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GENETIC VARIABILITY IN INTERSPECIFIC PROGENIES IN SUGAR CANE (*SACCHARUM* SPP.)

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ABSTRACT

Genetic variability of the progenies (30 per mating group) of *Saccharum officinarum* crossed with *S. barberi/sinense, S. robustum, S. spontaneum* and commercial hybrids were studied. The maximum genetic variability was observed among progenies of mating group involving *S. spontaneum* for all the characters except cane length and cane yield. The mean performance of progenies involving commercial hybrids was the best for cane diameter, single cane weight, quality characters and sugar yield. The *S. officinarum* x commercial hybrids mating group was found advantageous for obtaining promising clones as compared to other groups. The values of correlation coefficients between various characters of cane yield and quality characters varied among the four mating groups. The selected genotypes could be used to create a broader genetic base in sugarcane breeding.

Key words: Genetic variability, mating group, correlation coefficients, *Saccharum* spp.

Hybridization among clones of various *Saccharum* species steps up the variance among commercial cultivars, which at present, is diminishing to that of experimental error level in commonly adopted inter-varietal crossing programme. The need for a new cycle of mobilization using diverse clones of *S. officinarum, S. barberi, S. sinense, S. robustum* and *S. spontaneum* has been suggested by many workers [1–5]. But meagre published information exists on the effect of nobilization on quantitative characters and on the relative merits of individual characters in various mating groups [6]. The present study was carried out to understand the pattern of genetic variability and character association of progenies of interspecific crosses.

MATERIALS AND METHODS

The experimental material comprised of F_1 progenies from crosses of *S. officinarum* with *S. barberi (sinense), S. robustum, S. spontaneum* and commercial hybrids. Twenty clones of *S.*

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officinarum and six clones of *S. barberi/sinense, S. robustum, S. spontaneum* and commercial hybrids were used in hybridization programme. The progenies at seedling stage were subjected to selection pressure so as to surpass the threshold limits set up for each mating group for hand refractometer Brix 16% in all groups, number of millable canes in mating group involving commercial hybrids, cane diameter and single cane weight in progenies of *S. barberi (sinense), S. robustum* and *S. spontaneum* to bring down the number to a manageable level. Hybridity of selected progenies was ensured by distinct economic and morphological characteristics of each species. Thirty progenies in each mating group were taken at random limiting five genotypes in each cross. The progenies alongwith three checks, viz. Co 62175, Co 6304, CoC 671 were evaluated during 1988-89 in a randomized block design with three replications. Each F_1 clone was grown in a single row plot of 6 m long spaced 90 cm apart. Twenty three-budded setts were planted in a plot with equal distance. The trial was harvested at 360 days of crop age and data on 12 quantitative traits were recorded. Heritability (broadsense), genetic advance [7], and genotypic and phenotypic coefficients of variation [8] were computed. Correlation coefficients were calculated among nine characters. The significance of phenotypic correlation coefficients was tested according to Fisher and Yates [9].

RESULTS AND DISCUSSION

The analysis of F_1 genotypes showed significant differences among genotypes and between mating groups for all the characters indicating the potential of certain parents involved in crosses to produce better genotypes. The genotypes involving commercial hybrid significantly differed from other three mating groups involving *S. barberi (sinense), S. robustum* and *S. spontaneum* for all the characters, except germination per cent of *S. robustum* mating group and cane length of *S. spontaneum* mating group. Significant differences were also observed between genotypes involving *S. robustum* and *S. spontaneum* for all the characters except cane length, juice per cent, cane and sugar yields.

Coefficients of variation gives an idea of relative variability present in a population. Genotypic coefficient of variation (GCV) in progenies involving *S. spontaneum* was higher than that of other mating groups for all the characters studied except germination per cent, cane length and cane yield (Table 1). Such high variability among progenies of *S. spontaneum* could be due to high frequency of unfavourable alleles which were not able to use effectively the existing environment. The variability was the minimum for cane yield contributing characters in *S. barberi (sinense)* mating group and for quality characters in mating group involving commercial hybrids. The low variability was expected because *S. barberi (sinense)* and commercial hybrids are the close relatives of *S. officinarum* and the variability among the progenies is controlled by differences in allelic frequencies of the parents. This was in agreement with Bhat and Gill [10] who opined that as *S. officinarum* forms the major genetic constitution of all commercial varieties, greater emphasis may be placed on selection of

noble canes. The relative genetic variability appeared to be similar in mating groups involving commercial hybrids and *S. robustum* for quality characters. Similarly, the mating groups involving commercial hybrids, and *S. barberi (sinense)* showed no difference for relative genetic variability for cane yield attributes.

Heritability estimates and expected genetic advance for cane diameter, juice extraction per cent and all quality traits in mating group involving *S. spontaneum*, whereas for germination per cent in mating group involving *S. robustum* were higher in comparison with other groups (Table 1). The occurrence of high heritabilities for different characters of the progenies involving *S. robustum* and *S. spontaneum* indicates the presence and importance of additive and nonadditive variation in these populations. High heritability values for quality characters in mating group involving *S. spontaneum* revealed that the performance of these genotypes in the process of sugar accumulation was least affected by environment. In other groups, selection for component characters of cane yield and CCS per plot would be equally effective while selecting the parents for further hybridization programme. The estimates of heritability and genetic advance were the maximum for number of millable canes and cane yield indicating the reliability of these characters in selecting parents for further hybridization keeping the sucrose per cent at economic threshold level.

The mean of progenies of commercial hybrids and *S. officinarum* exceeded means of other three mating groups involving *S. barberi (sinense, S. robustum* and *S. spontaneum* for quality traits (Table 1). For cane yield, the mean of the mating group involving *S. barberi (sinense)* was significantly higher than means of other groups mainly due to higher number of millable canes and cane length maintaining other yield contributing characters at intermediate levels. No differences were noted for means of cane yield and CCS per plot of progenies of two wild species. It is quite clear that absence of genetic variation is CCS per plot between mating groups involving *S. robustum* and *S. spontaneum* was mainly due to cane yield. The negative effect of number of millable canes in mating groups involving *S. robustum* was compensated by the positive effects of other component traits of cane yield resulting in similar cane yields in two mating groups.

The interrelationships showed that number of millable canes (0.74), cane length (0.48) and single cane weight (0.50) were the characters of importance by associated with cane yield in the mating group involving commercial hybrids. In the mating group involving *S. barberi (sinense)*, only number of millable canes (0.83) and cane length (0.43) were correlated with yield. None of the quantitative traits, except number of millable canes (0.73 and 0.55, respectively) was of much importance for mating groups involving *S. robustum* and *S. spontaneum*. Amongst the component characters of cane yield, correlation between number of millable canes and single cane weight was negatively significant (–0.49) only in *S. spontaneum* mating group indicating chances of simultaneous improvement in other mating groups which ultimately would contribute to cane yield. Juice extraction per cent showed

Table 1. Mean, genotypic and phenotypic coefficients of variation, heritability (broad sense) and expected genetic advance in F_1 progenies of four mating groups in sugarcane

Character	Parameter	Progenies of *S. officinarum* crossed with			
		S. barberi (sinense)	*S. robustum*	*S. spontaneum*	commercial hybrids
Germination %	Mean	66.5a	61.3b	66.4a	58.9b
	GCV	21.7	27.9	23.0	22.1
	PCV	26.4	33.0	28.7	31.0
	h^2	0.67	0.72	0.64	0.51
	GA	24.35	29.81	25.19	19.14
No. of millable canes	Mean	73.3a	67.9a	108.0c	49.3b
	GCV	26.1	38.8	41.0	27.9
	PCV	32.5	47.1	51.2	34.6
	h^2	0.65	0.68	0.64	0.65
	GA	25.57	44.81	73.18	22.84
Cane diameter (cm)	Mean	2.54a	2.17c	1.88d	3.07b
	GCV	9.6	13.5	17.9	9.9
	PCV	13.8	15.7	20.2	12.7
	h^2	0.49	0.74	0.78	0.60
	GA	0.24	0.52	0.61	0.49
Cane length (cm)	Mean	231ac	225cd	219bd	213b
	GCV	9.7	10.6	9.1	12.2
	PCV	13.3	14.5	16.0	15.3
	h^2	0.53	0.53	0.33	0.64
	GA	24.76	35.62	23.46	42.86
Single cane weight (kg)	Mean	1.18a	0.85b	0.59c	1.54d
	GCV	15.7	29.6	37.9	20.8
	PCV	24.4	34.4	41.9	27.8
	h^2	0.41	0.74	0.81	0.56
	GA	0.16	0.45	0.41	0.49
Cane yield/plot (kg)	Mean	85.5a	55.0c	57.4c	74.6d
	GCV	27.9	34.6	32.7	32.3
	PCV	33.7	43.9	46.4	39.3
	h^2	0.69	0.62	0.50	0.68
	GA	33.59	30.80	27.30	40.79
Extraction %	Mean	44.7a	39.6c	40.6c	55.7b
	GCV	10.5	15.3	21.9	8.5
	PCV	13.8	17.2	23.7	11.2
	h^2	0.58	0.80	0.86	0.57
	GA	5.55	11.15	17.01	7.32
Brix %	Mean	16.22a	16.15a	14.93c	18.29b
	GCV	11.7	9.3	19.8	8.3
	PCV	15.3	12.0	21.9	11.5
	h^2	0.59	0.60	0.82	0.66
	GA	2.28	2.40	5.53	2.54

(Contd.)

Table 1. (Contd.)

Character	Parameter	Progenies of *S. officinarum* crossed with			
		S. barberi (sinense)	*S. robustum*	*S. spontaneum*	commercial hybrids
Sucrose %	Mean	13.01a	12.19c	10.85d	15.68b
	GCV	16.5	13.6	33.0	12.3
	PCV	21.5	17.6	35.6	18.5
	h^2	0.58	0.60	0.86	0.73
	GA	2.58	2.64	6.82	3.38
Purity %	Mean	79.49a	75.08c	70.56d	85.42b
	GCV	5.2	6.5	15.5	4.8
	PCV	7.7	8.7	17.6	6.3
	h^2	0.45	0.56	0.78	0.77
	GA	3.84	7.50	19.85	7.43
CCS %	Mean	8.56a	7.75c	6.73d	10.68b
	GCV	19.1	16.7	41.7	14.3
	PCV	25.3	21.6	45.1	16.6
	h^2	0.57	0.59	0.86	0.74
	GA	1.93	2.06	5.35	2.72
CCS/plot (kg)	Mean	7.29a	4.32c	4.01c	7.83b
	GCV	31.3	42.9	58.2	30.2
	PCV	41.2	51.7	74.5	38.4
	h^2	0.58	0.69	0.61	0.62
	GA	2.71	3.16	3.75	3.84

Note. Different letters indicate significant differences at P = 0.05. Same letters indicate nonsignificant difference in values in different crosses.

positive association with cane diameter (0.62), single cane weight (0.56) and all quality characters and negative association with number of millable canes (–0.45) in *S. spontaneum* mating group. Therefore, juice per cent could be important character for selecting elite clones among *S. spontaneum* progenies. Cane diameter and single cane weight showed low positive correlations with quality characters in mating groups involving *S. barberi/sinense, S. robustum* and *S. spontaneum*. This revealed that cane diameter and single cane weight may be utilized in selection for developing better quality genotypes particularly among progenies of *S. robustum* and *S. spontaneum*.

The mean cane yield and quality traits were lower in comparison to the mean of checks in *S. robustum* and *S. spontaneum* mating groups. But the association of cane yield and quality components in these two groups were positive, indicating chances of simultaneous improvement of these characters to contribute to more sugar yield. The commercial hybrids and *S. barberi (sinense)* progenies seemed to have reached the optimum level (commercial level) for these characters as their association approached a negative side. But the occurrence

of promising clones combining both yield and quality could not be completely ruled out as the associations between cane yield and quality parameters were not significant. Further, the proportion of independent genetic variance ($1-r^2$) shown by cane yield and sucrose per cent was also higher in these groups (0.87 in commercial hybrids group and 0.98 in *S. barberi (sinense)* group).

In practical sugarcane breeding programmes, the materials developed in early stages of nobilization could be used in two ways: (i) identification of genetic stocks for various component traits of cane and sugar yields, and (ii) selection of genotypes which combine all the economic characters for commercial exploitation. Of course, the presence of genotypes of commercial importance is meagre at first nobilization stage but five genotypes, viz. OB-28 (*S. officinarum* x *S. barberi*), OH-76, OH-139, OH-182 and OH-185 (*S. officinarum* x commercial hybrids) combined both cane yield and quality attributes. The mating group involving commercial hybrids showed clear advantage over other groups for number of promising genetic stocks for various characters out yielding the midlate check Co 62175. The occurrence of commercial types among the progenies of *S. officinarum* x commercial hybrids implies that the crossing of *S. officinarum* clones to a commercial hybrid forms a dependable and shortcut method of incorporation of new and varied germplasm into a genotype selected for adaptation to a particular environment. The use of commercial hybrids was found to result in better progenies [2, 11, 12]. Bakshi Ram and Hemaprabha [13] also noticed the occurrence of promising genotypes among the progenies of commercial hybrids crossed with *S. officinarum, S. barberi (sinense)* and *S. spontaneum*. This may be due to superiority of the gametes contributed by commercial hybrids, better balance of noble and wild chromosomes and n + n chromosome transmission which resulted in total diploid chromosome number within the range of 100–125, as in commercial varieties [14].

The improvement in sugar yield could be brought about by simultaneous selection for cane yield and quality characters wherever these characters are below the commercial level as in *S. robustum* and *S. spontaneum* mating groups. But the genotypes with quality at par with commercial level (checks) as in commercial hybrids and *S. barberi (sinense)* mating groups, the average cane yield would have to be increased maintaining, however, the threshold economic level of sucrose per cent for increasing the sugar yield per unit area. It is suggested that a more extensive use of selected genotypes could be made use in the interest of a broaden genetic base by bridging crosses among the genotypes from four mating groups and with proven parents.

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