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Effect of cytoplasmic diversity on performance of sugarcane hybrids

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Abstract

Selected clones of *S. spontaneum, S. barberi* and *S. sinense* were used as pistil parents and *S. officinarum*, Co and allied hybrids as pollen parents with the objective to introduce cytoplasmic diversity from *S. spontaneum, S. barberi* and *S. sinense*. The ultimate aim of the programme was to select elite donors for stalk yield and juice quality traits as well as for red rot resistance. Difference in means of *S. barberi* × commercial hybrids (F_1-Sb) progenies and (*S. spontaneum* × *S. officinarum* /commercial hybrid) × commercial hybrid (BC_1-S_s) progenies was significant only for red rot disease index. Mean performance of these two progeny groups was better than F_1 progenies of *S. spontaneum* × *S. officinarum* /commercial hybrid (F_1-S_s) for all the traits, except number of millable stalks (NMS) and stalk length. These results did not indicate any significant contribution (on the traits studied) of diverse cytoplasm from species other than *S. officinarum*.

Key words: Cytoplasmic diversity, yield components, juice quality, sugarcane, *Saccharum* spp.

Introduction

Present day sugarcane cultivars have their maternal cytoplasm from a limited number of clones of *Saccharum officinarum*. So the commercial varieties of sugarcane lack cytoplasmic diversity [1], and so extensive cultivation, these varieties may succumb to major pest and diseases [2] as experienced in the case of maize leaf blight epidemic in 1970. Walker *et al.* [3] suggested genetic base broadening of sugarcane to avoid genetic vulnerability of varieties to smut infection. This could be achieved by introducing variability through genetic and cytoplasmic differences. Keeping these aspects in view the present study was undertaken to enhance the cytoplasmic diversity for broadening of genetic base in sugarcane and to identify genetic stocks for various traits of sugar yield and red rot resistance.

Materials and methods

Three clones of *S. spontaneum* (SES 2, SES 148 and SES 515/7) were selected as pistil parents and crossed with *S. officinarum* (57NG203) and the commercial hybrids (CoC 671, Co 6806, Co 7704) as pollen parents. Five crosses with un-emasculated pistil parents and 12 crosses with emasculated pistil parents were attempted at Coimbatore. In each of the latter set of crosses, 150-200 spikelets were hand emasculated, tagged and pollinated for two days. The progenies were designated as F_1-S_S. Similarly, two clones of *S. barberi* (Kewali 14G and Nargori) and one clone of *S. sinense* (Khakai) were crossed as female parents with HR83-65, HR83-87, HR83-126, HR83-144 and HR83-159 as pollen parents and F_1s of these were designated as F_1-Sb group. In all cases, the hybridity of the seedlings obtained in F_1 generation was confirmed cytologically on the basis of counts of the chromosome numbers (n + n transmission). Hybridity could also be judged by variations in morphological traits of progenies. Many of the progenies, especially those derived from *S. spontaneum*, were male sterile. On the basis of gross morphology and hybridity, five F_1 seedlings (F_1-Ss) were selected and further backcrossed to Co 6806, Co 7704 and CoC 671. Backcrossed progenies were designated as BC_1-Ss. The selected clones were given CD (Cytoplasmic Diverse) numbers. Seventy-nine CD clones (14 = F_1-Ss, 28 = F_1-Sb and 37 = BC_1-Ss) were evaluated (in RBD with two replications) for stalk yield and juice quality traits, and red rot resistance under sub-tropical conditions. The plot size was two rows of 6 m length spaced at 0.85 m.

Stalks were inoculated with a mixture of 3 identified races Cf01 (Co 1148), Cf02 (Co 7717) and Cf03 (CoJ 64) of red rot during the 2nd week of August by plug method [4]. The field was irrigated on the next day of inoculation. Relative humidity was between 75 to 90% during the incubation period. The minimum and maximum temperatures ranged from 22-26°C and 31-34°C, respectively. Observations on disease infection were recorded at 60 days after inoculation. The reaction of

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each clone (disease index) was recorded by following the internationally accepted 0-9 scale [5]. Observations on number of millable stalks per plot (NMS), stalk diameter (cm), stalk length (cm), single stalk weight (SSW in kg), juice extraction % (JE %), pol % in juice at 10 month (10m) and 12 month (12m) crop age, stalk and sugar yields (kg/plot) were recorded following the standard procedures. The data for these traits and disease index was analyzed by standard statistical procedures.

Results and discussion

Mean performance of three progeny groups is presented in Table 1. Differences in means of F_1-Sb and BC_1-Ss progenies were not significant for any trait, except for red rot disease index. Mean performance of these two progeny groups was better than that of F_1-Ss progenies for all the traits, except number of millable stalks (NMS) and stalk length. Mean of F_1Ss progenies was the best for NMS and stalk length. Red rot resistance was more (lowest value) in progenies of *S. spontaneum* (F_1-Ss and BC_1-Ss) than that of F_1-Sb progenies. A comparison of mean performance of F_1-Ss and BC_1-Ss revealed that first backcrossing resulted in an improvement in sugar yield, stalk yield, stalk diameter, single stalk weight (SSW), juice extraction % (JE %) and pol % in juice at 10m and 12m crop age and reduction in NMS, stalk length and red rot resistance. F_1-Sb and BC_1-Ss progenies were comparable for all the traits, except red rot resistance, which was more (lower value) in BC_1-Ss progenies.

commercial hybrids or noble clones would be required to achieve the desirable types. Backcrossing F_1-Ss clones with cultivars made their progenies closer to commercial levels for most of the economic characters. As the mean performance of F_1-Sb and BC_1-Ss progenies were similar for all traits except disease index, utilization of clones from *S. barberi* and *S. sinense* instead of *S. spontaneum* could save one year. The results indicated that improvement in sugar yield is expected to be more if sugarcane clones are selected for stalk yield traits namely stalk diameter and SSW giving emphasis to pol % at 10m crop age.

As cytoplasm is transmitted to the progeny through egg cell of the female parent, these progenies are expected to have cytoplasm from *S. spontaneum, S. barberi* and *S. sinense*, which is supposed to be different from *S. officinarum* in the present day commercial hybrids. The reciprocals were not effected for studying the comparative effect of cytoplasm on progenies due to problems in making such crosses in sugarcane. However, the results were compared with earlier studies on inter-specific and inter-generic hybrid clones [6-8]. The results reported here, on progenies with diverse cytoplasm, are in good agreement to a greater extent with the earlier similar studies based on progenies having cytoplasm from *S. officianarum* and commercial hybrids (used as female parents). Hence, the cytoplasm does not have any significant effect on major traits of stalk yield and juice quality under study. These hybrids, with diverse cytoplasm, are being evaluated for other biotic and abiotic stresses to ascertain the effect of diverse cytoplasm on these traits in sugarcane.

Table 1. Mean of different categories ofsugarcane clones with diverse cytoplasm

Character	F_1-Ss**	F_1-Sb**	BC_1-Ss**	Mean of checks
Sugar yield (kg/plot†)	4.00±0.63b*	6.31±0.85a	7.74±0.70a	9.54
Stalk yield (kg/plot†)	48.39±5.34b	59.57±5.22a	68.65±15.83a	74.20
NMS/plot†	205.8±18.39a	118.8±11.33b	121.9±10.75b	101.33
Stalk length (cm)	259.8±21.85a	221.5±10.63b	228.6±14.37ab	218.75
Stalk diameter (cm)	1.29±0.09b	1.82±0.10a	1.80±0.08a	2.11
SSW(kg)	0.24±0.02b	0.55±0.07a	0.58±0.07a	0.74
Juice extraction %	31.03±3.68b	48.08±1.64a	43.66±1.05a	51.22
Pol % 10m	11.25±0.79b	13.49±0.99a	14.51±0.69a	15.71
Pol % 12m	12.37±0.96b	15.76±0.74a	16.91±0.77a	18.48
Red rot disease index	3.89±0.15c	4.97±0.07a	4.46±0.07b	6.20

*Different letters indicate significant differences amongst 3 progeny groups at P = 0.05
**F_1-Ss and BC_1-Ss: F_1 and BC_1 progenies of *S. spontaneum*
**F_1-Sb: F_1 progenies of *S. barberi* and *S. sinense*
†Plot size: 2 × 6m × 0.85m

The mean performance of three progeny groups with diverse cytoplasm was poor from commercial point of view for all the traits except NMS, stalk length and disease index. Two to three backcrossing with

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