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Correlation of Traits among cane yield and its component in Sugarcane (*Saccharum* Spp) Genotypes at Metahara Sugar Estate

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Abstract

The present study was carried out during the season of 2014/2015 at Metahara Sugar Estate, Ethiopia (8° N latitude and 39° 52' E longitude) under three salinity levels. Twelve 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. Highest cane and sugar yield was recorded in genotype Holland, Moris, key Ageda1 and the check NCO334 under 1.3ds/m and 4.4ds/m salinity levels. While, Moris had shown superiority for cane and sugar yield per ha under 6.5ds/m salinity levels. Correlation coefficient result indicated that under 1.3ds/m salinity level sugar yield was mainly determined by number of milleable stalks and cane yield while under 4.4ds/m salinity level it is by cane yield and its components milleable stalks and plant height and under 6.5ds/m salinity level sugar yield was mainly determined by milleable stalks, cane yield and recovery sucrose percent.

Keywords: Sugarcane (Saccharum spp), Genotype, Correlation

1. Introduction

Modern cultivated sugarcane (*Saccharum officinarum* L.) is a complex inter specific hybrid of five different species of *Saccharum* genus. Sugarcane belongs to the *Poaceae* family and is normally propagated by stem cuttings (Khan *et al.*, 2013). Cane yield and sucrose content are two important characters for obtaining high sugar yield (Terzi *et al*., 2009). Zhu *et al*., (2000) reported that cane yield and sucrose content and their interaction are important parameters for developing superior genotypes.

Yield is a complex, quantitatively inherited character, involving various traits. Therefore, selection based on a single trait might often be misleading (Stevenson 1965) reported 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.

Correlation coefficient is statistical measure that denotes the degree and magnitude of association between any two casually related variables (Phundan *et al*,. 1993). This association is due to peliotropic gene action or linkage or more likely both (Falconer *et al*., 1989). In plant breeding correlation coefficient analysis measures the mutual relationship between two characters and it determines characters association for improvement of yield and other economic traits. Since the association pattern among yield components help to select superior genotype from divergent population based on more than one interrelated characters. Thus, information on the degree and magnitude of association between characters is of prime important for the breeder to initiate any selection plan. The present study was therefore carried out to know the nature and extend of association among the morphological and qualitative traits in sugarcane.

2. Materials and Methods

The experimental materials consisted of twelve sugarcane genotypes (Nech Ageda, Kay Ageda1, Andegna Dereje Canada Shenkora, Engda, Moris, Holland, Yemilat Nech Shenkora, Kay Ageda 2, Nech Shenkora and Kay Ageda/Shenkora) were evaluated along with standard checks NCO 334 and B52-298 under three salinity levels of the sugar estate along with the check variety. The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. These advanced genotypes were found to be the best performing genotypes among the locally collected and characterized genotypes. Field managements were as per the plantation practices. Data were collected for cane sprouting, tillering, height, girth, number of millable cane, cane yield, brix%, pol%, purity%, 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) = √(1-r2ph)/(n-2) Where: n is the number of genotypes tested, rph is phenotypic correlation coefficient.

3. Results and Discussion

Mean Comparison

Genotype Holland (179.91) followed by Nech Shenkora (177.97), Kay Ageda1 (171.37), the check NCO 334 (170.37) and Moris (167.75) were the highest yielders under 1.3ds/m salinity level. Genotype Holland (158.27t/ha), NCO 334 (150.81 t/ha), Moris (141.05 t/ha) and Kay Ageda1 (138.86 t/ha) gave the highest cane yield (tons/ha) under 4.4ds/m salinity level but there were not statistically significant difference between them. And under 6.5ds/m salinity level genotype Moris (118.05 t/ha) and the check NCO 334 (94.53) were the top yielders. The result of this experiment also showed that most of the top yielding genotypes have the highest millable cane and better stalk weight.

Table 1 Cane and sugar yield of twelve sugarcane genotypes across three salinity levels

	Genotypes	Cane Yield (t/ha)			Sugar yield (t/ha)		
		1.3ds/m	4.4ds/m	6.5ds/m	1.3ds/m	4.4ds/m	6.5ds/m
1	Nech Ageda	177.97^{ab}	77.84^{cd}	64.10^{e}	24.23^{a}	6.97^{f}	4.26^{efg}
2	Kay Ageda1	171.37^{ab}	138.86^{a}	84.59^{c}	23.03^{a}	14.46^{ab}	5.89^{cd}
3	Andegna Dereja Canada Shenkora	158.42^{bc}	97.14^{bc}	59.73^{e}	17.48^{bc}	10.20^{cde}	3.89^{efgh}
4	Engda	91.99^{e}	67.06^{d}	38.85^{f}	13.04^{d}	7.62^{f}	2.92^{h}
5	Moris	167.75^{ab}	141.05^{a}	118.05^{a}	18.61^{b}	15.09^{a}	10.44^{a}
6	Holland	179.91^{a}	158.27^{a}	84.59^{c}	24.01^{a}	14.58^{a}	6.72^{bc}
7	Yemilat Nech Shenkora	120.62^{d}	69.70^{d}	45.05^{f}	13.76^{d}	8.05^{ef}	3.57^{fgh}
8	Kay Ageda2	160.30^{abc}	115.44^{b}	78.95^{cd}	21.58^{a}	10.45^{cd}	4.80^{def}
9	Nech Shenkora	143.55^{c}	86.51^{cd}	70.99^{de}	17.08^{bc}	8.77^{def}	5.15^{de}
10	Kay Ageda/Shenkora	108.53^{de}	77.41^{cd}	43.72^{f}	15.26^{cd}	6.67^{f}	3.14^{gh}
11	B52-298	166.54^{ab}	113.64^{b}	68.94^{de}	21.87^{a}	12.16^{bc}	5.98^{cd}
12	NCO334	170.37^{ab}	150.89^{a}	94.53^{b}	22.65^{a}	14.90^{a}	7.72^{b}
	Mean	151.44	107.81	70.85	19.38	10.83	5.39
	LSD	19.83	21.14	11.50	2.92	2.35	1.28
	CV	7.73	11.57	9.58	8.89	12.83	14.10

The difference in these traits among sugarcane genotypes is due to their difference in genetic constitution and their response to soil salinity factors. These traits have been widely studied by Nsassar et al. (2005), El-Shefai and Ismail (2006), Manjunath et al. (2007), Abo El-Ghait (2000) and El-Sogheir and Ismail (2006). For sugar yield genotypes Nech Ageda (24.23), Holland (24.01) and KayAgeda1 (23.03) gave the highest sugar yield under 1.3ds/m salinity level. Under 4.4ds/m salinity level genotypes Moris (15.09), the check NCO-334 (14.9), Holland (14.58) and Kay Ageda1 (14.46) gave the highest sugar While At 6.5ds/m salinity level genotypes Moris (10.44), NCO 334 (7.71) and Holland (6.72) were the best (Table 1). This result also agrees with the results of Nasir *et al.* (2000) and Nadioo *et al*. (2004) revealed that the effect of soil salinity was significant on sugar yield and as the salinity level increases the sugar yield also decreases. Therefore, those genotypes which performed best in cane and sugar yield under the salinity level where they grown and achieved the highest value were found to be promising genotypes in cane and sugar yield.

Correlations of Cane and Sugar Yield with other Traits

Under 1.3ds/m salinity level there was a significant correlation of germination percentage with number of tillers ($r=0.86^{***}$) which showed that the genotypes that had good germination were tend to produce highest number of tillers. Number of milleable stalks was significantly and negatively correlated with single stalk weight (r=-0.75**) which showed that heavier genotype had lower number of milleable stalks and positively correlated with cane yield (r=0.71**) and sugar yield (r=0.75**).

There were also Significant correlations between number of milleable stalks with cane yield ($r=0.71^{**}$) and sugar yield ($r=0.91^{***}$), plant height with stalk diameter ($r=0.61^{*}$), cane yield with sugar yield ($r=0.91^{***}$). Our results are in agreement with that of Raman *et al*., (1985) number of stalks per stool was a major yield contributing factor followed by height and cane girth.

Table 2 Character association for genotypes grown under 1.3ds/m salinity levels at Metahara

Traits	GER	TILL	MS	PH	SD	SW	CY	POL	BRX	PUR	RSP	SY
GER		0.86***	-0.02	0.36	0.23	0.36	0.35	-0.56	0.58*	0.52	-0.48	0.11
TILL			-0.03	0.34	0.18	0.18	0.19	0.55	-0.65*	0.52	-0.46	-0.04
MS				-0.23	-0.46	-0.75**	0.71**	0.14	0.11	-0.36	0.14	0.75**
PH					0.61*	0.46	0.22	-0.19	-0.32	-0.27	-0.14	0.14
SD						0.40	-0.15	0.05	0.08	-0.04	0.03	-0.16
SW							-0.08	-0.41	-0.37	0.04	-0.37	-0.25
CY								-0.15	-0.15	-0.53	-0.14	0.91***
POL									0.62*	0.62*	0.97***	0.25
BRX										0.37	0.45	0.05
PUR											0.61*	-0.24
RSP												0.27

Where GER=germination, TIL= tillers, MS=millable stalk, PH=plant height, SD= diameter, SW=stalk weight CY=cane yield, POL= pol percent, BRX= Brix percent RSP=sugar % and SY=sugar yield

In the case of quality traits there was a significant correlation between pol% with brix % (r=0.62*), purity % (0.62*), recovery sugar percent (r=0.97***) and purity percent with sucrose recovery percent (r=0.61*) (Table 2). Cane yield were mainly affected by number of milleable stalk and sugar yield were mainly dependent on number of milleable stalk and cane yield.

Under 4.4ds/m salinity level germination was significantly and positively correlated with stalks weight (r=-0.59*). There were also significant and positive correlations of Number of millable stalks with cane yield (r= 0.85***) and sugar yield (r=0.85***). Plant height also significantly and positively correlated with stalk weight, cane yield and sugar yield (r= 0.67*, 0.71** and 0.65*) respectively.

Table 3 Character association for genotypes grown under 4.4ds/m salinity levels at Metahara

Traits	GER	TIL	MS	PH	SD	SW	CY	POL	BRX	PUR	RSP	SY
GER		-0.50	-0.27	0.55	0.35	0.59*	0.05	0.33	0.42	-0.36	0.29	0.08
TIL			0.27	-0.23	-0.62*	-0.38	0.05	-0.34	-0.36	0.33	-0.32	-0.01
MS				0.30	-0.35	-0.33	0.85***	-0.16	-0.45	0.39	-0.04	0.85**
PH					0.39	0.67*	0.71**	-0.21	-0.24	-0.28	-0.19	0.65*
SD						0.56*	-0.01	-0.29	-0.20	-0.15	-0.31	-0.11
SW							0.18	-0.09	0.04	-0.61*	-0.14	0.12
CY								-0.24	-0.47	0.12	-0.14	0.96***
POL									0.91***	-0.21	0.98***	0.003
BRX										-0.32	0.84***	-0.25
PUR											0.16	0.09
RSP												0.10

Where GER=germination, TIL= tillers, MS=millable stalk, PH=plant height, SD= diameter, SW=stalk weight CY=cane yield, POL= pol percent, BRX= Brix percent RSP=sugar % and SY=sugar yield

Number of milleable stalks were also highly correlated with cane yield and cane yield also significantly correlated with sugar yield (0.96^{***}) (Table3) which indicates higher cane with highest number of milleable stalks contributes to highest cane yield. Sugar yield were mainly affected by cane yield. Pol % and brix% positively correlated with sucrose recovery percent. Terzi *et al*., 2009 also reported that the major contributing factors for high sugar yield are cane yield and recoverable sugar percentage

The correlation coefficient results of genotypes grown under 6.5ds/m salinity level (Table 4) indicated that the number of tillers was positively correlated with number of milleable stalk ($r=0.55^{*}$) and with stalk weight ($r= -0.57^{*}$), number of milleable stalk and plant height were positively correlated with cane yield, this indicates that genotypes with highest number of milleable stalks with tallest cane contribute to high cane yield. Chaudhry (1982) concluded that the increase in cane yield was due to combined effect of stalks per stool, length of stalk and weight per stool. According to Raman *et al*., (1985) number of stalks per stool was a major yield contributing factor followed by height and cane girth. Stalk weight also positively correlated with stalk diameter (r= 0.52*) which indicated that thicker genotypes had heavier stalks. In case of sugar yield strong positive correlation was observed with number of milleable stalk, plant height and cane yield (Table 4).

Table 4 Character association for genotypes grown under 6.5ds/m salinity levels at Metahara

Traits	GER	TIL	MS	PH	SD	SW	CY	POL	BRX	PUR	RSP	SY
GER		-0.01	-0.001	0.41	0.08	-0.01	0.02	0.38	0.32	-0.17	0.36	0.12
TIL			0.55^{*}	0.15	-0.47	-0.57^{*}	0.18	0.05	-0.14	0.60^{*}	0.16	0.19
MS				0.42	-0.40	-0.35	0.84^{***}	0.29	-0.03	0.43	0.45	0.83^{***}
PH					0.17	0.27	0.58^{*}	-0.03	-0.17	-0.17	0.06	0.50
SD						0.52^{*}	0.07	-0.50	-0.45	-0.37	-0.46	-0.17
SW							0.16	-0.19	0.05	-0.48	-0.31	0.06
CY								0.25	-0.01	0.22	0.38	0.95^{***}
POL									0.85^{**}	0.08	0.95^{***}	0.50
BRX										-0.20	0.65^{*}	0.19
PUR											0.24	0.23
RSP												0.62^{**}

Where GER=germination, TIL= tillers, MS=millable stalk, PH=plant height, SD= diameter, SW=stalk weight CY=cane yield, POL= pol percent, BRX= Brix percent RSP=sugar % and SY=sugar yield

4. Conclusion

Many component analyses have been performed for complex traits based on morphological and physiological characterizations (Liu *et al*., 1984; Bull *et al*., 2000; Petrasovits *et al*., 2007). It couldbemoreeffectivethatyieldcomponentswereselectedtoincreaseyieldbecauseoflowerheritabilityfor yield and higher heritability for yield components (Hogarth, 1971). However, yield is correlated with yield components in complicated ways (Risch, 2000; Darvasi & Pisanté-Shalom, 2002). Therefore, it is imperative to reveal the genetic relationship between yield and its component traits and their interaction to various environments. This study revealed that higher number of milleable stalks, endowed with taller stalks and highest cane yield are the important characters which should be considered while selection to be made for higher sugar yield in sugarcane genotypes grown under 4.4 ds/m salinity level, for those genotypes grown under 4.4ds/m and 6.5 ds/m salinity levels most determining traits were number of milleable stalks and cane yield. In addition to these sugar yields also mainly depend on recovery sucrose percent under 6.5ds/m salinity levels. There was almost zero correlation between cane yield and sucrose recovery under all the three salinity levels indicating the possibility of simultaneous improvement of both traits.

The association of cane yield character with qualitative traits namely, juice pol percent and juice purity percent was found non significant, indicated these characters are independent. Anshuman *et al*., 2003 reported that cane yield had non significant association with juice brix and juice purity and sucrose. Therefore, simultaneous improvement of these characters might be possible.

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