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Inter-relationships among Yield Contributing Characters in Sugarcane (*Saccharum spp.*)

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ABSTRACT

Plant height at 240 DAP, length of millable cane, single cane weight, number of millable canes, cane yield and per cent sucrose had significant and positive correlations with sugar yield both at phenotypic level. Associations among plant height with length of millable cane, single cane weight and cane yield, shoot population at 120 DAP with stalk population at 240 DAP and number of millable canes; stalk population at 240 DAP with number of millable canes; length of millable canes with single cane weight and number of millable canes and single cane weight with diameter of cane were positive and significant. Per cent juice sucrose showed non significant correlations with all the yield components. The association of number of millable canes with diameter of cane and cane weight was negative but non significant. Single cane weight and shoot population at 120 DAP had negative direct effect on sugar yield. Cane-yield followed by per cent sucrose, plant height and diameter of cane had higher positive direct effects on sugar yield. Plant height at 240 DAP via length of millable cane, single cane weight and number of millable canes showed higher positive indirect effects on sugar yield. Cane yield followed by per cent sucrose, plant height at 240 DAP, length of millable cane, diameter of cane, single cane weight and number of millable canes are the major contributing component traits of sugar yield in sugarcane.

Key words : Correlations, Path Analysis, Sugarcane.

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Cane and sugar yields are complex characters influenced by a number of inter-related characters. The inter-dependence of component characters among themselves often influence the direct relationship with dependable variable. Correlations are helpful in determining the strength of characters associated with complex characters like cane and sugar yield but these do not bring out the relative importance of the direct or indirect influence of each component character on the dependable traits viz., cane yield or sugar yield. Partitioning of correlation coefficients in to direct or indirect effects gives a more realistic relationship of characters and helps in identifying the effective yield contributing components. The present study in sugarcane was carried out to identify the major components of sugar yield through correlations and path analysis.

MATERIAL AND METHODS

The experiment was conducted with 14 pre release sugarcane clones in main yield trial stage at Sugarcane Research Station, Vuyyur during 2006-07. The design adopted was Randomised Block Design with three replications. Each clone was grown in eight rows of five meters length and with 80 cm. spacing between rows. The soils are clay loams, low in available nitrogen and high in available phosphorus and potassium. Organic carbon content of the soils is medium with neutral pH. The crop was raised under irrigated condition following all the recommended package of practices and fertilizer application (168 kg N + 80 kg P_2O_5 + 100 kg K_2O / ha). Data were recorded on plant height at 240 DAP, shoot population at 120 DAP, stalk population at 240 DAP, length of millable cane, diameter of cane, single cane weight, number of millable canes and cane yield. Estimates of per cent sucrose and sugar yield were determined following standard procedures (Meade and Chen, 1977). Simple correlation coefficients between yield components and sugar yield were estimated as per the procedures of Panse and Sukhatme (1957) and Miller *et al*., (1958). Path analysis was carried out as suggested by Wright (1934) and Dewey and Lu (1959).

RESULTS AND DISCUSSION

The estimates of simple phenotypic and genotypic correlation coefficient between yield components and sugar yield are presented in Table 1. In general, genotypic correlation coefficients are higher than phenotypic correlations indicating that environmental influence was of no importance and the magnitude of associations observed were of genetic causes. Plant height at 240 DAP (0.7258**),

length of millable cane (0.4928**), single cane weight (0.6274**), per cent sucrose (0.4714**), number of millable canes (0.4149**) and cane yield (0.9339**) showed positve and significant associations with sugar yield at phenotypic level. Similar results of positive and significant correlations of length of millable canes (Kundu and Gupta, 1997; Rishi Pal *et al.,* 1998 and Verma *et al.,* 1999); single cane weight (Kundu and Gupta, 1997), Rishipal Chaudhary et al., 1998 and Tyagi and Singh 1998) and diameter of cane (Jyothiramoy Ghosh and Singh 1977 and Kumar, 2004) with sugar yield were reported in sugarcane. Significant and positive association of number of millable canes (Purusothaman, 1997 and Kumar, 2004); cane yield and per cent sucrose (Kumar, 2004) with sugar yield were also reported in sugarcane.

The associations among yield components viz., plant height with single cane weight and length of millable cane; shoot population at 120 DAP with stalk population at 240 DAP and number of millable canes; stalk population at 240 DAP with number of millable canes; length of millable cane with single cane weight and number of millable canes and single cane weight with diameter of cane were positive and significant. Thus, it is evident from the association analysis that plant height at 240 DAP, single cane weight, length of millable cane, diameter of cane, number of millable canes and per cent juice sucrose are to be considered as major component characters of sugar yield. The existence of significant and positive associations between length of millable cane with number of millable canes (Chaudhary and Singh, 1994), diameter of cane with single cane weight (Verma et al and Rao, 1999) were also reported. Positive and significant associations between shoot population at 120 DAP and stalk population at 240 DAP observed in the present study suggests that profuse tillering at the early phenophase of the crop is needed to have more number of stalk populations at 240 DAP. However, stalk populations at 240 DAP had non-significant but positive association with sugar yield suggesting that number of stalks alone are not important but also other yield contributing component characters are important for getting higher sugar yield.

Per cent juice sucrose has significant and positive correlations with sugar yield but had non-significant correlations with all the yield components and low positive direct effects on sugar yield compared to cane yield. This indicates that sugar yield largely depends on cane yield rather than sucrose per cent while cane yield is largely dependent on length of millable cane, number of millable canes, plant height at 240 DAP, diameter of cane and single cane weight. Therefore, a threshold economic level of per cent juice sucrose along with cane yield may be considered so as to bring improvement in sugar yield.

Associations of shoot population at 120 DAP with single cane weight; stalk population at 240 DAP with single cane weight and diameter of cane were negative and significant. Non-significant but negative correlations observed between diameter of cane and number of millable canes (-0.2275) observed in the present study are contrary to the earlier findings of Singh *et al.,* 1994 (positive and significant) and Reddy and Reddi, 1985 (significant and negative). The discrepancy in the present findings and earlier findings may be either due to different genotypes used or to different environmental conditions existed in the course of investigation.

Non-significant negative correlations observed between number of millable canes and single cane weight in the present study indicates that there is always a compensation mechanism exists between number of millable canes and single cane weight.

The positive and significant associations of plant height with single cane weight and length of millable cane recorded in the study are in agreement with the findings of Saini and Chakor (1992). Similarly, the negative associations of shoot population at 120 DAP and stalk population at 240 DAP with single cane weight observed in the present investigation may be due to existence of a compensation mechanism in sugarcane for stalk population and single cane weight.

The direct and indirect effects of yield contributing characters at genotypic level are presented in Table 2. Cane yield (0.6434) followed by per cent juice sucrose (0.4178), plant height at 240 DAP (0.2160), diameter of cane (0.1288) had higher positive direct effects on sugar yield. Shoot population at 120 DAP (-0.1598), single cane weight (-0.1465) had exerted higher negative direct effects on sugar yield. The plant height at 240 DAP via single cane weight (0.1624), length of millable cane (0.1703) and number of millable cane (0.1106) had higher positive indirect effects on sugar yield.

Single cane weight had higher negative direct effect on sugar yield but significant and positive correlation with cane yield. The significant and positive correlations observed in the present study may be due to significant and positive associations with yield components viz., length of millable canes, cane diameter and cane yield.

Table 1. Phenotypic (above diagonal) and genotypic (below diagonal) correlation coefficients between yield components and cane yield with CCS yield

Character	Plant height at 240 DAP (Cm)	Shoot population at 120 DAP plot^{-1}	Stalk population at 240 DAP plot^{-1}	Length of millable cane (Cm)	Single cane weight (kg)	Cane diameter (Cm)	Number of millable canes plot^{-1}	Juice sucrose (%) at 10th month	Cane yield plot^{-1} (kg)
Plant height (cm) at 240 DAP	**1.0000**	0.0270	0.0691	0.6939 **	0.6772 **	0.2598	0.2963	-0.0465	0.8369 **
Shoot population at 120 DAP plot^{-1}	0.0458	**1.0000**	0.8382 **	0.0214	-0.4499 *	-0.2748	0.6750 **	-0.0984	0.1082
Stalk population at 240 DAP plot^{-1}	0.1111	0.9318	**1.0000**	0.0930	-0.4089 *	-0.3863*	0.6733 **	0.0611	0.1383
Length of millable cane (cm) at harvest	0.7861	0.0181	0.0376	**1.0000**	0.6534 **	0.1921	0.3358 *	-0.1300	0.6114 **
Single cane weight (kg) at harvest	0.7496	-0.4952	-0.4834	0.7471	**1.0000**	0.5127**	-0.0327	0.0672	0.6838 **
Cane diameter (cm) at harvest	0.3786	-0.3051	-0.4883	0.2608	0.6153	**1.0000**	-0.2275	-0.1595	0.3363 *
Number of millable canes plot^{-1}	0.5104	0.8698	0.9143	0.5532	-0.0566	-0.3369	**1.0000**	0.0077	0.4595 **
Juice sucrose (%) at 10th month	-0.0288	-0.1341	0.0709	-0.1237	0.0719	-0.1851	-0.0487	**1.0000**	0.1337
Cane yield (kg plot^{-1})	1.0053	0.1016	0.1624	0.7606	0.7354	0.4378	0.4210	0.1035	**1.0000**
CCS yield plot^{-1} (kg)	0.8786	0.0385	0.1734	0.6348	0.6775	0.3228	0.3739	0.4602	0.9288

* Significant at 5 % level ** Significant at 1 % level

Table 2. Direct and indirect effects of yield components and cane yield on CCS yield at genotypic (below diagonal) level

Character	Plant height at 240 DAP (Cm)	Shoot population at 120 DAP plot^{-1}	Stalk population at 240 DAP plot^{-1}	Length of millable cane (Cm)	Single cane weight (kg)	Cane diameter (Cm)	Number of millable canes plot^{-1}	Juice sucrose (%) at 10th month	Cane yield plot^{-1} (kg)
Plant height (cm) at 240 DAP	**0.0055**	0.0001	0.0004	0.0038	0.0037	0.0014	0.0016	-0.0003	0.0046
Shoot population at 120 DAP plot^{-1}	-0.0073	**-0.0170**	-0.0142	-0.0004	0.0076	0.0047	-0.0114	0.0017	-0.0018
Stalk population at 240 DAP plot^{-1}	0.0097	0.0812	**-0.0071**	-0.0007	0.0029	0.0027	-0.0048	-0.0004	-0.0010
Length of millable cane (cm) at harvest	0.0487	0.0011	0.0023	**-0.0074**	-0.0049	-0.0014	-0.0025	0.0010	-0.0045
Single cane weight (kg) at harvest	-0.1098	0.0726	0.0708	-0.1095	**-0.0102**	-0.0052	0.0003	-0.0007	-0.0070
Cane diameter (cm) at harvest	0.0488	-0.0393	-0.0629	0.0336	0.0792	**- 0.0112**	0.0026	0.0018	-0.0038
Number of millable canes plot^{-1}	0.0372	0.0634	0.0666	0.0403	-0.0041	-0.0246	**0.0158**	0.0001	0.0072
Juice sucrose (%) at 10th month	-0.0120	-0.0560	0.0296	-0.0517	0.0301	-0.0773	-0.0204	**0.3488**	0.0466
Cane yield (kg plot^{-1})	0.6468	0.0654	0.1045	0.4893	0.4731	0.2817	0.2709	0.0666	**0.8935**
CCS yield plot^{-1} (kg)	0.8786	0.0385	0.1734	0.6348	0.6775	0.3228	0.3739	0.4602	0.9288

Residual Effect = 0.0447

The low positive direct effects of length of millable cane on sugar yield and existence of positive and significant correlation between length of millable cane and sugar yield suggests that due weightage may be given for length of millable cane while aiming at increased cane and sugar yields.

It is evident from the present study that cane yield, number of millable canes, single cane weight, diameter of cane, length of millable cane, plant height at 240 DAP and per cent sucrose may be given due weightage while constructing selection indices in sugarcane or in the selection process at clonal generations.

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