

GENETIC ARCHITECTURE FOR VARIABILITY AND INTERRELATIONSHIP OF CANE YIELD AND THEIR COMPONENTS IN SUGARCANE (*Saccharum* SPP. COMPLEX)

MALI, S. C. AND *PATEL, A. I.

REGIONAL SUGARCANE RESEARCH STATION
NAVSARI AGRICULTURAL UNIVERSITY
NAVSARI - 396 450, GUJARAT, INDIA

E.mail: akshay742000@yahoo.co.in

ABSTRACT

The present study was conducted during 2009-10 at Regional Sugarcane Research Station, Navsari Agricultural University, Navsari to estimate the genetic variability and interrelationship among cane yield and various cane yield components in forty diverse genotypes of sugarcane. Study revealed sufficient variability in the genotypes under study for all the characters. High heritability with moderate to high genetic advance was recorded for stalk height, sucrose % juice at 12 month, internodes/stalk and single cane weight. Correlation and path analysis indicated that NMC at harvest ('000/ha), stalk height, cane diameter, internodes/stalk, single cane weight and sugar yield (t/ha) could be useful as selection indices for development of high yielding genotypes of sugarcane.

KEY WORDS: Correlation, genetic variability, heritability, path analysis, sugarcane

INTRODUCTION

Sugarcane (*Saccharum* spp.) contributes about 75 percent of world's sugar production. Apart from being chief source of sweetening agent to the millions of agriculturists in the country, sugarcane is an insurance against economic distress on account of sugarcane being an important cash crop coupled with its capacity to withstand the climatic vagaries better than most of the other crops. In the present situation, with the increasing population in the country and demand for consumption of sugar, the only option is to improve cane and sugar yield per unit area and time.

In sugarcane, the cane and sugar yields are considered to be the complex characters. The information on the phenotypic and genotypic interrelationship

of cane yield and commercial cane sugar (CCS) yield with their component characters would be of immense help to the sugarcane breeder. But the interdependence of these component characters among themselves often influence the direct relationship with yield (both cane and sugar yield), as a result the information based on the correlation coefficients becomes not dependable. Path coefficient analysis on the other hand provides direct and indirect effect of component traits which helps to understand true relationship of the character. Keeping these in view, the present study was undertaken to know the genetic variability, nature of association of morphological and juice quality characters with cane and sugar yields and also to assess the direct and

indirect effects of different component traits on cane and sugar yields

MATERIALS AND METHODS

A field experiment consisted of 40 diverse genotypes of sugarcane. The experiment was carried out in a Randomized Block Design replicated thrice at Regional Sugarcane Research Station, Navsari Agricultural University, Navsari (Gujarat) during 2009-10. The plot size was 5 rows of 6 meter length spaced at 90 cm between the rows. Two budded sets were used for planting @ 12 buds per meter length. The crop was grown with all the cultural practices and with the recommended fertilizer application schedule. Observations were recorded on 16 characters viz., germination % at 45 days, tillers at 120 days (000/ha), shoots at 240 days (000/ha), stalk height (cm), cane diameter (cm), internodes/stalk, single cane weight (kg), cane yield (t/ha) at harvest, number of millable canes (NMC) (000/ha), commercial cane sugar (CCS) (t/ha), Juice brix at 12 month, sucrose % juice at 12 month, juice purity % at 12 month, CCS % at 12 month, pol % cane at 12 month and fibre % cane at 12 month. The data were subjected to the analysis to determine genotypic and phenotypic coefficients of variation, heritability and genetic advance (as percent of mean) following the standard statistical procedures given by Panse and Sukhatme, (1978). Genotypic and phenotypic coefficients of correlation were computed as suggested by Burton (1952). The correlations were further partitioned into direct and indirect effects following the method of Dewey and Lu (1959).

RESULTS AND DISCUSSION

The analysis of variance showed significant differences among the genotypes for all the 16 characters studied. The highest genotypic and phenotypic coefficient of variation was observed for single cane

weight, CCS (t/ha) and internodes/stalk (Table 1), suggested that the selection based on these characters would facilitate successful isolation of desirable types. The moderate variation was observed for shoots at 240 days, stalk height and stalk diameter, while juice purity per cent at 12 month and fibre % at 12 month had low variation. In the present study, PCV was higher than GCV, indicated that the apparent variation is not only due to genotypes, but also due to the influence of environment and therefore, improvement by phenotypic selection is possible but sometimes may be misleading. Similar results were obtained by Sharma and Singh (1984). They reported highest GCV for weight of stalk, moderate for number of internodes and purity per cent. Verma *et al.* (1988) obtained highest GCV for brix per cent, moderate for number of internodes and stalk diameter (cm) and lowest for purity per cent. Hapase and Hapase (1990) obtained high GCV and PCV for cane yield (t/ha), moderate for number of internodes and lower for brix per cent and purity per cent. Hapase and Repale (2004) obtained highest GCV and PCV for germination percentage, tillers at 120 days (000/ha) and single cane weight (kg). Patel *et al.* (2006) obtained highest GCV and PCV for single cane weight followed by CCS (t/ha), cane yield (t/ha) and stalk length (cm). Murthy (2007) obtained highest GCV and PCV for single cane weight, CCS t/ha and cane yield (t/ha).

The high heritability coupled with high genetic advance as per cent of mean was observed for number of internodes/plant and single cane weight. This indicated that these characters are governed by additive gene action and selection for these characters will be effective in choice of best genotypes. Kumar *et al.* (2004) reported high heritability coupled with high genetic advance for NMC /ha, shoots at 240 days (000/ha), cane yield t/ha, CCS t/ha, cane

girth, cane height, single cane weight and number of internodes. Low heritability coupled with low genetic advances as per cent of mean was noticed for number of millable canes / ha. It indicated that the scope for improving these characters through selection is very limited which may be attributed to the non-additive gene effects on these traits (Johnson *et al.*, 1955). The characters pol % cane at 12 month and CCS % at 12 month showed high heritability estimates but low genetic advance rendering them unsuitable for improvement through selection. This confirmed that the high heritability alone does not signify an increased genetic advance.

The genotypic correlation was generally observed higher than the phenotypic correlations indicating the inherent association between various traits (Table 2). Association of cane yield was positive and highly significantly with stalk height, cane diameter, single cane weight, sucrose % juice at 12 month, CCS % at 12 month, NMC (000/ha), pol % cane at 12 month, sugar yield (t/ha), internodes/stalk, juice brix at 12 month and juice purity % at 12 month, indicating that these attributes were mainly influenced the cane yield in sugarcane. Thus, selection practiced for the improvement in one character will automatically resulted in the improvement in the other, even though direct selection for improvement has not been made for the complex yield character. Similar results were also obtained by Punia *et al.* (1983), who reported positive correlation of cane yield with number of shoots/ha, NMC/ha, cane diameter and single cane weight. Kang *et al.* (1983) observed correlation of cane yield with all yield contributing characters. Reddy and Khan (1984) reported positive correlation of cane yield with number of shoots/ha, NMC/ha, stalk length and CCS/ha. Shaikh *et al.* (1986) reported

correlation of cane yield with cane diameter, stalk length and number of shoots/ha.

Sucrose % juice at 12 month recorded highest positive direct effect on cane yield followed by juice brix at 12 month and sugar yield (t/ha) (Table 3). Similar results were reported by Reddy and Khan (1984), who observed high direct effect of CSS (t/ha) on cane yield followed by millable canes and cane height. Patel *et al.* (1993) also reported high direct effect of CCS (t/ha) followed by CCS per cent and stalk weight. Patel *et al.* (2006) observed high direct effect of CCS t/ha followed by number of shoots/ha and single cane weight.

CONCLUSION

From the above findings, it could be concluded that in breeding programme aiming at improving cane yield in sugarcane, more weightage should be given mainly on NMC at harvest (000/ha), stalk height, cane diameter, internodes/stalk and single cane weight. For the improvement of quality component in sugarcane, weightage should be given to sugar yield (t/ha).

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Table 1: Mean, range, genotypic, phenotypic and environmental variances, GCV, PCV, H² (b), GA and GA as per cent of mean of various yield contributing characters in sugarcane

Characters	Mean $\pm$ S.Em	Range	Variance			GCV (%)	PCV (%)	H ² (b) (%)	GA	GA as % of Mean
			σ_g^2	σ_p^2	σ_e^2					
Germination % at 45 Days	77.63 $\pm$ 2.97	70.83-86.57	16.55	43.17	26.61	5.24	8.46	38.40	5.19	6.68
Tillers at 120 Days (000/ha)	189.77 $\pm$ 6.60	164.81-211.85	114.16	244.93	130.77	5.63	8.24	46.60	15.02	7.91
Shoots at 240 Days (000/ha)	166.85 $\pm$ 6.61	140.12-189.50	106.70	238.05	131.34	6.19	9.24	44.80	14.24	8.53
Stalk Height (cm)	282.97 $\pm$ 7.48	226.67-347.33	460.30	628.32	168.01	7.58	8.85	73.30	37.82	13.36
Stalk Diameter (cm)	2.73 $\pm$ 0.09	2.25-3.22	0.03	0.06	0.02	7.07	9.36	57.00	0.30	11.00
Internodes/Stalk	25.95 $\pm$ 0.63	19.00-35.00	6.64	7.85	1.21	9.93	10.80	84.50	4.88	18.80
Single Cane Weight (Kg)	1.39 $\pm$ 0.04	1.07-1.81	0.03	0.04	0.006	13.97	15.16	84.90	0.37	26.51
Juice Brix (%) at 12 Month	20.31 $\pm$ 0.45	18.28-22.38	1.18	1.79	0.61	5.35	6.59	65.90	1.81	8.95
Sucrose % Juice at 12 Month	18.12 $\pm$ 0.42	15.63-20.15	1.22	1.76	0.54	6.10	7.33	69.30	1.89	10.47
Juice Purity (%) at 12 Month	89.34 $\pm$ 1.09	84.80-93.63	3.10	6.70	3.60	1.97	2.89	46.30	2.47	2.76
CCS % at 12 Month	12.58 $\pm$ 0.32	10.59-14.17	0.65	0.98	0.32	6.42	7.86	66.80	1.36	10.82
Pol % cane at 12 Month	13.01 $\pm$ 0.23	11.62-14.07	0.35	0.51	0.16	4.60	5.53	69.10	1.02	7.87
Fibre % at 12 Month	14.27 $\pm$ 0.33	12.47-15.21	0.29	0.64	0.34	3.80	5.61	46.10	0.76	5.32
Cane Yield at Harvest (t/ha)	123.19 $\pm$ 8.71	103.70-151.11	56.92	284.69	227.76	6.12	13.69	20.00	6.95	5.64
Number of Millable Canes (NMC) ('000/ha)	119.01 $\pm$ 7.95	101.23-147.16	42.01	231.68	189.66	5.44	12.79	18.10	5.68	4.77
Commercial Cane Sugar (CCS) (t/ha)	15.58 $\pm$ 1.30	12.46-20.21	2.95	8.09	5.14	11.02	18.25	36.50	2.13	13.72

Table 2: Genotypic and phenotypic correlation coefficients of sugarcane yield with various growth and quality components

Character		Germination % at 45 Days X1	Tillers at 120 Days (000/ha) X2	Shoots at 240 Days (000/ha) X3	Stalk Height (cm) X4	Cane Diameter (cm) X5	Internodes /Stalk X6	Single Cane Weight (Kg) X7	Juice Brix at 12 Month X8	Sucr. (%) Juice at 12 Month X9	Juice Purity (%) at 12 Month X10	CCS (%) at 12 Month X11	NMC (000/ha) X13	Fibre % at 12 Month X14	Pol % cane at 12 Month X15	CCS (t/ha)\ X16
X12 Cane Yield	rg	0.059	-0.056	0.014	0.717**	0.567**	0.533**	0.747**	0.260**	0.370**	0.494**	0.416**	0.914**	0.085	0.366**	0.844**
	rp	0.106	0.170	0.180*	0.258**	0.299**	0.205*	0.235**	0.181*	0.243**	0.179	0.262**	0.970**	-0.094	0.241**	0.877**
X1	rg	1.000	0.799**	0.804**	0.609**	-0.068	0.046	0.432**	-0.093	-0.011	0.204*	0.059	0.188*	-0.168	-0.007	0.093
	rp	1.000	0.473**	0.433**	0.284**	-0.089	0.044	0.218*	-0.171	-0.107	0.105	-0.075	0.145	-0.142	-0.106	0.040
X2	rg		1.000	1.032**	0.446**	-0.335**	-0.006	0.238**	-0.212*	-0.107	0.316**	-0.033	0.081	-0.149	-0.101	-0.065
	rp		1.000	0.899**	0.229*	-0.119	-0.009	0.095	-0.109	-0.019	0.200*	0.019	0.210*	-0.066	-0.014	0.130
X3	rg			1.000	0.476**	-0.318**	-0.039	0.196*	-0.220*	-0.088	0.409**	-0.002	0.158	-0.181*	-0.081	-0.002
	rp			1.000	0.242**	-0.068	-0.042	0.103	-0.160	-0.078	0.232*	-0.041	0.223*	-0.144	-0.075	0.114
X4	rg				1.000	0.113	0.197*	0.627**	-0.222*	-0.132	0.211*	-0.106	0.689**	-	-0.129	0.300**
	rp				1.000	0.108	0.135	0.536**	-0.114	-0.066	0.094	-0.045	0.237**	-0.210*	-0.065	0.159
X5	rg					1.000	0.615**	0.539**	0.526**	0.484**	0.042	0.444**	0.642**	0.218*	0.480**	0.572**
	rp					1.000	0.419**	0.397**	0.309**	0.286**	0.003	0.274**	0.307**	0.138	0.281**	0.342**
X6	rg						1.000	0.357**	0.399**	0.463**	0.365**	0.474**	0.591**	0.353**	0.458**	0.580**
	rp						1.000	0.302**	0.327**	0.376**	0.199*	0.374**	0.223*	0.216*	0.372**	0.305**
X7	rg							1.000	0.069	0.066	-0.037	0.062	0.826**	-0.224*	0.063	0.443**
	rp							1.000	0.062	0.048	-0.054	0.038	0.257**	-0.169	0.044	0.183*
X8	rg								1.000	0.963**	0.290**	0.919**	0.311**	0.515**	0.960**	0.716**
	rp								1.000	0.935**	0.057	0.859**	0.190*	0.418**	0.933**	0.508**
X9	rg									1.000	0.537**	0.991**	0.476**	0.472**	0.999**	0.812**
	rp									1.000	0.389**	0.974**	0.268**	0.424**	0.999**	0.618**
X10	rg										1.000	0.641**	0.686**	0.071	0.545**	0.639**
	rp										1.000	0.502**	0.225*	0.095	0.394**	0.385**
X11	rg											1.000	0.537**	0.422**	0.991**	0.840**
	rp											1.000	0.286**	0.405**	0.974**	0.649**
X13	rg												1.000	0.239**	0.476**	0.871**
	rp												1.000	-0.065	0.267**	0.865**
X14	rg													1.000	0.468**	0.335*
	rp													1.000	0.421**	0.123
X15	rg														1.000	0.809**
	rp															0.615**
X16	rg															1.000
	rp															1.000

*, ** Significant at 5 per cent and 1 per cent levels of significance, respectively.

Table 3: Path analysis showing direct and indirect effects of different characters on cane yield in sugarcane

Character	Germination % at 45 Days X1	Tillers at 120 Days (000/ha) X2	Shoots at 240 Days (000/ha) X3	Stalk Height (cm) X4	Cane Diameter (cm) X5	Internodes /Stalk X6	Single Cane Weight (Kg) X7	Juice Brix at 12 Month X8	Sucr. (%) Juice at 12 Month X9	Juice Purity (%) at 12 Month X10	CCS (%) At 12 Month X11	NMC (000/ha) X13	Fibre % at 12 Month X14	Pol % cane at 12 Month X15	CCS (t/ha) X16	Genotypic Correlation With Cane Yield X12
X1	<u>-0.0850</u>	-0.0679	-0.0684	-0.0518	-0.0058	-0.0040	-0.0367	-0.0079	-0.0009	-0.0173	-0.0051	-0.0161	0.0143	0.0006	-0.0079	0.059
X2	-0.1066	<u>-0.1334</u>	-0.1377	-0.0595	0.0447	0.0009	-0.0317	0.0284	0.0144	-0.0422	0.0044	-0.0109	0.0200	0.0135	0.0087	-0.056
X3	0.1201	0.1541	<u>0.1492</u>	0.0711	-0.0475	-0.0059	0.0293	-0.0329	-0.0131	0.0612	-0.0004	0.0236	-0.0271	0.0121	0.0004	0.014
X4	0.0927	0.0679	0.0724	<u>0.1521</u>	0.0172	0.0300	0.0955	-0.0339	-0.0202	0.0322	-0.0163	0.1049	-0.0506	-0.0198	0.0457	0.717**
X5	0.0021	0.0105	0.0100	-0.0036	<u>-0.0314</u>	-0.0193	-0.0170	-0.0166	-0.0152	-0.0013	-0.0140	-0.0202	-0.0069	-0.0151	-0.0181	0.567**
X6	0.0032	-0.0004	-0.0027	0.0135	0.0419	<u>0.0682</u>	0.0244	0.0272	0.0316	0.0249	0.0323	0.0403	0.0241	0.0312	0.0396	0.533**
X7	-0.0571	-0.0314	-0.0260	-0.0829	-0.0712	-0.0472	<u>-0.1321</u>	-0.0091	-0.0088	0.0050	-0.0083	-0.1091	0.0296	-0.0083	0.0585	0.747**
X8	-0.1441	-0.3291	-0.3409	-0.3445	0.8145	0.6179	0.1071	<u>1.5468</u>	1.4898	0.4494	1.4227	0.4824	0.7966	1.4852	1.1071	0.260**
X9	-0.0390	-0.3821	-0.3123	-0.4705	1.7203	1.6446	0.2364	3.4190	<u>3.5499</u>	1.9063	3.5204	1.6930	1.6785	3.5491	2.8820	0.370**
X10	0.0842	0.1304	0.1691	0.0873	0.0177	0.1507	-0.0156	0.1199	0.2215	<u>0.4125</u>	0.2647	0.2832	0.0294	0.2251	0.2638	0.494**
X11	-0.0561	0.0310	0.0026	0.1006	-0.4185	-0.4463	-0.0592	-0.8655	-0.9332	-0.6038	<u>-0.9411</u>	-0.5056	-0.3973	-0.9332	-0.7905	0.416**
X13	0.0859	0.0372	0.0718	0.3136	0.2922	0.2688	0.3756	0.1418	0.2168	0.3121	0.2443	<u>0.4546</u>	0.1089	0.2166	0.3962	0.914**
X14	0.0299	0.0265	0.0322	0.0590	-0.0387	-0.0627	0.0397	-0.0913	-0.0838	-0.0126	-0.0748	-0.0424	<u>-0.1772</u>	-0.0830	-0.0594	0.085
X15	0.0364	0.4951	0.3978	0.6348	-2.3473	-2.2382	-0.3083	-4.6914	-4.8849	-2.6660	-4.8453	-2.3278	-2.2889	<u>-4.8860</u>	-3.9558	0.366**
X16	0.0926	-0.0648	-0.0025	0.2981	0.5680	0.5759	0.4396	0.7099	0.8052	0.6343	0.8331	0.8644	0.3322	0.8029	<u>0.9917</u>	0.844**

Bold and underlined figures on main diagonal show the direct effects

Residual effect = 0.0994

***, ** Significant at 5 per cent and 1 per cent levels of significance, respectively.**

[MS received: January 18, 2014]

[MS accepted: March 16, 2014]