Evaluation of Sugarcane Germplasm for Development of Core-collections for Directional Breeding of Sugarcane (Saccharum hybrid spp.)

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Introduction

Sugarcane (*Saccharum* hybrid spp.) is cultivated globally as a main source of raw material for production of sugar. Currently, Sri Lanka produces about six percent of the local sugar requirement, which is around 650,000 tons per annum. The present government has launched programmes as per the Mahinda Chinthana Development Frame work (2005) to achieve 40% self-sufficiency in sugar by year 2020 and 100% by year 2030. Sugarcane variety improvement plays a major role in achieving the said targets by developing new varieties with commercial attributes and selecting of varieties suitable for growing in different agro-ecological regions in the country. Selection pressure is applied to select varieties with higher cane yields and sugar contents, equitable fiber and resistance to major pests and diseases. Germplasm evaluation, parental selection in hybridization and progeny selection using appropriate methodologies increase the efficiency of the sugarcane breeding programme. Most of the local collections belong to *Saccharum officinarum* and there were a few hybrids which could not be recognized visually. The imported varieties and standard varieties were hybrid derivatives of early nobilization work.The present study was carried out to assess the parental worth of 217 sugarcane accessions to identify the most suitable parent clones and I nclusion of them into the proven parents system for crossings directed to high cane yield, high sugar content in juice and moderate fiber content. The specific objectives of this study were to estimate breeding values of accessions for yield components, clustering of accessions for making core-collections and estimation of association between yield components of sugarcane.

Methodology

The experiment was laid out in a completely randomized design with two replicates. A uniformly prepared land with furrows opened 1.37 m apart were divided into 1 m plots across the furrow direction and 1 m space was given between two plots. A total of 217 accessions that comprised local collections (131), imported varieties (75) and standard varieties (11) were tested in plant crop and ratoon 1 crop.

Data collected from the plant crop included plot weight (WT), stalk length (SL), stalk diameter (DM), number of stalks (ST) and, hand refractometer brix (HB). In addition, laboratory brix (BRIX), pol in juice (POL), purity (PUR), pure obtainable cane sugar (POCS) and fiber percentage (FIB) were recorded in the ratoon 1 crop. Analyses of variance for all the characteristics followed by means separation employing the unnett's procedure against the commercial standard variety Co 775, and phenotypic correlation and cluster analysis using agglomerative hierarchical approach for the variables WT and HB for plant crop and WT and POCS ratoon 1 crop to characterize the accessions for cane yield and sugar content were done. Breeding values of the accessions were estimated as proposed by Marshall (2008) for all characteristics except FIB. The narrow-sense heritability values of the characteristics estimated by Wijesuriya et al. (2012) were used for the estimation of breeding values of the accessions.

Results and Discussion

There were significant differences between accessions for all the variables except for stalk length in both plant and ratoon 1 crops by the analyses of variance. For characteristics determined cane and sugar yields, a considerable number of accessions tested had exceeded the value of the standard variety signifying the existence of accessions in the collection, which possess commercial potentials. These accessions were included into the respective core-collections on the basis of superiority in particular characteristic/s.

As shown in table 1, the phenotypic relationships observed between WT with SL and ST in plant crop and ratoon 1crop proposed that SL and ST are the major determinants of cane yield of a sugarcane variety. Among the cane yield components, SD showed non-significant relationship with WT but a significant negative relationship with ST. It implies that thicker caned-clones produce less number of stalks. In parental selection, the accessions with higher number of millable stalks with acceptable diameter have to be selected for directional breeding for cane yield. The relationship between FIB and WT suggests that fibre content in cane contributes to cane yield to some extent. In this study, sugar content in cane is approximated by the variable POCS and therefore, POCS is strongly related to sugar yield. The phenotypic correlations between POCS and other biochemical characteristics were positive and very high. Fibre contributed to POCS is less than the other variables and it has no significant relationship. The relationship observed between HB and BRIX suggests that HB can be successfully used as a measure of brix in sugarcane instead of laboratory brix in the initial stages of clonal selection. The relationships of stalk length to most of biochemical characteristics were non-significant. All these results revealed, cane yield and sugar content are independent complex characteristics which can be improved simultaneously by manipulating their components during clonal selection. Stalk diameter had moderate-negative and significant relationships with fibre percentage. This suggests high fiber content is associated with thinner canes in the populations. Thicker canes consist of more *S. officinarum* (noble) genes and this would probably be the reason for higher sugar in thicker canes. It is a general belief that high fibre is associated with low sugar content and *vice versa*. However, these results indicated that though there is a little tendency of getting low sugar during the selection of clones on high fibre, there are good chances of improving sugar content while keeping the optimum fibre content (13% to 14%) needed for sugar factories. The clusters of accessions appearing in the dendrograms were classified into major groups based on dissimilarity level 0.9. In the cluster analyses on WT and HB in plant crop and on WT and POCS in ratoon 1 crop, the accessions were classified into three main groups (Table 2).

Table 1. The coefficient of phenotypic correlations among the cane yield and sugar yield components.

	S L	ST	DM	HB	BRIX	POL	PUR	POCS	FIB
WT	0.24***	0.83***	0.09^{NS}	0.15**	0.22***	0.26***	0.19**	0.23***	0.38***
SL		0.20**	-0.01^{NS}	-0.09^{NS}	-0.01^{NS}	-0.04^{NS}	-0.05^{NS}	-0.05^{NS}	0.18*
ST			-0.16**	0.09^{NS}	0.19**	0.23***	0.08^{NS}	0.19**	0.38***
DM				0.03^{NS}	-0.93^{NS}	-0.05^{NS}	-0.00^{NS}	-0.02^{NS}	-0.23***
HB					0.81***	0.79***	0.58***	0.74***	0.09^{NS}
BRIX						0.91***	0.59***	0.84***	0.09^{NS}
POL							0.59***	0.97***	0.11^{NS}
PUR								0.55***	0.11^{NS}
POCS									0.03^{NS}

** significant at $P \leq 0.05$, *** significant at $P \leq 0.001$, ^{NS} not significant

Identification of parents for directional breeding of cane yield and sugar content was done on the basis of means of the cluster groups. Accessions with high WT mean group and high HB mean HB or POCS group were selected as parents for directional breeding of cane yield and sugar content, respectively. Accordingly, the accessions in group 3 in plant crop and group 2 in

ratoon crop 1 were selected. The accessions categorized commonly for WT and HB or POCS in these two selected groups were chosen as parents to be used in the crosses for simultaneous improvement of cane yield and sugar content. A number of inter and intra cluster crosses were proposed in this regard. Clustering of accessions on FIB could not clearly distinguish 14 % optimum fiber and hence parent selection for moderate fiber was omitted. The accessions with the best 20 breeding values (BV) for all the characteristics *i.e.* nearly 10 percent of the population were selected as the parents in crosses to be performed for directional breeding of the respective characteristics baring fiber percentage. The best parents for directional breeding of moderate fiber content were selected considering the BV of the standard variety Co 775. The accessions with closest 7 BVs, each of upper and lower direction to BV of Co 775 were selected as best parents for directional breeding of moderate fiber content. One common parent, characterized by BVs of plot weight and POCS, namely; SLC 8 25, was considered as the parent to be used for simultaneous improvement of cane yield and sugar content. The accessions Co 775 and PH 58260 were classified commonly based on BVs for both POCS and fiber content. As such, these two parents can be considered for incorporation of moderate fiber content in high sugar progenies.

Table 2. Number of accessions and the means of plot weight, hand refractometer brix, POCS in cluster groups of accessions in plant crop and ratoon 1 crop.

	Plant crop				Ratoon 1 crop			
	WT (kg/plot)		HB		WT(kg/plot)		POCS	
	No. of acc.	Mean	No. of acc.	Mean	No. of acc.	Mean	No. of acc.	Mean
Group 1	164	38.5	103	16.2	133	22.64	98	10.22
Group 2	30	13.6	8	11.9	8	63.95	24	12.24
Group 3	19	78.3	102	19.2	22	42.21	21	6.96

Conclusions

Significant differences among accessions indicated that there is a good potential for selection of parental clones for directional breeding of sugarcane. The correlation studies proved that stalk length and number of stalks are the major determinants of cane yield of a sugarcane variety. In parental selection, the accessions with higher number of millable stalks with acceptable diameter have to be selected for directional breeding of cane yield. Parents for intra and inter group crosses were identified in the clusters for directional breeding of high cane yield and high sugar content. Fourteen accessions were found to be used as parents for crosses directed to improve both cane yield and sugar content simultaneously. Identification of parents for directional breeding of moderate fiber content in sugarcane through cluster analysis was proven unsatisfactory. Nearly 10 percent of the accessions in the population were classified as the parents in crosses to be performed for directional breeding of the respective characteristics using breeding values. The accessions Co 775 and PH 58260 were chosen as parents for incorporation of moderate fiber content in high sugar progenies.

References

Mahinda Chinthana Development Frame work. 2005.

Roach, B.T., Daniels, J., 1987. A review of the origin and improvement of sugarcane. Copersucar International Sugarcane breeding workshop, Copersucar technology centre, piracicaba SP, Brazil.

Marshall, K., 2008. Properties of estimating breeding values. IAEA Regional training course on selective breeding and gene technologies. Available at: http://www-naweb.iaea.org/ nafa/aph/estimating_BVs.pdf (Accessed on 5th February, 2011).

Wijesuriya, A., Perera, A.L.T., Ariyawansha, B.D.S.K., Manel, D., Sunil, H.K., 2012. Analysis of biparental families for estimation of heritabilities and cross predictions in sugarcane (*Saccharum* Hybrid spp.) breeding. Proceedings of the fourth symposium on plantation crop research. September 20 - 21, 2012, Colombo, Sri Lanka.