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CORRELATION AND PATH COEFFICIENT ANALYSES IN SUGARCANE

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ABSTRACT
This study was conducted to determine the contribution of different traits to cane yield in sugarcane (*Saccharum officinarum* L). Thirty-nine clones were evaluated in a replicated field experiment at M. S. R. S, Navsari for 16 morphological characters. Analysis of variance revealed significant differences for all the characters studied. Cane yield showed positive and highly significant correlation with tillers 120 DAS (0.24, 0.32), shoots at 240 days (0.31, 0.41), single cane weight (0.54, 0.57), NMC (0.30, 0.43) at harvest and CCS % (0.77, 0.82) at both genotypic and phenotypic level respectively Cane yield also had significant and positive correlation with juice purity per cent at genotypic level. Path coefficient analysis indicated that the highest positive direct effect of sucrose per cent cane (3.65) on cane yield, followed by sugar yield (1.17) and CCS per cent (0.66). Most of the had significant indirect effect toward yield via tillers at 120 days, shoots at 240 days, single cane weight, juice purity per cent at number of millable canes at harvest and sugar yield. The highest indirect effect was via single cane weight (0.798) on can yield.

INTRODUCTION

Sugarcane plant having heterozygous and polyploidy nature has resulted in generation of greater genetic diversity (Deleate Dagar *et al.,* 2002). 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 kind of effective selection programme.). Sugarcane breeding involves the production and evaluation of several thousand seedlings from different crosses every year and selection of the superior seedlings for further evaluation in clonal stages (Sundaresan *et al.,* 1979). For yield improvement in sugarcane through selection, the knowledge of the correlation between yield contributing characters is essential. A correlation study provides an opportunity to study the magnitude and direction of association of yield with its components and also among themselves. The concept of correlation was first proposed by Galton (1889) and later it was elaborated by fisher (1918) and is is rated as significant only when observed values are higher than the estimated value. Path coefficient is an excellent means of studying direct and indirect effects of interrelated components of a complex trait (Kang *et al.,* 1983). Path-coefficient analysis measures the direct influence of one variable on another. Each correlation coefficient between a predictor variable and the response variable is partitioned into its component parts: the direct effect or path coefficient (a standardized partial regression coefficient) for the predictor variable and indirect effects, which involve the product of a correlation coefficient between two predictor variables with the appropriate path coefficient in the path diagram (Dewey and Lu, 1959). Effects of stalk number, stalk diameter, stalk length and single cane weight on cane yield have been reported by Hogarth (1971), Chaudhary *et al.* (1994) and James (1971). Plant breeders generally select for only a few traits and it is very important to know the effects of this on other important characters as well. Therefore, this experiment was conducted to study the relations of certain morphological characters with sugarcane yield.

MATERIALS AND METHODS

The present investigation on "Correlation coefficient and path analysis in sugarcane " was carried out at Main Sugarcane Research Station, Navsari Agricultural University, during 2011-12. Prior to calculating the correlation coefficients, the analysis of co-variance for all the possible pairs of the characters under investigation was carried out using the procedure described by Panse and Sukhatme (1978). The genotypic (rg) and phenotypic (rp) correlation coefficients were calculated as under by adopting the procedure expounded by Miller et al. (1958). [(rg xy = Covg xy/?gx X ?gy) and (rp xy = Covp xy/ ópx X ópy)] and their test of significant tested by method of Fisher and Yates (1943). Simple correlation coefficients do not explain the cause and effect relationship between two

Table 1: Genotypic and phenotypic correlation coefficients of sugarcane yield with various growth and quality components

Chara.		Germin -ation% at45days	Tillers at 120 days(000/ha)	Shoots at 240 days(000/ha)	Single cane weight (Kg)	Stalk length at harvest (cm)	Stalk diameter (cm)	Internodes per stalk	Juice Brix (%) at 360 DAP	Sucrose % Juice at 360 DAP	Juice Purity (%) at 360 DAP	Fiber % cane	NMC ('000/ ha)	Sucrose % cane at 360 DAP	CCS % at 360 DAP	CCS t/ha
		X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X13	X14	X15	X16
X12	rg	0.096	0.240*	0.315**	0.749**	0.078	0.041	0.059	0.117	0.112	0.362**	0.061	0.307**	0.100	0.111	0.772**
	rp	0.054	0.342**	0.418**	0.576**	0.000	0.048	0.025	-0.033	-0.023	0.091	-0.186	0.439**	0.010	-0.008	0.829**
X1	rg	1.000	0.257*	0.171	0.062	-0.049	0.272*	0.175	-0.061	-0.055	-0.255*	-0.144	0.157	-0.028	-0.056	0.050
	rp	1.000	0.093	0.142	0.026	0.001	0.177	0.166	-0.091	-0.094	-0.095	-0.126	0.141	-0.073	-0.089	0.0005
X2	rg		1.000	1.035**	-0.531**	0.293**	0.041	0.015	0.141	0.089	-0.509**	0.116	1.049**	0.055	0.062	0.208
	rp		1.000	0.797**	-0.224*	0.101	0.005	0.045	-0.015	-0.028	-0.067	-0.049	0.811**	-0.021	-0.022	0.277*
X3	rg			1.000	-0.387**	0.178	-0.238*	0.212	0.061	0.042	-0.218	-0.062	0.987**	0.036	0.023	0.226*
	rp			1.000	-0.299**	0.099	-0.166	0.164	0.007	-0.002	0.010	-0.044	0.955**	-0.0002	0.001	0.349**
X4	rg				1.000	0.002	0.195	-0.872	0.061	0.066	0.514**	0.225*	-0.459**	0.039	0.087	0.597**
	rp				1.000	-0.050	0.058	-0.041	-0.059	-0.036	0.122	-0.051	-0.316**	-0.019	-0.022	0.474**
X5	rg					1.000	-0.007	0.515**	-0.259*	-0.323**	-0.379**	-0.297*	0.114	-0.287	-0.357**	-0.161
	rp					1.000	0.119	0.378**	-0.209	-0.285*	-.0248*	-0.169	0.059	-0.266*	-0.317**	0.168
X6	rg						1.000	0.108	-0.434**	-0.419**	-0.331**	-0.027	0.315**	-0.411**	-0.412**	-0.215
	rp						1.000	0.109	-0.242*	-0.271*	-0.226*	-0.005	-0.161	-0.277*	-0.280*	0.106
X7	rg							1.000	-0.343**	-0.365**	-0.319**	-0.059	0.151	-0.373**	-0.391**	-0.194
	rp							1.000	-0.214	-0.252*	-0.148	-0.019	0.113	-0.264*	-0.279*	-0.122
X8	rg								1.000	0.992**	0.503**	0.149	0.127	0.988**	0.989**	0.726**
	rp								1.000	0.965**	0.229*	0.209	0.047	0.956**	0.931**	0.492**
X9	rg									1.000	0.633*	0.179	0.106	0.992**	1.0000	0.719**
	rp									1.000	0.381**	0.251*	0.045	0.983**	0.993**	0.533**
X10	rg										1.000	0.158	-0.281*	0.634**	0.657**	0.645**
	rp										1.000	0.117	0.048	0.365**	0.430**	0.308**
X11	rg											1.000	-0.025	0.052	0.188	0.172
	rp											1.000	-0.047	0.082	0.252*	-0.0007
X13	rg												1.000	0.099	0.095	0.258*
	rp												1.000	0.048	0.051	0.391**
X14	rg													1.000	0.991**	0.706**
	rp													1.000	0.975**	0.548**
X15	rg														1.000	0.716**
	rp														1.000	0.549**
X16	rg															1.000
	rp															1.000

where,

x1.Germination%; x2.tillers at 120 daya; x3.shoots at 240 days; x4.single cane weight; x5.stalk length at harvest;x6.stalk diameter;x7.internodes/stalk; x8.Juice brix % at 360 DAP; x9.Sucrose % juice at 360 DAP;x10.Juice purity % at 360 DAP; x11.Fiber % cane; x12 cane yield; x13.NMC;x14.Sucrose % cane at 360 DAP;x15. CCS % at 360 DAP;x16.sugar yield

variables. Therefore, the data were subjected to a standard regression analysis known as path analysis to unravel whether the association of different traits with yield is due to their direct effect or it is a consequence of their indirect effect via some other traits. The procedure was adopted from Wright (1921), Dewey and Lu (1959).

RESULTS AND DISCUSSION

Correlation

The result of present study, which revealed comparatively higher degree of genotypic correlation coefficient than their phenotypic counterparts in most of the characters, indicated that there was a high degree of association between two characters at genotypic level than their phenotypic association was lessened due to the influence of environment. In few cases, however, the phenotypic correlation were slightly higher than their genotypic counterparts which implies 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*. (2001), Singh *et al*. (2002).

The pair wise simple correlation coefficient (r) among various characters are presented in Table 1. Cane yield showed positive and highly significant correlation with tillers 120 DAP (rg = 0.240 and rp = 0.342), shoots at 240 days ('000/ha) (rg = 0.315 and rp = 0.418), single cane weight (kg) ('000/ha) (rg = 0.747 and rp = 0.579), NMC ('000/ha) (rg = 0.307 and rp = 0.439) and CCS (t/ha) (rg = 0.772 and rp = 0.829) at both genotypic and phenotypic level, similarly with juice purity at 360 DAP (rg = 0.362) it exhibited highly significant correlation at genotypic level. A positive value of r shows that the changes of two variables are in the same direction, high values of one variable are associated with high values of other and vice versa. So it indicated that selection for such type of character should be effective to improve cane yield in further breeding programme. This result was akin by Brown et al (1969), Balasundarum and Bhagyalakshmi (1978) and Punia et al (1983). Hooda et al (1979) also observed cane diameter having significant positive correlation with cane yield.

Internodes per stalk displayed highly significant and positive correlation with stalk length at harvest (cm) (rg = 0.515 and rp = 0.378) at both genotypic and phenotypic levels. Juice brix per cent is the most important economic character indicated highly significant and positive correlation with sucrose per cent juice at 360 (rg = 0.992 and rp = 0.965), juice purity per cent (rg = 0.503 and rp = 229), sucrose per cent cane (rg = 0.988 and rp = 0.956), CCS per cent (rg = 0.989 and rp = 0.931) and sugar yield (t/ha) (rg = 0.726 and rp = 0.492) at both genotypic and phenotypic levels, while with stalk diameter (cm) (rg = -0.434 and rp = -0.242) stalk length at harvest (cm) (rg = -0.259) it showed negative highly significant and significant correlation at genotype and phenotype levels respectively. In present investigation cane yield had non-significant positive correlation with germination per cent at 45 days, stalk length at harvest (cm), stalk diameter (cm), internodes per stalk, sucrose per cent juice at 360 DAP, pol per cent at 360 DAP, CCS per cent at 360 DAP and fiber per cent at 360 DAP. It indicated that they have least influence on this trait.

Table 2: Path analysis showing direct and indirect effects of different characters on cane yield in sugarcane

Char	Germin -ation % at 45days	Tillers at 120 days(000/ha)	Shoots at 240 days 000/ha)	Single cane weight (Kg)	Stalk length at harvest (cm)	Stalk diameter (cm)	Internodes per stalk	Juice Brix (%) at 360 DAP	Sucrose % Juice at 360 DAP	Juice Purity (%) at 360DAP	Fiber % cane	NMC ('000/ha)	Sucrose % cane at 360 DAP	CCS % at 360 DAP	CCS (t/ha)	Cane yield (t/ha)
	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X13	X14	X15	X16	
X1	-0.077	-0.020	-0.013	-0.005	0.002	-0.020	-0.013	0.005	0.004	0.019	0.011	-0.012	0.002	0.004	-0.004	0.096
X2	-0.036	-0.139	-0.144	0.074	-0.041	-0.001	-0.002	-0.020	-0.012	0.071	0.016	-0.150	0.008	-0.009	-0.029	0.240*
X3	0.011	0.068	0.065	-0.025	0.012	-0.101	0.014	0.004	0.003	-0.014	-0.004	0.065	0.002	0.002	0.015	0.314**
X4	0.006	-0.052	-0.038	0.098	0.0002	0.040	-0.009	0.006	0.007	0.050	0.022	-0.045	0.004	0.009	0.058	0.798**
X5	-0.0002	0.001	0.001	0.000	0.004	-0.0003	0.002	-0.001	-0.001	-0.002	-0.001	0.0004	-0.001	-0.001	-0.001	0.074
X6	0.026	0.001	-0.015	0.040	-0.008	0.097	-0.009	-0.045	-0.039	-0.0024	-0.018	-0.017	-0.037	-0.037	-0.0019	0.042
X7	0.009	0.001	0.010	-0.004	0.025	-0.005	0.049	-0.017	-0.018	-0.016	-0.003	0.008	-0.018	-0.019	0.010	0.054
X8	-0.038	0.088	0.038	0.038	-0.162	-0.290	-0.215	0.626	0.621	0.315	0.094	0.080	0.618	0.620	0.455	0.110
X9	0.318	-0.510	-0.238	-0.379	1.854	2.313	2.098	-5.698	-5.743	-3.633	-1.029	-0.606	-5.597	-5.743	4.134	0.112
X10	-0.017	-0.033	-0.014	0.034	-0.025	-0.002	-0.021	0.033	0.041	0.065	0.010	-0.018	0.042	0.043	0.042	0.362**
X11	-0.070	0.056	-0.030	0.109	-0.143	-0.089	-0.029	0.072	0.086	0.076	0.483	-0.012	0.026	0.091	0.083	0.061
X13	0.044	0.296	0.278	-0.130	0.032	-0.048	0.043	0.036	0.030	-0.079	-0.007	0.282	0.028	0.027	0.073	0.307**
X14	-0.103	0.199	0.131	0.144	-1.046	-1.375	-1.340	3.604	3.621	2.316	0.193	0.363	3.650	3.618	2.575	0.100
X15	-0.307	0.041	0.019	0.058	-0.298	-0.253	-0.261	0.661	0.668	0.438	0.126	0.063	0.662	0.668	0.478	0.111
X16	0.059	0.244	0.265	0.700	-0.189	-0.023	-0.228	0.851	0.844	0.757	0.2011	0.302	0.828	0.820	1.173	0.772**

Balasundarum and Bhagyalakshmi (1978) also reported similar results. Negative correlation indicated their inverse relationship with each other. Single cane weight was positively and highly significant correlation with stalk length and cane diameter.

Path coefficient

Path coefficient analysis unfolds whether the association of cane yield with its components is due to the direct effects of component characters on cane yield or is a consequence of its indirect effects via some other traits. The highest positive direct effect on cane yield was exerted by sucrose per cent cane (3.650) followed by CCS (1.173) (Table 2) so direct selection for such character should increase cane yield similar result was found by Kang et al. (1983), observed that sucrose per cent had a direct positive effect on sugar per tone of cane. Das et al. (1996) also reported the highest positive direct effect and highest genotypic correlation of CCS (t/ha) with cane yield. Patel et al. (2006) reported that the highest positive direct effect and highest genotypic correlation of CCS (t/ha) with cane yield. Most of the characters had high positive and significant indirect effects on cane yield via tillers at 120 days, shoots at 240 days, single cane weight, juice purity per cent at 360 DAP, number of millable canes at harvest ('000/ha) and sugar yield (t/ha). For indirect effect all characters pertained to be positive indirect effect towards the yield but among them six character tillers 120 DAS (0.240), shoots at 240 DAS (0.314), single cane weight(0.798), juice purity per cent (0.362), number of millable cane (0.307) and sugar yield (0.772) pertained significant indirect effect to yield and indicated that this character indirectly affect on yield so breeder should have to do precise selection for such type of character to improve cane yield.

The result of present study, which revealed comparatively higher degree of genotypic correlation coefficient than their phenotypic counterparts in most of the characters, indicated that there was a high degree of association between two characters at genotypic level than their phenotypic association was lessened due to the influence of environment. In few cases, however, the phenotypic correlation were slightly higher than their genotypic counterparts which implies 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*. (2001), Singh *et al*. (2002).

Correlation study indicates that single cane weight and CCS are most important for cane yield improvement. Selection based on number of Sucrose per cent and CCS are directly increased cane yield. During selection indirect effect of stalk length via single cane weight should also be considered. Three characters viz tillers at 120 days, shoots at 240 days, single cane weight, juice purity per cent at 360 DAP, number of millable canes at harvest ('000/ha).

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