SUGARCANE

Sugarcane Improvement in Guangxi: Progress and Perspectives

Yu-mo Tan and Hong He
Guangxi Sugarcane Research Institute, Nanning, Guangxi - 530 007, China

This paper reviews the history of replacements of improved sugarcane varieties and their significant contributions to the cane yield and sugar content in the past several decades in Guangxi. Five obvious replacements of the varieties were recorded typically from local initial cultivated species (S. Sinense) varieties Bamboo cane and Rose Bamboo cane to POJ2878, F134, Guitang 11 (GT11) and ROC16 which is dominant at present. Therefore, from 1950s' to 2003, it had been increased by about 1,000 times in total sugar yield in Guangxi from 0.004 million tons to 5.86 million tons, and by 315% in milling cane yield per unit area which was increased from 26.6 t/ha. to 66.5 ton/ha. or by 6% per year, and by 0.92% in absolute sucrose % cane during the past five decades. It is considered that the replacements of sugarcane varieties have played an important role to promote the sugar industry in Guangxi. Based on the severe drought and unfertile soil conditions, the breeding targets of high cane yield, high sugar content, strong drought and disease resistance, and strong ratooning ability have been worked out for the sugarcane breeding program. Total 21 varieties have been bred and released to the commercial production since GXSCRI was established in 1956. It would take further about 10 to 12 years to complete the schedule for a successful new improved variety, in which about 5-6 years selecting in the GXSCRI and 5-6 years in regional trial out the GXSCRI. For broadening the germplasm base of sugarcane breeding, hundreds of wild germplasm materials including S. spontaneum, S. arundinaceum and Miscanthus, were collected from various locations in China, and 150 varieties were introduced from exotic countries during the past decades. Yacheng (YC)71-374, GT11, ROC1, CP65-357, CP72-1210, YC73-512, ROC10 etc. displayed good combining ability as desiring new parents in recent years. Molecular technology has been used as a supplementary tool for sugarcane breeding. The study made in Guangxi showed that sugarcane nitrogen-fixation research had very significant and good prospect. The RSD pathogen was detected by PCR molecular technology. Transformed plants from S. spontaneum, E. arundinaceus with bar gene have been cultured through gene gun and Agrobacterium mediated transformation.

KEYWORDS: Sugarcane, breeding, China

SUGARCANE PRODUCTION CONDITIONS AND BREEDING TARGETS IN GUANGXI

Guangxi Zhang Autonomous Region (GZAR) is the major sugar production area in China. It is located in the southern part of China along the sea coast with subtropical monsoon climate, north latitude 20°54'–26°23', east longitude 104°28'–112°04'. The climate of four seasons was distinguished into spring, summer, autumn and winter clearly. The annual average temperature ranged from 20.8 °C to 21.6 °C, maximum in July from 27.0 °C to 28.8 °C and minimum in January from 10.8 °C to 13.7 °C, average annual rainfall from 1100 mm to 2700 mm, sunshine from 1,680 hours to 1,840 hours, relative humidity ranged from 48% to 85% (Guangxi handbook, 1988).

The hot-wet season start from April to September and the cool-dry season from October to March, the natural conditions are very good for cane growth and sugar accumulation (Peng, 1981). Sugarcane could be harvested generally in early November with 6-9 months growing duration. The milling season ranges from early November to the end of March. However, because of being short of rainfall during the autumn frequently due to the monsoon climate and lack of irrigation in most of the cane area, cane growing and sugar accumulation are affected at late growth stage (Yi,1900). High cane tonnage and high sugar content are the major targets in the breeding program, but the drought resistance is also a key factor to be considered.

In Guangxi, 90 per cent of the cane growing area belongs to the hilly land or upland, and is composed of red, yellow, purple, or limestone soil, and minor
part of alluvial soil. Yellow and red soils are most common, especially in the area of north latitude 22°-23°, the south to the Tropic Cancer, and beneath altitude of 500m. The nutrients of soil generally include 1.5%-3.0% organic matter, 0.038%-0.205% total nitrogen, 2.018%-0.127% total phosphors and 0.07%-2.06% potassium with pH of 4.6-6.5. There is higher organic matter with 3%-5% and pH with 6.5-8.0 in the alluvial soil (GSFSS, 1994; Qin et al., 1991). Therefore, most soil is suitable for sugarcane growing in Guangxi, but the soil layer is thin which is about 10-25cm and barren infertile with varied topography. Most soil is solid and hard, and rain water is difficult to permeate through the surface into the root zone of red and yellow soil, so the soil is getting dry easily after raining and it is not good for root growing vertically and laterally (Qin, 1988). The poor capacity of water maintained is one of main factors limiting high cane yield in Guangxi (Peng, 1987).

High sugar productivity per unit area is the basic target of sugarcane improvement in Guangxi. The comprehensive characteristics are composed of high yield, high sugar content, early maturation, good ratooning, and strong resistance to drought, diseases, pest and lodging (Peng, 1987, 1984). The performance of growing fast at early stage is very important in the upland, and the varieties with middle stem is more suitable for the non-irrigated condition rather than those with large stem.

Some breeding goals were enhanced during the past two decades, such as high cane yield growing suitably in fertile soil rather than unfertile soil, and higher sugar content and drought tolerance.

THE CONTRIBUTION OF IMPROVED VARIETIES TO CANE YIELD AND SUGAR CONTENT

The cane cultivation history is over thousands years old in Guangxi, but only local varieties of Bamboo cane (S. sinese) and Rose Bamboo cane had been planted and occupied over 90% of the total cane area until 1940, when the exotic cane varieties of POJ, Co, F, CP series were introduced. The exotic commercial varieties, such as POJ2878, POJ213, POJ3016, F134, F108 CP45-50 Co419, Co290, NCo310 etc. became dominant until 1950s (Peng, 1980, 1987, 1988).

Guangxi Sugarcane Research Institute (GXSCRI) was established in 1956 in Nanning, the capital of Guangxi province and started the sugarcane breeding program with the hybrid seeds from Hainan Sugarcane Breeding Station, as one of the earliest units to carry out the sugarcane breeding in mainland China. Total 21 GT varieties had been released for commercial production by GXSCRI since 1968. However, the variety F134 had been dominant until early 1980s when GT11 was released (Li, 1982; Peng, 1987).

During 1981-2000, GT11, Trojan and YT63-237 replaced F134 as major varieties and they occupied over 80% of total cane growing area in Guangxi. Guitang 11 was the best among all the varieties bred in mainland China, which occupied about 3.3 million ha., during past 15 years, once played very important role for the development of sugar industry in Guangxi.

Sugar mills always expect those varieties with higher sugar content. In recent years, a set of the new varieties, such as ROC16, ROC22, YT93-159, GT94-119, GT94-116 etc., have became dominant since 2000.

Total five significant replacements of cane varieties took place in Guangxi in the past 50 years. The typical representative varieties are Rose bamboo cane and locate bamboo cane (before 1940), POJ series (1940-1950s), F134 (1950s-1981), GT 11 (1981-2000) and ROC series (since 2000) (see Fig. 1) (Lu, 2001; Tan, 1994).

During the past decades, about 10,000 times of total yearly sugar output, 315% of yearly milling cane yield per unit area were increased with 6%