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CORRELATIONS AND CORRELATED RESPONSES IN SUGARCANE *Saccharum officianum* L.)

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SUMMARY/ABSTRACT.

Studies were carried out for two years at two locations to determine the inter character relationships between various quantitative traits of sugarcane, using eight genetically diversified sugarcane clones. The experiments were laid out in randomized complete block design with three replications. Performance data were used to obtain correlations between ten agronomic and seven quality traits in sugarcane. Correlation coefficients obtained between cane yield and all the important yield components were positive and significant except for stalk diameter and leaf width. The correlation coefficients revealed that stalk weight, stalk height, number of stalks per stoll, leaf area, juice and commercial cane sugar percentages were the major traits contributing to cane and sugar yield. Stem diameter, an important component of yield, is positively correlated with stalk weight, stalk height and leaf area. Path Coefficient analysis which unlike correlation, specifies the causes of the association and their importance, showed that stalk weight, stalk height, number of stalks per stool, had high direct effect on cane yield. Stalk diameter was indirectly related to its weight and height. Estimation of expected correlated response of cane yield when components are selected individually, showed that selection for stalk weight gave the highest increase in correlation responses. This was followed by number of stalks per stool.

INTRODUCTION

Sugarcane is a vegetatively propagated perennial crop belonging to the family gramineae which consist of the following species: *Saccharum officinarum* L, *S. barberi* Jesw., *S. sinense* Roxb., *Spontaneum* .L., *S. robustum* Prandes/Jesw. Ex Grassl and S. *elude* Husk.. Of these, *S. spontaneum* and *S. robustum* occur wild in nature while the other four are the cultivated species (Thuljaram., 1987). Sugarcane originated from Northern India and New Guinea and is adapted to tropical and subtropical climates (Grassl, 1977). The cultivation of sugarcane in West Africa started in early periods of 20th century. In Nigeria, commercial cane cultivation started about six decades ago (Ann., 1998) Average yield of the crop has however witnessed sporadic fluctuation ranging from 30-80 tonnes on both farmers field and the sugar estates.

Genetic improvement of sugarcane has been embarked upon for several years but the results obtained have not been so spectacular due to high ploidy level and heterozygous nature of the crop. This has made genetic analysis difficult (Albert, 1984). At the National Cereals Research Institute Badeggi, which has national mandate for genetic improvement of sugarcane, germplasm with wide genetic base is maintained. Only basic information on the existence of genetic variability between and within the exotic and local germplasm accession of sugarcane for yield and yield components (Olaoye, 1995), and correlation between cane yield and yield components (Ishaq *et al*, 1998) is available. This study however investigated the nature of the interrelationships between the growth and yield characters and determined the associated genetic changes obtained during indirect selection.

MATERIALS AND METHODS:

The experiments were conducted for two years at two locations: Badeggi (9^0 45^1N; 6^0 07^1E) in the southern guinea savannah and Uyo (4^0 58^1N; 8^0 21^1E) in the forest zone of Nigeria using the following eight genotypes: BD-04, Co-1997, B6604, OG-12, OG-08, LS-21, OY-09 and Co-957. At each location in each year, the land was first prepared at the onset of the rain (June, at both locations in each year) by ploughing, harrowing. The land was then leveled using a leveler attached to the tractor. The experiments were laid out as randomized complete blocks with three replications. Plots consisted of four rows, which were 4m long and spaced 1m apart. Immature whole canes were cut in to setts of 3 nodes each and ten setts laid horizontally per row. Weeding was done 3 and 8 weeks after planting and NPK fertilizer (20:10:10) applied at the rate of 120Kg/ha. Data were taken from ten randomly selected stalks per plot on nine traits. Viz: establishment count (at 42 days after planting), stalk diameter, stalk height, stalk weight, number of stalks per stool (ten stools selected randomly), number of internodes per stalk, leaf length, leaf width, leaf area and cane yield per plot. The two inner rows of each plot were harvested and weighed as yield/plot ten months after planting. At the onset of dry season (Nov.- Dec.) before the canes matured, supplementary irrigation was applied for Badeggi location for two months. Three to five stalks were cut for laboratory analysis to obtain quality parameters. These include brix, polarity, purity fibre, juice, moisture and

commercial cane sugar in percentages. The data was subjected to pooled analysis as suggested by Steel and Torrie (1981).. Phenotypic and genotypic correlations were estimated following the formulae given by Mode and Robinson (1959) as follows:

Genotypic correlation:

$$(r_g) = \frac{\delta^2 gX.Y}{\sqrt{(\delta^2_g X)(\delta^2_g Y)}}$$

Where: $\delta^2 gXY$ = genetic covariance between the two traits X and Y

$\delta^2 gX$ = the genetic variance of trait X.

$\delta^2_g Y$ = the genetic variance of trait Y.

Phenotypic correlation:

$$(r_{ph}) = \frac{\delta^2 phXY}{\sqrt{(\delta^2_{ph} X)(\delta^2_{ph} Y)}}$$

Where $\delta^2 phXY$ $_{ph}X.Y$ = Phenotypic covariance between traits X and Y

$\delta^2_{ph} X$ = Phenotypic covariance of trait X

$\delta^2_{ph} Y$ = Phenotypic covariance of trait Y

Correlated responses were computed according to Fakorede and Obilana (1979) using 5% selection intensity.

$CR\ YX = i_x . h_x . h_y . r_x (X.Y)\ \delta^2 Y$

Where CR_{yx} = Correlated response in trait

i_x = selection intensity of trait X

h_x = Heritability of trait X

h_y = Heritability of trait Y

$r_g(X.Y)$ = genotypic correlation between trait X and Y

$\delta^2 Y$ = standard deviation of trait Y

Path coefficient analysis was calculated using the methods of Dewey and Lu (1959).

RESULTS

The mean performance of the eight varieties across the locations and years are presented in Table 1. There were significant differences between the varieties for all traits. Variety BD-04 out-yielded all the other varieties across the environments. The estimates of genotypic and phenotypic correlation among the morphological characters are in Table 2. The result showed significant positive correlations between establish - ment count and number of stalk per stool, leaf area, cane yield per plot. Between stalk diameter and stalk weight, stalk height, leaf width and leaf area; between stalk height and stalk weight, number of internodes per stalk, leaf length, leaf area and cane yield per plots; between number of stalks per stool and leaf area as well as cane yield per plot. Significant positive correlation coefficients were however observed between number of stalks per stool and cane yield per plot.

Correlations between morphological and quality traits are presented in Table 3. Significant positive correlations were obtained between establishment count and purity and fibre percents; between stalk diameter and brix, polarity, juice, moisture and commercial cane sugar percents; between number of stalks per stool and purity, fibre, juice and moisture percents; between number of

Table 1: MEAN PERFORMANCE OF SUGARCANE ACROSS TWO AND TWO LOCATIONS

Clones	Establ. Count	Stalk height (cm)	Stalk diameter (cm)	Single Stalk weight (g)	No. of stalks/ stool	No. of internodes/ Stalk	Leaf length (cm)	Leaf width (cm)	Leaf Area (cm^2)	Yield/Plot (kg)
BD-04	27.42ab	154.78abc	2.39ab	504.92a	10.26c	16.25abc	124.93b	3.74ab	352.25ab	140.67a
Co-997	26.92b	135.23bcd	2.21bc	392.33cde	11.19bc	16.28abc	118.48bc	4.03a	296.21a	91.70b
B6604	29.42a	166.80a	2.24bc	449.58abc	10.25abc	16.25abc	141.47a	3.14c	329.03b	100.54abc
OG-08	25.08b	135.87cd	2.06c	336.08e	11.88a	16.59ab	126.85b	3.02c	279.35c	87.18bc
OG-12	26.17b	134.75cd	2.30ab	410.83cd	11.36ab	17.76abc	128.08b	3.56abc	343.21b	90.11bc
LS-12	29.17a	158.25ab	2.43a	499.75ab	10.19cd	18.76a	126.63b	3.98a	377.65ab	99.85a
OY-09	27.42ab	146.38abcd	2.37ab	433.75ab	11.10bc	15.70c	142.61a	3.36bc	365.74ab	90.70a
Co-957	26.42bc	128.92d	2.19c	346.58de	10.03d	17.79ab	126.11ab	3.44bc	331.63b	84.95c

Means followed by similar letter(s) are not significantly different at 5% level of probability (DMRT)

internodes per stalk and brix, polarity, purity, juice and moisture percents.

The result of path coefficient analysis for cane yield and morphological characters is shown in Table 4. The path analysis showed high effect for stalk height (0.498), stalk weight (0.618), number of stalks per stool (0.513). Though stalk diameter showed high direct negative effect (-0.318), it showed high indirect effect through stalk weight. The correlated response in cane yield when selection is practiced for the various traits is presented in Table 5. From the results, it is apparent that selection for stalk weight will give the highest increase in cane yield per plot as it showed the highest correlated response (18.36kg) for cane yield. This was followed by number of stalks per stool (14.39kg) and stalk height (12.11) kg).

DISCUSSION

The result of this study demonstrated different pattern of associations among characters studied. General genotypic correlations were higher than phenotypic correlations with few exceptions. This means that although there were strong inherent associations between the various characters, environmental influence masked the expression of the phenotypic correlations. This also confirms earlier report of Robinson *et al.* 1951 that selection for correlated characters could give greater response in yield than would be expected on the basis of the phenotypic associations. In sugarcane, the trait of most interest to the breeder is cane yield per plot. Since yield is a complex character highly influenced by environmental factors, response to direct selection for yield is very low. It would have been desirable to have one or more traits in which indirect selection for cane yield could be practiced through stalk weight, number of stalks per stool and stalk height in that order, with the hope that improvement in these traits would lead to simultaneous increases in cane yield; though the effectiveness of this would depend on their genetic control. Reddy and Reddy (1986), as well as Kang and Miller (1990), also obtained similar results in their findings

Table3: Genotypic and Phenotypic Correlation Coefficients Between Morphological and Quality Transits in Eight Sugarcane Clones

	Brix%	Pol%	Purity%	Fibre%	Juice%	Moisture%	Comm. Cane sugar%
Establishment count	0.240	0.104	0.527**	0.533**	-0.381*	-0.230	0.314
	0.700	0.124	0.510**	0.196	-0.087	-0.623**	0.731**
Stalk diameter	0.900**	0.545**	-0.260	-0.141	0.643**	0.554**	0.284
	0.656**	0.034	-0.470**	-0.432*	0.462**	0.338*	0.350*
Stalk weight	0.259	0.158	-0.171	-0.196	0.679**	0.680**	0.432*
	0.005	0.021	-0.510**	-0.422*	0.442*	0.420*	0.306*
Number of stalks/Stool	0.030	0.517**	0.530**	0.707**	0.501**	0.806**	-0.775**
	0.249	0.201	0.196	0.464**	0.466**	0.535**	-0.285
Number of internodes/ stalk	0.535**	0.534**	0.745**	-0.602**	0.782**	0.740**	-0.051
	0.514**	0.466**	0.203	-0.495**	0.490**	0.485**	-0.557**
Leaf lenght	0.622**	0.591**	0.662**	0.944**	-0.659**	-0.563**	0.746**
	0.424*	0.800**	0.537**	0.306**	-0..282	-0.511**	0.526**
Leaf width	0.724**	-0.443*	-0.384*	-0.250	-0.546**	0.328*	0-0.381*
	0.518**	-0.725*	-0.519**	-0.351*	0.352*	0.423*	-0.436*
Leaf area	0.317	0.095	-0.029	0.846**	0.637**	-0.697**	0.312
	0.447*	0.095	-0.015	0.149	0.173	-0.482**	0.579**
Yield/plot	-0.027	0.299	-0.178	-0.888**	0.823**	0.452**	0.932**
	-0.176	0.135	-0.370	-0.445	0.461**	0.274	0.428*

Upper and lower value represent genotypic and phenotypic correlation coefficients respectively
*Significant at 5% level (r =0.285); **Significant at 1% level (r = 0.368)

Table 2: GENOTYPIC AND PHENOTYPIC CORRELATION COEFFICIENT AMONG TEN TRAITS IN EIGHT SUGARCANE CLONES

Establishment count	Stalk diam. (cm)	Stalk height (cm)	Single stalk Weight(g)	No. of stalks/ stool	No. of internodes/ stalk	Leaf Length (cm)	Leaf width (cm)	Leaf Area (cm^2)	Yield/ plot(kg)
Establishment	0.246	0.152	0.368*	0.621**	0.321*	0.291*	0.148	0.391**	0.258*
Count	0.123	0.031	0.238	0.415**	0.127	0.175	0.172	0.268*	0.314*
Stalk diameter		0.493**	0.753**	-0.356	0.135	0.247	0.345*	0.551**	0.208*
		0.256	0.592**	-0.249	0.006	0.071	0.286*	0.297**	0.312*
Stalk height			0.436**	0.346	0.308**	0.396*	0.434**	0.623**	0.793**
			0.529**	0.245	0.521**	0.529**	-0.209	0.405**	0.634**
Single stalk weight				-0.234	-0.153	0.480**	0.109	0.347*	0.853**
				-0.468*	0.081	0.369**	0.206	0.189	0.699**
Number of					-0.386*	-0.181	0.241	0.289*	0.692**
Stalk/stool					-0.291*	-0.125	0.009	0.365*	0.537**
Number of						-0.300*	0.317*	0.319*	-0.356*
Internodes/stalk						0.196	0.291*	0.249	-0.423**
Leaf length							-0.293*	-0.106	0.315*
							-0.119	-0.234	0.264
Leaf width								-0.342*	-0.345*
								-0.312*	-0.255
Leaf area									0.445**
									0.398**

Table4: path coefficient analysis of cane yield ad its components in eight sugarcane colones

	Estable. Count	Stalk diameter	Stalk height	Single stalk weight	No of stalks/stool	No of Internodes/Stalk	Leaf length	Leaf width	Leaf area
Estable. Count	0.052	-0.078	-0.076	0.227	-0.319	0.069	0.006	0.019	0.155
Stalk diameter	0.513	-0.318	-0.246	0.465	0.183	-0.029	0.005	-0.045	0.218
Stalk height	0.008	-0.157	0.498	0.269	-0.177	-0.066	0.008	0.056	0.247
Single stalk weight	0.019	-0.239	-0.217	0.618	0.120	0.033	0.009	-0.014	0.137
No of stalk/stool	0.032	0.113	-0.172	0.145	0.513	0.083	-0.003	0.031	0.114
No of inter/stalk	0.017	-0.043	0.153	-0.095	0.205	-0.214	0.006	-0.041	0.126
Leaf length	0.015	-0.079	0.197	0.297	0.093	-0.064	0.019	0.038	-0.042
Leaf width	-0.008	-0.110	0.216	0.067	-0.124	-0.068	-0.130	-0.006	0.135
Leaf area	0.020	-0.175	0.310	0.214	-0.148	0.068	-0.002	0.044	0.396

Residual. The figures in bold ink are the direct effect

Table 5: Selection of Yield Components of Sugarcane and Expected Correlated Resources in Cane Yield	
Character	Correlated response in cane yield
Establishment count	4.88
Stalk diameter	2.59
Stalk height	12.11
Stalk weight	18.36
Number of stalks/stool	14
Number of internodes/stalk	-4.80
Leaf length	3.75
Leaf width	
Leaf area	5.83

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