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EVALUATION THE PERFORMANCE AND ESTIMATING THE ASSOCIATION OF THE IMPORTANT TRAITS FOR SOME SUGARCANE GENOTYPES

M.H.M. Ebid[1], Soha R. A. Khalil[1] and Y. A. El-Gabry[2]

1. Sugar Crops Res. Inst., Agric. Res. Center, Giza, Egypt.
2. Agron. Dept., Fac. of Agric., Ain Shams Univ., Shoubra EL-Kheima, Cairo, Egypt

ABSTRACT

Seven sugarcane promising genotypes, viz. G.84-47, G.95-19, G.98-28, G.99-103, G.2003-47, G.2003-49, G.2004-27 from program of Egyptian sugarcane breeding and the commercial cultivar (GT.54-9) were evaluated, clustered and measured for the association among their important traits. The experiments were carried out at El-Mataana location Agricultural Research Center Station, Luxor Governorate (Latitude 25°41'N, Longitude 32°39'E). Sugarcane seed sets were planted in the spring of two seasons (2018-2019 and 2019-2020) as plant cane crop. The experiments were led out in a randomized complete blocks design with three replications. The results of the statistical analysis of the collected data recorded that, G.99-103 genotype surpassed all studied sugarcane genotypes in millable cane yield, tallest stalks and the largest stalk circumference as well as heaviest stalk weight. Meanwhile, G.2003-47 genotype also surpassed in the total solids%, brix and sucrose%. While, both genotypes had highest insignificant values in juice yield, sugar yield, their bagasse, purity%, sugar recovery% and total phenolic content in juice. With respect to association among traits, positive correlation was found between stalk weight with brix, sucrose, cane yield and juice yield, as well as, cane yield with stalk number per m^2 and between sugar yield/fed with stalk weight, brix and sucrose. The eight studied genotypes clustered to three clusters for yield (millable cane, Juice and sugar yield/fed). Cluster I of low yield mean, that included the two genotypes G.95-19 and G.98-28. Cluster II of moderate yield mean, included the five genotypes G.84-47, G.2003-47, G.2003-49, G.2004-27 and cultivated variety GT.54-9. The last cluster III of high yield contained only one genotype (G.99-103).

Kew Words**: *Saccharum spp., Breeding, Clusters analysis, Crystallization, Syrup, Chewable*.**

INTRODUCTION

Sugarcane is the first crop for sugar production in the world and considered among the important industrial converting crops. The average yield of sugar and by-products of cane sugar differs from one country to another according to cane variety, climate and efficiency of both agricultural production and factory processing. The sugar cane crop is used in many other industries such as alcohols and fuel…etc (O’Reilly, 1998). Sugarcane bagasse is a fibrous material that combine of two and/or more materials to give a unique grouping of properties, one of which is made up of stiff, long fiber and the other, a binder which holds the fibers in place. However, bagasse account for over 65% of the remains after sugar extraction.

Sugarcane improvement programs worldwide depend on collection and utilization of sugar cane genetic resources. Interspecific hybridization involving cultivated and wild species of *Saccharum* has formed the basis of varietal improvement programs (Amalrai and Balasundaram, 2016).

Breeders and agronomists charged the responsibility of selecting commercial variety among promising varieties. The early and the late immature stages should be of much value to obtain juice of maximum quality commensurate with maximum cane yield (Miller and James 1978). Commercial sugar cane production focuses on the most productive variety in terms of sugar content and sucrose while, thick noble canes which are relatively soft with a higher juice content and sugar and low fiber are the best for chewing (Glyn 2004). The objectives of sugarcane breeding programs around the world are to produce cultivars with improved characteristics such as increased cane yield, higher sucrose content, pest and disease resistance, tolerance to abiotic stress and improved ratooning ability (Hogarth 1971). For example stem borers are economically important pests as they significantly reduce number of sugarcane as well as cane and sugar yields (Jhansi and Rao 1996) and Galal *et al* 2017) and also cause of sugarcane lodging (Hu *et al*, 2017 and Li *et al* 2019). Successful sugarcane breeding program requires effective crossing and selection program to develop improved varieties and maintain sustainable sugar industry throughout supplying the sugarcane growers with the superior varieties (Coleman 1968).

In Egypt, the total production of sugar is representing about 81.7% of domestic demand and more than 99% of cultivated sugarcane area in Egypt depends on one variety, namely. GT.54-9. (Anonymous 2021), therefore sugar industry could face a high risk. Great policy is needed to release, a new variety in order to avoid this problem. The sugar cane crop is used in many other industries such as alcohols and fuel…etc (O'Reilly 1998). In addition, it is the main source for producing some products such as brown sugar, black honey (treacle), beverages industries, and soft drinks. In many countries some varieties are used for chewing purpose (Alam *et al* 2018). In Egypt, total product of sugar cane crop is divided into 75% for sugar manufacturing, 3.2% for treacle productions and 20.2 for fresh juice and other confectionery manufacturers (Anonymous 2021).

The evaluation of the sugarcane genotypes performance has been discussed widely in sugarcane breeding program to identify the promising genotype. The new promising sugarcane variety should have a significant superiority in agronomic and juice quality traits compared to other genotypes, as revealed by many researchers (El-Bakry 2018, Galal *et al* 2018 and Gadallah and Abd El-Aziz 2019).

The understanding of the correlation among important traits of sugarcane genotypes is an essential tool to improve the sugarcane selection program and developing a new sugarcane variety. Sugarcane agronomic characters are highly affected by the environment and are inherited quantitatively. Analysis of correlation coefficient can offer guide to breeders for best new varieties selection (Tyagi and Lal 2007). Significant correlations were detected between each of cane yield and its components and juice quality traits, but the interrelationships among quality traits were positive and high (Puneet-Jain *et al* 2002 and Mohamed 2007).

The objectives of this paper: were the evaluation and clustering genotypes according to the performance and estimating the association of the important traits of some sugarcane genotypes, to determine the utilization of the studied genotypes for a specific purpose.

MATERIALS AND METHODS

This study used comprised seven sugarcane genotypes namely G.84-47, G.98-28, G.99-103, G.2003-47, G.2003-49, G.2004-27 from program of Egyptian sugarcane breeding along with the commercial variety G.T.54-9 as a check variety for evaluation of their characteristics to identify their uses (Table 1). They were evaluated at El-Mataana location, Agricultural Research Center Station, Luxor Governorate (Latitude 25°41′N, Longitude 32°39′E). Sugarcane seed sets were planted as spring in the second week of March in the two seasons 2018-2019 and 2019-2020 as plant cane crop. The experiments were laid out in a randomized complete blocks design (RCBD) with three replications. The experimental unit area was 15 m^2 including 5 rows of 3 m long and one meter apart. Each row was planted by 21 three-budded cane cuttings. Nitrogen, phosphorus and potassium fertilizer were applied, as same as, hoeing and the other agricultural practices were done as recommended by Sugar Crops Research Institute were adopted throughout the growing seasons.

Table 1. Sugarcane genotypes used in this study and their parentage.

Genotypes	Parentage	Source
G.84-47	NCo.310 x ? (Polycross)	Egypt
G.95-19	SP.79-2278 x SP.80-1043	Egypt
G.98-28	C.34-33 x ? (Polycross)	Egypt
G.99-103	US.74-3 x CP.76-1055	Egypt
G.2003-47	CP.55-30 x 85-1697	Egypt
G.2003-49	CP.55-30 x 85-1697	Egypt
G.2004-27	CP.55-30 x Roc.22	Egypt
GT.54-9 (Check)	NCo.310 x F.37-925	Fuzz introduced from Taiwan and selection was achieved in Egypt

After 12 months from planting,middle rows were harvested for measuring all traits.The studied characters were as follows:

A. Vegetative characters

1. **Stalk height (cm)**: Five plants were taken at random from each plot and measured from the soil surface up to the top visible dewlap and the average height of cane stalks in centimeter.
2. **Stalk diameter (cm)**: Diameter of the same stalks was measured from the middle internode and the average diameter of cane stalks in centimeter.

* Stalks of central one meter were cut, counted and weighted after complete cleaning to estimate the following characters:

3. **Number of millable cane/m^2**
4. **Stalk weight (kg)** was determined as mean of main stalks weight.
5. **The bending stress (BS)** in MPa was calculated according to Hirai *et al* (2002).

B. Juice quality:

A sample of 20 millable cane stalks from each plot was taken at random, topped, stripped, cleaned then squeezed by an electric pilot mill. The extracted juice was mixed thoroughly and a sample of one liter was poured in a graduated cylinder and left to settle for 15-20 minutes to remove the foams and setting the sediments before starting analysis of the following characters:

1. **Total solids content (TS)** was calculated as related to moisture content. **Moisture content** in juice was estimated by using the equation: Moisture%= 100- TS% as recommended **(A.O.A.C 2010)**.
2. **Brix:** It was estimated by using Brix hydrometer. Simultaneously juice temperature was registering to extract Brix/100 cm^3 juice and density from Schibler's tables.
3. **Sucrose percentage:** It was calculated by the following equation: Sucrose percentage (/100 cm^3 juice) = direct reading of saccharimeter x 1.04

   Where, 1.04 is a factor depending on the length of saccharimeter's tube (A.O.A.C 2010).
4. **Reducing sugar percentage**: It was determined using Fehling method according to (A.O.A.C 2010).
5. **Purity percentage:** It was calculated using the following equation according to Singh and Singh (1998): Purity percentage = Sucrose percentage x 100 / Brix
6. **Sugar recovery** was calculated according to the formula described by Yadav and Sharma (1980). **Sugar recovery = [S – 0.4 (B-S)] x 0.73**

Where: B =Brix percentage**, S =Sucrose percentage, 0.4 and 0.73 constants**

7. **Total phenolics content in juice** was determined by Folin-Ciocalteau (FC) according to Baba and Malik (2015).

C. Quantitative analysis of sugar cane bagasse

1. Determination of bagasse **crude fiber** it was conducted according to A.O.A.C. (2010).

2. Determination of bagasse fiber fractions (cellulose, hemicelluloses and lignin) in dried sugar cane bagasse was conducted and calculated according to Georging and Van Soest (1975) where samples were analyzed to acid-detergent fiber fraction (ADF), neutral detergent fiber fraction (NDF) and acid detergent lignin (ADL).
3. Determination of Cellulose fractions (ᾱ, B and ɤ) in dried sugar cane bagasse was conducted according to Wells (1921)

D. Yield traits

Stalks of the middle three rows from each plot were harvested to determine the following measurements:

1. **Net cane yield (ton/fed)** millable cane weight (kg/plot), which was converted to ton/fed.
2. **Juice cane yield(ton/fed)** was determined by weighting the juice extracted from the stripped stalk samples (kg/plot), which was converted to ton/fed
3. **Sugar yield (ton/fed)** was calculated according to the following formula
   Sugar yield (ton/fed) = (net cane yield (ton/fed) x sugar recovery percentage)/100
4. **Wet bagasse yields (ton/fed)** was determined by bagasses of cane stalk samples (kg/plot), which was converted to ton/fed.

Statistical analysis

The combined analysis of variance for the data of the two seasons was performed after testing the error homogeneity. Statistical analysis was combined over two years using a randomized complete blocks design (RCBD) with three replications and mean values were compared using Duncan's (1955) multiple range test ($P < 0.05$) using the computer "CoStat" statistical analysis version 6.400 described by CoHort Software (1998).

The data obtained on various characters was analyzed to estimate correlation coefficient using statistical software SPSS software (SPSS for Windows, SPSS Inc., Chicago, USA) for calculating correlation coefficients. Cane, juice and sugar yield traits of the eight sugarcane genotypes were subjected to classify groups as low, moderate and high yield using Hierarchical cluster analysis in SPSS software.

RESULTS AND DISCUSSION

The data from Table (2) showed that, significant differences were recorded among the studied eight genotypes in stalk height (cm), diameter (cm), number/m^2 and weight (kg) except the difference in stalk diameter between G.2004-27 and GT.54-9 genotypes which was similar.

Table 2. Mean performance of eight sugarcane genotypes for some agronomic traits and bending stress of outer rind.

Genotypes	Stalk height (cm)	Stalk diameter (cm)	Stalk number/ m^2	Stalk weight (kg)	Bending stress (GPa)
G.84-47	270.0 d	2.33 e	12.2 a	0.92 d	3.9e
G.95-19	240.3 g	2.20 g	10.3 g	1.01 c	10.2abc
G.98-28	216.7 h	2.27 f	9.7 h	1.04 c	8.8bcd
G.99-103	293.0 a	2.72 a	10.5 f	1.22 a	11.2ab
G.2003-47	268.3 e	2.50 c	11.9 b	1.05 bc	7.8bcd
G.2003-49	265.0 f	2.47 d	10.7 e	1.11 b	13.2a
G.2004-27	280.3 b	2.63 b	11.5 d	1.11 b	7.1cde
GT.54-9 (Check)	273.3 c	2.63 b	11.7 c	1.07 bc	5.6 de

The highest stalk height, diameter and weight was given by genotype G.99-103 followed by G.2004-27. On the contrary, the shortest stalk was given by genotype G.98-28 while the thinnest stalk was recorded by G 95-19 genotype. Genotype G.84-47 produced significantly the greatest stalk number/m^2 across all genotypes, while, G.99-103 hade lowest stalk number density. That may be due to genetic background difference among genotypes. Moreover, bending stress of hardness rend for eight sugarcane genotypes statistically differ significantly among them. From the results, the highest value of bending stress was obtained by G.2003-49 genotype with significant difference with all other genotypes. On the contrary, the lowest bending stress value was recorded by the genotype G.84-47. The bending stress was evaluated as a function of moisture content. As the moisture content of the stem increased, the bending stress decreased, indicating a reduction in the brittleness of the stem (Hoseinzadeh and Shirneshan 2012). This effect of moisture content was also reported in sunflower stem by Ince *et al* (2005).

Data presented in Table (3) indicated that moisture% of G.2003-47 genotype was significantly lower than that of the other studied genotypes except the G.2004-27 genotype which was insignificantly difference. Furthermore, G.99-103 recorded significantly lower TS% than that of G.2003-47 and G.2004-27 genotypes while G.2003-49 genotype recorded significantly lower TS than that of G.2003-47 genotype. However, the differences in TS% among the other genotypes were insignificant. It is interesting to note that all tested genotypes had statistically significant differences in brix % and non-significant differences in reducing sugar %. Besides, G.84-47 recorded significantly lower sucrose% than those of the other tested genotypes. However, G.2004-27 recorded significantly lower sucrose % than that of G.2003-47 genotypes. In addition, G.84-47, G.98-28 and GT.54-9 genotypes had purity % significantly lower than that of G.99-103 and G.2003-47 genotypes which had statistically similar purity % to those of G.95-19, G.2003-49 and G.2004-27 genotypes. At the same time, G.95-19, G.99-103, G.2003-47 and G.2003-49 had statistically similar sugar recovery% which were higher than that of G.84-47 genotype which had sugar recovery % that was statistically similar to those of G.98-28, G.2004-27 and GT.54-9 genotypes. It was also noted that, G.2003-47 and G.2003-49 genotypes had significantly higher total phenolics than those of G.84-47 and GT.54-9 genotypes.

In this regard, Kung and Stanley (2014) demonstrated that the dry matter content of sugarcane increased with advancing stage of maturity. Moreover, the variation among genotypes confirms the effect of the genetic variation on this character which mostly represents a large part of sucrose.

Table 3. Means of juice characteristics for eight sugarcane genotypes.

Genotypes	TS %	Moisture %	Brix reading	Sucrose %	Reducing Sugar%	Purity %	Sugar recovery %	Total Phenolics mg/100g juice
G.84-47	26.74 abc	73.26 a	20.17 h	16.87c	0.53	83.64c	11.35 b	240 b
G.95-19	26.61 abc	73.39 a	23.23 e	20.30ab	1.03	87.39ab	13.96a	249 ab
G.98-28	27.05 ab	72.95 a	22.83 f	19.50ab	1.25	85.41bc	13.26ab	250 ab
G.99-103	23.47c	74.53 a	24.00 b	21.42ab	0.82	89.25a	14.88a	258 a
G.2003-47	29.57a	70.43 b	24.67 a	21.98a	0.35	89.10a	15.26a	255 a
G.2003-49	25.97 bc	74.03 a	23.43 c	20.50ab	0.36	87.49ab	14.11a	247 ab
G.2004-27	27.20 ab	72.80 ab	22.27 g	19.31b	0.50	86.71ab	13.23ab	246 ab
GT.54-9 (Check)	26.30 abc	73.70 a	23.38 d	20.14ab	0.78	86.14bc	13.76ab	241 b

From results in Table (3) it were noticed that, comparing the values of studied traits for tested genotypes to the values of the some traits for GT.54-9 variety, G.2003-47 surpassed other genotypes in TS%, brix reading, sucrose% and sugar recovery%, while it was the lowest one in moisture%. Meanwhile, G.99-103 showed the lowest value TS% but the highest values in moisture%, purity% and total phenolics. Whereas, the highest purity%, sugar recovery% and total phenolic content were obtained by G.99-103 and G.2003-47. It was also noted that, G.84-47 genotype revealed the lowest values in the same traits. The differences among sugarcane genotypes in juice quality are probably due to the genetic background. It could be noticed that G.2003-47 surpassed all tested genotypes in brix%, sucrose%, purity, sugar recovery% and total phenolics which proves that this genotype collect good technological qualities compared to all the tested genotypes and commercial variety. It seems that, brix and sugar content values are one of major factors to ensure the feasibility of selection in sugarcane breeding program to obtain juice of maximum quality commensurate with maximum cane yield. Therefore, when looking in the previous tables, it could be observed clearly that, the genotype G.99-103 was the highest in stalk height, stalk diameter and stalk weight as well as in brix, purity% and sugar recovery% and also sucrose%. On the other hand the high value of total phenolics content in this genotype might help in distinguishing it to tolerate environmental stress and diseases.

In this respect, Lee *et al* (2007) mentioned that simultaneous expression of multiple antioxidant enzymes has been shown to be more effective than single or double expression for developing transgenic plants with enhanced tolerance to multiple environmental stresses. Phenolics group involves sub-categories as flavonoids, phenolic acid, lignins, tanins, stibenes and oxidized polyphenols (Pereira *et al* 2007). These molecules can function by scavenging radicals, chelating metal ions or modulating enzyme activity while also affect the singnal transduction activity of transcription factor and gene expression (Srinivasan *et al* 2005).

Bagasse is a fibrous residue that remains after crushing the stalks and contains long and fine fibers are located in the rind part of the stalk, and short fibers in the inside part known as the pith (Chaabouni *et al* 2006).

Data in Table (4) disclosed the significant difference in bagasse characteristics that was found among some of tested genotypes while non-significant differences existed among the others. Fibrous materials are a combination of cellulose and hemicellulose which are one components of cell wall which give structural strength to the standing of cane plant, percent contribution of each of these components varies according to the variety, maturity, method of harvesting and the efficiency of the crushing plant (Paroha *et al* 2020).

Through these data (Table, 4) it was found that, the highest crude fiber% and α cellulose were obtained by G.2003-49, cellulose% and B cellulose by G.99-103 and hemicellulose% by G.95-19 and ɤ-cellulose and lignin by G.95-19. Meanwhile, the results in the same table showed that no significant differences were found among commercial variety GT.54-9 and some genotypes in some traits such as among genotypes G.84-47, G.98-28 and G.2003-47 in crude fiber% trait and also among G.95-19, G.99-103 and G.2003-47 in α cellulose trait; as well as between it and G.2003-47 in B cellulose trait also between it and G.2004-27 in hemicellulose% trait; as well as among G.84-47, G.95-19 and G.2004-27 in lignin% trait.

Table 4. Means of characteristics of bagasse for eight sugarcane genotypes.

Genotypes	Crude fiber%	Cellulose%	Cellulose fractions			Hemi-cellulose%	Lignin%
			α	Β	γ		
G.84-47	12.1ab	45.02 f	42.12 cd	24.42ab	33.46c	23.86ab	11.00ab
G.95-19	11.2b	41.58 g	47.42d	19.64cd	32.94cd	26.58a	12.53ab
G.98-28	12.9ab	40.31 h	49.25b	11.61e	39.14a	22.52abc	13.14a
G.99-103	11.3b	51.41 a	38.51d	26.97a	34.52bc	19.09cd	10.4b
G.2003-47	11.7ab	49.92 d	40.25d	21.39bc	38.36a	15.94d	11.43ab
G.2003-49	13.2a	47.36 e	53.86a	16.6 d	29.54d	22.32bc	7.6c
G.2004-27	11.4b	50.93 b	46.18bc	15.68de	38.14ab	16.23d	12.12ab
GT.54-9 (Check)	12.1ab	50.05 c	39.6 d	21.34bc	39.06a	15.91d	12.03ab

The noticeable increase in ratio of cellulose% to the other components may be described by this sugarcane bagasse is a fibrous material that combine two or more materials to give a unique combination of properties, one of which is made up of long fibers, stiff and the other, a binder which holds the fibers in place which consists of fiber, pith, and rind particles whereas, cellulose is the main component (Verma *et al* 2012). It is worthy to mention that, the rises of crude fiber% and bending stress will benefit for resistance to insect of stem borers which consider economically important pests as they significantly reduce yields of sugarcane. In this concern, using resistant or tolerantvarieties and biological control are two major ways to control stem borer attacks such as species, *E. saccharina* and *C. sacchariphagus* (Goebel and Sallam 2011). But if you have sown resist varieties, it would be more successful, from biological control which is more difficult to implement, especially on *E. saccharina* as mentioned by Kvedaras *et al*, (2007) and Kouamé *et al* (2010). On the other hand high fiber% and Lignin% helping cane stalks to tolerate lodging such as genotype

G.98-28 and the commercial variety GT.54-9 whereas, after lodging, the growth of plants and accumulation of sugar in stalk was seriously affected, resulting in considerable reduce in cane and sugar yield. Generally believed that lignin content significantly affected the mechanical strength of plant stems so, the varieties with strong lodging resistance had high lignin content so the varieties with strong lodging resistance had high lignin content, in this regard approved by Hu *et al* (2017), Tian *et al* (2017) and Kamran *et al* (2018)

The increases in the cellulose% and also alpha cellulose with low lignin% it could be utilized for recycling as byproduct to produce bio-industrial applications including the production of fermentation alcohol, alkaloids, single cell proteins, enzymes and other microbial products, fungi for animal feed, biogas and biomass, compost to use as a soil conditioner, biobalstic and super adsorption, and also high alpha cellulose% with low lignin% benefit for manufacturing pulping and pulping paper…ect., as an add value to productivity of unit area/fed (Ashok *et al* 2000).

Data in the Table (5) showed that yield for the eight genotypes (Millable cane, juice, sugar and their bagasses) are significantly difference among them. The differences among sugarcane genotypes in juice quality are probably due to the genetic variation among their genotypes. Data also cleared that the highest value of millable cane was obtained by genotype G.99-103 by significant increases amounted to1.36 ton/fed as compared to the commercial variety GT.54-9 corresponding to 0.77 ton/fed in sugar yield. Moreover, there are no significant differences in juice yield and wet bagasse. Meanwhile there are non-significant differences among genotypes (G.99-103, G.2003-47, G.2004-27 and the commercial variety GT.54-9) and between (G.99-103 and G.2003-47) and also between (G.84-47 and G.95-19) in juice yield as well as among (G.95-19, G.2003-49, G.2004-27 and commercial variety G.T.54-9) and between (G.99-103 and G.2003-47) and also between (G.84-47 and G.98-28) in sugar yield, and among (G.99-103, G.2003-47, G.2003-49, G.2004-27 and the commercial variety GT.54-9) and also between (G.95-19 and G.98-28) for yield of wet bagasse

Table 5. Means yield of eight sugarcane genotypes.

Genotypes	Millable cane yield/fed. (ton)	Juice yield/fed. (ton)	Sugar yield/fed. (ton)	Wet bagasse yield/fed. (ton)
G.84-47	45.02 f	31.55bc	5.11b	13.47ab
G.95-19	41.85 g	30.35bc	5.84ab	11.50b
G.98-28	40.31 h	29.22c	5.35b	11.09b
G.99-103	51.41 a	35.98a	7.65a	15.43a
G.2003-47	49.92 d	34.92a	7.62a	15.00a
G.2003-49	47.36 e	33.15ab	6.68ab	14.21a
G.2004-27	50.93 b	35.20a	6.74ab	15.83a
GT.54-9 (Check)	50.05 c	35.04a	6.88ab	15.01a

The results in Table (5) insulted that, genotype G.99-103 surpassed others in millable cane yield, juice yield, sugar yield and their bagasse. It showed also the tallest stalks and the thickest stalk circumference as well as the heaviest stalk weight as shown in Table 2 and also gave the highest purity%, sugar recovery% and total phenolics. But it showed no significant difference in sucrose% between it and the commercial variety GT.54-9. Moreover it has a high cellulose content % plus it has reasonable and meddle ratio content of lignin (Table 4). These genotypes could be used for sugar crystallization because it possesses an economic target in sugar cane crop for farmers and sugar yields and byproduct for factories. Meanwhile G.2003-47 genotype surpassed others in juice, sugar and their bagasse and also in total solids %, brix reading, sucrose%, purity% sugar recovery%, total phenolic content in juice (Table 3) plus it has a reasonable and moderate content of lignin as shown in Table 4 and thus it could be suitable for syrup manufacturing. Moreover the genotypes G.95-19 and G.98-28 have characterized with low content of cellulose and wet bagasse thus it could be suitable for chewable cane.

Correlation coefficients between the different pair of yield traits (millable cane yield, juice yield and sugar yield) and their yield component traits (stalk number per m^2, stalk weight, brix reading, sucrose%, crude fiber% and lignin%) were calculated to detect the relationship among the various studied traits. The correlation coefficient values are presented in Table 6.

The data in Table (6), it can be showed that, there was a positive, strong and significant correlation (P = 0.01) between brix with sucrose%, as same as, cane yield/fed with juice and sugar yield/fed, in addition to, juice yield/fed with sugar yield/fed.

Table 6. Correlation coefficients between different yield and its components traits

	Stalk number/m^2	Stalk weight	Brix reading	Sucrose	Crude fiber	Lignin	Cane yield	Juice yield
Stalk weight	-0.334	1						
Brix reading	-0.306	0.625*	1					
Sucrose	-0.275	0.660*	0.991**	1				
Crude fiber	-0.216	-0.157	-0.118	-0.194	1			
Lignin	-0.094	-0.309	-0.109	-0.158	-0.406	1		
Cane yield	0.540*	0.612*	0.329	0.387	-0.346	-0.340	1	
Juice yield	0.489	0.650*	0.400	0.456	-0.382	-0.310	0.995**	1
Sugar yield	0.178	0.761*	0.774*	0.818*	-0.336	-0.310	0.845**	0.882**

***. Correlation is significant at the 0.05 level, **. Correlation is significant at the 0.01 level.**

Positive and significant correlation (P=0.05) were found among the characters sugar yield/fed with stalk weight, brix and sucrose. Moreover, positive and significant correlation were found between stalk weight with brix reading, sucrose, cane yield and juice yield, cane yield with stalk number per m^2. This has very important implications for selection between genotypes to be used as purposes crossing parents. The previous information indicates that, yield traits were affected by the previous traits but the degree at which each trait affects yield is dependent upon the degree of association of that trait to different yield traits. In this case, selecting for the traits stalk weight and number of millable stalks would produce maximum cane yield as compared with any of the other traits. Brown *et al* (1969), Hogarth (1971), James (1971), Mariothi (1972), Rao *et al* (1983) and Tyagi and Lal

(2007) found that, cane yield was more correlated with stalk population than stalk weight or stalk diameter.

Estimates of correlation between a pair of traits indicate the relationship of traits inherent (Heinz, 1987). If there is a positive and high correlation between two traits, selection for one trait of them should result in selection for the other trait. Comstock and Robinson (1952) highlighted the importance of genotype correlation. They point to that, traits not selected may deteriorate and those under selection may show little response due to negative genotype correlation. While, phenotypic correlation which is approximations of genotypic correlation have been reported by many authors including James and Falgout (1969), James (1971), Reimers *et al* (1982), Wu *et al* (1983) and Tyagi and Lal (2007).

Cluster analysis is the task of grouping a set of items in such a way that items in the same group (called a cluster) are more similar (in some sense or another) to each other than to those in other groups (clusters). Table (7) and Figure (1) show the dendrogram plot of the clusters within which the genotypes are similar for yield traits (millable cane, juice and sugar yield).

Table 7. Mean of yield traits clusters of eight sugarcane genotypes.

Cluster	Cane yield/fed	Juice yield/fed	Sugar yield/fed
1	**41.08**	**29.78**	**5.60**
II	**48.66**	**33.97**	**6.61**
III	**51.41**	**35.98**	**7.65**

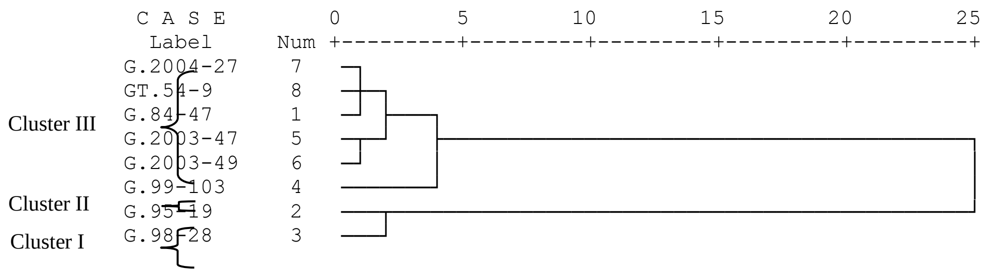

Fig. 1. Cluster dendogram of eight sugarcane genotypes using multivariate parameters.

Figure 1 showed that, cluster I consisted of two genotypes G.95-19 and G.98-28 that had low yield mean (41.08, 29.78 and 5.60 ton/fed for millable cane, Juice and sugar yield/fed). Cluster II contained five genotypes G.84-47, G.2003-47, G.2003-49, G.2004-27 and the cultivated variety GT.54-9 that showed moderate yield mean (48.66, 33.97 and 6.61 ton/fed for millable cane, Juice and sugar yield/fed). The cluster III involve the high yield genotype (G.99-103) of yield means (51.41, 35.98 and 7.65 ton/fed for millable cane, juice and sugar yield/fed). This result may be due to genetic diversity for tillering, stalk weighing, juice content and sucrose content. Similar results were revealed by Ram and Hemaprabha (1991); Tahir *et al* (2013); Khan *et al* (2015) and Khalid *et al* (2016) who obtain that, the progenies of a cross can be clustered to groups independently of their parent's characteristics.

CONCLUSION

All discussion about the screening of eight sugarcane genotypes had shown that a potential traits of germplasm to identify donors for juice quality and high yield of millable cane, juice and sugar is very important for the development of sugarcane new varieties and for inclusion in program of Egyptian sugarcane breeding. It could be concluded from this study that genotype G.99-103 could be used to sugar crystallization. Besides G.2003-47 variety could be suitable for syrup manufacturing. However, the genotypes G.95-19 and G.98-28 have been characterized by low content of cellulose and wet bagasse thus they could be suitable as chewable cane.

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تقييم الأداء وتقدير التلازم للصفات الهامة لبعض التراكيب الوراثية لقصب السكر

محمود حمدي محمد عبيد[١]، سها رمضان أبو العلا خليل[١]، ياسر عبد الجواد الجابري[٢]

١. معهد بحوث المحاصيل السكرية – مركز البحوث الزراعية – الجيزة – مصر

٢. قسم المحاصيل – كلية الزراعة – جامعة عين شمس – شبرا الخيمة – مصر

تضمنت هذه الدراسة تقييم عدد ٧ تراكيب وراثية من قصب السكر ناتجة من البرنامج المصري لتربية قصب السكر هى: (جيزة٨٤-٤٧ وجيزة٩٥-١٩ وجيزة٩٨-٢٨ وجيزة٩٩-١٠٣ وجيزة٢٠٠٣-٤٧ وجيزة٢٠٠٣-٤٩ وجيزة٢٠٠٤-٢٧) والصنف التجاري جيزة تايوان ٥٤-٩ وتقدير الإرتباط بين الصفات الهامة وتقسيم هذه التراكيب الوراثية إلى مجموعات. وقد أقيمت هذه التجربة في محطة بحوث المطاعنة لمركز البحوث الزراعية بمحافظة الأقصر (دائرة عرض ٢٥ ٤١ شمالاً وخط طول ٣٢ ٣٩). حيث زرعت التجربة في موسمين زراعيين غرس ربيعي ٢٠١٨-٢٠١٩ و٢٠١٩-٢٠٢٠. حيث كان التصميم التجريبي المستخدم هو تصميم قطاعات كاملة العشوائية في ثلاث مكررات. يمكن الاستنتاج أنه من خلال التحليل الإحصائي للنتائج التي تم جمعها أن التركيب الوراثي جيزة٩٩-١٠٣ قد تفوق على جميع التراكيب الوراثية من قصب السكر في حاصل القصب القابل للعصر وأظهر أيضا أطول نباتات وأكبر قطر للساق بالإضافة إلى أثقل وزن للساق. وفي الوقت نفسه تفوق التركيب الوراثي جيزة٢٠٠٣-٤٧ في صفات نسبة المواد الصلبة الكلية والبركس والسكروز، بينما سجل كلا التركيبين الوراثيين أعلى القيم (مع عدم وجود فروق معنوية بينهما) في حاصل العصير وحاصل السكر والمصاص الناتج منهما وكذلك النقاوة وناتج السكر والمحتوى الفينولي الكلي في العصير. أظهرت النتائج من خلال تحليل الإرتباط وجود ارتباط موجب بين وزن الساق مع البركس والسكروز وحاصل القصب وحاصل العصير وكذلك حاصل القصب مع عدد السيقان لكل م^2 وأيضاً بين حاصل السكر/ف مع وزن الساق والبركس والسكروز. تم تقسيم التراكيب الوراثية الثمانية المدروسة إلى ثلاث مجموعات من حيث متوسط الحاصل (حاصل القصب القابل للعصر والعصير والسكر/فدان). المجموعة الأولى ذات متوسط الحاصل المنخفض: تحتوي على تركيبيين وراثيين جيزة٩٥-١٩ وجيزة٩٨-٢٨. المجموعة الثانية ذات الحاصل المتوسط: والتي تتضمنت خمسة تراكيب وراثية جيزة ٨٤-٤٧ وجيزة٢٠٠٣-٤٧ وجيزة٢٠٠٣-٤٩ وجيزة٢٠٠٤-٢٧ والصنف التجاري جيزة تايوان٥٤-٩، ثم المجموعة الأخيرة ذات متوسط الحاصل العالي: التي أحتوت على تركيب وراثي واحد فقط هو جيزة٩٩-١٠٣.

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