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Research Article

GENETIC VARIABILITY, HERITABILITY AND GENETIC ADVANCE IN SUGARCANE

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ABSTRACT

Twenty genotypes were evaluated in a replicated trial to estimate phenotypic and genotypic coefficients of variation, heritability and genetic advance for ten traits in sugarcane (*Saccharum officinarum* L.). Analysis of variance revealed highly significant differences between genotypes for all the traits studied. High GCV and PCV were recorded for all the traits however the sugar yield recorded highest GCV and PCV followed by cane weight. High heritability estimates and maximum genetic gain as per cent of mean was observed for all traits. This indicates that a scope to improve cane yield by adopting suitable breeding procedures.

INTRODUCTION

Sugarcane varieties in commercial cultivation are complex polyploid. The heterozygous and polyploid nature of this crop have resulted in generation of greater genetic variability. The genetic variability present in the sugarcane varieties, cultivated by the growers have different hybrid origin, generally arising from single cross among commercial varieties to a poly crosses involving wide combinations. The *Saccharum officinarum* have been contributing for genetic variability in sugarcane more than *Saccharum spontaneum, Saccharum sinense, Saccharum barberi* (Matsuoke *et al.,* 1999). The information on the nature and the magnitude of variability present in the genetic material is of prime importance for a breeder to initiate any effective selection programme. Genotypic and phenotypic coefficients of variation along with heritability as well as genetic advance are very essential to improve any trait of sugarcane because this would help in knowing whether or not the desired objective can be achieved from the material (Tyagi and Singh, 1998). The present study was, therefore carried out to know the nature and extent of genetic variability, heritability and genetic advance in some important traits of sugarcane.

MATERIALS AND METHODS

The experimental material for the present study consisted of twenty genotypes of sugarcane (*Saccharum* complex) including two true species and three related genera, were raised. The experiment was laid out in randomized block design with two replications. The genotypes were raised in plot of 5 rows with each row of 5 meter length and 0.8 metre distance between rows. The recommended agronomic practices were followed. They were evaluated for ten traits including cane yield and sugar yield attributing traits *viz.* cane length, internode length, number of millable cane, cane thickness, single cane weight, brix per cent, sucrose per cent, commercial cane sugar per cent (CCS%), cane yield and sugar yield.

Analysis of variance was used for calculating genotypic, phenotypic and environmental characters. The broad sense heritability was estimated according to the method suggested by Johnson *et al.* (1955) and the expected genetic advance was calculated by the method given by Robinson *et al.* (1949).

RESULTS AND DISCUSSION

The analysis of variance for all the traits showed that genotypes differed significantly ($P<0.01$) with respect to all traits studied (Table 1). This indicates that there was significant amount of phenotypic variability and all the genotypes differed each other with regard to the characters that opened a way to proceed for further improvement through simple selection (Punia, 1982).

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Table 1 ANOVA for ten traits in 20 sugarcane genotypes

Source	df	Cane length (cm)	Internode length (cm)	Number of millable cane (per plot)	Cane thickness (cm)	Single cane weight (kg)	Brix per cent	Sucrose per cent	Commercial cane sugar per cent	Cane yield per plot (kg)	Sugar yield per plot (kg)
Replication	1	462.4000	0.8703	1199.0250	0.2890	0.397	2.4602	1.4251	1.5406	6227.0194	135.0930
Treatment	19	9241.6368*	26.2880*	4888.6039*	1.8192*	0.7563*	68.9751*	71.9812*	40.3744*	19711.2539*	360.0503*
Error	19	16.6105	0.229	9.7092	0.0037	0.006	0.0719	0.1069	0.0854	64.7857	3.0485

*Significant at 1 per cent level

Table 2 Mean values of sugarcane yield and its attributes as affected by different genotypes

S. No.	Genotypes	Cane length (cm)	Internode length (cm)	Number of millable cane (per plot)	Cane thickness (cm)	Single cane weight (kg)	Brix per cent	Sucrose per cent	Commercial cane sugar per cent	Cane yield kg per plot	Sugar yield kg per plot
1	*Saccharum officinarum* cv. Badila	146	7.70	144	2.65	2.04	22.55	18.85	13.00	293.900	37.115
2	Co 6907	167	7.65	138	2.75	1.28	21.30	18.38	12.51	176.760	22.145
3	Co 8021	193	8.95	144	2.55	1.32	21.27	17.25	11.12	189.005	21.090
4	CoSi 95071	216	8.55	150	3.70	1.80	19.59	16.77	11.91	277.000	33.035
5	CoC 671	220	8.00	178	2.90	1.64	22.65	19.00	13.26	292.040	38.800
6	Co 86032	242	9.10	189	2.95	1.69	21.10	18.24	13.21	318.810	42.190
7	CoC 85061	225	7.85	185	3.50	1.66	18.45	15.25	10.20	305.460	31.200
8	CoC 92061	203	7.60	200	2.80	1.50	21.35	17.45	11.60	298.260	34.580
9	CoG 93076	197	7.45	181	3.00	1.51	17.40	15.10	10.36	272.690	28.120
10	Co8371	172	7.45	142	3.70	2.05	17.41	13.96	9.18	288.300	26.440
11	Co 99004	198	7.65	152	2.65	1.62	18.71	15.16	10.03	247.230	24.790
12	Co 99006	204	7.65	151	2.75	1.56	18.72	15.10	9.98	235.840	23.440
13	Co 7219	178	7.60	128	2.75	1.46	17.55	13.91	9.11	187.040	17.040
14	Co 99012	199	7.60	178	2.70	1.56	18.81	15.18	10.02	276.275	27.655
15	Co 99008	204	7.65	182	2.75	1.52	18.79	15.14	9.99	276.780	27.630
16	Co C90063	195	7.45	191	2.85	1.60	19.86	16.46	11.03	304.855	33.575
17	Saccharum spontaneum	99	13.60	253	0.75	0.26	5.54	2.08	0.55	64.410	0.350
18	Navenga porphyrocoma	64	12.70	281	0.35	0.04	5.81	2.17	0.53	9.825	0.055
19	Erianthus arnndinaceum	396	22.50	221	1.90	0.46	6.16	2.28	0.55	100.780	0.560
20	Miscanthus sacchariflorus	81	12.20	315	0.45	0.05	6.23	2.19	0.42	15.85	0.07

Mean values for cane yield and sugar yield varied between 9.8 T/ha and 0.055 T/ha respectively in *Navenga porphyrocoma* and 318.8 T/ha and 42.19 T/ha respectively in Co 86032 (Table 2). Commercial cane sugar (CCS%) varied from 0.42% in *Erianthus arundinaceum* to 13.26% in CoC 671. Single cane weight varied between 0.04 gm in *Narenga porphyrocoma* and 1.80 gm in CoSi 95071. Cane thickness varied from 0.35 cm in *Narenga porphyrocoma* to 3.70 cm in CoSi 95071 and Co 8371. Number of millable cane varied between 128 in Co 7219 and 315.0 in *Miscanthus sacchariflorus.* Internode length varied from 7.45 cm in CoC 90063, Co 8371 and CoG 93076 and 22.5 cm in *Erianthus arundinaceum.* Likewise *Erianthus arundinaceum* was the tallest (396 cm), while *Narenga porphyrocoma* was the shortest (63.5 cm) in stalk length (Table 2).

Table 3 Estimation of genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV)

S. No.	Character	GCV (%)	PCV (%)
1	Cane length	35.77	35.84
2	Internode length	38.80	38.82
3	Number of millable cane	26.70	26.75
4	Cane thickness	37.81	37.89
5	Cane weight	46.25	46.30
6	Brix per cent	34.60	34.64
7	Sucrose per cent	44.42	44.50
8	Commercial cane sugar per cent	50.29	50.39
9	Cane yield	44.74	44.88
10	Sugar yield	56.86	57.34

Genotypic and phenotypic coefficients of varieties

After partitioning components of variance, genotypic and phenotypic variance were computed (Table 2). The results indicate that high GCV and PCV were recorded for all the traits. However the sugar yield recorded highest GCV and PCV of 50.27% and 50.39% respectively followed by cane weight (46.25% GCV, 46.29% PCV).

As stated by Sinha Subramanian and Menon (1973) the PCV and GCV values are ranked as low, medium and high with 0 to 10%, 10 to 20% and > 20% respectively. Similar to this study high genotypic coefficient of variation for sugar yield, cane yield and number of millable cane were reported by Feyissa Tadesse *et al.* (2014). High GCV and PCV for cane weight and number of millable cane were reported earlier by Singh and Sangwan (1980) and Chaudhary (2001). Similar to this study high GCV for millable cane was reported by Balasundaram and Bhagyalakshmi (1978) and Nair *et al.* (1980).

High GCV and PCV indicated that selection may be effective based on these traits and their phenotypic expression would be good indication of the genotypic potential (Singh *et al.,* 1994).

Heritability

Genotypic coefficient of variation is not a correct measure to know the heritable variation present and should be considered together with heritability estimates. In the present experiment, high heritability estimates were recorded for all the traits studied (Table 4). Heritability values are categorized as low (0-

30%), moderate (30-60%) and high (>60%) above as stated by Robinson *et al.* (1949).

Table 4 Estimation of heritability and genetic advance

S. No.	Character	Heritability (%)	Genetic advance (% of mean)
1	Cane length	99.64	73.56
2	Internode length	99.83	79.84
3	Number of millable cane	99.60	54.90
4	Cane thickness	99.59	77.72
5	Cane weight	99.83	95.20
6	Brix per cent	99.79	71.21
7	Sucrose per cent	99.70	91.38
8	Commercial cane sugar per cent	99.58	103.37
9	Cane yield	99.34	91.85
10	Sugar yield	98.32	116.14

Similar to present study high heritability, estimates results were reported by Feyissa Tadesse *et al.* (2014), for sugar yield (86.09%), cane yield (75.05%) and millable cane (81.51%), Chaudhary (2001) for millable cane (88%), stalk diameter (85%) and cane weight (84%), Nair *et al.* (1980) and Singh *et al.* (1994) reported. Similar results for mentioned traits. This indicate that simple selection for these traits would be effective method of sugarcane variety breeding programme. Since these traits are highly heritable from parent to progenies.

Genetic advance

Heritability estimates along with expected genetic gain is more useful than the heritability value alone in predicting the resultant effect for selecting the best genotypes (Johnson *et al.,* 1955). High genetic advance (as per cent of mean) for all the traits were observed from this study indicating that there exists a scope to improve cane yield by adopting suitable breeding procedures. High genetic advance (as per cent of mean) was recorded by Choudhary (2001) for single cane weight (70%) and number of millable cane (52.9%), Sahi *et al.* (1977) for cane weight, Tyagi and Singh (1998).

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