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Conservation of The Living Repositories of Sugarcane Plant Genetic Resources

Sheelamary, S and S.Karthigeyan
[1]Breeding section, ICAR-SBI, Coimbatore
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Introduction

Plant breeding and development of new cultivars are essential components for increasing the productivity of crop plants. Plant genetic resources, is a natural resource necessary for the existence of human life on this earth. Plant breeders are in need of an uninterrupted supply of diverse but novel genetic diversity to produce new crop varieties able to cope with the impacts of changing climatic conditions. There is an urgent need to preserve genetic diversity of known and unknown economic importance which is having a potential for use in future. Plant genetic resources consist of diversity of genetic material of crop wild relatives and wild plant species, modern cultivars and released varieties. Field Gene bank maintenance of sugarcane diversity which are vegetative propagated, that are being maintained in the fields are called Field Gene bank. Field Gene bank is an ex-situ collection of crop diversity and dynamic system of *Saccharum* species. It is conserving and maintaining as much diversity as possible in a single place. Field Gene bank has many advantages like crop diversity conservation, sources of propagating materials, resources for research and study, providing diversity options and selection opportunity, access to all from anywhere and materials for pre-breeding and breeding, etc. Field Gene bank is not only for conservation and distribution; it is considered as learning centre for the researchers involved in sugarcane research.

Promotion of germplasm collection and their maintenance

The International Society of Sugarcane Technologist (ISSCT) had an interest in collection and conservation of sugarcane gerrmplasm. This opened up a committee of technologists to collect and conserve noble and wild sugarcanes species. Plant breeders and research organisations had become concerned at the narrow genetic base of commercial sugarcane and the possible loss of valuable wild gerrmplasm. First in the world, India offered to expand its national germplasm collection at Coimbatore, and this was recognised as an ISSCT world collection at the Ninth Congress in 1956. NATP introduced an action plan to

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establish a collection, encourage expeditions to unexplored areas and sanctioned a fund to characterise germplasm. With the funding from NATP on Biodiversity, efforts were renewed to explore and collect sugarcane germplasm from unrepresented areas to make the existing collections more representative of the genetic variability available in the country.

Exploration

The collection of plant genetic resources primarily aims at tapping germplasm variability in different crop plants, their wild relatives and related species. The germplasm so collected reveals extent of variability in different species, within species, cultigens, etc. as also their geographical distribution. For sugarcane improvement and for the breeders a large diverse germplasm collection is essential. Specific missions were carried out to collect the variability available in sugarcane. Separate expeditions across India and across globe have been made from 1912 to till date to collect genotypes focusing on a particular area. During the period of 1999-2004, 11 explorations were conducted in different parts of the country. There are about more than 25 explorations were made so far. These clones have been deposited and being maintained in ICAR-SBI, Coimbatore. These materials are the new sources for specific needs especially for yield, quality and for biotic and abiotic stress resistance so as to Borden the genetic base of the sugarcane. The collection is made up largely of landraces and cultivars, some obtained through recent collecting expeditions.

Current status of sugarcane germplasm

The cultivated plants together with wild species of *Saccharum* and related genera including *Erianthus, Miscanthus, Narenga, and Sclerostachya* form the basic genetic resources of sugarcane. The World Germplasm Collection of Sugarcane consists of approximately 2140 Saccharum and related genera and is being maintained at ICAR-Sugarcane Breeding Institute, Coimbatore, Tamil Nadu, and India since 1912. Some collections are also maintained at ICAR-SBIRC, Kannur, and Kerala. Currently, the ICAR-SBI, the major environmental event that affects the World Germ plasm Collection of Sugarcane is temperature. At present, 2140 accessions were being maintained in Coimbatore which included *S. spontaneous*, E. *arundinaceous*, *Erianthus* spp., Allied Genera, improved Erianthus for fibre and Saccharum clones. The analysis of genomes in *Saccharum* had been made by Nishiyama (1956). He studied the meiotic configurations of *Saccharum* species and their interspecific hybrids. Based on homologies of chromosomes in all these hybrids, he

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concluded that there were two basic numbers, 8 and 10, since polypoloidy in Saccharum consisted of multiples and combinations of these two basic numbers. In the middle of the 19th century, as many as 62 species were recorded under the genus *Saccharum* (Steudel, 1855). About a century later, they were reduced to five, *Erianthus, Sclerostachya, and Narenga* being transferred to three different genera. Mukherjee (1957) had demonstrated that the latter three genera were interrelated and interbreeding and he termed them as " Saccharum complex." *Saccharum* extends through the tropics and subtropics from the Pacific islands through Asia to the Mediterranean and Africa (Panje and Babu, 1960). *Erianthus* is widely present in the tropics and subtropics region (Mukherjee, 1957); *Sclerostachya* and *Narenga* are mainly confined to the humid tropics of South East Asia. Thus the maximum number of this complex was centered in the Indo-Burma China border region.

Saccharum spontaneum, wasteland weed, is a tall perennial grass with deep roots and rhizomes, up to 4 m height. It is believed to be a predecessor of the important species *S. officinarum* L. (cultivated sugarcane). It has the worldwide distribution extending across three geographic zones i.e. East Zone, Central Zone, and West Zone and other countries infesting millions of acres, often causing abandonment of fields. The plant stem and outer sheath have high content of carbohydrate fraction in its cell wall (67.85% by wt.), meriting its quality to be an appropriate substrate for ethanol production.

For the effective conversion of lignocellulosic material into ethanol, there are three major steps involved firstly, thermochemical pretreatment – a preprocessing step that improves enzyme access to the cellulose; secondly, enzymatic saccharification – use of cellulases and hemicelluloses; and thirdly, fermentation of released sugars by specialized organisms .The enzymatic hydrolysis is a promising and environmentally feasible method for saccharification of lignocelluloses to sugars. Pretreatment of any lignocellulosic biomass is an important tool for practical cellulose conversion processes, which is required to alter the structure of cellulosic biomass to make cellulose more accessible to the enzymes. Aqueous ammonia or ammonium hydroxide is a cheaply available chemical, which effectively removes lignin and eventually increases the surface area and pore size of the substrate resulting in enhancing enzymatic digestibility. It is generally more specific towards lignin removal than to carbohydrate degradation as compared to the other chemicals used for

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delignification.To make ethanol from lignocellulose successful at industries, the choice of fermenting microbial trait lies upon its capability to survive at high temperatures, osmotolerance and could withstand against fermenting inhibitors resulting into high ethanol yield within shorter time periods. Thermotolerant *Saccharomyces cerevisiae* VS_3, isolate of our laboratory proved its efficacy by showing thermotolerance (grow up to 45 °C) and ethanol production up to 93 g/L from 200 g/L of glucose. A recent report proved its capability in fermentation of *L. camara* hydrolysates by giving the ethanol yields (0.431 g ethanol per g of sugar) with fermentation efficiency (83.7%).

Erianthus arundinaceus, a wild relative of the genus *Saccharum* is a broad-leaved species and well known for its drought tolerance, high fiber and biomass. It also has resistance to pests and diseases with good ratooning ability. Sweetcane can adapt to a variety of growth environments due to its wide resistance to abiotic and biotic stresses. Compared with other bioenergy grasses under the same growth conditions, sweetcane usually has a higher photosynthetic efficiency, biomass yield, cellulose content and calorific value. Moreover, sweetcane could be a highly effective phytoremediator for wetlands, buffer strips along surface waters, and contaminated lands due to its highly efficient uptake of nutrients and heavy metals. Additionally, the subsequent biomass can be harvested for bioenergy production. However, the study of sweetcane as a bioenergy is still in its infancy. More works on breeding, cultivation, genetic transformation, biorefinery, and energy conversion technologies need be done.

Conservation of sugarcane germplasm at Coimbatore

The collection is replanted every year during the January-February planting season. The centre is maintained without the interruption of diseases and pests and with all necessary measures. In addition, 47 accessions from Arunachal Pradesh at IARI Regional Station, Wellington and IND collections are maintained at the main campus, Coimbatore. Maintenance of the germplasm collection is meticulously planned and the replanting of more than 2000 genotypes every year involves large resources. Routine quarantine measures are conducted by plant protection scientists. Although there have been difficulties in maintaining some noble canes and hybrid clones infected by SCBV no germplasm has been lost.

Purpose of germplasm maintenance

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The most important reason for maintaining a germplasm is to provide germplasm with desirable traits for the breeding programs. Some clones from higher altitude will not be flowered, but most have traits of benefit to sugarcane improvement programs. These traits may be disease or insect resistance and other abiotic stresses. The main recipients of sugarcane germplasm were, who received more than 60% of the germplasm accessions for ICAR-SBI projects, 20 % for research and remaining 20% of the germplasm were unutilized. The main purpose of distribution were i) cytological studies for identification of somatic chromosome number ii) prebreeding purpose to introduce new genes iii) evaluation of clones for biotic and abiotic stresses iv) for applied research (biotechnology).

Conclusion

Plant genetic resource conservation and maintenance involves managing and using resources in a manner that does not deplete them. So, it is necessary to safeguard plant genetic diversity from loss by a variety of causes. This may also help traditional farming cultures to survive. Conservation of PGR effectively requires a sound scientific and technical basis. Effective conservation must be an understanding of the extant genetic diversity in the sugarcane species and distribution.