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THE INFLUENCE OF CHARACTERS ASSOCIATION ON BEHAVIOR OF SUGARCANE GENOTYPES (*SACCHARUM* SPP) FOR CANE AND SUGAR YIELD UNDER THREE SOIL TYPES

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ABSTRACT

The research was conducted at Metahara Sugar Estate, Ethiopia (8° N latitude and 39° 52' E longitude) during the season of 2014/2015 on three soil types. Fourteen sugarcane genotypes were evaluated in a randomized complete block design with three replications to study association of characters influenced the final behavior of fourteen sugarcane genotypes regarding cane and sugar yield characters namely; number of tillers and millable cane, stalk height, stalk diameter and recoverable sucrose (%). The results indicated that genotypes CP 96 1252 and NCO 334 had shown superiority for cane and sugar yield per ha under medium soil. While, CPCL 02926 and VMC 96120 for cane yield CPCL 02 926 and CP 96 1252 for sugar yield under heavy soil; and B 52-298 and CP 04 1935 for cane yield and CPCL 02 926 and CP 04 1935 for sugar yield under light soil had shown superiority. Characters association results showed sugar yield was mainly determined by recoverable sucrose percent under heavy soil while it is by cane yield and its components number of tillers, milable stalks and plant height under medium and light soil types.

KEYWORDS: Sugarcane (Saccharum spp), Genotype, Correlation

INTRODUCTION

Sugarcane (*Saccharum* spp) is a vegetative propagated crop grown by many countries commercially for it sugar constituent. Yield is a quantitatively inherited character involving various traits. Therefore, selection of genotypes with high cane and sugar yield based on a single trait might often be misleading, Stevenson (1965) pointed that there may not be specific genes controlling the complex characters, but the sum total of their components might be influencing the important economic characters namely*;* cane and sugar yield. The concept of correlation is used to explore and reveal the relationship between yield and its components. It has also proved valuable in determining the association of quantitative attributes with yield for selecting characters that influence the yield. Yield is a complex quantitative character so as knowledge of interrelationships between yield and its contributing components will improve the efficiency of breeding programs through the use of appropriate selection indices (Mohammadi *et al*., 2003). Selection is an integral part of a breeding program by which genotypes with high productivity in a given environment could be developed. However, selection for high yield is made difficult because of its complex nature. Yield per unit area is the end product of the combined effects of several characters, which are polygenic in inheritance and thus are highly influenced by environment. Therefore, only little progress could be made over along span of time through direct selection for yield (Ford, 1964). This selection criterion takes into account the information on interrelationship among agronomic characters, their relationship with yield as well as their direct influence on sugar yield. Information on the extent and nature of interrelationship among characters help in formulating efficient scheme of multiple trait selection. Since the association pattern among yield components help to select superior genotype from divergent population based on more than one interrelated characters, the present study was conducted to give clues and information on the association of various yield traits that dictated the final performance of genotype under field condition pertaining to yield of cane sugar.

MATERIALS AND METHODS

The study was carried out during 2014/2015 to test fourteen sugarcane genetic stocks during the plant cane season, at the Metahara Sugar Estate (8° N latitude and 39° 52' E longitude) under three major soil types. Eleven newly introduced sugarcane genotypes from CIRAD designated as CP 96 1252, CP 00 2180, CP 04 1935, CPCL 02-926, VMC 96-61, VMC 96-89, VMC 96-120, FG 06-622, FG 04-356, MPT 96-273 and MPT 97-203 were evaluated along with standard checks NCO 334, B 52- 298 and Mex 54/245. The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. Field managements were as per the plantation practices. Data were collected for cane sprouting, tillering, height, girth, number of millable cane, cane yield, sugar percent cane and sugar yield. The data analyses were as per the following.

Estimation of phenotypic correlation coefficients was done based on the Procedure of Dabholkar (1992):

Phenotypic Correlation Coefficient (rph) = (COVph (xy))/ (σph (x) * σph (y))

Where: COVph (xy) is the phenotypic covariance's of two variables (X and Y); and σph (x) and σph (y) are the phenotypic standard deviations of variables, X and Y, respectively. The calculated phenotypic correlation value was tested for its significance using t-test: t = rph/SE (rph) Where: rph = Phenotypic correlation; and, SE (rph) = Standard error of phenotypic correlation was obtained using the following formula (Sharma, 1998), SE (rph) = $\sqrt{}$ (1-r^2ph)/ (n-2) Where: n is the number of genotypes tested, rph is phenotypic correlation coefficient.

RESULTS

Mean Performances of Cane and Sugar Yield

Cane yield is the outcome of all yield components. Genotype CPCL 02 926 followed by VMC 96-120 and B 52-298 were the highest yielding genotypes in heavy soil. CP 96 1252 followed by NCO 334 and MEX 54/245 were the highest yielders under medium soil. B 52-298 followed by VMC 96-89 and CP 04 1935 gave the highest cane yield (tons/ha) under light soil. None of the correlations between ranks of genotypes by cane yield in pairs of the three soil types were statistically significant (r=0.04, 0.09 and 0.46) indicating that performance of genotypes was not consistent over the three soil types. This is evident from the fact that the genotypes that ranked 1st 2nd and 3rd in all the three soil types were different.

Sugar yield is the function of stripped cane yield and corresponding commercial cane sugar. The genotype CPCL 02 926 followed by CP 96 1252 and B 52-298 under heavy soil; CP 96 1252 followed by NCO 334 and CP 04 1935 on medium soil and CPCL 02 926 followed by CP 04 1935 and VMC 96-89 on light soil produced the highest sugar yield (tons/ha) (Table 1). The rank correlation between sugar yields under the three soil types was not significant indicating the inconsistency of performance of the genotypes. For example, VMC96 89, a genotype from Philippines, ranked 3rd under light soils but 7th in medium and 11th in heavy soils. The check Mex-54/245 ranked 5th in light soils and 6th in medium soils, but 14th (the lowest yielding) in heavy soils. Khan *et al.* (2007) and Getaneh *et al.* (2015) also found differences among varieties for cane and sugar yield.

Table 1: Cane and Sugar Yield Performances of Genotypes Across Three Soil Types

Genotypes	Cane Yield (Tons/ha)			Sugar Yield (Tons/ha)		
	Heavy	Medium	Light	Heavy	Medium	Light
CP 96 1252	240.8	134.5	44.2	25.71	16.5	5.79
NCO 334	212.0	134.3	46.3	19.04	12.08	4.44
MPT 97 203	191.6	76.0	42.0	18.85	8.78	4.38
VMC 96 61	208.9	35.7	53.0	14.15	3.43	5.02
FG 04 356	213.3	88.4	41.4	24.13	10.78	5.23
MPT 96 273	218.2	65.0	30.4	21.88	6.51	3.097
CP 04 1935	178.0	97.7	62.3	20.11	11.85	6.62
CPCL 02 926	265.0	73.5	52.2	26.06	8.66	6.64
B 52-298	241.8	96.1	69.1	24.88	9.73	6.35
VMC 96-120	262.2	91.2	44.3	14.10	8.04	4.48
VMC 96-89	219.5	91.3	67.6	16.19	8.91	6.56
FG 06-622	219.2	70.3	40.2	18.39	8.39	4.19
CP 00-2180	188.4	51.6	26.9	18.48	5.84	2.47
MEX 54/245	161.6	108.5	60.5	12.50	9.3	6.11
Mean	215.74	89.74	48.6	19.6	9.2	5.098
LSD	52.71	17.28	9.92	8.7289	2.42	1.256
CV	14.56	11.87	12.16	26.53	15.67	14.68

Character Association

Under heavy soil there was a significant correlation of number of tillers with germination percentage (r=0.54*) and number of millable stalks (r=0.57*) which showed that the genotypes that had good germination were tend to produce highest number of tillers and millable stalks.

Table 2: Character Association for Genotypes Grown Under Heavy Soil Type at Metahara

Traits	GER	TILL	MS	PH	SD	CY	RSP	SY
GER		0.54*	0.36	-0.03	-0.23	-0.06	0.29	0.17
TILL			0.57*	-0.24	-0.44	0.25	-0.08	0.07
MS				0.31	-0.76***	0.42	0.13	0.31
PH					-0.09	0.5*	0.19	0.44
SD						0.03	-0.04	0.001
CY							-0.05	0.45
RSP								0.85***

Where GER=germination, TILL= tillers, MS=millable stalk, PH=plant height, SD= diameter, CY=cane yield, RSP=sugar % and SY=sugar yield

Number of millable stalks was significantly and negatively correlated with stalks diameter (r=-0.76***) which indicated that thicker genotypes had lower number of millable stalks. There were also significant correlations between cane yield and plant height (r=0.5*) and sugar yield and recoverable sugar percent (r=0.85***) which revealed that cane yield was mainly affected by plant height while sugar yield is mainly affected by sugar yield (Table 2).

Under medium soil germination was significantly and negatively correlated with stalks diameter (r=-0.57*). Number of tillers and millable stalks were significantly correlated with stalks diameter (r=-0.70**and -0.81***)) and cane yield (r=0.55* and 0.82***). There were also significant correlations of cane yield with plant height (r=0.71**) and sugar yield (0.9***); and sugar yield with number of millable stalks (r=0.74**) and plant height (r=0.58*) (Table 3).

Table 3: Character Association for Genotypes Grown Under Medium Soil Type at Metahara

Traits	GER	TILL	MS	PH	SD	CY	RSP	SY
GER		0.50	0.36	-0.17	-0.57*	-0.001	0.08	0.02
TILL			0.78***	0.41	-0.70**	0.55*	0.02	0.50
MS				0.56*	-0.81***	0.82***	-0.01	0.74**
PH					-0.38	0.71**	-0.14	0.58*
SD						-0.46	0.01	-0.39
CY							-0.10	0.90***
RSP								0.34

Where GER=germination, TILL= tillers, MS=millable stalk, PH=plant height, SD= diameter, CY=cane yield, RSP=sugar % and SY=sugar yield

Under light soil, number of millable stalks was significantly correlated with stalks diameter, cane yield and sugar yield. Cane yield was significantly correlated with number of millable stalks (r=0.67**) and sugar yield (r=0.89***). Sugar yield was significantly correlated with number of millable stalks (r=0.75**), plant height (r=0.64*) and cane yield (r=0.89***) (Table 4).

Table 4: Character Association for Genotypes Grown Under Light Soil Type at Metahara

Traits	Ger	Till	Ms	Ph	Sd	Cy	Rsp	Sy
GER		0.05	0.37	0.03	-0.21	0.28	-0.35	0.12
TILL			-0.07	-0.13	-0.15	-0.22	0.27	-0.11
MS				0.38	-0.63*	0.67**	0.21	0.75**
PH					-0.62*	0.51	0.32	0.64*
SD						-0.23	-0.61*	-0.51
CY							-0.12	0.89***
RSP								0.34

Where GER=germination, TILL= tillers, MS=millable stalk, PH=plant height, SD= diameter, CY=cane yield, RSP=sugar % and SY=sugar yield

The correlations between cane yield and its components (number of tillers and millable stalks, and plant height) were positive in all soil types except with tillering under light soils where this correlation was negative but statistically non significant (r = - 0.22). These correlations were all statistically significant under medium and light soils. Under heavy soils the only significant correlation was that with plant height. Genotypes with many tillers and many long millable stalks produce high cane yield; the relationships being stronger under medium and light soils. Although the correlation between germination percentage and number of tillers was positive in all soil types, it was statistically significant only under heavy soils (r = 0.54*, 0.50, 0.5 respectively). Genotypes with good germination tend to produce more tillers. However the good initial germination does not necessarily lead to high number of millable canes since the correlation between germination and number of millable canes was statistically non significant in all soil types. The survival rate of tillers seems to differ among genotypes. The correlation between sucrose recovery and sugar yield was positive under all soil types but significant only in heavy soils (r = 0.85***, 0.34 and 0.34, respectively). However the correlation between cane yield and sugar yield was statistically significant under medium and light soils only (r = 0.45, 0.90*** and 0.89***, respectively). Sugar recovery is more important in determining sugar yield under heavy soils. Under medium and light soils sugar yield is determined mainly by cane yield. There was almost zero correlation between cane yield and sucrose recovery (r =-0.1 in all soils) indicating the possibility of simultaneous improvement of both traits. Rehman *et al*. 1992 and Khan *et al*. (2003) reported that increase in cane yield might be due to maximum plant height and cane diameter. Similarly, Javed *et al.* (2001) reported that cane yield tons per hectare depends upon number of stalks per hectare, stalk length and stalk girth. Similarly, Khan *et al.* (2007) demonstrated that number of millable stalks, plant height, cane yield and recoverable sugar percent possessed highly positive correlation with sugar yield.

CONCLUSIONS

More emphasis should be given on number of tillers, millable cane, cane height, cane yield, recoverable sugar percent as they were positively correlated by compromising for traits negatively correlated with them during phenotypic selection for developing high sugar yielding genotypes of sugarcane. Sugar recovery is more important in determining sugar yield under heavy soils. Under medium and light soils sugar yield is determined mainly by cane yield. There was almost zero correlation between cane yield and sucrose recovery in all soils indicating the possibility of simultaneous improvement of both traits.

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