Sucrose Accumulation and Maturity Patterns of Sugarcane under Rain-fed and Irrigated Conditions in Sri Lanka

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Abstract

Under ideal conditions, sugarcane is capable of storing sucrose in the stalk up to 62% of dry weight. It varies with growing conditions, crop age and cultivar. A field experiment was conducted at the Sugarcane Research Institute, Uda Walawe in 2002/07 using eight commercial sugarcane (Saccharum hybrid L.) varieties under rain-fed and irrigated conditions in a split-plot design in three replicates with the objective of evaluating the patterns of sucrose accumulation and maturity in sugarcane under different growing conditions to identify promising varieties having high-quality juice at maturity. Laboratory analysis of cane samples for the juice quality parameters, i.e., brix%, pol% (sucrose% out of brix%) and fibre% was carried out at 215 and 304 days after planting (DAP) under irrigated and rain-fed conditions, respectively and continued at one-month intervals up to 510 DAP to determine the purity of juice and pure obtainable cane sugar content. The ratio between brix% values in the top and bottom portions of the cane stalk (T/B ratio of brix%) of different sugarcane varieties were determined. The seasonal variation in juice quality parameters and maturity patterns indicated by the T/B ratio of brix% values of the sugarcane varieties tested showed a significant effect between water regime and variety. Early stage water deficit appears to have depressed the vegetative growth and the rain-fed crops had significantly lower values in all parameters up to 400 DAP in comparison to the irrigated crops. Sucrose accumulation throughout the growing season and final sucrose content in the stalk at harvesting was highest in the improved varieties of SL 88 116 and SLI 121 compared to Co 775. Therefore, replacing the standard variety Co 775 in sugarcane plantations with the improved varieties which have higher sucrose content under different growing conditions would ultimately increase the sugar production in Sri Lanka.

Keywords: Irrigated, Maturity patterns, Rain-fed, Sucrose accumulation, Sugarcane

Introduction

The accumulation of sucrose in sugarcane stalk begins from the bottom of the stalk and gradually progresses upward with maturity to the higher internodes. This process occurs parallel to the progress of growth of the crop. At full maturity, the top internodes have a total water soluble dry matter (brix%) and sucrose concentration (pol%) levels which are almost similar to that in the bottom internodes. Sucrose content (SC) varies along the stem with respect to changes in crop age, stalk height, biomass and seasonal variation in climate (Inman-Bamber et al., 2002). Therefore, the ratio between brix% values in the top and bottom portions of the cane stalk (T/B ratio) and purity% which is the amount of sucrose present out of total water soluble dry matter in the cane juice are used to determine the maturity of sugarcane. At full maturity, T/B ratio should be equal to 1 and purity % should be greater than 85 % to be recommended for milling. The pol % and pure obtainable cane sugar (pocs%, a measure of stalk sucrose concentration on a fresh weight basis) in cane juice are used to determine the seasonal sugar accumulation in sugarcane and the quality of cane juice. Under ideal conditions, hybrid sugarcane cultivars are capable of storing sucrose in the stalk up to 62% of the dry weight or 25% of the fresh weight (Bull and Glasziou, 1963). But it is well known that SC of stalk varies from the start of stalk growth to harvesting. It also varies with irrigation, crop age (Evensen et al., 1997), water stress (Inman-Bamber et

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brix% values of different sugarcane varieties showed a significant ($p<0.05$) interaction between water regime and variety (Fig. 1). The seasonal patterns of variation of pocs% (Figs. 1.A_3, B_3 and C_3) and total biomass under irrigated conditions were similar (De Silva, 2011).

At 409 DAP, when the irrigated crops were harvested, the rain-fed crops had significantly ($p<0.05$) lower values as compared to the irrigated crops (averaged across varieties) in all the above parameters except fiber% (Figs. 1.C_{1-4}). The respective mean values at 409 DAP were15.6% of brix, 13.1% of pol, 83.6% of purity, 12.9% of fiber, 9.5% of pocs and 0.8 of T/B ratio under rain-fed conditions and 18.2% of brix, 16.2% of pol, 88.8% of purity, 13.3% of fiber, 12.1% of pocs and 0.9 of T/B ratio under irrigation. As purity of cane juice should be greater than 85% at maturity, it was obvious that the irrigated crop which had 88.8% of purity, matured for harvesting whereas the rain-fed crop which had 83.6% of purity, did not mature for harvesting at 409 DAP. However, the T/B ratio of brix% reached up to 0.94 and 1.01, and purity was 85.96% and 86.65% under irrigated and rain-fed regimes respectively at the time of harvesting rain-fed plots at 508 DAP. At the time of harvesting, both rain-fed and irrigated crops had similar sucrose concentration (12.1% pocs). It

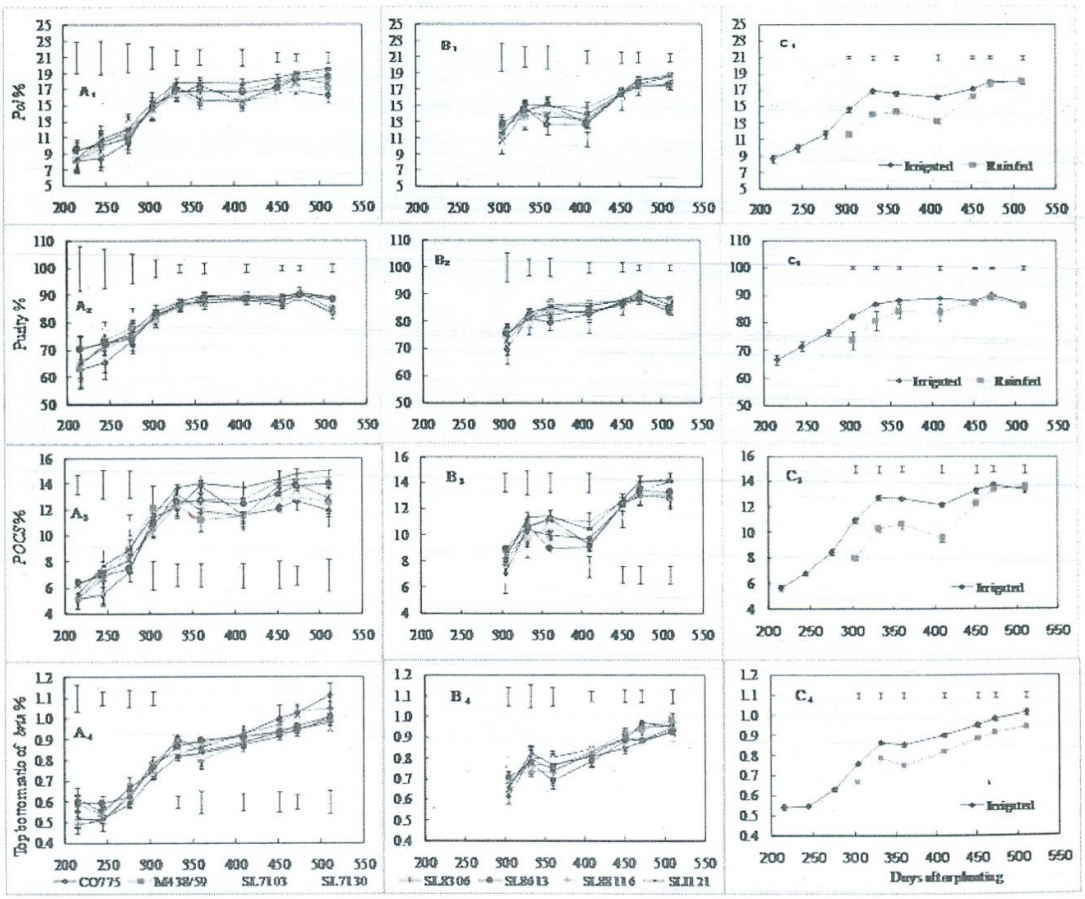

Figure 1 Seasonal variation of pol%, purity%, pocs% and top to bottom ratio of brix% in cane juice with age in different sugarcane varieties, (A_{1-4}) under irrigation, (B_{1-4}) under rained conditions and (C_{1-4}) when averaged across varieties. Each data point in the graphs 'C_{1-4}' is the average of eight varieties and error bars indicate the respective standard error and LSD of the means.

appears that the variation of juice quality characters between the two water regimes at 409 DAP occurred due to different growing stages.

Most of the above-mentioned quality variables in rain-fed crops significantly ($p<0.05$) increased from 409 DAP to 508 DAP, which showed rapid maturity of cane whereas pol%, purity% and pocs% in irrigated crops showed reductions after 470 DAP which may have resulted due to over maturation. Similar observations have been made by Evensen et al. (1997) that a decrease in SC after 18 months after planting (MAP) under irrigated conditions. Similarly, Gascho and Shih (1983) reported that non-irrigated sugarcane had a higher SC at 5 MAP, but SC in the irrigated crops increased rapidly from 7-8 MAP and it was higher from 8-12 months than the non-irrigated cane. After 11 months, the SC in the irrigated cane became constant while that in non-irrigated cane continued to increase until 14 months. When it began to decrease, the SC of non-irrigated cane dropped less than that in irrigated cane after 16 MAP.

There was a varietal variation in sucrose accumulation in the stalks of sugarcane. When averaged over the season and at the time of harvesting, the highest brix%, pol% and pocs% were recorded in the varieties of SLI 121 and SL 88 116 under both water regimes whereas the lowest brix%, pol% and pocs% were recorded in the varieties Co 775 and SL 71 30 (Fig.1). These results showed that sucrose accumulation throughout the growing season and final SC in the stalk at the stage of harvesting were highest in locally-improved SL 88 116 and introduced SLI 121 varieties compared to the standard (Co 775) and old (SL 71 30) varieties. Therefore, replacing the standard variety Co775 which has currently occupied more than 30% of sugarcane plantations with the improved varieties such as SL 88 116, which are having high SC under different growing conditions would ultimately increase the sugar production in Sri Lanka.

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