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RESEARCH ARTICLE

SUGAR ACCUMULATION PATTERN IN TROPICAL AND SUBTROPICAL SUGARCANE VARIETIES OF DIFFERENT MATURITY GROUPS

K. Chandran[1]* and M.N. Premachandran[2]

Abstract

In sugarcane, sugar accumulation is not uniform throughout the crop season and varieties show variation in the pattern of accumulation.The present study was conducted to understand the pattern of sugar accumulation in different genotypes identified as subtropical and tropical varieties with different maturity period. Hand refractometer Brix data of 28 varieties were recorded at 30 days interval from six months after planting to 12 months after planting. It was observed that the varieties classified as early and mid-late did not display any definite pattern of sugar accumulation and varieties within the groups differed in the accumulation pattern. Similarly, the subtropical varieties had not shown any difference in the Brix build up when compared with that of tropical varieties. There was a dip in sugar accumulation during December/January in most of the genotypes, which could be due to the difference in the minimum and maximum temperatures and the vegetative growth triggered due to rainfall at the location of study.The sugar accumulation pattern determined using the Brix build up at specific locations is to be considered while classifying commercial sugarcane varieties as early, midlate or late maturing clones for that location.

Key words : Sugarcane, *Saccharum*, tropical varieties, subtropical varieties, Brix, sugar accumulation.

Introduction

Sugarcane (*Saccharum* spp. hybrid) is a major crop grown in both subtropical and tropical belts of the world for production of sugar. The sucrose synthesised in the leaves is transported to the culm or cane for storage. In general,the vegetative growth rate of sugarcane slows down and sucrose content in cane increases approximately by 180 days after planting. Genotype, plant maturity and environment play a significant role in the rate of sucrose accumulation (Glaziou and Gaylor 1972; Moore 1995; Jackson 2005). Duringthe growth of the cane, each internode operates as an independent unit and the lower internodes ripe early while the upper part of the stem continues growth. As the cane matures, more internodes attain higher sucrose content. The suitability of sugarcane varieties in terms of varying maturity and different harvesting timeis determined based on the peak accumulation of sucrose. On the basis of the variation in sucrose content, varieties are classified in to early, mid-late or late maturing types. Brix is the percentage weight of solids in a pure sucrose solution and it is generally accepted that Brix represents the apparent solids in a sugar solution (Chen 1985). The indirect estimation of sucrose content in juice in each internode is possible through the non-destructive method of observing

K. Chandran[1]*
Sugarcane Breeding Institute Research Centre, Kannur (Kerala) – 670 002
M.N. Premachandran[2]
Crop Improvement Division, Sugarcane Breeding Institute, Coimbatore (Tamil Nadu) – 641 007
*email : chandranksd62@gmail.com

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Table 1. List of sugarcane varieties used for the study on sucrose accumulation pattern

Tropical early	Tropical mid- late	Subtropical early	Subtropical mid-late
Co 449	Co 419	BO 43	BO 34
Co 527	Co 740	BO 99	BO 91
Co 775	Co 785	Co 395	Co 312
Co 997	Co 62175	CoJ 64	Co 453
Co 6415	Co 6304	CoP 1	Co 975
Co 8231	Co 6806	CoP 2	Co 1148
CoC 671	84 WL 22	CoS 510	Co 1158

hand refractometer Brix. The present study was taken up to determine the sucrose accumulation pattern in Indian commercial sugarcane varieties from early and mid-late maturity groups for tropical and subtropical regions maintained at Kannur, a high rainfall area in the west coast of India.

Materials and methods

The study was conducted at Sugarcane Breeding Institute Research Centre, Kannur (Kerala) where the average annual rainfall is above 3500mm. The clones were planted in the field in 2 m rows with a rowtorow spacing of 90 cmand recommended package of practices was adopted. The hand refractometer Brix (HR Brix) was recorded in 28 sugarcane varieties representing tropical early, tropical mid-late, subtropical early and subtropical mid-late groups (Table 1).

HR Brix data were collected at30 days interval beginning six months after planting (August) and ending 12 months after planting (February) from bottom, middle and top internodes of the cane using a drop of juice collected with a cane piercer.The second internode above the ground was taken as bottom internode, the one above the top most dry leaf was taken as the top internode and the internode in the middle of the cane in between top and bottom was taken as the middle internode. The observations were made on three canes for each variety and mean value was considered for the study. The sugar accumulation pattern in different varieties was compared after plotting the data in graphs. TheBrix data were correlated with the mean minimum and maximum temperature seven days preceding the date of observation.

Results and discussion

At sixth month (August),the highest Brix was recorded at the bottom of the cane compared to middle or top of cane in all the sugarcane varieties studied. At 12th month (February), the bottom, middle and top of cane had almost equal or top had higher Brix in few varieties.There was gradual increase in Brix from August to November in all the varieties and bottom, middle and top internodes did not differ much in Brix in November.Among the varieties studied, the highest Brix was observed in BO 34, with values above 25 in bottom, middle and top of the cane in February. Flowering in different varieties occurred from third week of October to fourth week of November.

Tropical early: In this category,the two varietiesCo 997 and Co 6415 had no flowering during the period of observation whereas the other five varieties, namelyCo 449, Co 527, Co 775, Co 8231 and CoC 671 floweredfrom last week of October to second week of November. The cane thickness in this group ranged from 1.7 to 2.5 cm and single cane weight ranged from 0.68 to 1.35 kg. The HR Brix values in the month of August ranged from 13.0 to 19.0 at bottom, 13.0 to 20.2 at middle and 15.0 to 20.3 at top of the cane. In all the varieties in this group,there was a gradual increase of Brix from August to November followed by a decrease in the month of

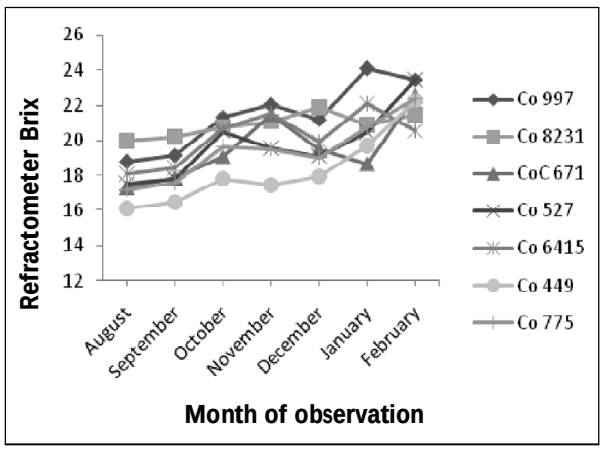

Fig. 1. Sugar accumulation pattern in tropical early varieties

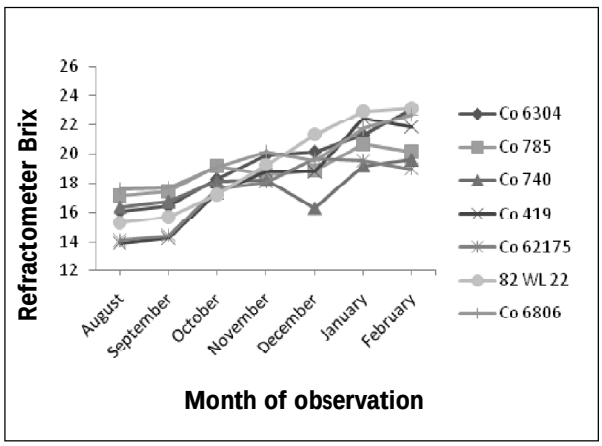

Fig. 2. Sugar accumulation pattern in tropical mid-late varieties

December (Fig.1).Thereafter, there were differencesamong the varieties in Brix build up pattern. A gradual increase in Brix after the decrease in December was observed in Co 449, Co 527, and Co 8231.There was a dip in Brix in the month of January in Co 775, Co 997, and Co 6415, and it further decreased in February (12th month) confirming the early peak maturityin these varieties before 10 months.

Tropical mid-late: Six out of the seven varieties studied in this category flowered, the exception being Co 6806. The flowering period was from fourthweek of October to fourth week of November. The cane thickness ranged from 1.8 to 2.7cm with single cane weight of 0.76 - 1.06 kg. In the mid-late varieties studied, the initial Brix values were low compared to early maturity varieties,with Brix values being 11.0 (Co 62175 and Co 419)to 16.0 (Co 6806 and Co 785) at bottom, 14.0 (Co 419) to 17.0 (Co 6806, Co 785) at middle and 16.0 (Co 419, Co 62175, Co 98001) to 19.0 (Co 6806) at top. In this group, except for Co 62175 and 84 WL 22, there was reduction in Brix in the month of December (Fig. 2). Co 62175 is the male parent of the clone 84 WL 22 and both the clones exhibited high waterlogging tolerance. This indicated that the excess moisture stress during the month of December had not affected the sucrose accumulation pattern in these waterlogging tolerant clones.

Subtropical early: In this group,only CoS 510 has not flowered while in the other varieties the flowering occurred between third week of October andfourth week of November. All the varieties studied had relatively thin canes with stalk thickness ranging from 1.3 to 1.9 cm and single cane weight ranging from 0.34 to 0.66 kg. This group had the highest range (12.5-19.0) ofBrix valuesin August. Varieties showed variation in the pattern of accumulation with most of themshowing highBrix in the month of November. At the time of harvest, except BO 99 which had the highest Brix in February, the mean Brix value of the varieties was almost same as that in the month of November(Fig. 3). This indicated that early maturing subtropical varieties attained peak maturity by November (at ninth month) even in the tropical region of Kannur. Brix value at bottom

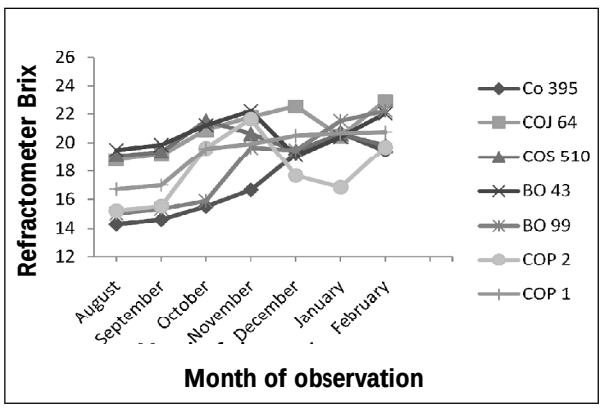

Fig. 3. Sugar accumulation pattern in sub-tropical early varieties

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ofcane in BO 99 had decreased in December from that in August, though the mean brix value of the cane showed steady increaseafter a slight decrease inthe month of December.

Subtropical mid-late: The canes in this group were relatively thicker than those in the early maturing types. The cane thickness ranged from 1.7 to 2.6 cm and single cane weight ranged from 0.42kg to 1.02kg. All the clones studied in this group were regular flowering types with the flowering period extending from third week of October to second week of November. This group showed highest Brix values during harvest at 12 months which rangedfrom 17.0(Co 975) to 25.8(BO 34).There was a dip in sucrose accumulation in Co 312 in November whereas in all other varieties, except for Co 975,in December. Co 975, Co 1148 and Co 1158 exhibited decrease in Brix at 12th month (Fig 4).

The mid-late varieties studied were with very low Brix initially compared to the early varieties. The subtropical varieties included in the study were older varieties which were with lower Brix compared to the tropical varieties studied.There was a reduction in Brix values in most of the varieties in December which could be due to rainfall in November resulting in high soil moisture content and humidity that may have favoured vegetative growth. Moisture status of sugarcane differentially affects the CO_2 assimilation and rate of sucrose movement from leaf

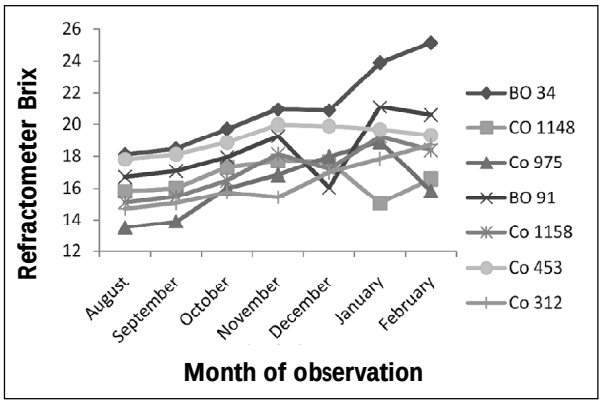

Fig. 4. Sugar accumulation pattern in sub-tropical mid-late varieties

to storage tissue (Hartt 1967). There was decrease in brix value either in December, January or February inthe case of early maturing types. Lingle et al. (2009) observed that physiological traits that contribute to sugar accumulation include the growth of the stalks, and the growth of internodes and sugar accumulation within them. Bacchi and Sousa (1977) and Liu et al. (1998) reported that the sugarcane development rate is strongly influenced by temperature. In the present study, the mean minimum temperature during the week preceding the Brix observation was negatively correlated toBrix with coefficients of -0.558, -0.455 and -0.349 for the top, middle and bottom internodes, respectively. But maximum temperature had positive correlations (0.613, 0.483 and 0.363 for top, middle and bottom respectively.The difference in minimum and maximum temperature and the triggered vegetative growthdue to the extended rainfall may have contributed to the decrease in Brix value in certain varieties in December or in subsequent months.The genotype is playing a major role in the Brix accumulation pattern among varieties in varying climatic and edaphic conditions.

It was observed that the varieties classified as early and mid-late did not have any definite pattern of sugar accumulation and varieties within the groups differed in the accumulation pattern. This shows that while classifying clones in to different maturity groups the sugar build up pattern needs to be considered. Between the tropical and subtropical varieties also there was no specific difference in the Brix pattern in the internodes. Along with the sugar content, the cane yield potential at the location is equally important for the performance of the variety. So, even if the subtropical variety showedhigh sugar content in the tropical area or vice versa, it may not be suitable as a commercial variety if the cane yield and response to biotic and abiotic stress factors prevailing in the other region are not favourable. The high Brix build up in certain subtropical varieties in the tropical region indicated that they can be used as parental clones or donors for high sucrose trait in tropical varieties. In sugarcane breeding, while selecting the parental clones their sugar build up

pattern should also be taken in to consideration so as to have the desired early high sugar or late high sugar cloneswith optimum cane yield in the progeny.

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