustrations of high standards and attracted good discussions among the delegates. The sessions also served as platforms for a close interaction among the delegates. Best poster awards were presented to the authors from each session depending on the number of posters in each session.
Winners of best poster awards

I. A recurrent selection programme for yield in sugarcane (Saccharum spp)
   S. Alarmelu, G. Hemaprabha and R. M. Shanthi

   Stability analysis and selection of elite clones with high cane yield and quality in sugarcane (Saccharum spp)
   R. Latha, P.S. Purushothaman and S. Nazeer Ahmed

II. Effect of different herbicides on binding weeds (Ipomoea sp.) in sugarcane
   S. Singh, M. Chand, R. Singh, N. Singh and R. Mehra

   Optimizing tillage, moisture regimes and nitrogen use efficiency and sugarcane yield in subtropical India

   Gluconacetobacter diazotrophicus – a potential endophytic biofertilizer for sugarcane
   K. Hari, M. Madhaiyan, V. Venkateswaran and R. Kumaran

III. Variability and correlation between resistance to red rot (Colletotrichum falcatum) and internode shape of sugarcane (Saccharum hybrid complex)
   D.K. Pandey, S. Lal, PK Singh, S. Kumar, J. Singh and A. Saxena

   An assessment of high temperature tolerance potential of elite genotypes of sugarcane (Saccharum spp.) evaluated in the peninsular zone of India
   G. Hemaprabha, T.S. Sarath, S. Alarmelu, S.P. Adhini, R.M. Shanthi and C. Appunu

   Physiological markers for screening waterlogging resistance in sugarcane
   R. Gomathi and K. Chandran

IV. Mechanization devise for chipping sugarcane bud chips from sugarcane- A step ahead for entrepreneurs in sustainable sugar initiative
   R. Naik, S.J.K. Annamalai, N. V. Nair and N. R. Prasad

   Cloning and prokaryotic expression of sucrose phosphate synthase gene (SOFSPSB) from sugarcane
   H. Dongliang, L. Shuangxi, Q. Cuixian, L. Qing, F. Fengxue and L. Yangrui

V. Male sterility in intergeneric hybrids of Saccharum with alien cytoplasm
   V. Raffee Viola and M.N. Premachandran

   Characteristics of intergeneric hybrids between sugarcane (Saccharum spp.) and Erianthus spp.

VI. Complete genome characterization of Sugarcane yellow leaf virus from India and its phylogenetic relationship with other reported genotypes
   C. Chinnaraja, R. Viswanathan, R. Karuppaiah, K. Bagyalakshmi, B. Parameswari and P. Malathi

   A new scarabid specific Bacillus thuriniensis cry8 gene from sugarcane ecosystem
   B. Singaravelu, N. Crickmore, J. Srikanth, K. Hari, C. Sankaranarayanan, R. Nirmala, M. Meghna, S. Radesh Krishnan and S.M. Mathew

   Transcript profiling of plant - pathogen interaction pathway signaling molecules from KEGG database during sugarcane x C. falcatum interaction
   M. Muthumeena, NMR. Ashwin, A. Ramesh Sundar, P. Malathi and R. Viswanathan

   Assessment of Beauveria bronchiaartii and Metarrhizium anasopliae for the management of white grub Holotrichia serrata (Blanch) in sugarcane
   P.S. Shanmugham, N.A. Saravanan and N. Tamliselvan

VII & IX Identification of microsatellite markers for fibre traits in sugarcane
   L. Nivetha, P.T. Prathima, A. Selvi and N.V. Nair

   Characterization of intergeneric hybrids of Saccharum using molecular markers
   A. Selvi, A.S. Anu, Punnya Raj and N. V. Nair

VIII. Changes in transcript expression pattern and enzymatic activities of key genes of sucrose metabolism during stem development of high and low sugar sugarcane genotypes
   P.T. Prathima, G.S. Suresha, A. Selvi and M.N. Premachandran

   GI registration of Central Travancore jaggery: a boon for sugarcane farmers
   S. Cherian, V.R. Shajan, A. Sajeena, B. Thomas and J.S. Bindhu

   Documenting farmer’s innovations and indigenous practices in sugarcane production system – An exploratory study
   C. Karpagam, T.R. Shanthy, D. P. Prathap and P. Murali
VALEDICTORY FUNCTION

The three day deliberations came to a close with the valedictory function chaired by Dr. N. Gopalakrishnan, ADG (CC), ICAR, New Delhi. The conveners of technical sessions summarized each session and presented specific recommendations based on the discussions held during the sessions. The authors of the best posters were honoured with merit certificates during the function. Mementos were given to distinguished speakers and session conveners. In the function, Dr. N. V. Nair, Director, SBI and Chairman, Organizing Committee, ISNPSR made a recap of the symposium and expressed the hope that the deliberations that took place during the three days would lead to a better understanding of the technology landscape as it exists today and provide opportunities for close collaboration among the sugarcane scientists. Dr. S. Solomon, Dr. Frikke Botha and Shri. K. Nagendran gave their views about the symposium. Dr. G. Hemaprabha, member secretary, ISNPSR-2012 welcomed the delegates and Dr. R. Viswanathan, organizing secretary proposed vote of thanks. He thanked the ICAR for permitting to conduct this symposium as part of Centenary Celebrations of SBI. He affirmed that the grand success of this symposium was due to the guidance and support offered by Dr. N. V. Nair, Director, SBI; President (SSRD) and Chairman, Organizing Committee. He specifically thanked Dr. N. Gopalakrishnan, ADG (Commercial Crops) for his support and help in organizing this symposium. The events and sessions were well guided by eminent scientists and technocrats. He thanked the conveners for conducting the sessions efficiently. He profusely thanked the chairpersons and members of the symposium organizing committee for their tireless efforts. The symposium had overwhelming response from delegates far and wide representing almost all major sugarcane growing countries and sugar industries. He profusely thanked the delegates for taking efforts to participate in this symposium and their respective organizations for sponsoring them. The symposium also received generous support from sugar industries, allied sectors, exhibitors and NABARD which was acknowledged thankfully. The support and help rendered by the SSRD was also thanked. In the annals of SBI, this historic event will be a memorable one. The function came to an end with national anthem.
EXHIBITION

An exhibition was arranged for the participants during all the three days to give the right kind of exposure to the products and technologies available in the country. Fourteen exhibitors have participated in the exhibition. Various input manufacturers / suppliers, farm machinery manufacturers and biotechnology firms have participated. The delegates evinced keen interest in viewing the stalls and had fruitful discussions with the exhibitors to know about their products. Display of combined cane harvester as part of the exhibition invited good number of visitors and delegates from the factories.

INSTITUTE VISIT

A visit was organized to Sugarcane Breeding Institute on 18-10-2012. The delegates visited the varietal museum, National Hybridization Garden, Controlled Condition testing facility for rapid evaluation of red rot resistance, wide row spacing and water management experiments apart from laboratories. The varietal museum included the recent releases from SBI, Coimbatore and its regional station at Karnal, interspecific and intergeneric hybrids and representative members of Saccharum complex.

The delegation showed keen interest on the varieties released and in pipeline and in the genetic resources available for sugarcane improvement programmes, including interspecific and intergeneric hybrids at different
stages of nobilization involving: *Erianthus arundineaeus*, *E. bengalense* and *S. spontaneum*.

The activities of the National Hybridization Garden raised curiosity among the foreign delegates as a unique feature of the organized structure of Indian sugarcane varietal development programme. The elevated hybridization runway made pollination easy and efficient as demonstrated to the delegates. Red rot being the major sugarcane disease of India, the need for a controlled condition testing (CCT) was essential to eliminate highly susceptible types early in the breeding generation. This simple technique to simulate the natural endemic conditions was also demonstrated to the delegates.

As the last part of the symposium, the delegates visited M/s Sakthi Sugars Ltd, Appakudal ~100 km from Coimbatore, which is one of the largest and well organized sugar factory complexes in the country. The President of the unit, Mr. Natarajan welcomed the delegates and Mr. Sezhiyan, General Manager presented facts about the factory and its sugarcane research & development activities to achieve high cane yield in the region. The delegates interacted with the members of “100 tonnes an acre farmers’ club” on various cane production and protection technologies adopted and witnessed various machineries such as rotary tiller, multi row rotary tiller, sugarcane planter, whole cane harvester, spading machine etc used in sugarcane cultivation.
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