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Studies on Correlation and Path Analysis for Quality Attributes in Sugarcane [*Saccharum* Spp. Hybrid]

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ABSTRACT

Pooled analysis for correlation coefficient revealed that cane yield was found to be highly significant and positive correlation with CCS (t/ha) followed by stalk weight, NMC at harvest, fiber (%) cane and internodes per stalk at both genotypic and phenotypic levels indicating that these attributes were mainly influencing the cane yield in sugarcane. While, CCS (t/ha) had highly significant and positive correlation with almost all the characters except stalk height and diameter, juice purity (%). These yield contributing characters also possessed highly significant and positive association among themselves. Path coefficient analysis indicated that stalk weight had the highest positive direct effect but it had positive highly significant correlation with cane yield, while highest positive indirect effect on cane yield by stalk weight via CCS % followed by tillers at 120 days, sucrose % juice and germination % at 45 days.

Key words: *Correlation, Path analysis, Sugarcane.*

INTRODUCTION

Sugarcane is a C_4 plant and is photo synthetically one of the most efficient converters of solar energy in to dry matter. Yield is a complex character which cannot be improved to a greater extent on its own. Because, it is influenced by a set of other characters known as yield components which are related among themselves and with yield either favorably or unfavorably. In general, in most crops, the associations among yield components are reported to be undesirable thereby hindering the rapid progress that could be made. Correlation studies provide an opportunity to study the magnitude and direction of association of yield with its components and also among various components. To accumulate optimum combination of yield contributing characters in a single genotype, it is essential to know the implication of the interrelationship of various characters along with standard partial correlation or regression (path coefficient). Considering these points, the present study was conducted to understand interrelationship among economic traits in sugarcane.

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MATERIALS AND METHODS

The experimental material consisted of 8 sugarcane families (crosses) made at SBI Coimbatore in 2011 and their respective 14 progenies (total 112 genotypes) developed through clonal selection at MSRS, NAU, Navsari. The details of families and their respective progenies are given in (Table-1).

Table 1: Details of 8 families and their respective 14 progenies under study in the experiment

FAMILY (F)	CROSS OF FAMILY	PROGENIES (PR)
F-1	CoPant 84211 × CoSnk 05-103	2011N 61,65,67,69,83,92, 95,98,101,102,107,111,112,114
F-2	Co 8371 × Co 86011	2011N 186,189,190,192,193, 195,196,198,199,205,206,210,211,213
F-3	Co 8371 PC	2011N 468,474,476,478,482,488,497,507,508,511, 512,513,514,533
F-4	CoN 85134 GC	2011N 542,547,549,551,552, 553,554,559,560,561,563,568,572,573
F-5	CoN 03132 GC	2011N 605,606,607,608,610, 612,613,618,619,620,621,622,623,625
F-6.	Co 81V48 PC	2011N 663,664,665,666,672, 680,700,702,706,711,725,727,738,743
F-7.	Co 97017 × Co 94008	2011N 915,920,925,929,934, 935,940,944,948,950,957,961,965,972
F-8.	CoS 8408 × CoN 85134	2011N 987,997,1004,1006,1010, 1015,1022,1030,1034,1041,1049,1052,1053,1086

Experiment was conducted in compact family block design (CFBD) with two replications. The gross plot size for each genotype was consisted of 4 rows each of six meter length with row to row spacing of 90 cm and the net plot was consisted of middle 2 rows each of 5 meter length with row to row spacing of 90 cm (Excluding 0.5 m ring line at both ends of the plot). The two budded setts of sugarcane were planted in rows keeping 12 buds per meter row length. Correlation coefficient was worked out for all possible combination of characters as per the procedure outlined by Panse and Sukhatme[20]. Path analysis was carried out following the method suggested by Dewey and Lu[6].

RESULTS AND DISCUSSION

Correlation coefficient-

Prior to breeding crops for higher yield, it is imperative to obtain the information regarding the inter-relationship of different characters with yield and among themselves since it facilitate quicker assessment of high yielding genotypes. The real association could be known only through genotypic correlation which eliminates the environmental influence.

The results of present study which revealed comparatively higher degree of genotypic correlation coefficient than phenotypic counterpart indicated that though there was a high degree of association between two characters at genotypic level, their phenotypic association was lessened due to influence of environment. In few cases, however the phenotypic correlations were slightly higher than their genotypic counterparts which implied that the non-genetic causes inflated the value of genotypic correlation because of the influence of the environmental factors. Similar findings were reported by Roodagi *et al*[28]., Singh *et al*[34]., Kumar *et al*[12]., Dagar *et al*[3]., Patel *et al*[21]., Murthy[17], Sahu *et al*[29]., Rahman *et al*[27]., Ahmed *et al*[1]., and Mali and Patel[15].

Cane yield showed highly significant and positive correlation with CCS t/ha followed by stalk weight, NMC at harvest, fiber per cent cane and internodes per stalk at both genotypic

and phenotypic levels indicating that these attributes were mainly influencing the cane yield in sugarcane. Similar results were also obtained by Punia *et al*[24]., who reported positive correlation of cane yield with number of millable canes, cane diameter and single cane weight. Sangwan and Singh[30] observed positive correlation of CCS t/ha with cane yield.

Verma *et al*[37]., who observed positive correlation of cane yield with all characters mentioned above. Milligan *et al*[16]., also obtained the same results. Khan *et al*[10]., observed correlation of cane yield with number of tillers at 120 days, stalk height and NMC/ha. Patel *et al*[22]., reported correlation of cane yield with number of internodes, CCS t/ha and stalk weight Correlation of cane yield was similar reported by Delvadia and Baraiya[5] with NMC and Cane weight, Ravishankaran *et al*[25]., for NMC and single cane weight. Patel *et al*[21,] observed correlation of cane yield with number of shoots/ha, single cane weight, stalk length, stalk diameter, number of internodes, NMC/ha and CCS t/ha. Murthy[17] recorded correlation of cane yield with number of tillers, NMC/ha, cane length (cm), cane girth (cm) and number of internodes. Mali and Patel[15] found positive and highly significant correlation with NMC per plot, single cane weight and CCS t/ha. Kheni *et al*[11]., reported cane yield correlation with single cane weight and NMC at harvest.

In present investigation cane yield had positive correlation with all quality components except sucrose per cent juice and juice purity per cent. It indicated that these attributes were also mainly influencing the cane yield. Germination per cent at 45 DAP had positive and highly significant genotypic correlations with tillers at 120 days, stalk weight, juice brix, cane yield, CCS t/ha and stalk height. Kumar *et al*[13]., recorded correlation of germination percentage with number of tillers per plot, NMC per plot, stalk girth and cane yield. Tillers at 120 days and shoots at 240 days had highly significant and positive correlation with each other and they were also positively correlated with cane yield, CCS t/ha, stalk height, stalk weight, no. of millable canes and internodes per stalk. Thippeswamy *et al*[35]., reported positive correlation with cane yield (t/ha). Kumar *et al*[12]., observed positive correlation of tillers at 120 days and shoots at 240 days with NMC at harvest. Murthy[17] with number of millable canes, cane length, cane yield and sugar yield. Sahu *et al*[29]., reported positive correlation with stalk height and stalk weight. Kheni *et al*[11]., found positive correlation with single cane weight, stalk length and NMC/ha.

In results it was observed that NMC at harvest was an important attribute for yield because it was significantly and positively correlated with cane yield.The important yield contributing trait NMC at harvest had highly significant and positive correlation with CCS t/ha, fiber per cent cane, stalk height, shoots at 240 days, juice purity, cane yield and internode per stalk. All quantitative characters were significantly and positively correlated with one another and with qualitative traits except with fiber per cent cane and juice purity per cent which was significantly and negatively correlated with most of the traits. Thus, improvement in one character would improve the other character. Milligan *et al*[16]., Patel *et al*[22]., Chaudhry and Singh, Das *et al*[4]., Verma[38], Patel *et al*[21]., also obtained strong association of quantitative characters, which were in conformity with these results. Also similar results were reported by Rahman *et al*[27]., Ahmed *et al*[1]. and Khan *et al*[9].

From the results of this investigation it may be concluded that for improving cane yield breeder should give weightage on characters like NMC at harvest, shoots at 240 DAP, tillers at 120 DAP, internodes per stalk, stalk weight, fiber per cent cane and CCS t/ha which were high significantly and positively correlated with cane yield. While, for quality improvement trait sugar yield (t/ha) which had significant association with quality parameters.

Path coefficient analysis

Yield is a complex character and is the multiplicative end product of several component traits. Some of them may be grouped as main components which directly

contribute towards yield, whereas, others may not contribute directly to the yield but indirectly may influence the yield by changing the behavior and growth of different components, therefore, it would be better to know how the yield is directly and indirectly influenced by other characters.

The simple correlation, being calculated on an average basis, may not give a clear picture of the cause effect system operating on the material selected for study. However, when numbers of variables are increased then the situation becomes complex then computation of path analysis that facilitates the partitioning of genotypic correlation coefficient into direct and indirect effect of various characters becomes necessary. In order to achieve a clear picture of inter-relationship of various component characters with yield, direct and indirect effects were calculated using path coefficient analysis at genotypic level.

From the present study it was observed that stalk weight has the highest positive direct effect on cane yield followed by shoot at 240 days, NMC at harvest, CCS per cent, germination per cent at 45 DAP and stalk height. Similar results were reported by Kang *et al*[8]. Punia[23] for stalk weight and number of millable stalk had high direct positive effect on yield. Above mention result were observed by Reddy and Khan[26] with NMC, cane height and cane weight, Patel *et al*[22]., and Pal *et al*[19]., with CCS per cent and stalk weight. Singh *et al*[34]., revealed that NMC/clump, cane height, shoots at 240 days, single cane weight and stalk diameter reflected highly positive direct effect on cane yield at genotypic level.

In the present investigation CCS t/ha had the highest negative direct effect on cane yield followed by fiber per cent cane, juice bix per cent, tillers at 120 DAP, sucrose per cent juice and juice purity per cent. This type of result was also obtained by Kang *et al*[8]., who reported that sucrose per cent juice had a small negative effect on cane yield. Pal *et al*[19]., noted that total stalk height and juice brix was not important trait for direct selection to obtained higher cane yield. Niraj and Singh[18] observed that fiber per cent cane, brix per cent had negative direct effect on cane yield.

Stalk weight had the highest positive direct effect but it had positive highly significant correlation with cane yield, while highest positive indirect effect on cane yield by stalk weight via CCS per cent followed by tillers at 120 days, sucrose per cent juice and germination per cent at 45 days. As well as sugar yield t/ha also having high negative direct effect on cane yield and it had positive and highly significant strong association with cane yield. Thus, it is the most important and reliable character and can be utilized in direct selection for improving cane yield. Das *et al*[4]., also reported the highest negative direct effect and highest genotypic correlation of CCS (t/ha) with cane yield (t/ha). Patel *et al*[21]., reported that the highest positive direct effect and highest genotypic correlation of CCS t/ha with cane yield. Gana *et al*[7]., reported highest direct and indirect effect on sugar yield. Sayed *et al*[31]., found highest direct and indirect effect on sugar yield followed by stalk weight.

Germination per cent at 45 DAP, tillers at 120 days, shoots at 240 days, internodes per stalk, stalk weight, NMC at harvest, fiber per cent cane, CCS per cent at harvest and CCS t/ha had highly significant positive genotypic correlation with cane yield, so they are also important characters for selection criteria. Reddy and Khan[26], Sharma and Singh[33], Shaikh *et al*[32]., Choudhary and Singh[2], Das *et al*[4]., Pal *et al*[19]., Kumar and Singh[14], Tyagi and Lal[36], Gana *et al*[7]., and Kheni *et al*[11]., suggested single cane weight and numbers of internodes as reliable characters for selection.

Sugar yield had high negative direct effect and highly significant correlation with cane yield and its indirect effect via other characters is also found negative and high. An important consideration for formulating the path diagram is that all important causal factors affecting the cane yield t/ha are included. Since cane yield is very complex character being affecting by so many characters. Under these circumstances, provision is made for a residual path which

would take care of all such factors excluded. In the present study the residual effect at genotypic level was 0.0123 which suggest that there is no other traits directly or indirectly influenced the cane yield other than those character included in this study.

So, it may be pointed out that for improving cane yield, on overall basis emphasis in order of preference during selection can be laid out on CCS t/ha, stalk weight, stalk height, internodes per stalk, germination per cent at 45 DAP, shoots at 240 DAP and NMC at harvest because besides they have high direct effect, they also have strong association with cane yield.

Table 2: Genotypic (r_g) and Phenotypic (r_p) Correlation Coefficients of Sugarcane yield with various growth and quality components in Sugarcane (Pooled)

Characters		Germination % at 45DAP	Tillers at 120 DAP ('000/ha)	Shoot at 240 DAP ('000/ha)	Stalk height (cm)	Stalk diameter (cm)	Inter nodes /stalk	Stalk weight (Kg)	NMC at harvest ('000/ha)	Juice brix %	Sucrose % juice	Juice purity %	Fiber % cane	CCS %	CCS t/ha
										At 12 months					
Cane yield (t/ha)	r_g	0.153**	0.273**	0.182**	-0.226**	-0.009	0.467**	0.782**	0.623**	0.029	0.087	-0.335**	0.538**	0.309**	0.974**
	r_p	0.062	0.038	0.064	-0.036	-0.213**	0.220**	0.855**	0.490**	0.012	-0.074	-0.056	0.262**	-0.033	0.895**
Germination % at 45DAP	r_g	1.000	0.209**	-0.094*	0.116**	-0.284**	-0.007	0.179**	-0.039	0.167**	-0.116*	0.069	-0.154**	-0.041	0.145**
	r_p	1.000	0.004	-0.002	-0.017	-0.100*	-0.005	0.050	0.068	-0.033	-0.036	0.034	-0.010	-0.040	0.036
Tillers at 120 DAP ('000/ha)	r_g		1.000	0.476**	0.180**	-0.123**	0.079	0.230**	0.078	-0.400**	-0.337**	0.438**	-0.098*	-0.333**	0.180**
	r_p		1.000	0.496**	-0.013	0.038	0.020	0.044	-0.012	0.039	0.072	-0.071	-0.019	0.048	0.061
Shoot at 240 DAP ('000/ha)	r_g			1.000	0.096*	-0.057	0.173**	0.056	0.163**	0.039	0.334**	0.225**	0.228**	0.327**	0.234**
	r_p			1.000	-0.024	0.018	0.076	0.035	0.028	0.040	0.104*	0.019	0.092	0.080	0.102*
Stalk height (cm)	r_g				1.000	0.137**	-0.014	-0.348**	0.091	0.189**	0.056	0.196**	-0.079	-0.122**	-0.225**
	r_p				1.000	0.041	-0.018	0.110*	0.124**	0.116*	0.018	-0.010	-0.048	-0.046	-0.061
Stalk diameter (cm)	r_g					1.000	0.246**	-0.029	0.054	0.091	0.067	0.294**	0.167**	-0.266**	-0.062
	r_p					1.000	0.087	-0.264**	-0.009	0.026	-0.025	-0.033	0.085	-0.026	-0.213**
Internodes /stalk	r_g						1.000	0.041	0.706**	0.040	0.059	-0.512**	0.858**	0.286**	0.463**
	r_p						1.000	0.018	0.359**	-0.017	-0.024	-0.081	0.571**	0.005	0.210**
Stalk weight (Kg)	r_g							1.000	0.005	0.083	0.206**	-0.747**	-0.004	0.283**	0.772**
	r_p							1.000	0.018	0.048	0.014	-0.103*	0.003	-0.015	0.776**
NMC at harvest ('000/ha)	r_g								1.000	-0.075	-0.221**	0.248**	0.882**	-0.006	0.574**
	r_p								1.000	-0.020	-0.057	0.069	0.476**	-0.002	0.432**
Juice brix at 12 months (%)	r_g									1.000	0.266**	-0.454**	-0.183**	-0.039	0.014
	r_p									1.000	0.606**	-0.117*	-0.045	0.403**	0.185**
Sucrose % juice at 12 months	r_g										1.000	-0.610**	-0.140**	0.001	0.308**
	r_p										1.000	-0.075	-0.020	0.837**	0.301**
Juice purity % at 12 months	r_g											1.000	0.252**	-0.227**	-0.487**
	r_p											1.000	0.024	-0.025	-0.063
Fiber % cane at 12 months	r_g												1.000	0.100*	0.498**
	r_p												1.000	0.063	0.274**
CCS % at 12 months	r_g													1.000	0.540**
	r_p													1.000	0.405**

* , ** Significant at 5 and 1 per cent levels respectively

Table 3: Direct and indirect effects of different characters on cane yield in sugarcane (pooled)

Characters	Direct effect on cane yield t/ha	Indirect effects on cane yield														Genotypic correction with cane yield
		Germination % at 45DAP	Tillers at 120 DAP (‘000/ha)	Shoot at 240 DAP (‘000/ha)	Stalk height (cm)	Stalk diameter (cm)	Inter nodes /stalk	Stalk weight (Kg)	NMC at harvest (‘000/ha)	Juice brix %	Sucrose % juice	Juice purity %	Fiber % cane	CCS %	CCS t/ha	
										At 12 months						
Germination % at 45days	0.149	0.149	0.031	-0.014	0.017	-0.043	-0.001	0.028	-0.006	0.028	-0.018	0.010	-0.024	-0.006	0.022	0.153**
Tillers at 120 DAP (‘000/ha)	-0.175	-0.037	-0.175	-0.083	-0.032	0.021	-0.014	-0.041	-0.014	0.084	0.070	-0.076	0.018	0.058	-0.032	0.273**
Shoot at 240 DAP (‘000/ha)		-0.023	0.118	0.249	0.024	-0.016	0.043	0.015	0.041	0.013	0.096	0.056	0.058	0.081	0.060	0.182**
Stalk height (cm)		0.013	0.020	0.011	0.110	0.015	-0.002	-0.039	0.010	0.025	0.007	0.133	-0.009	-0.014	-0.025	-0.226**
Stalk diameter (cm)		-0.022	-0.009	-0.005	0.011	0.076	0.019	-0.002	0.004	0.009	0.005	0.021	0.013	-0.021	-0.005	-0.009
Internodes /stalk		0.002	-0.003	-0.006	0.001	-0.008	-0.033	-0.001	-0.024	-0.002	-0.002	0.017	-0.029	-0.010	-0.016	0.467**
Stalk weight (Kg)		0.257	0.321	0.082	-0484	-0.027	0.051	0.360	0.005	0.088	0.315	-0.971	-0.007	0.402	0.058	0.782**
NMC at harvest (‘000/ha)		-0.048	0.098	0.203	0.113	0.066	0.877	0.005	0.243	-0.131	-0.317	0.308	0.111	-0.008	0.714	0.623**
Juice brix % at 12 months		-0.035	0.088	-0.009	-0.041	-0.021	-0.008	-0.012	0.019	-0.184	-0.025	0.086	0.039	0.037	0.008	0.029
Sucrose % juice at 12 months		0.010	0.032	-0.031	-0.005	-0.006	-0.004	-0.019	0.020	-0.011	-0.080	0.053	0.014	-0.074	-0.023	0.087
Juice purity % at 12 months		-0.007	-0.047	-0.024	-0.129	-0.029	0.054	0.076	-0.026	0.050	0.071	-0.106	-0.025	0.130	0.052	-0.335**
Fiber % cane at 12 months		0.031	0.019	-0.045	0.016	-0.032	-0.165	0.001	-0.170	0.040	0.032	-0.046	-0.190	-0.018	-0.098	0.538**
CCS % at 12 months		-0.007	-0.060	0.059	-0.022	-0.050	0.052	0.053	-0.001	-0.036	0.166	-0.222	0.018	0.181	0.092	0.309**
CCS t/ha at 12 months		-0.123	-0.152	-0.200	0.191	0.051	-0.391	-0.645	-0.476	0.035	-0.235	0.406	-0.427	-0.423	-0.828	0.974**

Residual effects = 0.0123

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