

Full Length Research Paper

## Correlation and path coefficient analysis in sugarcane germplasm under subtropics

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Three hundred and thirty-nine genotypes of sugarcane germplasm were planted during spring 2006-2007 and 2007-2008 to study the associations among 15 characters. The cane yield, considered as the most important character of sugarcane was positively and significantly correlated with germination percentage, number of shoots, number of millable canes, stalk diameter, stalk length, number of internodes, length of internodes, stalk weight, number of green leaves, while with the top weight, it showed positive but non-significant correlation. Cane yield was negatively correlated with brix at all the stages. Sugarcane is influenced by a number of characters to various degrees of relationship among themselves. Thus, the path coefficient analysis for cane yield, as dependent (or effect) and the other characters as independent (or causes) have been done at phenotypic level. Hence, the present study was conducted to elucidate the genetic association among different agronomic traits in sugarcane germplasm under sub-tropics.

**Key words:** Sugarcane, genotype, correlation and path coefficient analysis, cane yield.

### INTRODUCTION

Sugarcane is the main source of sugar production in India and one of the most important agroindustrial crops of the world (Anonymous, 1997). It also boosts national economy by providing direct and indirect employment to about 35 million people in India. Sugar per unit area is determined by the cane yield per unit area and sucrose percent in juice. These two characters are influenced by their component traits. As the demand for white sugar is increasing continuously, the cane productivity and sugar recovery has to be increased accordingly. In sugarcane, complex traits like cane yield and quality are influenced by a number of characters. These characters directly and indirectly contribute to the yield (Ram et al., 2000). Swaminathan (1991) emphasized that genetic diversity and location specific varieties are essential for achieving sustainable advances in productivity. Variety is the pivot

and the cheapest technology for boosting cane production and productivity through sugarcane varietal improvement programme and this programme proceeds via choosing parents, making crosses. This experiment was taken up to study the correlation and path coefficient among different characters in a set of 339 sugarcane germplasm to understand the inter - relationship among the characters and also to foresee the consequences of selection based on various components.

### MATERIALS AND METHODS

The present study comprised 339 sugarcane commercial hybrids or genotypes were conducted at Choudhary Chotu Ram (P.G.) College, Agricultural Farm, Muzaffarnagar (U.P), India during spring 2006-2007 and 2007-2008. These 339 genotypes were

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**Table 1.** Correlation coefficient for 15 characters in sugarcane germplasm during 2006-07.

Character	No. of shoots/plot	No. of millable canes/plot	Stalk diameter (cm)	Stalk length (m)	No. of internode/stalk	Length of internode (cm)	Stalk weight (kg)	No. of green leaves/stalk	Top weight (gm)	Brix at 10 <sup>th</sup> month	Brix at 11 <sup>th</sup> month	Brix at 12 <sup>th</sup> month	Brix at 13 <sup>th</sup> month	Cane yield (kg)/plot
Germination (%)	0.527**	0.457**	-0.0008	0.058	0.056	-0.169**	-0.003	0.133	-0.039	-0.106	-0.024	-0.045	0.075	0.346**
Number of shoots/plot		0.806**	-0.098	0.015	0.002	-0.069	-0.101	0.071	-0.019	-0.042	-0.001	-0.013	-0.003	0.491**
Number of millable canes/plot			-0.069	0.065	0.021	-0.031	-0.098	0.053	-0.002	-0.027	-0.003	-0.023	-0.027	0.631**
Stalk diameter (cm)				-0.187**	0.225**	0.087	0.593**	0.272**	0.227	-0.028	-0.008	-0.020	0.126*	0.388**
Stalk length (m)					0.775**	0.452**	0.547**	0.195**	0.193**	0.043	0.031	0.019	0.036	0.480*
Number of internodes/stalk						-0.114*	0.512**	0.210**	0.057	0.009	0.017	0.043	0.030	0.405**
Length of internode (cm)							0.275**	0.002	0.026	0.119**	0.125*	0.012	0.020	0.198**
Stalk weight (kg)								0.306**	0.081	0.010	0.034	0.011	0.077	0.661**
Number of green leaves/stalk									0.563**	0.022	0.091	0.052	0.066	0.268**
Top weight (gm)										0.061	0.021	0.097	0.118*	0.109
Brix at 10 <sup>th</sup> month											0.502**	0.382**	0.346**	-0.045
Brix at 11 <sup>th</sup> month												0.671**	0.207**	-0.019
Brix at 12 <sup>th</sup> month													0.260**	-0.009
Brix at 13 <sup>th</sup> month														-0.042

\*Significant at 5% level of probability. \*\* Significant at 1% level of probability.

planted in augmented block design. The experiment was divided into 7 blocks each of 51 plots, the plot size of 6.0 × 1.8 m had 6 m long two rows 90 cm apart the planting was done at 12 buds per running meter. All the recommended cultural practices were followed to obtain a good crop. The data were recorded as per standard statistical procedures for both the years on 15 agronomic attributes. viz. No. of shoots/Plot, No. of millable canes/plot, stalk diameter, Stalk length, number of internodes per stalk, length of internode, stalk weight, No. of green leaves/stalk. Top weight, Brix at 10<sup>th</sup> month, Brix at 11<sup>th</sup> month, Brix at 12<sup>th</sup> month, Brix at 13<sup>th</sup> month, cane yield (kg) per plot.

Correlation and path coefficient analysis were calculated as per formulae suggested by Al-Jibouri et al. (1958) and Miller et al. (1958) and Dewey and Lu (1959) (Table 1).

## RESULTS AND DISCUSSION

One of the objectives of this present

investigation was to study the association of various characters among themselves which ultimately gave the indication that selection for one trait will automatically change the other attributes. Therefore, to develop an understanding of association between the component characters is a necessary prerequisite to carry out an effective breeding programme.

The association between any two characters is dependent upon their inheritance. If they are inherited together, the relationship between them may be observed. The average between genes governing two or more characters, that is, location of genes on the same chromosome or chromosome governing particular character or pair is the cause for association between characters at phenotypic and genotypic levels.

In the present investigation (Tables 1 and 2),

the germination showed a positive and significant correlation with number of shoots, number of millable canes and cane yield as also reported earlier by Sahu et al. (2008).

Number of shoots should of millable canes and cane yield. The numbers of shoots showed highly positive and significant associations with number of millable canes were closely associated with each other during both years, as it was the primary shoots (Tillers) which subsequently developed into millable canes. On the other hand, number of shoots showed a negative association with stalk diameter and stalk weight. These results were also in conformity with the findings made earlier by several workers Reddy and Khan (1984), and Khan (1995). Being the most important yield contributing characters number of millable canes demonstrated a highly positive and

**Table 2.** Correlation coefficient for 15 characters in sugarcane germplasm during 2007-2008.

Character	No. of shoots/plot	No. of millable canes/plot	Stalk diameter (cm)	Stalk length (m)	No. of internode /stalk	Length of internode (cm)	Stalk weight (kg)	No. of green leaves/stalk	Top weight (gm)	Brix at 10 <sup>th</sup> month	Brix at 11 <sup>th</sup> month	Brix at 12 <sup>th</sup> month	Brix at 13 <sup>th</sup> month	Cane yield (kg)/plot
Germination (%)	0.640**	0.526**	0.010	0.045	0.145*	-0.231**	-0.037	0.105	-0.039	-0.056	-0.028	-0.035	0.080	0.347**
Number of shoots/plot		0.806**	-0.078	0.031	0.018	-0.047	-0.112	0.057	0.001	0.004	-0.020	-0.054	-0.015	0.488**
Number of millable canes/plot			-0.069	0.040	0.036	-0.001	-0.076	0.054	0.049	-0.005	-0.003	-0.015	-0.052	0.616**
Stalk diameter (cm)				-0.214**	0.210**	0.066	0.614**	0.315**	0.253**	-0.055	-0.096	-0.052	0.045	0.418**
Stalk length (m)					0.750**	0.401**	0.610**	0.192**	0.226**	0.038	-0.029	-0.009	0.010	0.486**
Number of internodes/stalk						-0.027	0.480**	0.186**	0.111	0.007	0.083	-0.019	-0.025	0.394**
Length of internode (cm)							0.297**	0.016	0.045	0.058	0.023	0.091	0.023	0.231**
Stalk weight (kg)								0.286**	0.063	0.005	0.081	0.067	0.034	0.650**
Number of green leaves/stalk									0.578**	0.061	0.020	0.003	0.060	0.263**
Top weight (gm)										0.082	0.110	0.102	0.113	0.025
Brix at 10 <sup>th</sup> month											0.499**	0.254**	0.304**	-0.020
Brix at 11 <sup>th</sup> month												0.643**	0.175**	-0.069
Brix at 12 <sup>th</sup> month													0.414**	-0.034
Brix at 13 <sup>th</sup> month														-0.029

\*Significant at 5% level of probability. \*\*Significant at 1% level of probability.

significant correlation with cane yield, while it had negative association with stalk diameter, stalk weight and brix at different crop age from 10<sup>th</sup> to 13<sup>th</sup> month was also reported by Singh and Sharma (1997) and Kumar and Singh (2005). These confirmed the present observations showing that number of millable canes had a positive association with the cane yield. On other hand, Khan (1995) reported a negative association of number of millable canes with brix, stalk diameter and stalk weight as also observed in the present investigation.

The Stalk diameter though had positive association with characters like cane yield, stalk weight, number of internodes, number of green leaves and top weight, it has a negative association with stalk length and brix and 10<sup>th</sup>, 11<sup>th</sup> and 12<sup>th</sup> month crop age. However, it showed a

positive association with brix at 13<sup>th</sup> month crop age. Results showing positive association of cane diameter with cane yield have already been reported by several investigations (Singh and Sharma, 1995; Singh and Saxena, 1997; Singh and Sharma, 1997).

Stalk length was found significantly and positively associated with cane yield, number of internodes, length of internodes, stalk weight, number of green leaves, top weight, while positively and non-significantly associated with number of shoots, number of millable canes and brix at 10<sup>th</sup> and 13<sup>th</sup> months. Earlier it was reported by Lu (1983), Madhavi et al. (1990), Singh et al. (1995) and Singh and Saxena (1997).

Number of internodes had a highly significantly and positive association with cane yield, stalk weight, number of green leaves and a non-

significant positive association with top weight and brix at 10<sup>th</sup> to 13<sup>th</sup> month crop age. On the other hand, it showed significant negative association with length of internodes. Similar association between traits was also reported by Singh et al. (1998).

Length of internode was found positively correlated with cane yield, stalk weight, number of green leaves, top weight and brix from 10<sup>th</sup> to 13<sup>th</sup> month. Previous findings of Madhavi et al. (1990) and Singh and Sharma (1995, 1997) also confirmed the present results showing that length of internode emerged as another important trait which may be responsible for improving yield and quality of sugarcane.

Stalk weight showed highly positive significant correlation with cane yield, number of green leaves, while positive and non-significant

**Table 3.** Path coefficient analysis showing direct and indirect effects of 15 characters on cane yield in sugarcane germplasm during 2006-2007.

Character	Germination (%)	No. of Shoots/plot	No. of Millable canes/plot	Stalk diameter (cm)	Stalk length (m)	No. of Inter nodes/stalk	Length of internode (cm)	Stalk weight (kg)	No. of green leaves/stalk	Top weight (gm)	Brix at 10 <sup>th</sup> month	Brix at 11 <sup>th</sup> month	Brix at 12 <sup>th</sup> month	Brix at 13 <sup>th</sup> month	Cane yield (kg)/ plot
Germination (%)	-0.021	0.010	0.280	0.083	0.087	0.000	-0.129	0.092	0.089	-0.042	-0.146	0.011	0.089	0.043	0.346
Number of shoots/plot	-0.043	0.565	0.298	-0.393	0.133	0.000	-0.081	-0.097	0.015	-0.018	-0.087	-0.038	0.113	0.133	0.491
Number of millable canes/plot	-0.077	0.170	0.566	-0.288	0.138	0.000	0.036	-0.024	0.008	0.040	-0.018	-0.012	0.012	0.080	0.631
Stalk diameter (cm)	0.000	-0.254	-0.214	0.675	-0.237	0.028	0.019	0.310	-0.201	0.146	0.015	0.036	0.002	0.063	0.388
Stalk length (m)	0.010	0.059	0.243	0.001	0.540	0.081	-0.243	0.094	-0.326	-0.056	0.009	0.066	0.003	0.002	0.480
Number of internodes/stalk	-0.008	-0.056	-0.027	0.018	0.045	0.278	0.339	-0.077	-0.168	-0.078	0.042	0.043	0.051	0.003	0.405
Length of internode (cm)	0.000	0.128	0.182	-0.127	0.130	0.111	0.193	0.212	-0.145	-0.226	0.028	0.011	0.046	0.041	0.198
Stalk weight (kg)	-0.022	-0.036	-0.127	0.142	0.243	-0.238	-0.001	0.742	-0.093	-0.061	0.031	0.058	0.019	0.004	0.3668
Number of green leaves/stalk	-0.019	0.034	0.072	0.064	0.061	0.163	-0.001	0.079	-0.285	0.051	0.082	0.080	0.105	0.109	0.268
Top weight (gm)	-0.033	-0.054	-0.011	0.005	0.176	-0.035	-0.008	0.045	0.003	-0.120	0.022	0.084	0.031	0.004	0.109
Brix at 10 <sup>th</sup> month	-0.00	-0.020	0.008	0.148	0.128	-0.017	-0.014	-0.124	0.028	-0.008	-0.060	-0.028	-0.031	-0.038	-0.045
Brix at 11 <sup>th</sup> month	-0.000	-0.094	-0.057	0.202	0.217	-0.102	-0.032	0.047	-0.020	-0.023	-0.047	-0.059	-0.035	-0.014	-0.019
Brix at 12 <sup>th</sup> month	-0.000	-0.086	-0.060	0.289	0.184	-0.008	-0.044	0.104	-0.048	-0.060	-0.160	-0.003	-0.088	-0.028	-0.009
Brix at 13 <sup>th</sup> month	-0.004	-0.057	-0.089	0.255	-0.24	-0.098	-0.086	0.279	-0.052	-0.068	-0.145	-0.072	-0.008	-0.112	-0.042

Residual effect = 0.0217.

association with top weight and brix at all the stages (Singh et al., 1998). On the basis of results of the present investigation as well as earlier reports, it may be concluded that the stalk weight being an important yield contributing character should be taken into consideration during parental as well as varietal selection. Number of green leaves showed a highly positive significant association with cane yield and top weight and positive but non-significant correlation with brix at 10<sup>th</sup>, 11<sup>th</sup>, 12<sup>th</sup> and 13<sup>th</sup> month crop age. These results suggested that higher number of leaves/stalk showed positive correlation with cane yield and brix possibly due

to higher photosynthetic activity and it may also be considered as an important selection criterion.

Top weight showed a positive and non-significant association with cane yield and brix at

early crop age. Heavier tops, although useful with the fodder point of view are responsible for cane lodging. Since, this trait is not contributing enough towards yield and quality.

Brix at 10<sup>th</sup> month crop age had a positive association with brix at 11<sup>th</sup>, 12<sup>th</sup> and 13<sup>th</sup> month. Brix at 11<sup>th</sup> month showed a positive association with brix at 12<sup>th</sup> and 13<sup>th</sup> month and Brix at 12<sup>th</sup> with brix at 13<sup>th</sup> month. Brix from 10<sup>th</sup> to 13<sup>th</sup> month showed negative association with cane yield during both the years. This result indicates that brix at early months had positive association with brix at later age which is in conformity with the previous findings of Khan (1995). The negative association observed between brix and cane yield in the present investigation indicated the antagonistic relationship between yield and quality.

Path analysis helps us in identifying the most important characters affecting directly and indirectly through other characters. In the present study, the path coefficient analysis was performed for cane yield as a dependent variate (Tables 3 and 4).

Germination was found to have negative and considerably low direct effect on cane yield. The direct effect was counter balanced by the positive indirect effect through number of millable canes, stalk length, stalk diameter and stalk weight.

Number of shoots showed positives and high direct effect on cane yield. The indirect effect of number of shoots was positive through number of millable canes and stalk length. However, its negative indirect effect was observed through stalk diameter.

Number of millable cane showed higher direct

**Table 4.** Path coefficient analysis showing direct and indirect effects of 15 characters on cane yield in sugarcane germplasm during 2007-2008.

Character	Germination (%)	No. of shoots/plot	No. of Millable canes/Plot	Stalk diameter (cm)	Stalk length (m)	No. of internodes / stalk	Length of internode (cm)	Stalk weight (kg)	No. of green leaves/ stalk	Top weight (gm)	Brix at 10 <sup>th</sup> month	Brix at 11 <sup>th</sup> month	Brix at 12 <sup>th</sup> month	Brix at 13 <sup>th</sup> month	Cane yield (kg)/ plot
Germination (%)	-0.012	0.085	0.206	0.157	0.142	0.000	-0.082	0.020	0.003	-0.042	-0.028	-0.028	0.025	0.058	0.347
Number of shoots/plot	-0.086	0.693	0.293	-0.399	0.063	0.000	-0.003	-0.054	-0.095	-0.049	-0.050	-0.050	0.049	0.139	0.488
Number of millable canes/plot	-0.036	0.145	0.778	-0.289	0.137	0.000	0.029	-0.039	-0.049	-0.089	-0.029	-0.029	0.030	0.037	0.616
Stalk diameter (cm)	-0.001	-0.182	-0.278	0.629	-0.128	0.001	0.056	0.223	-0.102	0.020	0.010	0.010	0.005	0.134	0.418
Stalk length (m)	0.040	0.079	0.205	0.007	0.378	0.015	-0.151	0.147	-0.222	0.010	0.043	0.043	0.035	0.080	0.486
Number of internodes/stalk	-0.001	-0.007	-0.010	0.077	0.012	0.240	-0.177	-0.032	-0.100	0.002	0.009	0.009	0.017	0.020	0.394
Length of internode (cm)	0.000	0.131	0.115	-0.132	0.113	0.020	-0.139	0.167	-0.122	0.077	0.079	0.079	0.018	0.078	0.231
Stalk weight (kg)	-0.090	-0.046	-0.227	0.129	0.206	-0.119	-0.114	0.738	-0.008	0.059	0.066	0.066	0.007	0.114	0.650
Number of green leaves/stalk	-0.000	0.049	0.092	0.013	0.073	-0.113	-0.007	0.058	-0.301	0.043	0.084	0.084	0.096	0.102	0.263
Top weight (gm)	-0.007	-0.029	-0.021	0.005	0.094	-0.069	-0.028	0.023	0.004	0.020	0.026	0.026	0.043	0.112	0.025
Brix at 10 <sup>th</sup> month	-0.000	-0.023	-0.002	0.136	0.132	-0.029	-0.042	-0.138	0.009	-0.021	-0.007	-0.007	-0.018	-0.009	-0.020
Brix at 11 <sup>th</sup> month	-0.000	-0.082	-0.043	0.278	0.222	-0.085	-0.085	0.143	-0.064	-0.152	-0.072	-0.072	-0.033	-0.005	-0.069
Brix at 12 <sup>th</sup> month	-0.000	-0.072	-0.058	0.269	0.185	-0.052	-0.057	0.110	-0.056	-0.158	-0.002	-0.022	-0.097	-0.012	-0.034
Brix at 13 <sup>th</sup> month	-0.001	-0.080	-0.061	0.252	0.260	-0.112	-0.058	0.160	-0.020	-0.132	-0.012	-0.012	-0.016	-0.119	-0.029

Residual effect = 0.0104.

effect on cane yield. On the other hand, it had negative effect on the cane yield through germination, stalk diameter and stalk weight. Stalk diameter exerted direct effect on cane yield which was positive and markedly high. The indirect effect of stalk diameter on cane yield through stalk weight was positive which was counter balanced by its negative effect through number of shoots, number of millable canes and stalk length. Stalk length was found to have positively direct effect on cane yield. Stalk length positively contributed to the cane yield through number of millable canes, stalk weight and negatively through length of internodes.

Number of internodes showed positive direct effect on cane yield. It contributed to cane yield positively through length of internodes was also reported by Khan (1995) and Singh and Sharma

(1997). Length of internode was found negative direct effect on cane yield which was counter balanced by number of millable canes, number of shoots, stalk length and number of internodes.

Stalk weight, an important yield contributing character was positively and high direct effect on cane yield. The stalk weight also showed indirect and positive effect on cane yield through stalk length and stalk diameter and negative through number and length of internodes, number of shoots and number of millable canes.

Number of green leaves was found negative direct effect on cane yield. This negative direct effect was counter balanced through characters like number of shoots, number of millable canes, stalk diameter, stalk length, stalk weight, and brix at 10<sup>th</sup> to 13<sup>th</sup> month crop age.

Top weight should negative direct effect on

cane yield. The results of correlation and path analysis between top weight and cane yield appeared to be self explanatory. Brix from 10<sup>th</sup> to 13<sup>th</sup> were found negative direct effect on cane yield. The positive indirect effect of brix at different crop age was found to be high through stalk diameter, stalk length, and stalk weight while negative through rest of the brix stages, number of shoots and number of millable canes. Thus, on the basis of correlation and path coefficient, analysis may be stated that number of millable canes and stalk weight are most important characters for cane yield. Correlation and path analysis revealed that while selecting the clones from F<sub>1</sub> and subsequent clonal generation, the characters viz number of millable canes, cane height, cane diameter, cane weight and Brix must be taken into consideration for ameliorating overall

sucrose and cane yield.

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