Evaluation and stability analysis of some sugarcane genotypes across different environments

By

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Introduction

Egypt is the first country in productivity of sugarcane by 8647219 tons of cane resulted from 248220 Faddan produced 930250 tons of sugar. (**Annual Report of Sugar Crops Council, 2019**).

The great challenge faces the sugar industry from sugarcane is the lacking of the commercial varieties. Furthermore, Egyptian sugarcane breeding program is working hard to develop a new sugarcane varieties having high and stable yield of cane and sugar, in addition to, resistance to diseases, pests and adverse conditions.

High and stable cane and sugar yields of sugarcane genotypes across varying environments of production regions are the basic and desirable traits for selection in all sugarcane breeding programs. Therefore, elite sugarcane genotypes normally evaluating in multi-environments trails which take into account the multiple harvesting nature and maturity pattern of the sugarcane crop. Harvesting of sugarcane extends for five months at least and it involves more than one – crop class, i.e., plant cane and ratoon crops which are in different growing seasons and years.

There are several methods for analysis of GE interactions and stability of genotypes. The linear regression suggested by **Finlay and Wilkinson (1963), Eberhart and Russell (1966) and Tai (1971)** are the most techniques commonly used. Furthermore, sugarcane production is manly estimated by sugar yield per unit area. Cane yield and sugar recovery per ton of cane are the two components of sugar cane. Millable stalk weight is determined by its length, diameter and density, in addition to, number of millable stalk are the two components of the cane yield while brix and sucrose percentage are the two components of the sugar recovery. The association of these traits with sugar yield and with each other should be determined to predict their responses to selection. This could be achieved by using correlation coefficient (**Guprasad *et al.*, 2015 and Pandya and Patel, 2017)**. Also, stability analysis of these traits may shed light on the adaptive behaviors of the evaluated genotypes and may provide information for the possibility of use these traits for indirect selection of high and stable genotypes (**Mebrahtom *et al.*, 2017 and Esayas *et al.*, 2019)**.

Maturity is the most important factor affecting yield in sugar cane crops. The appropriate age for harvesting of sugar cane depends upon sugar accumulation rate and when the peak of maturity is achieved because harvesting either under-aged or over-aged cane without prober timing lades to loss in cane yield, sugar recovery, poor juice quality and problems in milling (**Bashir *et al.*, 2013 and Abdul-Khaliq *et al.*, 2018)**.

The objectives of this study were:

1. Estimation the performance and stability of tested elite genotypes for cane yield, sugar yield and related components across the entire range of environments in three production areas in Egypt
2. Determining the association among sugar yield, cane yield, recovery sugar and among these traits with related components
3. Identifying the proper age for the harvesting of tested genotypes in plant-cane and first-ratoon crops.

Review of literature

A-Performance of sugarcane genotypes under different environments:

Jadhav *et al.* (2000) evaluated the effect of harvesting dates (12, 14 and 16 month-old) during 1995-98 on juice quality and cane yield of eight sugarcane varieties. They reported that the juice quality showed significantly higher sucrose, brix and cane yield values at the age of 14 months than the others.

Bissessur *et al.* (2000) studied 154 genotypes at two sites in plant cane and first ratoon crops. The differences among genotypes and their interactions with locations were highly significant for all examined traits i.e., stalk height, stalk diameter, sucrose content, tonnes cane per hectare (TCH) and tonnes sugar per hectare (TSH) in both plant-cane and first-ratoon crops. In addition, mean squares due to locations were highly significant for these traits, except for the main effects of sites for cane yield in the first ratoon was non-significant. The results showed that the individual genotypes performed differently at the two sites.

Bissessur *et al.* (2001) evaluated five sugarcane genotypes under seven environments for three traits i.e., cane yield (TCH), industrial recoverable sucrose percentage cane (IRSC), and ton sugar yield (TSH). They found that highly significant differences among the genotypes and the environments for the three studied traits**.** However, the G × E interaction was not significant.

Rea and Orlando (2002) evaluated fourteen genotypes and three sugarcane cultivars for plant cane and first ratoon at six locations in Venezuela. Genotypes, genotypes × locations, crops-years, and crops-years × genotypes and crops-years × locations interactions were significant for cane yield. Three clones; B80- 549, B80-408, and B81-503 were significantly superior compared to the rest of genotypes for cane yield.

Imtiaz *et al.* (2002) tested two sugarcane clones AEC81-8415 and AEC80-2046 along with four commercial varieties viz., BL4, PR1000, BF129 and L116 at three locations in two consecutive years for cane and sugar yields. The results showed significant ($P \leq 01$) differences among genotypes and their interaction with locations for the cane yield and sugar yield traits. But, locations, years, years × locations, years × genotypes and locations × years × genotypes interactions were non-significant for cane yield.

Arumugam *et al.* (2002) studied the effect of crop age at harvest (10, 11, and 12 month-old) on the cane and sugar yields of six sugarcane cultivars. The results indicated that cane and sugar yields increased with the increase of crop age from 10 to 12 month-old.

Ahmed (2003) studied the effect of harvesting ages (10, 11, 12, 13 and 14month-old) for three promising sugarcane varieties (G. 95-19, G. 95-21 and Ph. 8013). He stated that the 14 month-old was the most suitable age for harvesting the examined varieties whether for plant cane or ratoon crops on cane yield (ton/fed.) and its components (millable cane height, diameter and weight) as well as brix%, sucrose%, sugar recovery% and sugar yield (ton/fed.). In addition, he found significant difference among the studied varieties for all tested characters.

Wagih *et al.* (2004) studied 26 genotypes of sugarcane planted in early November 1998 and harvested during ten months, started when cane was 5 month- old in April1999 and ended in January 2000 when cane was 14 month-old) based on standards of 85% purity and 17.5 tons sugar per hectare. They found 8 superior genotypes, L 6, 10, 11, 13, 14, 22, 25 and 26were equal or higher than the standard values. The first two genotypes matured in less than 11 month–old (early maturing), while the remaining six genotypes matured in 11-13 month–old (medium maturing). In addition, the genotype (L26) gave high sugar yield with medium maturing and long production period and it is an ideal.

Imtiaz *et al.* (2004) evaluated four sugarcane clones CP67-412, AEC82-1026, AEC86-328 and AEC86-347 along with commercial variety BL4 at 6 locations in the province of Sindh during 1999-2000 and 2000-200. Mean squares due to genotypes and their interaction with locations were significant (P≤0.01) differences for cane yield and sugar yield.

Queme *et al.* (2005) studied performance of 16 cultivars in the plant cane and first ratoon at five locations in the sugarcane production zone of Guatemala for tonnes of cane per hectare (TCH), sucrose percent in cane (SUC%) and tonnes of sugar per hectare (TSH) variables. The results showed that environments (E), genotypes (G) and their interactions were highly significant (P ≤ 01) for these traits.

Oliveira *et al.* (2005) evaluated one hundred and eighty clones of the series RB96 with promising clones of the series RB89, RB94, and RB95 plus two commercial standard cultivars RB72454 and RB835486 at three production environments of plant cane and first ratoon for trait tons of cane per hectare. They reported that the two best clones presented a mean superiority of 28% (RB955466) and 19% (RB965518) over the general mean of the three locations.

Jesus *et al.* (2005) evaluated six varieties under cutting times at 8, 10, 12 and 14 month-old for total recoverable sugar (TRS%). They noticed increases in TRS percentage with increase the age of the crop. The highest values were in four varieties i.e., MZC 74-275 at 12 months of age and MEX 64-1487, CC 84-75 and V 71-51 at 14 months of age.

Gilbert *et al.* (2006) studied the performance of 8 different genotypes planted at five locations (some locations were repeated in different years) across two different cropping seasons and five harvesting times (mid- October to mid-March) for kilograms of sugar per ton (KST), tons of cane per hectare (TCH) and tons of sugar per hectare (TSH). They indicated that genotypes, environments, harvesting times and their interactions had different significant effects for the studied traits. Sugarcane KST and TSH were reduced by 28 and 29%, respectively, when harvested in mid-October compared to optimum harvest dates in February.

Queme *et al.* (2007) assessed the performance of twenty-one sugarcane cultivars across five sites in the sugarcane production low zone of Guatemala, for plant, first, and second ratoon crops on tonnes of cane per hectare (TCH). The environments, genotypes, and GE interaction were highly significant. In addition, the superior cultivars were RB732577 and SP71-6180 for the other genotypes.

Khandagave and Patil (2007) indicated that increasing age at harvest from 10 to 16 month-old across the varieties enhanced the average cane and sugar yield from 72.3 to 99.4 t/ha and 8.24 to 12.92 t/ha, respectively.

Barry and Manjit (2008) investigated sixteen genotypes in two or three crop cycles from 2002 to 2005 at nine locations for three traits (cane yield, theoretical recoverable sucrose (TRS) and sucrose yield). Genotypes x locations interactions were highly significant for each of the three traits analyzed in each crop cycle. The variation attributed to the GL interaction was smaller than the variation among genotypes for TRS in the plant-crop and first-ratoon crop cycles. Variation in either cane or sucrose yield attributed to the GL interaction was greater in all three crop cycles than was variation among genotypes. Generally, replacing an organic-soil location with a sand-soil location will the desirability in the final testing stage of this sugarcane breeding and selection program.

Kimbeng *et al.* (2009) evaluated seventeen genotypes and three commercial cultivars at five locations during three successive years for tonnes of cane per hectare (TCH), tonnes of sugar per hectare (TSH) and percent sucrose. They indicated that the G × L, G × C and G × L × C variance components were significant ($P \leq 0.05$) for all three traits and associated with changes in the relative ranking of genotypes across environments (locations and crop-years).

Ramburan *et al.* (2009) adopted two field trials (12 month-old harvest for six seasons and 18 month-old harvest for three seasons) on set of 10 varieties for two traits; cane yield ton/ha and recoverable crystal. Variety × trial interactions were highly significant for cane yield t/ha and recoverable crystal. Six varieties; N27, N29, N33, N35, N39 and N41 produced high (most were non-significant) cane yield when harvested at 12 months. While, four of them (N12, N21, N31 and NCo376) were out yielded at the 18-month harvest cycle. Quick maturing varieties produced high cane yield at the 12-month cycle, while slower maturing varieties yielded high on the longer cycle.

Rakkiyappan *et al.* (2009) studied the effect of three harvesting times (12, 13 and 14 month-old) on cane varieties. They found that both juice sucrose and purity increased at the 13 month-old followed by at 14 month-old.

Viator *et al.* (2010) investigated the effect of two harvesting dates (early harvest on 1^{st} October; 9 month-old and mid-season on 1^{st} December; 11 month- old) in plant-cane and first-ratoon on cane yield, sucrose yield and theoretical recoverable sucrose of four cultivars (LCP 85-

384, ho 95-988, hoCP 96-540, and L97-128). Early harvesting date of both plant-cane and first-ratoon reduced sucrose yields and sugar yields for all cultivars compared to the mid-season harvesting date.

Osman *et al.* (2011) found that the effect of harvesting dates (10,12 and 14 month-old) was significantly differed on stalk height, diameter, weight, brix%, sucrose%, sugar recovery%, cane and sugar yields/fed in the plant cane and first ratoon crops. The harvesting date up to 14 months gave the highest values of stalk height, weight and cane yields/fed. in plant cane and 1^{st} ratoon crops over the other harvesting dates.

Naeem *et al.* (2011) evaluated seven genotypes planted in February 2008 and harvested in five dates (1^{st} Nov. to 1^{st}March 2009) for cane yield. They reported that the effect of genotypes and harvesting dates were significant ($p \leq 0.05$).While, genotypes and harvesting dates interaction was insignificant. Harvesting date in February produced the maximum ratoon cane yield (64.93 t/ha), but it was statistically at par with March harvest (64.66).While, the minimum ratoon cane yield (46.62 t/ha) recorded by harvesting date in November.

Kumar *et al.* (2011) evaluated nine sugarcane genotypes at seven locations in two crop seasons (2008-09 and 2009-10) for cane yield. They found that 61.11% of the total sum of squares was attributable to genotype x environment interaction effects. However, they showed that 22.34% and 16.05% of the total sum of squares were attributable to environments and genotypes, respectively.

Tiawari *et al.* (2011) assessed 16 genotypes for three years (two plant-cane and one ratoon) at three environments. The results showed that mean squares of environments, genotypes and genotypes × environments interaction (G x E) were significant for all the variables (number of millable cane, sucrose percentage and cane yield).

Ramburan *et al.* (2011) evaluated fifteen commercial cultivars in 43 trials (32 post release cultivar evaluation trials and 11 advanced plant breeding selection trials) grown in 18 different locations during the period 1999–2009. They indicated that the genotype, environment and the G × E interaction effects were significant for all three variables; cane yield in tons ha^{-1}, recoverable crystal percentage and the tons recoverable crystal.

Mario *et al.* (2012) evaluated fifteen early-maturing genotypes at 18 environments (8 locations x plant cane and/or first ratoon and/or second ratoon) during 2009/2010 and 2010/2011 seasons for yield of stalk and brix. They found that genotype × environment interactions were highly significant and evidenced changes in the genotype ranking according to the environment. New genotypes exceeded the standard early genotype RB855156 for productivity and stability, although it still stands out for its high productivity, moderate stability and wide adaptability. Genotype RB966928 stood out for its yield of brix, moderate stability and wide adaptability. Salto do Jacuí, RS, Brazil, is the most suitable site for preliminary tests of genotype selection.

Abd El-Razek and Besheit (2012) tested four promising sugarcane varieties cultivated at two different locations in Egypt (El-Mattana and Mallawi) and harvested in different dates (10, 11, 12 and 13 month-old) for cane and sugar yields traits. They reported that the varieties G99-103 and G95-21 recorded the highest cane and sugar yields in harvest dates at 12 and 13 months old.

Bashir *et al.* (2012) studied the effect of sugarcane cultivars planted in February 2007 and harvested in five dates (1st Nov., 1st Dec., 1st Jan., 1st Feb. and 1st March 2008) on cane yield. The results showed that significant varied for genotypes and harvesting date effects on cane yield. February harvesting date gave the highest cane yield (79.11 t/ha) followed by March and November dates (69.85 and 60.74 t/ha, respectively). However, the genotypes S2001-SP-104 and S2001-SP-104 were the highest cane yield (99.96 and 97.00 t/ ha respectively) in February.

Bashir *et al.* (2013) observed varied significantly among all the harvesting dates; 1stNovember, 1st December, 1st January, 1st February and 1st March in 2010-2011 of sugarcane when planted in February on cane yield. In addition, the highest cane yield (56.25 t ha^{-1}) was in February.

Alida *et al.* (2013) evaluated seventeen experimental and three commercial varieties in a 3-year crop cycle (plant cane, first and second ratoon) at four locations on tonnes of cane per hectare (TCH). A combined analysis across the four localities or environments showed significant differences ($p \leq 0.05$). The highest average TCH was obtained in La Pastora (L), with 136.64 t/ha, followed by Puricaure (L) with 119.56 t/ha. Varieties V98-120, V98-62, V99-236, V00-50, V99-190, V99-208, and V99-213 produced statistically superior TCH to other clones.

Pedro *et al.* (2013) evaluated 20 sugarcane genotypes and two cultivars as control (RB855156 and RB855453) in 2009/10 (plant cane), 2010/11(first ratoon) and 2011/12 (second ratoon) growing seasons at five environments for tons of sugar per hectare (TSH). The analysis of variance showed that the effects of genotypes, environments and GE interactions were significant for tons of sugar per hectare (TSH).

Tahir *et al.* (2013) evaluated sixteen genotypes including two checks at three environments during 2005-06 and 2006-07 for plant height, cane yield and millable canes. Highly significant differences for environments (E), genotypes (G) and their interaction (G × E) were obtained for all the tested characters.

Imtiaz *et al.* (2013) carried out evaluation trails between sugarcane clone NIA0819/P5 along with four commercial varieties at six different locations during 2008-09 and 2009-10 seasons. Highly significant differences were among varieties, environments and varieties x environments interaction for cane and sugar yields. Two varieties (NIA-2010 and clone NIA0819/P5) gave significantly highest cane and sugar yields, respectively, followed by NIA-2004. The lowest performing genotypes were the check variety (Thatta-10).

Fooladvand *et al.* (2013) evaluated 26 promising sugarcane varieties and 4 standard cultivars for plant cane, first ratoon and second ratoon at 3 locations. They found that the effect of years, locations, years by locations and genotypes were highly significant ($P < 0.01$) and effect of genotypes by locations was found to be significant ($P<0.05$) on sugar yield.

Rea *et al.* (2014) evaluated twenty sugarcane genotypes at seven locations during three years (plant, first and second regrowth) during 2006-2010 for cane yield (TCH). This trait was significantly by environmental and genotypic effects, which explain, respectively, 41.16 and 40.67% of the total sum of squares. The genotypes x environments interaction expressed the 17.90% of the variation.

Guddadamath *et al.* (2014) investigated eight sugarcane genotypes along with four commercial checks during 2012-2013 under four environments. They revealed that the genotypes, environments and G x E component of variation were significant for all studied characters (cane height, cane girth, single cane weight, sucrose percentage, cane yield and sugar yield).

Yohannes and Netsanet (2014) evaluated 12 sugarcane varieties to determine the effect of different harvesting ages (12, 14 and 16 month-old after planting) on plant cane crop**.** They noticed that, the main effects; age of harvesting and variety were significant (p<0.01) for sucrose percent, cane yield and sugar yield traits. However, the interactions were insignificant. Sucrose percent was significant (p<0.01) at 14 months age of harvesting compared to the others.

Hagos *et al.* (2014a) evaluated four sugarcane varieties (N-14, NCO-334, CO-680 and B52-298) under six harvesting ages (10, 12, 14, 16, 18 and 20 month-old) for yield and quality parameters. The results showed that harvesting ages significantly influenced (P<0.001) on quality parameters (brix, purity and estimated recoverable sucrose) and yield parameters (plant height, cane yield and sugar yield). Early harvesting ages 12 and 14 month-old high recorded sugar yield. Therefore, adjusting harvesting age to 12 months for the major sugarcane varieties economically recommended obtaining optimum sugar yield with efficient time use at the tropical areas of Tendaho.

Hagos *et al.* (2014 b) reported that harvesting ages (12, 13, 14 and 15 month-old) significantly influenced (p<0.01) on quality and yield parameters i.e., (brix, purity and recoverable sucrose) and (plant height, cane yield and sugar yield), respectively. Delaying harvesting age caused increasing significantly quality and yield parameters.

Hamam *et al.* (2015) showed that harvesting times had significant effect on cane and sugar yields of sugarcane in both seasons. Delaying harvesting times of sugarcane from 11 to 14 month-old caused increasing cane yield of sugarcane from 51.42 to 61.23 t/fed. and from 58.37 to 63.35 t/fed. in the first and second seasons, respectively. While, it from 11 to 13 month-old caused increasing sugar yield from 5.83 to 7.76 t/fed. and from 6.98 to 8.30 t/fed. in the first and second seasons, respectively. On the other hand, sugar yield decreased from 7.76 to 6.47 t/fed. and from 8.30 to 7.63 t/

fed. with delaying harvesting times from 13 to 14 months in the first and second seasons, respectively.

Rea *et al.* (2015) investigated 20 genotypes at seven locations over three crop-years (plant crop, first and second ratoon) during 2008-2010 for cane yield (TCH).They indicated that the genotypic, environmental effects and GE interactions were significant.

Jun *et al.* (2015) studied 21 cultivars during 2011 to 2013 (two plant cane crops plus one ratoon crop) at fourteen locations for sugar yield. They showed that the impact of each factor on the yield variability could be ordered from high to low as locations (29.79%) > locations x genotypes (19.28%) > locations × genotypes x years (16.50%) > locations × years (10.17%) > genotypes (7.42%) > genotypes x years (3.05%) > years (0.43%). Obviously, the last single factor (years) played a minor role in the variability in yield.

Njabulo (2016) evaluated eight varieties across different environments under five successive crops (plant plus four ratoons). They showed that genotypes (G), locations (L), crops-years(C) and their interactions were significant for all the studied traits (tons of sucrose per hectare (TSH) and its components, tons cane per hectare (TCH) and sucrose content, except G x L x C for TSH and TCH. For TSH and sucrose percentage cane, GEI accounted for larger variation than G, while the opposite was true for TCH (G > GEI).

Ahmed *et al.* (2016 a) found that all the studied traits; stalk cane length, diameter, Brix, sucrose, purity, sugar recovery percentages, cane and sugar yields (ton/fed.) were significantly influenced by delaying the harvesting ages from 10 to 14 month-old either in plant cane or first ratoon.

Ahmed *et al.* (2016 b) studied the effect of harvesting ages (11, 12, 13 and 14 month-old) on three promising sugarcane varieties (G.98-28, G. 99-160 and G.2003-49) compared with the commercial variety (G.T. 54-9) in plant cane and first ratoon. They noticed that all the studied traits; stalk cane length, diameter, weight, brix, sucrose, purity, sugar recovery percentages and cane and sugar yields were significantly influenced by increasing the harvesting ages from 11 to 14 month-old. However, they found that the best harvesting age for the studied sugarcane varieties could be 14 month-old to obtain the best quality parameters as well as the maximum cane sugar yield.

Priyanka *et al.* (2016) found that increase in percent juice sucrose through harvesting dates was from October (9 month- old) until April (15 month-old) for early maturing and mid-late varieties planting in February.

Mehareb and Sakina (2017) studied the effect of harvesting ages (10, 11, 12 and 13 month-old) in plant cane and first ratoon at Upper Egypt conditions. Harvesting age at 13 month-old recorded the highest mean values of most studied traits (yield and juice quality), but it not significantly increased cane and sugar yield compared with harvesting at 12 months.

Mahmood-Ul-Hassan *et al.* (2017) studied ability of five sugarcane varieties/clones, which planted in 1st February under the varying harvesting dates (1st Nov., 1st Dec., 1st Jan., 1st Feb. and 1st March).They found that, highly significant differences among all the genotypes and harvesting dates for cane yield and sugar yield. In addition, they concluded that sugarcane genotypes differed in ratooning ability for cane and sugar yield under harvesting dates from 1st February to 1st March.

Sphamandla *et al.* (2017) evaluated thirty genotypes including three to five control cultivars planted from 2002 to 2006 and harvested from 2003 to 2009 in five sites. Genotype effects were highly significant ($p \leq 0.01$) for all the studied traits (stalk height, stalk diameter, brix percentage, cane, recoverable sugar, purity percentage, ton of cane per hectare (TCH) and ton of sugar per hectare (TSH). While, genotypes x locations interaction was non-significant ($P>0.05$), but genotypes x crops-years was significant ($P \leq 0.05$) for ton cane per hectare, tons sugar per hectare, estimable recoverable crystal and brix percentage cane. Genotype × locations x crops-years was non-significant ($P> 0.05$) for the studied traits.

Susie *et al.* (2017) evaluated four consecutive genotype series (S00, S03, S04, and S05) at the seven sites under four years (2011–2014). They revealed that the significant differences due to genotype × location (GL) interaction, always higher than that due to genotype × crop-year (GC) interaction, indicating that testing genotypes across locations are more important than testing for ratooning ability for tonnes of cane per hectare (TCH) and estimable recoverable sugar (ERS) characters.

Sujeet *et al.* (2017) assessed 226 segregating genotypes at two environments during 2011-12 (plant-cane). They found that environments, genotypes and genotypes x environments (G × E) interaction were significant ($P \leq 0.01$) for stalk length, stalk diameter, stalk weight and HR brix. Furthermore, the effect of genotypes and genotypes × environment (G × E) interaction were significant, while, the effect of environment was non-significant for cane yield.

Edwin *et al.* (2017) tested 22 sugarcane genotypes with three checks at three sites during 2011-2014. Significant differences ($p \leq 0.05$) were observed among genotypes for sugar yields, brix percent cane and juice purity. In addition, the effects of locations on quality were significant ($p<0.05$) for all the tested traits. However, effects of G×L were non-significant for all the quality traits, except of brix percentage cane. Under conditions of this study, seven genotypes (KEN 82-493, KEN 04-1809, KEN 04-1603, KEN 04-1079, KEN 04-419, KEN04-2010 and KEN 04-2192) had a good potential for production in sugar and cane yields. These results suggests that evaluation of sugarcane clones for yield and quality in plant crop in many locations rather than crop-years to identify superior clones for specific locations.

Dubey *et al.* (2017) evaluated seven varieties across three environments during 2009 to 2011. Mean squares due to genotypes and environments were highly significant for number of millable cane, cane length, cane diameter, single cane weight and yield (t/ha). While, the genotypes × environments interactions for both cane length and yield (t/ha) were significant.

Prema *et al.* (2017) analyzed seventeen genotypes at five locations in one season (plant cane).There were highly significant ($p\leq 0.001$) variations among the genotypes (G), environments (E) and GE interactions for cane and sugar yields.

Mebrahtom *et al.* (2017) studied 49 genotypes at five locations and three seasons (two successive plant cane crops plus first ratoon crop trials) under five crop- age (10, 12, 14, 16and 18 month-old) for brix. They found significant effect of the genotype × location × crop-age interaction suggested that brix accumulation of the studied genotypes depends on crop-age, which governed by location.

Abdul-Khaliq *et al.* (2018) studied the effect of harvesting times; 15th Nov., 15th Dec., 15th Jan., 15th Feb. and 15th March on sugarcane genotypes planting in February. They revealed that the effect of genotypes, harvesting dates and their interactions were significant at ($p \leq 0.05$) on cane yield in plant-crop. In addition, the maximum cane yield was found with 15^{th} February harvesting date for plant crop and (91.9 t ha^{-1}), while the lowest cane yield for ratoon kept on 15^{th} December harvesting date (60.1t ha^{-1}).

Correlation coefficient:

Correlation coefficient is very important in plant breeding because it measures the degree of genetic or non-genetic association between two traits. If general association exists, selection for one trait will be because changes in other traits, this called correlation response. The cause of correlation can be genetic and/or environmental. Genetic causes may attributed to pleiotropism and/or linkage disequilibrium. Environmental correlation also exists because measurements of several traits taken from the same family.

Singh *et al.* (2005) studied the correlation among different agronomic as well as quality characters with cane and sugar yields. They indicated that the single cane weight and cane height had significant positive correlation with cane yield and sugar yield.

Chaudhary and Joshi (2005) estimated correlation for cane yield and its components. Cane yield showed positively and highly significant correlation with single cane weight and stalk length. There was also positively significant correlation of cane diameter with cane yield. Stalk diameter and stalk length were positive and significantly correlated with cane yield.

Farooq *et al.* (2007) concluded that plant height and cane diameter had positive and significant correlation with millable cane weight.

Yahaya *et al.* (2009) investigated the correlation analysis to determine the interrelationship of various characters like stalk length, stalk diameter and cane yield of sugarcane genotypes across 2002-03 and 2003-04 growing seasons. In both seasons, stalk length and stalk girth had high positive correlation with cane yield and with each other.

Mali *et al.* (2010) studied the correlation 21 sugarcane genotypes for cane and sugar yields and their components. The results revealed that cane yield was significant and positively correlated with cane diameter, single cane weight, sugar yield.

Imtiaz *et al.* (2012) indicated that cane yield was positively correlated with cane girth, sugar yield and purity percentage. But, it showed negative correlation with sugar recovery. Sugar yield showed non-significant correlation with cane girth.

Tyagi *et al.* (2012) studied thirteen sugarcane cultivars to evaluate the associations for cane and sugar yields and their components during 2005-08 crop seasons. The results showed that cane yield had almost positive association with its components. A highly significant correlation was observed for association of cane yield with cane weight (+ 0.683), cane height (+ 0.779). Sugar yield had also a highly significant positive correlation with cane yield (re =+0.979, rp = +0.890, rg = +0.869) almost similar pattern of association with cane weight. However, juice sucrose percent had a non-significant negative association with sugar yield. Sucrose percent also exhibited negative association with cane yield.

Al-Sayed *et al.* (2012) evaluated the correlation coefficient for sugar yield and its components of three sugarcane varieties viz., G.T54-9, G.99-103 and Phi 8013 over 2009/2010 and 2010/2011. Highly significant and positive correlation was detected between sugar yield and each of brix percentage and sucrose percentage. Stalk height character had only significant positive association with sugar yield. However, associations between sugar yield and each of stalk weight and stalk thickness were insignificant. Correlation between brix percentage and sucrose percentage, stalk height and brix percentage and stalk height and sucrose percentage was positive and highly significant.

Imtiaz *et al.* (2013) revealed that the correlation coefficient on the stalk weight, stalk height and sugar recovery were the major traits contributing to cane and sugar yields.

Tahir *et al.* (2014) estimated correlation on the stalk, yield and quality characters. Cane yield was negatively associated with stalk diameter and brix, while had positive and non-significant associations with stalk height.

Guprasad *et al.* (2015) conducted that the correlation between cane yield and sugar yield with cane length and single cane weight was significant positive. While, cane yield had non-significant negative correlations with sucrose percent, purity percent, sugar recovery, whereas its correlation with sugar yield was significant positive. Sugar yield also had significant positive correlations with cane yield.

Esayas *et al.* (2016) assessed phenotypic and genetic correlations for cane and sugar yields and their components using 400 accessions during 2012/2013 season as plant-cane at two locations. All traits had low to high genetic correlations ($r_g = -0.005$ to 0.884) with cane yield and ($r_g = 0.027$ to 0.999) with sugar yield. On average genetic correlations were higher than phenotypic correlations.

Pandya and Patel (2017) determined correlation for cane and sugar yield and their Attributes on 112 genotypes of sugarcane during 2011. Pooled analysis for correlation coefficient revealed that cane yield was highly significant and positive correlation with sugar yield followed by stalk weight at both genotypic and phenotypic levels, indicating that these attributes were mainly influencing the cane yield in sugarcane. While, sugar yield had highly significant and positive correlation with almost all the characters, except stalk height and diameter, juice purity. These yield contributing characters also possessed highly significant and positive association among themselves.

Imtiaz *et al.* (2019) studied correlation in 38 clones and 7 commercial sugarcane genotypes during 2017-2018 season on yield and its component traits. Correlation analysis revealed that significant and positive association of brix, sugar yield, single cane weight and plant height with cane yield.

B- Stability analysis:

Bissessur *et al.* (2001) studied the stability of five genotypes across seven environments for the three characters; cane yield (TCH), industrial recoverable sucrose percentage cane (IRSC) and sugar yield (TSH). They reported the variety R570 showed a wide adaptation, whereas MI658178 has to consider with caution in some environments.

Imtiaz *et al.* (2002) tested two sugarcane clones AEC81-8415 and AEC80-2046 along with four commercial varieties viz., BL4, PR1000, BF129 and L116 at three locations in two consecutive years for cane and sugar yields. They noticed high mean performance of AEC81-8415 with 'b' values greater than 1.00 for cane and sugar yield, indicating its potential to take advantage of favourable environmental conditions for yield.

Imtiaz *et al.* (2004) analyzed four sugarcane clones CP67-412, AEC82-1026, AEC86-328 and AEC86-347 along with commercial variety BL4 at six locations in the province of Sindh during 1999-2000 and 2000-

2001. They found that high mean performance and stable of AEC86-347 for cane and sugar yields in favourable environmental.

Queme *et al.* (2005) studied the plant cane and first ratoon crop of 16 cultivars at five locations in the sugarcane production zone of Guatemala for tonnes of cane per hectare (TCH), sucrose percent in cane (SUC%) and tonnes of sugar per hectare (TSH) variables. Two cultivars; CP72-2086 and CG97-97 showed good and stable TSH, while, three cultivars; CG96-21, CG97-77 and CG96-01 showed strong interaction.

Gilbert *et al.* (2006)investigated performance of 8 different genotypes were planted at five locations (some locations were repeated in different years) across two different cropping seasons and harvesting over a 5-month period (mid-October to mid-March) for kilograms of sugar per ton (KST), tons of cane per hectare (TCH) and tons of sugar per hectare (TSH). They indicated that growers in the Everglades Agricultural Area interested in improving sugarcane crop sucrose concentration should planting the genotype CP89-2143 which had a remarkably high, stable KST ranking across environments.

Marcelo (2008) studied ten genotypes and two control varieties at three locations during the years 2004 and 2005. They found that the genotypes, IAC87-3396, IAC91-1099 and IACSP94-4004 can recommended for planting under a twelve months cycle at Jaú, Piracicaba and São João da Boa Vista regions of São Paulo State, Brazil.

Jun *et al.* (2009) assessed 13 sugarcane varieties for yield characters by their ratoons. They found that six varieties, YZ99-596, CK (“ROC”10), HoCP 92-648, MT96-1409, Q170 and Mex105 had higher cane and sucrose yields with better stability. But, five varieties, FN98-1103, FR93-435, CP88-1762, Hocp91-555 and MT93-730 had lower cane and sucrose yields with the less stability.

Irlane *et al.* (2009) investigated 70 clones and two commercial varieties (RB72454 and RB835486) under seven environments on the plant-cane and first ratoon for the characteristic brix tons per hectare (TBH). The clones RB947653 and RB957575 presented specific adaptability to unfavorable and favorable environments, respectively. The control variety RB72454 presented general adaptability, while, RB835486 presented specific adaptability to unfavorable environments.

Rea *et al.* (2011) evaluated ten sugarcane genotypes across ten Venezuelan environments through two years (plant cane and first ratoon) for tons of cane per hectare (TCH).They reported that the V77-12 genotype exhibited high yield and wide adaptability to different environments. However, the CP74-2005, CP72- 2086, PR61-632, PR980 and V78-2 genotypes showed high yield but with specific adaptations through locations.

Tiawari *et al.* (2011) assessed 16 genotypes for three years (two plants and one ratoon) at three environments. They found that the stability parameters for cane yield and sucrose% shown by the genotype Coj 64 compared to the genotypes; UP05233, CoS05266, CoS0520,CoS05276 andCoS05263, indicating better adoption and less sensitive to environmental changes. However, the genotypes UP05233 and CoS05263 had performance better than the rest of elite genotypes due to having high mean values of genotypes over all three environments. Therefore, these genotypes may be commercially cultivated over a wide range of environments.

Ramburan (2011) investigated seven commercial cultivars under different harvesting times in two trails for cane yield in tons ha-1(TCANE), recoverable crystal percentage (ERC) and the tons ERC (TERC). One trial was established in November 2000 and harvested annually in the late season (October/November) for 6 successive ratoons (regrowth after harvest), while the other trial was established in March 2001 and harvested annually in the early season (April/May) for the same duration**.** The results cleared that environments (E), genotypes (G) and G x E interactions were significant ($P<0.001$) for all three variables. Three cultivars of them (N17, N19 and N27) showed adaptability to harvesting annually in the late season (October/ November), while, the rest cultivars (NCo376, N36, N35 and N29) demonstrated adaptability to harvesting annually the early season (April/May).

Klomsa *et al.* (2013) established two crop-classes of ten sugarcane genotypes at nine locations during 2005–2009.They noticed that the genotypes Khon Kaen 3 and Kps94-13 were as the most superior genotypes for sugar yield, having consistent performance and stability of sugar yield across the two crop-classes, while K88-92 was the most superior genotype in cane yield.

Gustavo *et al.* (2013) studied twenty-four clones at six locations in three years. They revealed that five clones of them (RB92579, RB867515, SP81-3250, RB947520 and RB931530) as the best, additionally clones with greater genotypic potential were identified for each test in the six locations.

Alida *et al.* (2013) studied seventeen experimental and three commercial varieties in a 3-year crop cycle (plant cane, first ratoon and second ratoon) at four locations on tonnes of cane per hectare. The results obtained in all four agro-ecological zones showed that three varieties; V98-62, V99- 236 and V00-50 were the most promising ones. These sugarcane varieties were excellent yield potential, adaptation, and stability in different environments tested.

Sawan (2013) evaluated twenty sugarcane genotypes across three locations of Punjab during two crop seasons (autumn 2010 and spring 2011), totaling six environments (three locations x two crop seasons). He discovered that the ideal test environments were Faridkot spring (E) and Ludhiana autumn (E) for cane yield and quality traits. In addition, genotype CoH 05262 was as an ideal genotype with the highest mean performance and stable across environments for all quality characters. Also, genotype , Co 0238 was found to be stable across environments and had high cane yield and quality, while, genotype, CoH 119 had high cane yield with displayed inconsistent performance in six environments and low cane quality.

Pedro *et al.* (2013) evaluated 20 sugarcane genotypes plus 2 cultivars as controls (RB855156 and RB855453) in the growing seasons of 2009/10 (plant cane), 2010/11(first ratoon) and 2011/12 (second ratoon) at five environments for tons of sugar per hectare (TSH). The stability and adaptability of GGE biplot and AMMI indicated that the genotypes RB006970, RB855156 and RB855453 as the most productive in tons of sugar per hectare (TSH) and indicated São Pedro do Ivai as the environment with the greatest effect of GE interaction.

Tahir *et al.* (2013) evaluated sixteen genotypes including two checks at three environments during 2005-06 and 2006-07 for plant height and cane yield. The results showed that all genotypes were unstable overall environments for all characters. While, the two check genotypes; Mardan 93 and CP 77/400 showed a comparative stability for cane yield (t/ha).

Antonio *et al.* (2013) assessed ten clones and two commercial checks in first ratoon under ten environments. They reported that five clones of them (RB975201, RB975157, RB975932, RB975242 and RB975162) were higher production and stable than the checks. The environment Tarumã presented higher stability and capacity to discriminate genotypes, allowing an ordering more reliable as compared to the overall mean of the environments tested.

Fooladvand *et al.* (2013) studied 26 promising sugarcane varieties and 4 standard cultivars for plant-cane and first and second ratoon at three locations of sugar yield characterized. The results showed that five varieties (14, 27, 28, 29 and 30) had the lowest genotypes x environments interactions and highest average yield. While, the clone 30 was identify as the most stable genotype.

Imtiaz *et al.* (2013) assessed clone NIA0819/P5 along with four commercial varieties of sugarcane under six different locations during 2008-010 for cane yield and sugar yield. The results indicated that this clone (NIA0819/P5) produced maximum stable cane yield and sugar yield compared to the commercial varieties.

Dutra *et al.* (2014) assessed 25 sugarcane genotypes at five sites for sugarcane ton cane per hectare (TCH) and ton recoverable sugar per hectare (TRSH). Results indicated that seven genotypes of them (RB863129, RB867515, RB92579, RB953180, SP81-3250, RB75126 and RB942520) were higher in productivity as well as phenotype adaptability and stability than the other genotypes.

Jun *et al.* (2014) tested six cultivars and one control under seven sites for plant cane and first ratoon. They found that high significant effects for genotypes, environments and G X E interaction in plant cane and first ratoon on cane yield and sugar yield. In addition, the cultivar Fn38 produced a high and stable sugar yield, while, the cultivar Gn02-70 had the lowest cane yield with high stability. The cultivar Yz06-407 was a high cane yield with poor stability in sugar yield. Two cultivars (Yz05-51 and Lc03-1137) had an unstable cane yield, but it was relatively high sugar yield. The cultivar Fn39 produced stable high sugar yield with low and unstable cane production. Significantly, different sugar and cane yields were across seasons due to strong cultivar-environment interactions. Three areas, Guangxi Chongzuo, Guangxi Baise, and Guangxi Hechi were higher representativeness of cane yield and sugar content than the rest. On the other hand, the areas Guangxi Chongzuo, Yunnan Lincang, and Yunnan Baoshan showed strong discrimination ability, while the areas Guangxi Hechi and Guangxi Liuzhou showed poor discrimination ability.

Ramburan (2014) evaluated six to ten genotypes at four locations during 20004-2008 for tonnes estimated recoverable crystal yields(TERC) for plant-cane and ratoon-crops .Three cultivars; N36, N41, and N48 produced significantly ($P< 0.05$) higher tonnes estimated recoverable crystal yields (TERC) than commercial controls (N16 and N21) across multiple ratoons. Genotype + genotype × environment (GGE) biplot analysis showed that frost sites on humic and sandy soils are necessary when developing a breeding strategy. Cultivars N36, N41, and N48 may be suitable check cultivars for use in breeding trials. Cultivar N36 exhibited faster rates of TERC deterioration following frosts and may need prioritized for harvesting as a result.

Rea *et al.* (2014) evaluated twenty sugarcane genotypes at seven locations during three years (plant and first and second regrowth) during 2006 -2010 for Cane yield (TCH). Four genotypes; V98-62, V98-120, V99-236 and V00-50 were the highest yielding and stable based on AMMI1.

Surinder *et al.* (2014) evaluated 20 sugarcane genotypes (including three checks) across six environments (two crop seasons" autumn and spring" x three location) in Punjab for cane yield and sucrose percentage. Combined analyses of variance showed that effects of genotypes, environments and genotypes x environments interaction were significant ($p\leq 0.05$). Test environment Faridkot (FDK) spring, being both discriminating and representative, was an ideal test environment for selecting generally adapted genotypes for cane yield. Similarly, Ludhiana (LDH) autumn was an ideal test environment for selecting generally adapted genotypes for quality traits. Genotypes Co 0238 and CoPb 08214, had high mean performance and stability across environments for cane yield and quality traits, which identified as ideal genotypes. The GGE biplot helped in identify a specifically adapted genotype, CoH 119, which was the best performer in Gurdaspur (GDSP) in both crop seasons.

Guddadamath *et al.* (2014) investigated eight sugarcane genotypes along with four commercial checks during 2012-2013 among four environments. They revealed that the genotypes SNK 07680 and SNK 07337 was found stable for cane yield (132.60 and 105.66 t ha^{-1}, respectively), sugar yield (14.44 and 12.70 t ha^{-1}, respectively) and its component characters such as sucrose (16.81 and 16.31% respectively). The genotype SNK 07658 showed adaptation to unfavorable environment for single cane weight and sucrose as evident by its deviation from regression and regression coefficient.

Rajesh and Sinha (2015) evaluated three mid-late entries; Co 06031, CoC 08339 and CoC 09337 and 3 standards; CoV 92102, Co 7219 and ‘Co 86249 during three crop cycle (I and II Plant and Ratoon crop) at five locations for sucrose percentage. They found that two entries were higher than the best standard; CoV 92102for sucrose percentage. The entry Co 06031 that was the outstanding genotype as it ranked first for all the characters; index value, sucrose percentage and stability value. The entry CoC 09337 was the second best because it recorded second best index value and stability value for sucrose percentage.

Rea *et al.* (2015) investigated20 sugarcane genotypes at seven locations over three crop-years (plant crop, first and second ratoon) during

2008-2010 for cane yield (TCH).They indicated that the genotypes V99-213, V99-236 and V00-50 proved to be promising due to their yield and stability according to all of the non-parametric statistics.

Jun *et al.* (2015) studied 21 cultivars during 2011 to 2013 (two plant cane crops plus one ratoon crop) at fourteen locations for sugar yield. Results showed that the two cultivars; DZ 03–83 (G2) and FN 1110 (G5) produced stable higher yields than the other 19 cultivars including the check ROC 22 (G1).

Otieno (2016) evaluated 33 cultivars including seven standards across the nine test environments for cane yield. Results indicated that genotype, environment and their interaction effects were significant ($p \leq 05$). The five of them (MS271, Ms326, Ms278, Ms556 and MS395) were considered ideal cultivars where exhibited stable and high yielding.

Liu *et al.* (2016) evaluated eleven varieties at five sites of ratoon–cane yield trait. They revealed that three varieties; GT07-994, GT06-244 and GT06-1721 were characterized by high yield and sugar content but ordinary stability. Two varieties; LC05-136 and GT03-1438 were characterized by very high yield or sugar content and poor stability. Three varieties; GYC1-2003, GT07-645 and GT06-3283 were characterized by same yield with control variety and ordinary stability. Furthermore, the variety GT06-2361 was low yield and poor stability. The varieties; GT05-3626 and GT03-3005 were low yield and strong stability. However, the varieties; GT06-244, GT07-994, GT06-1721, LC05-136 and GT06-3283 showed higher comprehensive yield-trait performance, which should be demonstrated, promoted and applied according to local conditions and variety characteristics.

Anand *et al.* (2016) evaluated fifteen sugarcane genotypes for their phenotypic stability under four different environments in respect of cane yield and its component characters. Three genotypes; BO 146 , BO 147 and BO 141were most stable in a wide range of environments for cane yield at favourable environments and its attributes and less sensitive to environmental change.

Njabulo (2016) evaluated eight varieties across different environments; at two locations between early and late season harvest under five successive crops (plant-cane plus four-ratoons). Results showed that the biplot analyses characterized the test environments according to harvest seasons, indicating greater seasonal effect on variety performance than soil type effect. On average, early season trials had higher cane yield but lower sucrose percentage cane than the late season trials. While, late season trials had higher sugar yield than early season trials. On sugar yield, varieties; M1176/77 and M1551/80 were widely adapted across environments, while, the variety M1400/86 was specifically adapted to good draining soil. Varieties; M1176/77 and M1400/86 produced higher sugar yield under their recommended conditions.

Sujeet *et al.* (2017) assessed226 segregating genotypes at two environments during 2011-12 (plant cane). They found that 19 genotypes were stable for sugar yield-related traits. However, seventy genotypes were stable for quality traits across both the environments, indicating the promising nature of these genotypes.

Dubey *et al.* (2017) evaluated seven varieties across three environments during 2009 to 2011. They revealed that variety CoPk 05191 was stable for number of millable cane and yield (t/ha) traits. Variety CoH 05265 was stable for cane diameter and single cane weight (kg) traits. Variety CoH 05262 was also stable for cane diameter. Hence, these varieties, CoPk 05191, CoH 05265 and CoH 05262 promising lines could be recommendation for commercial cultivation or could be suitability used in further improvement programme.

Prema *et al.* (2017) analyzed seventeen genotypes at five locations in one season (plant cane). There were two genotypes; LF82-2122 and LF60-3917 had higher yield and stability statistics for the two most important traits; cane and sugar yields. Thus, the genotypes can be recommendation for adoption and cultivation on all soil types in Fiji.

Mebrahtom *et al.* (2017) studied 49 genotypes at five locations and three seasons (two successive plant-cane crops and first-ratoon crop trials) under five crop ages (10,12,14,16and 18 month-old) for brix. Data showed that four genotypes; TCP93- 4245, FG04 705, FG04 829 and FG06 729 were adapted to all crop ages and all locations, and are categorized as early maturing genotypes. While, five genotypes; HO95 988, DB70047, CP99 1894, FG06 700 and C86-12 accumulated high brix within 10-16 crop ages of all locations (except for Belles condition), and are classified as early maturing genotypes. Three genotypes; FG03 173, FG04-466 (22) and FG04 187(38) adapted to Tendaho and Belles conditions within 14-18 months of crop age. However, six genotypes; FG05 408, FG03 418, FG04 754, FG03 526, PSR97 092 and FG03 520 were medium maturing genotypes across all locations. On the contrary, four commercial varieties; CO- 678, NCO-334, DB66 113 and Mex54/245 accumulate relatively low brix percentage at all brix measurements (sampling months); could be late maturing genotypes (mature later than 18 months cane age) or can be poor performing genotypes.

Meena *et al.* (2017) tested20 sugarcane clones in 4 environments (two plant-cane and two first-ratoon) for cane yield. They revealed that significant differences among genotypes, environments and their interactions. The early maturing high sugar varieties; Co 0238 and Co 0118 gave 89.27 and 80.11 t/ ha cane yield, respectively and thus considered as widely adapted genotypes across the environments and can be recommended for commercial cultivation in sub-tropical region. Two genotypes; Co 98014 and Co 05011 exhibited better adaptability in ratoon trials and appeared to be suitable for multiple-ratoons. Considering, IPCA score, the genotype CoS 767 was most stable standard (check) across the environments. With regard to the environments, (spring season, plant-crop) placed on the upper right half of axis of AMMI biplot due to the positive interactions and hence (autumn season plant crop) is the favourable environments for obtaining higher cane yield.

Jiuli *et al.* (2018) evaluated twenty-five early clones plus five control clones during two cuts (plant-cane and ratoon-cane) at 14 locations, totaling 24 environments (location x cut combinations). The locations x cut combinations would have totaled 28 environments but 4 of these were lost, 1 of ratoon-cane and 3 of plant cane, due to the occurrence of accidental fires tons of stems per hectare. Results concluded that the most promising clones in terms of stability and general adaptability were G5, G12, and G13; the last two were closest to the ideal genotype .The G13 clone was highly productive in favorable and unfavorable environments, presenting the highest averages for ton of stems. The G3, G4, G10, G15, G17, G18, G22, G23, G25, G26 and G30 clones not recommended for the 24 evaluated environments.

Gulzar *et al.* (2018) evaluated three early maturing clones CoPb 08211, CoPb 08212, CoS 08233 and two standards *viz.*, CoJ 64 and CoPant 84211 in three crop cycles (I and II plant-crop and ratoon-crop)at seven locations in North West Zone in India during 2012-14 for cane yield (t/ha) and sucrose (%). The significant interactions of clones x environments (locations and years combination) suggest that cane yield (t/ha) and sucrose percentage of clones varied in plant and ratoon crop. From the analysis, it may be concluded that the entries; CoPb 08212 and CoS 08233 were stable clones with high yield and sucrose percentage in early maturity group of North West Zone.

Talyta *et al.* (2018) tested 14 sugarcane genotypes at 13 environments (production unit × cutting season) for tons of sugarcane per hectare (TCH). Results revealed that a highly significant differences ($P \leq 0.01$) between the genotypes (G), environments (E) and the interaction G x E for tons of sugarcane per hectare. The genotype G12 displayed general adaptability, phenotypic stability and high productivity for (TCH). Three genotypes G10, G13 and G14 had the highest yield, largest contribution of G x E, indicating specific adaptability. The environments A12 and A13, in Primavera, are recommended for preliminary selection trials.

Muhammad *et al.* (2018) studied responses of sixteen genotypes of sugarcane in an experiment (genotypes x locations interactions) in two different agro ecological zones (Mardan and Harichand) of Khyber Pakhtunkhwa, Peshawar-Pakistan during the spring cropping seasons of 2011-12 and 2012-13. Results revealed that four genotypes; MS99HO317, MS99HO93, MS92CP979 and MS91CP238 were superior at SCRI, Mardan (test location-I) based on cane yield, sugar recovery and sugar yield. While, in Sugarcane Seed Multiplication Farm (SSMF), Harichand-Charsadda (test location-II), four cultivars; MS91CP272, MS99HO391, MS94CP15 and MS99HO391 were superior based on sugar recovery and sugar yield compared to other genotypes. Based on the combined over years and locations performance the genotypes MS99HO317, MS91CP238, MS92CP979 and CP89831 were superior in terms of cane yield, sugar recovery and sugar yield. It is suggested that Mardan (test location-I) is the best location for sugarcane cultivation because all the genotypes showed relatively better performance there as the performance of some genotypes was almost double for some parameters.

Esayas *et al.* (2019) studied eleven sugarcane clones plus the check variety G5 (NCO334) during three crop cycles (plant-cane, first-ratoon and second-ratoon crops) at eight environments for sugar yield**.** The results revealed that significant (P< 0.01) among genotype and environmental effects as well as G x E with respect to sugar yield. Three genotypes; G3 (FG05-424), the check variety G5 (NCO334) and G10 (FG06-750) were the most productive in tons of sugar yield per hectare and stable.

Materials and Methods

The present investigation was carried out under Upper Egypt conditions to study the performance and stability analysis of sugarcane genotypes.

The genetic materials consisted of eleven genotypes of sugarcane (*Saccharum officinarum* L.). The name and pedigree of these genotypes are presented in Table 1.

The eleven genotypes (ten new genotypes, in addition, G.T.54-9 as a control) were evaluated at twelve environments (six environments for each year). These environments included three locations, i.e., Kom-Ombo Agric. Res. Station, Aswan, governorate, El-Mataana Agric. Res. Station, Luxor governorate and Shandaweel Agric. Res. Station, Sohag governorate and two harvesting dates; first week of February and first week of March in 2015/2016 (plant cane) and 2016/2017 (first ratoon).

The genotypes were planted in first week of March in 2015/16 season. The harvesting dates of the plant cane and its first ratoon crops were 11 and 12 month-old from planting in plant crop, or from harvesting plant cane for the first ratoon crop.

The experimental design was a randomized complete block in split-plot arrangement with three replications at each location. The two harvesting dates were applied to the main plots, while the sugarcane genotypes were randomly distributed on the subplots. The experimental unit area was 56 m^2 including eight rows of 7m long and one meter apart. The recommended agricultural practices of sugarcane growing were adopted throughout the growing seasons.

This study cane is divided in two parts:

Table 1. The name and pedigree of the tested sugarcane genotypes.

No.	Name	Pedigree
1	G.T.54-9 (commercial variety)	N.Co.310 X F. 37-925
2	G.84-47	N.Co.310 X ??
3	G.99-103	US. 74-3 X CP 76-1053
4	G.2003-44	CP 55-30 X CP 85-1697
5	G.2003-47	CP 55-30 X CP 85-1697
6	G.2003-49	CP 55-30 X CP 85-1697
7	G.2004-27	CP 55-30 X RoC 22
8	G.2007-61	CP 67-412 X SP 71-1406
9	G.2010-7	IN 94/116-3 X ??
10	G.2010-26	EH 94/134-1 X ??
11	G.2011-82	CP 57-614 X G 85-37

Part I: Mean performance and simple correlation

The following traits were studied at each harvesting date:

A. Cane yield and its components traits:

1.Stalk height (cm): A sample of 25 stalks were randomly chosen from each plot and measured from the soil surface up to the top visible dewlap and the average was estimated.

2.Stalk diameter (cm): Diameter of the same stalks used to measured stalk height were used to measure the diameter at middle internode of the stalk and the average was estimated.

3.Stalk weight (kg): It was determined by dividing the cane weight of the plot by its number of millable cane.

4.Cane yield (ton/fed): It was estimated on plot basis.

B. Sugar yield and juice quality traits:

A sample of 20 millable cane stalks from each plot were 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.Brix %: was estimated by using Brix hydrometer. Simultaneously juice temperature was registering to extract Brix/100 cm^3 juice and density from **Schibler's** Tables.

2.Sucrose%: It was calculated by using the following equation according to **(A.O.A.C 1995)**.

Sucrose percentage = (sucrose % cm^3 juice)/juice density.

(sucrose% cm^3 juice) = direct reading of saccharimeter × factor depending on the length of saccharimeter's tube.

Juice density taken from **Schibler’s** Tables.

3.Purity percentage: It was calculated using the following equation according to **Singh and Singh (1998).**

Purity percentage = Sucrose percentage × 100 / Brix

4.Sugar recovery: calculated according to the formula described by **Yadav and Sharma (1980).**

Sugar recovery = [S – 0.4 (B-S)] × 0.73

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

5. Sugar yield (ton/fed.): was calculated according to the following formula described by **by Mathur (1981).**

Sugar yield (ton/fed.) = Cane yield (ton/fed.) × Sugar recovery percentage.

Statistical analysis:

Analysis of variance:

The obtained data were subjected to analysis of variance of split-plot design according to **Gomez and Gomez (1984)** by **(MSTAT-C)** Computer program.

Table 2. Analysis of variance for the studied genotypes.

S.O.V.	d.f	MS	EMS
Replications	**r - 1**	M_3	$\sigma^2_e + g\sigma^2_r$
Genotypes	**g - 1**	M_2	$\sigma^2_e + r\sigma^2_g$
Error	**(r-1)(g-1)**	M_1	σ^2_e

Simple correlation:

Simple correlation coefficient among different pairs of the studied traits was calculated according to **Steel and Torrie (1980)**.

Comparisons between means were estimated by using revised L. S. D according to **El-Rawi and Khalafalla (1980)**.

Where:

L. S. D = least significant differences between means of genotypes and was computed as:

Rev.LSD = $t'_\alpha \times \sqrt{2MSe/lhr}$ (For each season).

Rev.LSD = $t'_\alpha \times \sqrt{2MSe/ylhr}$ (For overall environments).

Where:

t' from minimum-average-risk table.

y = Number of years, l = Number of locations and h = Harvesting date.

Part II: Stability analysis

Stability analysis for all studied traits was carried out using **Eberhart & Russell model (1966) as follows:**

$$Y_{ij} = \mu_i + B_i I_j + \partial_{ij}$$

Where:

Y_{ij} is the genotype mean of the i^{th} genotype at the j^{th} environment (i=1, 2.... n).

μ_i is the mean of all i^{th} genotype over all the environments.

B_i is the regression coefficient that measures the response of the i^{th} genotype to varying environments.

I_j is the environmental index obtained as the deviation of the mean of all genotypes at the j^{th} environment from the grand mean.

$I_j = (\sum i\ Y_{ij} / \nu) - (\sum i \sum j\ Y_{ij} / \nu n)$ with $\sum j\ I_j = 0$

and ∂_{ij} is the deviation from regression of the i^{th} genotype at the j^{th} environment

Eberhart and Russell (1966) proposed that the ideal variety is one that has three characteristics as follows:

1- Regression coefficient significantly different from zero ($b \neq 0$) and not significantly different from unity ($b = 1$).
2- Minimum value of the deviation from regression, i.e., ($S^2d = 0$).
3- High performance with a reasonable range of environmental.

Results and discussion

The present investigation was carried out to:

1. Evaluate the performance of eleven genotypes of sugarcane under different environments in plant-cane and first-ratoon.
2. Study the stability parameters for the studied traits of these genotypes under different environments according to the model of **Eberhart & Russell (1966).**

Part-I: Mean performance and simple correlation:

The performance for the studied traits in plant-cane and first-ratoon were in illustrated this part as follows:

1- Stalk height:

The combined analysis of variance over six environments; three locations (Kom-Ombo, El-Mattana and Shandaweel) and two harvesting dates (first week in February and first week in March) in 2015/2016 (plant-cane) and 2016/2017 (first-ratoon) for stalk height are presented in Tables 3 and 4, respectively.

Highly significant differences were observed among locations and between harvesting dates for stalk height in 2015/2016, plant-cane and 2016/2017, first-ratoon, (Tables 3 and 4). This indicates the wide differences in climatic and edaphically factors prevailing at the three locations. The studied genotypes as well highly significant differed for stalk height in each of plant-cane and first-ratoon, showing the genetic diversity between them. The first order interaction of locations× harvesting dates was highly significant in plant-cane only. This reflects that the effect of harvesting date varied from location to another for this trait. Moreover, the effect of locations was more pronounced than that of harvesting dates.

Table 3. Combined analysis of variance of 11 genotypes over six environments for the studied traits in 2015/2016 season (plant-cane).

S. O. V	d.f.	Mean squares								
		Stalk height (cm)	Stalk diameter (cm)	Stalk weight (kg)	Cane yield (t/fad)	Brix (%)	Sucrose (%)	Purity (%)	Sugar recovery (%)	Sugar yield (t/fad)
Locations (L)	2	33382.36**	0.419**	2.068**	4245.31**	67.68**	70.27**	254.50**	41.32**	51.06**
Error (a)	6	59.85	0.017	0.034	121.97	1.79	1.39	10.74	0.65	1.52
Harvesting (H)	1	1693.14**	0.049	0.397**	566.29*	96.01**	45.85**	42.47	16.78**	17.46**
L × H	2	878.61**	0.004	0.011	31.06	0.99	1.93	15.51	1.57	1.41
Error (b)	6	34.47	0.008	0.029	73.37	0.50	0.87	7.24	0.45	0.74
Genotypes (G)	10	5977.09**	0.494**	0.479**	302.01**	14.32**	20.44**	86.92**	13.35**	4.29**
L × G	20	1289.41**	0.022**	0.081**	480.99**	1.02**	1.77**	20.87**	1.42**	4.56**
H × G	10	118.64**	0.012**	0.027	23.98	0.53	0.94	15.14**	0.73**	0.53
L × H × G	20	85.34**	0.006	0.036*	26.62	1.20*	1.83**	13.69**	0.94**	0.61
Error (c)	120	28.86	0.005	0.020	64.45	0.45	0.83	3.86	0.29	0.62

***, ** Significant at 0.05 and 0.01 probability levels, respectively.**

Table 4. Combined analysis of variance of 11 genotypes over six environments for the studied traits in 2016/2017 season (first-ratoon).

S. O. V	d.f.	Mean squares								
		Stalk height (cm)	Stalk diameter (cm)	Stalk weight (kg)	Cane yield (t/fad)	Brix (%)	Sucrose (%)	Purity (%)	Sugar recovery (%)	Sugar yield (t/fad)
Locations (L)	2	21889.02**	0.136**	0.636*	1224.97*	26.87**	86.55**	715.14**	66.93**	46.63**
Error (a)	6	11.99	0.007	0.075	222.48	0.63	0.59	12.14	0.71	3.71
Harvesting (H)	1	158.23**	0.022	0.350**	833.45**	83.41**	124.63**	308.65**	70.42**	47.50**
L × H	2	2.02	0.001	0.111*	238.66	1.96	9.66**	107.18**	6.88*	3.10*
Error (b)	6	2.83	0.006	0.013	52.16	0.46	0.49	9.10	0.70	0.51
Genotypes (G)	10	11446.78**	0.246**	0.246**	610.41**	10.69**	18.49**	107.44**	12.69**	8.61**
L × G	20	2211.89**	0.048**	0.153**	387.50**	3.28**	5.46**	28.42**	3.62**	4.98**
H × G	10	2.58*	0.004*	0.009	28.47	2.32**	2.70**	8.86	1.46**	0.76**
L × H × G	20	1.69	0.003*	0.013*	36.54*	0.54**	0.77*	8.93	0.52	1.55**
Error (c)	120	1.36	0.002	0.008	22.01	0.23	0.45	5.52	0.32	0.30

***, ** Significant at 0.05 and 0.01 probability levels, respectively.**

Mean squares due to interaction between genotypes, harvesting dates and locations for this trait were highly significant (Tables 3 and 4). Accordingly, there were a differential response between genotypes to harvesting dates and locations.

The mean values and range of stalk height for all genotypes over six environments in 2015/2016 (plant-cane) and 2016/2017 (first-ratoon) are shown in Tables 5 and 6, respectively.

At Kom-Ombo, the average stalk height for all genotypes (Appendix 1) ranged from 275.5 and 236.5 cm for the genotype G.2010-26 to 330.2 and 320.2 cm for the genotype G.99-103 with an average of 307.8 and 293.8 cm in plant-cane and first-ratoon, respectively.

Under El-Mattana, it ranged from 268.0 and 262.8 cm for the genotype G.2010-26 to 330.2 cm for the genotype G.84-47 and 315.0 cm for the genotype G.2010-7 with an average of 295.0 and 296.1 cm in plant-cane and first-ratoon (Appendix 1), respectively.

Regarding to Shandaweel, the average stalk height (Appendix 1) ranged from 191.0 and 145.2 cm for the genotype G.2010-26 to 299.2 cm for the genotype G.84-47 and 295.8 cm for the genotype G.2003-44 with an average of 265.2 and 263.5 cm in plant-cane and first-ratoon, respectively.

Over six environments, the average stalk height ranged from 244.8 and 214.8 cm for the genotype G.2010-26 to 311.9 cm for the genotype G.84-47 and 303.3 cm for the genotype G.2010-7 with an average of 289.3 and 284.4 cm in plant-cane (Table 5) and first-ratoon (Table 6), respectively. From data (Tables 5; plan-cane and 6; first-ratoon), half genotypes (G.84-47, G.99-103, G.2003-44, G.2004-27 and G.2010-7) were taller than the control (G.T.54-9 variety). This indicates that these genotypes had accumulated favourable alleles for tallness and could be used in future breeding programs because this trait showed significantly positive correlated with cane and sugar yields (Table 7). **Ahmed (2003), Osman** ***et al.*** **(2011**), **Hagos** ***et al.*** **(2014 b)** and **Ahmed** ***et al.*** **(2016 a)** reported that delay harvesting date up to 14 months gave the highest values of stalk height in plant-cane and 1^{st} ratoon-crops.

Table 5. Average performance of 11 genotypes over six environments for the studied traits in 2015/2016 season (plant-cane).

No.	Genotypes	Stalk height (cm)	Stalk diameter (cm)	Stalk weight (kg)	Cane yield (t/fad)	Brix (%)	Sucrose (%)	Purity (%)	Sugar recovery (%)	Sugar yield (t/fad)
1	G.84-47	311.9	2.43	1.26	55.90	20.55	17.57	85.55	11.95	6.10
2	G.99-103	307.4	3.00	1.70	64.09	18.65	15.71	84.30	10.62	5.93
3	G.2003-44	296.4	2.53	1.23	51.13	20.13	17.18	85.33	11.70	5.85
4	G.2003-47	280.2	2.64	1.35	56.76	20.68	17.93	86.69	12.19	6.87
5	G.2003-49	285.3	2.64	1.30	55.51	20.26	17.50	86.37	11.93	6.60
6	G.2004-27	299.3	2.59	1.29	57.19	19.46	16.12	82.95	10.76	6.07
7	G.2007-61	278.1	2.46	1.19	57.29	20.17	17.00	84.27	11.48	6.43
8	G.2010-7	299.8	2.47	1.45	58.71	17.84	14.17	78.74	9.12	5.27
9	G.2010-26	244.8	2.67	1.17	48.02	20.29	17.02	83.69	11.42	5.40
10	G.2011-82	286.6	2.41	1.11	54.10	20.20	16.66	82.51	11.14	5.73
11	G.T.54-9 (control variety)	292.4	2.53	1.42	56.40	19.10	16.08	84.04	10.85	5.70
Average of all genotypes		289.3	2.58	1.31	55.92	19.76	16.63	84.04	11.20	6.00
Range		244.8-311.9	2.41-3.00	1.11-1.70	48.02-64.09	17.84-20.68	14.17-17.93	82.51-86.69	9.12-12.19	5.27-6.87
R. L. S. D.0.05		1.55	1.55	0.09	5.76	0.43	0.59	1.29	0.33	0.56
R. L. S. D.0.01		2.03	2.03	0.12	8.17	0.59	0.81	1.78	0.46	0.79

Table 6. Average performance of 11 genotypes over six environments for the studied traits in 2016/2017 season (first-ratoon).

No.	Genotypes	Stalk height (cm)	Stalk diameter (cm)	Stalk weight (kg)	Cane yield (t/fad)	Brix (%)	Sucrose (%)	Purity (%)	Sugar recovery (%)	Sugar yield (t/fad)
1	G.84-47	301.5	2.37	1.09	57.61	21.44	17.41	80.80	11.46	6.11
2	G.99-103	298.3	2.73	1.43	62.31	20.02	16.42	81.99	10.95	6.17
3	G.2003-44	297.0	2.46	1.03	50.08	21.08	17.84	84.58	12.10	5.58
4	G.2003-47	285.7	2.56	1.17	57.59	21.93	19.02	86.67	13.06	6.66
5	G.2003-49	279.9	2.49	1.14	53.13	21.73	19.17	88.12	13.25	6.63
6	G.2004-27	300.3	2.54	1.18	56.82	20.53	16.50	80.28	10.90	5.75
7	G.2007-61	274.2	2.43	1.06	56.97	21.02	17.31	82.16	11.55	6.05
8	G.2010-7	303.3	2.43	1.12	55.92	19.33	15.90	82.23	10.61	5.48
9	G.2010-26	214.8	2.63	0.98	39.66	21.42	17.62	82.20	11.68	4.29
10	G.2011-82	278.9	2.36	1.06	54.66	21.44	17.91	83.28	11.93	5.73
11	G.T.54-9 (control variety)	294.8	2.61	1.17	56.52	21.01	17.87	84.97	12.13	6.70
Average of all genotypes		284.4	2.51	1.13	54.66	20.99	17.54	83.39	11.78	5.92
Range		214.8-303.3	2.36-2.73	0.98-1.43	39.66-62.31	19.33-21.93	15.90-19.17	80.28-88.12	10.61-13.25	4.29-6.70
R. L. S. D. 0.05		0.74	0.03	0.06	2.49	0.31	0.43	1.53	0.39	0.35
R. L. S. D. 0.01		0.98	0.04	0.08	3.43	0.43	0.59	2.11	0.54	0.49

2- Stalk diameter:

The combined analysis of variance over six environments; three locations (Kom-Ombo, El-Mattana and Shandaweel) and two harvesting dates (first week in February and first week in March) in 2015/2016 (plant-cane) and 2016/2017 (first-ratoon) for stalk diameter are presented in Tables 3 and 4, respectively.

Mean squares due to genotypes and their interactions with locations, harvesting dates and locations × harvesting dates were significant and highly significant in both plant-cane and first-ratoon, except the second order interaction in 2015/2016 (plant-cane) was not significant. This indicates that it is essential to evaluate such trait for number of locations and harvesting dates. Moreover, the differences among locations were highly significant in 2016/2017 (plant-cane) and 2016/2017 (first-ratoon), while their interaction with harvesting dates was insignificant in both seasons. In addition, the differences between harvesting dates in plant-cane and first-ratoon were insignificant.

The mean values and range of stalk diameter for all genotypes over six environments in 2015/2016 (plant-cane) and 2016/2017 (first-ratoon) are shown in Tables 5 and 6, respectively.

At Kom-Ombo, the average stalk diameter for all genotypes (Appendix 2) ranged from 2.40 cm for the genotypes (G.84-47 and G.2011-82) and 2.33 cm for the genotype G.2011-82 to 2.85 and 2.67 cm for the genotype G.99-103 with an average of 2.55 and 2.50 cm in plant-cane and first-ratoon, respectively.

Under El-Mattana, it ranged from 2.47 cm for the genotype G.2011-82 and 2.27 cm for the genotype G.2007-61 to 3.10 cm for the genotype

G.99-103 and 2.67 cm for the genotype G.2010-26 with an average of 2.67 and 2.47 cm in plant-cane and first-ratoon (Appendix 2), respectively.

With respect to Shandaweel, the average stalk diameter (Appendix 2) ranged from 2.35 and 2.32 cm for the genotype G.84-47 to 3.05 and 2.95 cm for the genotype G.99-103 with an average of 2.52 and 2.56 cm in plant-cane and first-ratoon, respectively.

Over six environments, the average stalk diameter (Tables 5 and 6) ranged from 2.41 and 2.36 cm for the genotype G.2011-82 to 3.00 and 2.73 cm for the genotype G.99-103 with an average of 2.58 and 2.51 cm in plant-cane (Table 5) and first-ratoon (Table 6), respectively. The results indicated that five genotypes (G.99-103, G.2003-47, G.2003-49, G.2004-27 and G.2010-26) and two genotypes (G.99-103 and G.2010-26) were thicker than the control variety (G.T.54-9) These results are in harmony with those obtained by **Ahmed (2003)** and **Ahmed *et al.* (2016 a)**.

3- Stalk weight:

The combined analysis of variance over six environments; three locations (Kom-Ombo, El-Mattana and Shandaweel) and two harvesting dates (first week in February and first week in March) in 2015/2016 (plant-cane) and 2016/2017 (first-ratoon) for stalk weight are presented in Tables 3 and 4, respectively.

Mean squares due to among locations and between harvesting dates were highly significant differences for stalk weight in 2015/2016; plant-cane and 2016/2017; first-ratoon, (Tables 3 and 4). This indicates the wide differences in climatic and edaphically factors prevailing at the three locations. The studied genotypes as well highly significant differed for stalk weight in each of plant-cane and first-ratoon, revealing the genetic diversity between them. The first order interaction of locations × harvesting dates was significant in first-ratoon only. This shows that the effect of harvesting date varied from location to another for this trait. Moreover, the effect of locations was more pronounced than that of harvesting dates. Mean squares due to interaction between genotypes, harvesting dates and locations for this trait were highly significant. Accordingly, there were a differential response between genotypes to harvesting dates and locations.

The mean values and range of stalk weight for all genotypes over six environments in 2015/2016 (plant-cane) and 2016/2017 (first-ratoon) are shown in Tables 5 and 6, respectively.

Results of Kom-Ombo location indicated that the average stalk weight for all genotypes (Appendix 3) ranged from 1.14 for the genotype G.2010-26 to 1.84 for the genotype G.99-103 with an average of 1.42 kg. in 2015/2016 (plant-cane) and from 1.10 for the genotype G.84-47 to 1.38 for the genotype G.T.54-9 with an average of 1.22 kg. in 2016/2017 season (first-ratoon), respectively.

Regarding to El-Mattana, it ranged from 1.19 kg for the genotype G.2011-82 and 0.81 kg for the genotype G.2007-61 to 1.90 kg and 1.25 kg for the genotype G.99-103 with an average of 1.41 and 1.03 kg in plant-cane and first-ratoon, respectively, (Appendix 3).

Under Shandaweel, the average stalk weight (Appendix 3) ranged from 0.92 kg for the genotype G.2011-82 and 0.64 kg for the genotype G.2010-26 to 1.36 and 1.70 kg for the genotype G.99-103 with an average of 1.11 and 1.14 kg in both seasons, respectively.

Over six environments, the average stalk weight ranged from 1.11 kg for the genotype G.2011-82 and 0.98 kg for the genotype G.2010-26 to 1.70 and 1.43 kg for the genotype G.99-103 with an average of 1.31 and 1.13 kg in plant-cane (Table 5) and first-ratoon (Table 6), respectively. It noticed that the genotypes G.99-103 and G.2010-7 in plant-cane as well as two genotypes; G.99-103 and G.2004-27 in first- ratoon were heavier in stalk weight than the control variety (G.T.54-9). **Ahmed (2003)** and **Osman *et al*. (2011)** concluded that the 14-month-old was the most suitable age for harvesting whether for plant-cane or ratoon-crops on stalk weight.

4- Cane yield:

The combined analysis of variance over six environments; three locations (Kom-Ombo, El-Mattana and Shandaweel) and two harvesting dates (first week in February and first week in March) in 2015/2016 (plant-cane) and 2016/2017 (first-ratoon) for cane yield are presented in Tables 3 and 4, respectively.

The differences among locations were highly significant for cane yield in 2015/2016, plant-cane and 2016/2017, first-ratoon, (Tables 3 and 4), reflecting the wide differences in edaphically factors prevailing at the three locations. The main effect of harvesting dates was highly significant for this trait as it would be expected for early and late dates. Mean squares due to genotypes were highly significant for cane yield in each of plant-cane and first-ratoon, indicating a wide range of variability present among the genotypes. The interaction between locations and harvesting dates was not significant in both seasons; plant-cane and first-ratoon, indicating the consistent effects of edaphic factors on different harvesting dates. Moreover, the effect of locations was more pronounced than that of harvesting dates. Mean squares due to interaction between genotypes and locations for this trait were highly significant (Tables 3 and 4). Accordingly, there were a differential response between genotypes and locations.

The mean values and range of cane yield for all genotypes over six environments in 2015/2016 (plant-cane) and 2016/2017 (first-ratoon) are shown in Tables 5 and 6, respectively.

The average cane yield for all genotypes at Kom-Ombo location (Appendix 4) ranged from 48.17 t/fad. for the genotype G.84-47 to 67.00 t/fad. for the genotype G.2003-47 with an average of 60.67 t/fad. and from 45.66 t/fad. for the genotype G.2010-26 to 70.97 t/fad. for the genotype G.2007-61 with an average of 58.69 t/fad. in plant-cane and first-ratoon, respectively.

Under El-Mattana, it ranged from 46.25(t/fad.) for the genotype G.2010-26 and 42.65 t/fad. for the genotype G.2007-61 to 79.95 and 72.79 t/fad. for the genotype G.99-103 with an average of 60.43 and 55.18 t/fad. in 2015/2016 (plant-cane) and 2016/2017 (first-ratoon), respectively, (Appendix 4).

With respect to Shandaweel, the average cane yield (Appendix 4) ranged from 33.51 t/fad. for the genotype G.2003-44 to 50.74 t/fad. for the genotype G.2003-49 with an average of 46.66 in plant- cane and from 27.17 t/fad. for the genotype G.2010-26 to 60.26 t/fad. for the genotype G.99-103 with an average of 50.12 t/fad. in first-ratoon.

Over six environments, the average cane yield (Tables 5 and 6) ranged from 48.02 and 39.66 t/fad. for the genotype G.2010-26 to 64.09 and 62.31 t/fad. for the genotype G.99-103 with an average of 55.92 and 54.66 t/fad. in plant- cane (Table 5) and first-ratoon (Table 6), respectively. The results showed that half genotypes were higher in cane yield than the control variety (G.T.54-9), indicating that these genotypes could be used in future breeding programs.

These results are in harmony with those obtained by **Ahmed (2003)**, **Naeem *et al.* (2011)** and **Ahmed *et al.* (2016 a)**.

Arumugam *et al.* (2002), Ahmed (2003), Ramburan *et al.* (2009), Osman *et al.* (2011), Abd El-Razek and Besheit (2012), Bashir *et al.* (2012), Hagos *et al.* (2014 b), Ahmed *et al.* (2016 a) and Mehareb and Sakina (2017) concluded that cane yield increased with increase of crop age up to 13-14 month-old. **Bashir *et al.* (2013) and Abdul Khaliq *et al.* (2018)** found that the highest cane yield was in February harvesting time in both different cropping seasons. **Hamam *et al.* (2015)** found that delaying harvesting times of sugarcane from 11 to 14 month-old caused increasing cane yield of sugarcane from 51.42 to 61.23 t/fad. and from 58.37 to 63.35 t/fad. in the first and second seasons, respectively.

5- Brix:

The combined analysis of variance over six environments; three locations (Kom-Ombo, El-Mattana and Shandaweel) and two harvesting dates (first week in February and first week in March) in 2015/2016 (plant-cane) and 2016/2017 (first-ratoon) for brix are presented in Tables 3 and 4, respectively.

Mean squares due to among locations and between harvesting dates were highly significant differences for brix in 2015/2016, plant-cane and 2016/2017, first-ratoon, (Tables 3 and 4), reflecting the wide differences in climatic and edaphically conditions prevailing at the three locations. The differences among genotypes were highly significant for brix in each of plant-cane and first-ratoon, indicating the genetic diversity between them. The interaction between locations and harvesting dates was not significant in two different cropping seasons, indicating the consistent effects of edaphically conditions on different harvesting dates. Mean squares due to interaction between genotypes, harvesting dates and locations for this trait were highly significant (Tables 3 and 4). Accordingly, there were a differential response between genotypes to harvesting dates and locations.

The mean values and range of brix for all genotypes over six environments in 2015/2016 (plant-cane) and 2016/2017 (first-ratoon) are shown in Tables 5 and 6, respectively.

Considering Kom-Ombo location, the average brix for all genotypes (Appendix 5) ranged from 18.01 and 18.73% for the genotype G.2010-7 to 21.20% for the genotype G.2003-47 and 22.75% for the genotype G.84-47 with an average of 20.14 and 21.42% in plant-cane and first-ratoon, respectively.

Under El-Mattana (Appendix 5), it ranged from 16.90% for the genotype G.T.54-9 and 19.55% for the genotype G.99-103 to 19.62 and 20.95% for the genotype G.2003-47 with an average of 18.61 and 20.26% in plant-cane and first-ratoon, respectively.

Respect to Shandaweel (Appendix 5), the average brix ranged from 18.33 and 19.00% for the genotype G.2010-7 to 21.40 % for the genotype G.84-47 and 22.51 % for the genotype G.2003-49 with an average of 20.53 and 21.30% in plant-cane and first-ratoon, respectively.

Over six environments, the average brix ranged from 17.84 and 19.33% for the genotype G.2010-7 to 20.68 and 21.93% for the genotype G.2003-47 with an average of 19.76 and 20.99 % in plant-cane (Table 4) and first-ratoon (Table 5), respectively. Most of genotypes were higher in percentage of brix than the control variety (G.T.54-9). **Ahmed (2003), Hagos *et al.* (2014a), Hagos *et al.* (2014 b), Ahmed *et al.* (2016 a)** found that brix was significantly influenced by delaying the harvesting ages from 12 to 14 month-old either in plant-cane or first-ratoon. **Mebrahtom *et al.***

(2017) suggested that brix accumulation of the studied genotypes depends on crop-age, which governed by location.

6- Sucrose:

The combined analysis of variance over six environments; three locations (Kom-Ombo, El-Mattana and Shandaweel) and two harvesting dates (first week in February and first week in march) in 2015/2016 (plant-cane) and 2016/2017 (first-ratoon) for sucrose are presented in Tables 3 and 4, respectively.

Mean squares due to among locations were highly significant differences for sucrose in 2015/2016, plant-cane and 2016/2017, first-ratoon, (Tables 3 and 4). This reveals the wide range in edaphically conditions prevailing at the three locations. The main effect of harvesting dates was highly significant for this trait as it would be expected for early and late harvesting dates. The differences among genotypes were highly significant for sucrose in each of plant-cane and first-ratoon, indicating a wide range of variability present among the genotypes. The interaction between locations and harvesting dates was significant in first-ratoon (2016/2017 season) only, indicating the consistent effects of edaphically factors on different harvesting dates. Mean squares due to interaction between genotypes, harvesting dates and locations for this trait were highly significant (Tables 3 and 4). This indicates that it is essential to evaluate such trait for number of locations and harvesting dates.

The mean values and range of sucrose for all genotypes over six environments in 2015/2016 (plant-cane) and 2016/2017 (first-ratoon) are shown in Tables 5 and 6, respectively.

Concerning Kom-Ombo location, the average sucrose for all genotypes (Appendix 6) ranged from 14.81 and 15.77% for the genotype

G.2010-7 to 18.78 and 20.19% for the genotype G.2003-47 with an average of 17.40 and 18.66% in plant-cane and first-ratoon, respectively.

Under El-Mattana (Appendix 6), it ranged from 13.58% for the genotype G.2010-7 and 15.10% for the genotype G.2007-61 to 17.20% for the genotype G.84-47 and 17.81% for the genotype G.2003-47 with an average of 15.46 and 16.37% in plant-cane and first-ratoon, respectively.

With respect to Shandaweel (Appendix 6), the average sucrose ranged from 14.13 and 15.03% for the genotype G.2010-7 to 18.40% for the genotype G.2003-47 and 20.47% for the genotype G.2003-49 with an average of 17.04 and 17.61% in plant-cane and first-ratoon, respectively.

Over six environments, the average sucrose ranged from 14.17 and 15.90 % for the genotype G.2010-7 to 17.93% for the genotype G.2003-47 and 19.17% for the genotype G.2003-49 with an average of 16.63 and 17.54% in plant-cane (Table 5) and first ratoon (Table 6), respectively. Most of the studied genotypes were higher in percentage of sucrose than the control variety (G.T.54-9) in plant-cane, while, three genotypes were higher in percentage of sucrose than the control variety (G.T.54-9) in first-ratoon. **Ahmed (2003) and Ahmed *et al.* (2016 a)** indicated that sucrose increased with the increase of crop age from 10 to 12 month-old. **Viator *et al.* (2010)** indicated that early harvesting date of both plant-cane and first-ratoon reduced sucrose yield for all cultivars compared to the mid-season harvesting date. **Rakkiyappan *et al.* (2009), Yohannes and Netsanet (2014) and Priyanka *et al.* (2016)** found that juice sucrose increased at the 13 month-old followed by at 14 month-old.

7- Purity:

The combined analysis of variance over six environments; three locations (Kom-Ombo, El-Mattana and Shandaweel) and two harvesting dates (first week in February and first week in march) in 2015/2016 (plant-cane) and 2016/2017 (first-ratoon) for purity are presented in Tables 3 and 4, respectively.

Highly significant differences were among locations for purity in 2015/2016, plant-cane and 2016/2017, first-ratoon, (Tables 3 and 4). This reveals the wide range in edaphically conditions prevailing at the three locations. The main effect of harvesting dates was highly significant for this trait in the second season (first-ratoon) only as it would be expected for early and late harvesting dates. The differences among genotypes were highly significant for purity in plant-cane and first-ratoon, indicating the genetic diversity between them. The interaction between locations and harvesting dates was significant in first-ratoon (2016/2017 season) only, indicating the consistent effects of edaphically conditions on different harvesting dates. Mean squares due to interaction between genotypes, harvesting dates and locations for this trait were highly significant in first-ratoon (2016/2017 season) only. This indicates that it is essential to evaluate such trait for number of locations and harvesting dates.

The mean values and range of purity for all genotypes over six environments in 2015/2016 (plant-cane) and 2016/2017 (first-ratoon) are shown in Tables 5 and 6, respectively.

With respect to Kom-Ombo, the average purity for all genotypes (Appendix 7) ranged from 81.79 and 84.14% for the genotype G.2010-7 to 88.92% for the genotype G.2003-49 and 89.74% for the genotype G.2003-45 with an average of 86.30 and 87.03% in plant-cane and first-ratoon, respectively.

At El-Mattana (Appendix 7), it ranged from 78.93% for the genotype G.2010-7 to 88.43% for the genotype G.84-47 with an average of 83.03% in plant-cane (2015/2016 season). While, the average purity ranged from

76.34% for the genotype G.2007-61 to 85.40% for the genotype G.2003-49 with an average of 80.62% in first ratoon (2016/2017 season).

Under Shandaweel, the average purity (Appendix 7) ranged from 75.31% for the genotype G.2010-7 and 77.52 % for the genotype G.84-47 to 86.82 % for the genotype G.2003-47 and 90.91% for the genotype G.2003-49 with an average of 82.79 and 82.51% in plant-cane and first-ratoon, respectively.

Over six environments, the average purity ranged from 82.51% for the genotype G.2011-82 to 86.69% for the genotype G.2003-47 with an average of 84.04% in plant cane (Table 5). Moreover, it ranged from 80.28% for the genotype G.2004-27 to 88.12% for the genotype G.2003-49 with an average of 83.39% in first-ratoon (Table 6). Most of the studied genotypes were higher in percentage of purity than the control variety (G.T.54-9) in plant-cane, while, two genotypes were higher in percentage of purity than the control variety (G.T.54-9) in first-ratoon. **Rakkiyappan *et al.* (2009)** found that purity increased at the 13 month-old followed by at 14 month-old. **Hagos *et al.* (2014a)** showed that harvesting ages significantly influenced (P<0.001) on purity. **Ahmed (2003), Wagih *et al.* (2004) and Ahmed *et al.* (2016 a)** found that purity, were significantly influenced by delaying the harvesting ages from 10 to 14 month-old either in plant-cane or first-ratoon.

8- Sugar recovery:

The combined analysis of variance over six environments; three locations (Kom-Ombo, El-Mattana and Shandaweel) and two harvesting dates (first week in February and first week in March) in 2015/2016 (plant-cane) and 2016/2017 (first-ratoon) for sugar recovery are presented in Tables 3 and 4, respectively.

The differences among locations were highly significant for sugar recovery in 2015/2016, plant-cane and 2016/2017, first-ratoon, (Tables 3 and 4), indicating the wide range in edaphically conditions prevailing at the three locations. The main effect of harvesting dates was highly significant for this trait in plant-cane and first-ratoon as it expected for early and late harvesting dates. The differences among genotypes were highly significant for sugar recovery in plant-cane and first-ratoon, indicating the genetic diversity between them. The first order interaction of locations × harvesting dates was significant in first-ratoon (2016/2017 season) only (Table 4), showing the consistent effects of edaphically conditions on different harvesting dates. Mean squares due to interaction between genotypes, harvesting dates and locations for this trait were highly significant in first-ratoon (2016/2017 season) only (Table 4). This indicates that it is essential to evaluate such trait for number of locations and harvesting dates.

The mean values and range of sugar recovery for all genotypes over six environments in 2015/2016 (plant-cane) and 2016/2017 (first-ratoon) are shown in Tables 5 and 6, respectively.

Regarding to Kom-Ombo (Appendix 8), the average sugar recovery for all genotypes ranged from 9.88 and 10.65% for the genotype G.2010-7 to 13.00 and 14.08% for the genotype G.2003-47 with an average of 11.89 and 12.80% in plant cane and first ratoon, respectively.

With respect to El-Mattana (Appendix 8), the average sugar recovery for all genotypes ranged from 9.31% for the genotype G.T.54-9 2010-26 to 11.90% for the genotype G.84-47 with an average of 10.33% in plant-cane. Moreover, it ranged from 9.66% for the genotype G.2007-61 to 12.13% for the genotype G.2003-47 with an average of 10.78% in first-ratoon.

At Shandaweel (Appendix 8), the average sugar recovery ranged from 8.64 and 9.81% for the genotype G.2010-7 to 12.61% for the genotype G.2003-47 and 14.35% for the genotype G.2003-49 with an average of 11.37 and 11.77% in plant-cane and first-ratoon, respectively.

Over six environments, the average sugar recovery ranged from 9.12 and 10.61% for the genotype G.2010-7 to 12.19 % for the genotype G.2003-47 and 13.35% for the genotype G.2003-49 with an average of 11.20 and 11.78% in plant-cane (Table 5) and first-ratoon (Table 6), respectively. Most of the studied genotypes were higher in sugar recovery than the control variety (G.T.54-9) in plant-cane, while, two genotypes were higher in sugar recovery than the control variety (G.T.54-9) in first-ratoon. **Ahmed (2003), Osman *et al.* (2011) and Ahmed *et al.* (2016 a)** found that the harvesting date up to 14 months gave the highest values of sugar recovery percentage in plant cane and 1st ratoon crops over the other harvesting dates.

9- Sugar yield:

The combined analysis of variance over six environments; three locations (Kom-Ombo, El-Mattana and Shandaweel) and two harvesting dates (first week in February and first week in March) in 2015/2016 (plant-cane) and 2016/2017 (first-ratoon) for sugar yield are presented in Tables 3 and 4, respectively.

The differences among locations were highly significant for sugar yield in 2015/2016, plant-cane and 2016/2017, first-ratoon, (Tables 3 and 4), indicating the wide range in edaphically conditions prevailing at the three locations. The main effect of harvesting dates was highly significant for this trait in plant-cane and first-ratoon as it would be expected for early and late harvesting dates. The differences among genotypes were highly significant for sugar recovery in plant-cane and first-ratoon, a wide range of variability present among the genotypes. The first order interaction of locations × harvesting dates was significant in first-ratoon (2016/2017 season) only (Table 4), showing the consistent effects of edaphically conditions on different harvesting dates. Mean squares due to interaction between genotypes, harvesting dates and locations for this trait were highly significant in first-ratoon (2016/2017 season) only (Table 4). This indicates that it is essential to evaluate such trait for number of locations and harvesting dates.

The mean values and range of sugar yield for all genotypes over six environments in 2015/2016 (plant-cane) and 2016/2017 (first-ratoon) are shown in Tables 5 and 6, respectively.

Under Kom-Ombo (Appendix 9), the average sugar yield for all genotypes from 5.88 t/fad. for the genotype G.84-47 to 8.50(t/fad.) for the genotype G.2033-47 with an average of 6.98 t/fad. in plant-cane. However, it ranged from 5.33 t/fad. for the genotype G.2010-26 to 8.34 t/fad. for the genotype G.T.54-9 with an average of 6.88 t/fad. in first-ratoon.

Concerning El-Mattana (Appendix 9), the average sugar yield for all genotypes ranged from 4.42 t/fad. for the genotype G.2010-26 to 7.51t/fad. for the genotype G.84-47 with an average of 5.72 t/fad. in plant-cane. Moreover, 4.44 t/fad. for the genotype G.2007-61 to and 6.58 t/fad. for the genotype G.99-103 with an average of 5.72 and 5.59 t/fad. and first-ratoon, respectively.

With respect to Shandaweel (Appendix 9), the average sugar yield ranged from 3.69 t/fad. for the genotype G.2003-44 and 2.90 t/fad. for the genotype G.2010-26 to 6.02 and 7.68 t/fad. for the genotype G.2003-49 with an average of 5.30 t/fad. in plant-cane and first-ratoon, respectively.

Over six environments, the average sugar yield ranged from 5.27 t/fad. for the genotype G.2010-7 to 6.87 t/fad. for the genotype G.2003-47 with an average of 6.00 t/fad. in plant cane (Table 5). However, it ranged from 4.29 t/fad. for the genotype G.2010-26 to 6.70 t/fad. for the genotype G.T.54-9 with an average of 5.92 t/fad. in first-ratoon (Table 6). Most of the studied genotypes were higher in sugar yield than the control variety (G.T.54-9) in plant-cane, while, in first-ratoon all genotypes were low. **Arumugam *et al.* (2002), Ahmed (2003), Osman *et al.* (2011), Jadhav *et al.* (2000), Abd El-Razek and Besheit (2012), Hagos *et al.* (2014a and b), and Ahmed et al. (2016 a)** found that the harvesting date up to 14 months gave the highest values of sugar yield in plant cane and 1st ratoon crops over the other harvesting dates. **Gilbert *et al.* (2006) Viator *et al.* (2010)** found that early harvesting date of both plant-cane and first-ratoon reduced sugar yields for all cultivars compared to the mid-season harvesting date. On the other hand, sugar yield decreased from 7.76 to 6.47 t/fad. and from 8.30 to 7.63 t/ fad. with delaying harvesting times from 13 to 14 months in the first and second seasons, respectively **(Hamam *et al.*, 2015)**. Harvesting age at 13 month-old not significantly, increased sugar yield compared with harvesting at 12 months in plant-cane and first-ratoon **(Mehareb and Sakina, 2017)**.

Simple correlation coefficient:

The correlation coefficients between all pairs of the studied traits for eleven genotypes were computed using the data in plant-cane and first-ratoon (2015/2016 and 2016/2017, respectively) are shown in Table 7.

In plant-cane; 2015/2016:

The correlation coefficient between cane yield and each of stalk height and stalk weight was significantly positive, in addition, it was positive and non-significant with stalk diameter and sugar yield. while, cane yield was negative and insignificant with brix percentage, sucrose, purity and sugar recovery.

Sugar yield were positive and significant correlated with sucrose, purity and sugar recovery, positive and non-significant with stalk height, stalk diameter and brix percentage.

The value of correlation coefficient was positive and highly significant between sucrose and brix percentage, purity and sugar recovery, while, it was negative and insignificant with stalk height, stalk diameter and stalk weight.

Purity possessed positive and highly significant correlated with each of brix percentage and sugar recovery. In addition, it was positive and insignificant with stalk diameter. While, purity was negative and insignificant with stalk height and stalk weight.

Stalk weight recorded positive and highly significant correlated with stalk diameter, but it was positive and insignificant with stalk height.

Table 7. Simple correlation coefficient between each pairs of nine traits in plant-cane; 2015/2016 (above diagonal) and in first-ratoon; 2016/2017 (below diagonal)

Traits	Stalk height	Stalk diameter	Stalk weight	Cane yield	Brix	Sucrose	Purity	Sugar recovery	Sugar yield
Stalk height	-	-0.011	0.494	0.659*	-0.397	-0.314	-0.087	-0.267	0.048
Stalk diameter	-0.223	-	0.724**	0.415	-0.239	-0.083	0.244	-0.028	0.108
Stalk weight	0.496	0.591	-	0.795**	-0.696*	-0.518	-0.108	-0.456	-0.051
Cane yield	0.822**	-0.024	0.725*	-	-0.569	-0.454	-0.146	-0.407	0.217
Brix	-0.401	-0.164	-0.414	-0.319	-	0.968**	0.752**	0.001	0.577
Sucrose	-0.354	-0.082	-0.275	-0.236	0.903**	-	0.890**	0.995**	0.683*
Purity	-0.040	0.069	-0.023	-0.082	0.514	0.833**	-	0.926**	0.758**
Sugar recovery	-0.198	-0.034	-0.202	-0.184	0.827**	0.988**	0.905**	-	0.696*
Sugar yield	0.632*	-0.001	0.505	0.753**	0.201	0.394	0.508	0.456	-

***, **: Significant at 0.05 and 0.01 levels of probability, respectively.**

In first-ratoon; 2016/2017

Cane yield possessed significantly positive correlated with stalk height, stalk weight and sugar yield, while, it was negative and insignificant with the other studied traits.

The correlation between sugar yield and stalk height was significantly positive, while, it was positive and insignificant with the other traits except stalk diameter was negative and insignificant.

The value of correlation coefficient was positive and highly significant between sugar recovery with brix percentage, sucrose and purity, but it was negative and insignificant with the other studied traits. Sucrose was highly significant and positive correlated with each of purity and brix percentage. Many researchers, such as **Chaudhary and Joshi (2005), Yahaya *et al.* (2009), Mali *et al.* (2010), Al-Sayed *et al.* (2012), Guprasad *et al.* (2015), Pandya and Patel (2017) and Imtiaz *et al.* (2019)** were partially in harmony with the obtained data. So, direct selection would be valuable for yield or for one or most components of yield or to improve other traits exhibiting strong association of yield.

Part-II: Stability analysis:

The stability parameters of eleven genotypes were studied over twelve environments i.e.; two seasons (2015/2016, plant-cane and 2016/2017, first-ratoon), three locations (Kom-Ombo, El-Mattana and Shandaweel) and two harvesting dates (first week in February and first week in March) for stalk height, stalk diameter, stalk weight, cane yield, brix, sucrose, purity, sugar recovery and sugar yield.

The joint regression analysis of variance (Table 8) revealed highly significant differences among genotypes for stalk height, stalk diameter, stalk weight, cane yield, brix, sucrose, purity, sugar recovery and sugar yield. This indicates that the presence of genetic variability on the material under study for these traits. Moreover, partitions of the genotypes × environments interaction as indicated by Env. + (G × Env.), Envi. (Linear) and genotypes × environments interaction were highly significant for all the studied traits. Since, genotype × environment (linear) was significant. It could be proceed in the stability analysis **(Eberhart & Russell, 1966)**. This reveals that the relative ranks of the genotypes differed from environment to another.

Table 8. Analysis of variance of 11 genotypes for the studied traits overall environments.

S. O. V	d.f.	Mean squares								
		Stalk height (cm)	Stalk diameter (cm)	Stalk weight (kg)	Cane yield (t/fad)	Brix (%)	Sucrose (%)	Purity (%)	Sugar recovery (%)	Sugar yield (t/fad)
Genotypes (G)	10	5513.028**	0.225**	0.230**	194.79**	8.05**	11.73**	49.38**	8.35**	2.77**
Env. + (G × Env.)	121	527.702**	0.011**	0.050**	65.15	1.88**	2.37**	14.21**	1.47**	1.93**
Env. (Linear)	1	36576.37**	0.566**	3.667**	3171.67**	175.24**	196.57**	942.79**	114.46**	129.82**
G × Env. (Linear)	10	1686.76**	0.022**	0.039**	76.50*	0.84*	1.45*	12.21*	0.94*	1.66*
Pooled deviation	110	94.62**	0.005**	0.019**	35.88**	0.40**	0.69**	5.95**	0.49**	0.79**
Pooled error	240	5.28	0.001	0.006	7.85	0.12	0.22	2.71	0.16	0.19

***, ** Significant at 0.05 and 0.01 probability levels, respectively.**

In addition, mean squares due to pooled deviation were highly significant for all the studied traits, indicating that the genotypes differed considerably with respect to their stability for these characters.

Based on the stability analysis results, it is possible to identify the best genotype to be grown under the different environments. **Jun *et al.* (2014)** found that high significant effects for genotypes, environments and G X E interaction in plant-cane and-first ratoon on cane yield and sugar yield. In addition, **Surinder *et al.* (2014)** showed that effects of genotypes, environments and genotypes x environments interaction were significant ($p \leq 0.05$) for cane yield and sucrose percentage. **Otieno (2016) and Meena *et al.* (2017)** indicated that genotype, environment and their interaction effects were significant (p≤05) respect cane yield. **Gulzar *et al.* (2018)** showed significant interactions of clones x environments regard cane yield (t/ha) and sucrose percentage of clones. **Talyta *et al.* (2018) and Esayas *et al.* (2019)** found significant interactions of clones x environments sugar yield.

Eberhart & Russell (1966) proposed that an ideal genotype is the one which has the highest value over a broad range of environments, $b_i = 1$ and $S^2d_i = 0$

1-Stalk height:

The estimates of various stability parameters i.e.; regression coefficient (b_i), deviation from regression (S^2d) and the mean performance ($\overline{X}$) of the individual genotype are presented in Table 9 and Fig. 1.

The results indicated that the b_i of stalk height for the genotypes ranged from 0.37 for the genotype G.T.54-9 to 2.67 for the genotype G.2010-26 (Table 9).

Table 9. Stability parameters for Stalk height, Stalk diameter and Stalk weight of 11 genotypes over 12 environments.

No.	Pedigree	Stalk height			Stalk diameter			Stalk weight		
		Means ($\bar{X}$)	b_i	S^2d	Means ($\bar{X}$)	b_i	S^2d	Means ($\bar{X}$)	b_i	S^2d
1	G.84-47	306.7	0.55**	121.34**	2.40	0.83	0.002*	1.17	0.47**	0.015**
2	G.99-103	302.9	1.31	46.21**	2.87	2.42**	0.017**	1.56	1.46	0.027**
3	G.2003-44	296.7	0.45**	60.48**	2.49	1.18	0.001	1.13	1.05	0.008
4	G.2003-47	282.9	0.39**	114.49**	2.60	1.16	0.001	1.26	0.82	0.003
5	G.2003-49	282.6	1.03	-3.15	2.57	1.51	0.003**	1.22	0.83	0.007
6	G.2004-27	299.8	0.59*	15.42**	2.57	0.48	0.001	1.23	1.01	0.009
7	G.2007-61	276.1	1.24	117.40**	2.44	1.61	0.005**	1.12	1.07	0.009
8	G.2010-7	301.6	0.55**	18.57**	2.45	0.29*	0.006**	1.29	1.37	0.028**
9	G.2010-26	229.8	2.67**	290.01**	2.65	0.41	0.001	1.08	0.77	0.022**
10	G.2011-82	282.8	1.75**	105.37**	2.38	0.64	0.000	1.09	0.64	0.001
11	G.T.54-9 (control variety)	293.6	0.37**	96.57**	2.57	0.46	0.008**	1.29	1.52**	0.015**
Mean		286.9	-	-	2.54	-	-	1.22	-	-
R. L. S. D. 0.05		30.12	-	-	0.06	-	-	0.06	-	-
R. L. S. D. 0.01		41.16	-	-	0.08	-	-	0.09	-	-

***, ** Significantly from unity for (b_i) and from zero for (S^2d) at 0.05 and 0.01 probability levels, respectively.**

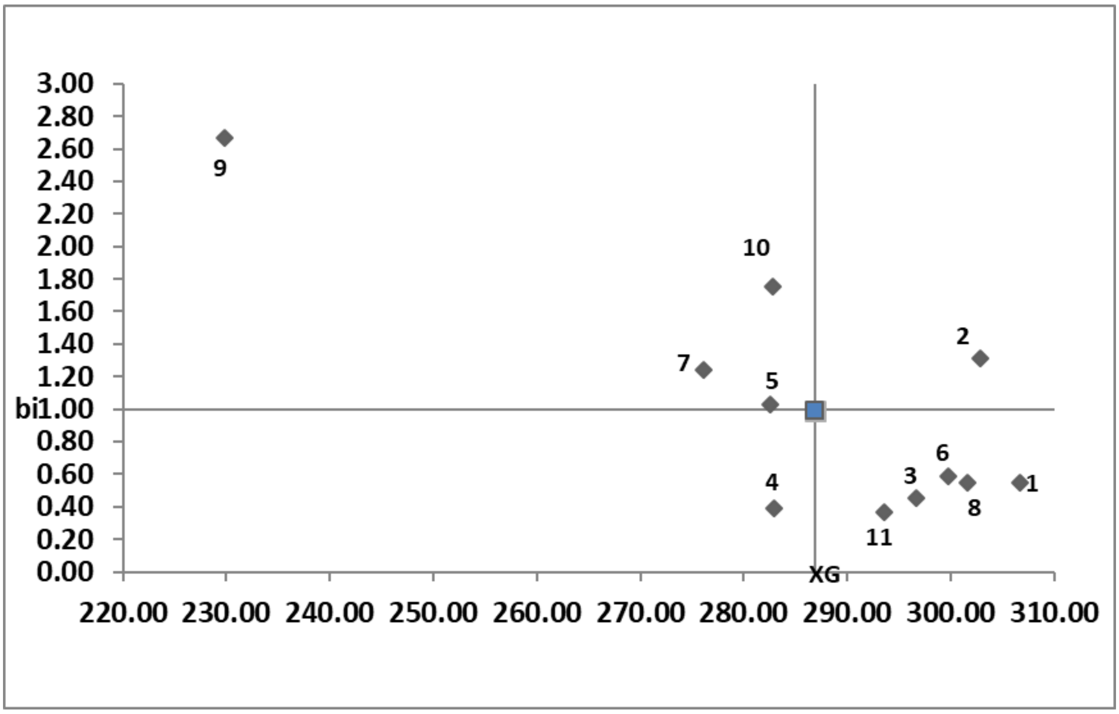

Fig. 1. Graphical illustration of the stability parameter (bi) and the mean performance of individual genotypes ($\overline{X}$) for stalk height.

Regarding the second stability parameter (S^2d_i), the genotypes varied from -3.15 for the genotype G.2003-49 to 290.01 for the genotype G.2010-26.

Concerning stalk height, it noticed that the genotype G.2003-49 was stable because the regression coefficient (b_i) was insignificant from unity and the deviation from regression (S^2d_i) was insignificant from zero. The remainder genotypes were unstable and gave highly significant S^2d_i, irrespective of the two genotypes, which showed regression coefficients, which did not differ significantly from unit slope (Table 9 and Fig. 1). **Tahir *et al.* (2013)** showed that all sugarcane genotypes were unstable overall the studied environments for plant height.

2-Stalk diameter:

The estimates of various stability parameters i.e.; regression coefficient (b_i), deviation from regression (S^2d_i) and the mean performance ($\overline{X}$) of the individual genotype are presented in Table 9 and Fig. 2.

The results in Table 9 showed that the b_i for stalk diameter for the genotypes ranged from 0.29 (G.2010-7) to 2.42 (G.99-103).

Regarding the second stability parameter ($S^2d_{i)}$, the genotypes varied from 0.000 (G.2011-82) to 0.008 (G.T.54-9).

Regarding stalk diameter, the regression coefficient (b_i) for five genotypes (G.2003-44, G.2003-47, G.2004-27, G.2010-26 and G.2011-82) were insignificant from unity and the deviation from regression (S^2d_i) were also insignificant from zero, indicating that these genotypes considered to be stable for such trait (Table 9 and Fig. 2). Three of them (G.2003-47, G.2004-27 and G.2011-82) were also stable for cane yield. According to **Eberhart & Russell** (1966) the genotype G.2003-47 performed consistently better in favourable environments because the regression coefficient (b_i) was more than one. In addition, the performance of the genotypes G.2004-27 and G.2010-26 were relatively better in less favourable environments ($b < 1$). The means of the stalk diameter ranged from 2.38 to 2.87 cm.

The remainder six genotypes were unstable (S^2d_i significantly different from zero), irrespective of the four genotypes, which regression coefficients, which did not differ significantly from unit slop (Table 9 and Fig. 2). **Dubey *et al.* (2017)** revealed that two varieties; CoH 05265 and CoH 05262 were stable for cane diameter. Hence, these varieties promising lines could be recommendation for commercial cultivation or could be suitability used in further improvement programme.

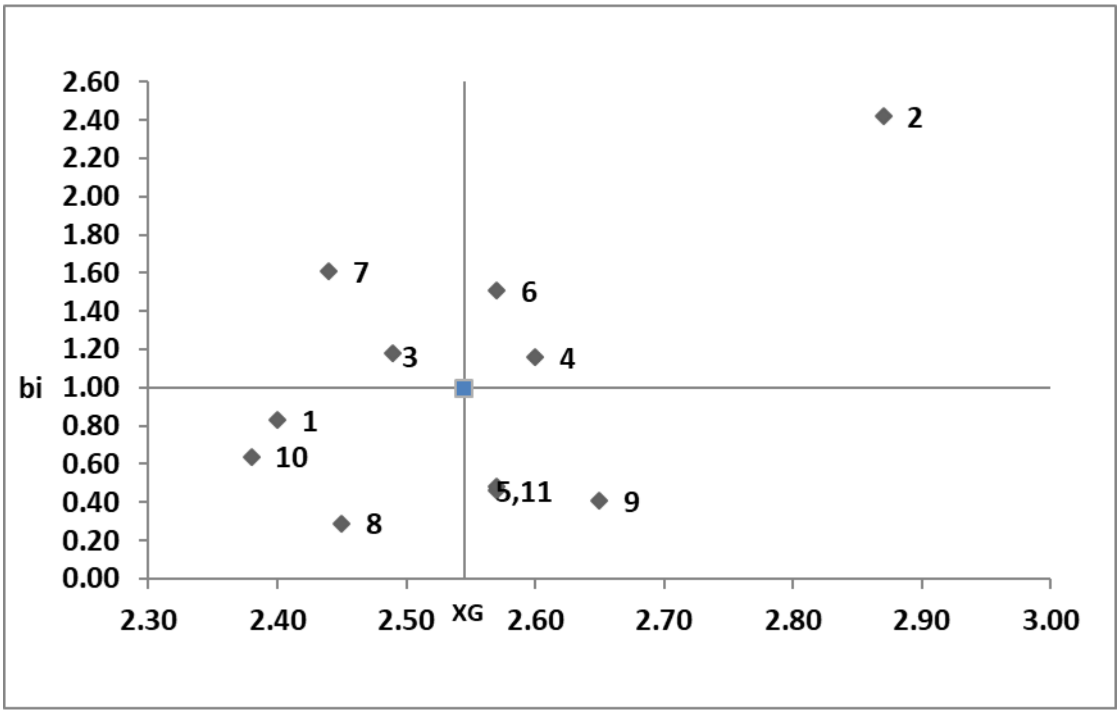

Fig. 2. Graphical illustration of the stability parameter (b_i) and the mean performance of individual genotypes ($\overline{X}$) for stalk diameter.

3-Stalk weight:

The data in Table 9 and Fig. 3 showed that the b_i for stalk weight for the genotypes ranged from 0.47 (G.84-47) to 1.52 (G.T.54-9).

Regarding the second stability parameter (S^2d_i), the genotypes varied from 0.001 (G.2011-82) to 0.028 (G.2010-7).

Considering stalk weight, six genotypes (G.2003-44, G.2003-47, G.2003-49, G.2004-27, G.2007-61 and G.2011-82) were stable because these genotypes have regression coefficient (b_i), which are not significant different from the unit slope and have S^2d_i that are not significantly different from zero (Table 9 and Fig. 3). Three of them (G.2003-47, G.2004-27 and G.2011-82) were also stable for cane yield.

According to **Eberhart & Russell (1966)** the genotype G.2004-27 considered to be superior because the regression coefficient of this genotype equal one (b_i = 1), the deviation from regression (S^2d_i) was insignificant from zero and

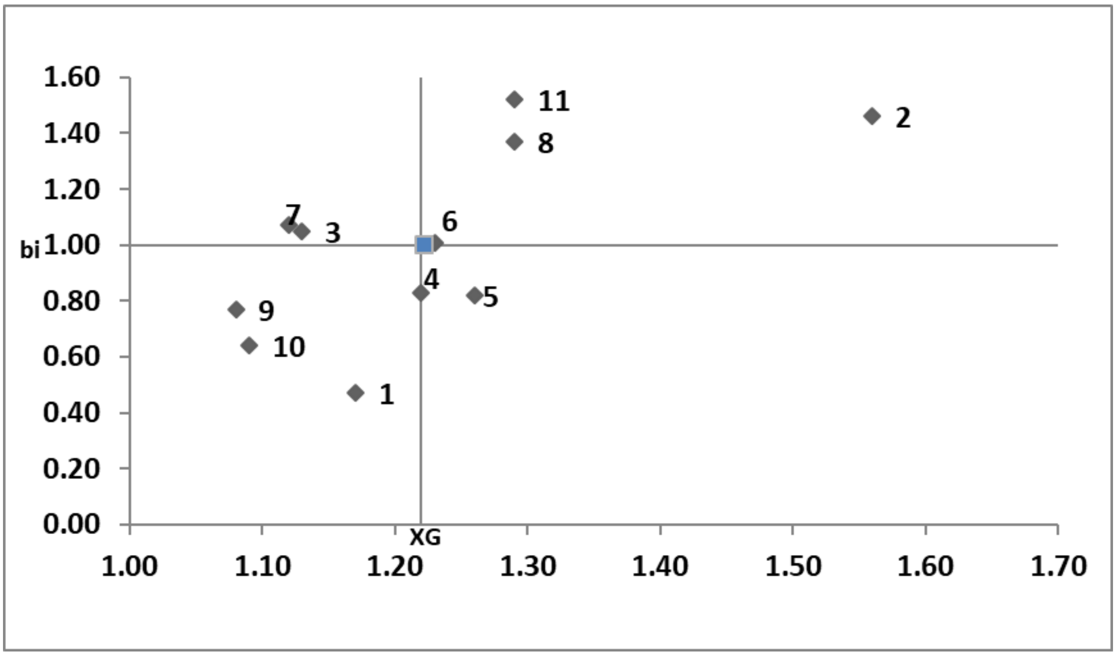

Fig. 3. Graphical illustration of the stability parameter (b_i) and the mean performance of individual genotypes ($\bar{X}$) for stalk weight.

a high mean when compared with the mean overall genotypes. Moreover, two of them (G.2003-47 and G.2003-49) performed consistently better in favourable environments because the regression coefficient (b_i) was more than one. The means of the stalk weight ranged from 1.08 to 1.56 kg (Table 9 and Fig. 3).

The remainder five genotypes i.e., G.T.54-9, G.84-47, G.99-103, G.2010-7 and G. 2010-26 were unstable and gave highly significant $S^2d_{i,}$ irrespective of the three genotypes that showed regression coefficient, which did not differ significantly from unit slope (Table 9 and Fig. 3). **Guddadamath *et al.* (2014)** revealed that the genotype SNK 07658 showed adaptation to unfavorable environment for single cane weight as evident by its deviation from regression and regression coefficient. **Dubey**

***et al.* (2017)** found that variety CoH 05265 was stable for single cane weight (kg) trait.

4-Cane yield:

The estimates of various stability parameters i.e.; regression coefficient (b_i), deviation from regression (S^2d_i) and the mean performance ($\overline{X}$) of the individual genotype are presented in Table 10 and Fig 4.

The results in Table 10 showed that the b_i for cane yield for the genotypes ranged from 0.52 (G.2003-49) to 1.59 (G.2003-44).

Regarding the second stability parameter (S^2d_i), the genotypes varied from 3.19 (G.2011-82) to 117.41 (G.84-47).

The stability parameters (Table 10 and Fig. 4) showed that the genotypes varied in their b_i values as well as S^2d_i. It noticed that the intermediate yielding genotypes (G.2003-47, G.2004-27 and G.2011-82) were stable and ranged in cane yield from 54.38 to 57.17 ton/fad. According to **Eberhart & Russell (1966)** the genotype G.2004-27 considered to be superior because the regression coefficient of this genotype equal one (b_i = 1), the deviation from regression (S^2d_i) was insignificant from zero and had a high mean when compared with the mean overall genotypes. The genotype G.2003-47 was relatively better in favourable environments because the regression coefficient (b_i) was more than one (Table 10 and Fig. 4).

The remainder eight genotypes i.e., G.T.54-9, G.84-47, G.99-103, G.2003-44, G.2003-49, G.2007-61, G.2010-7 and G. 2010-26 were unstable and gave highly significant $S^2d_{i,}$ irrespective of these genotypes that showed regression coefficient, which did not differ significantly from unit slope (Table 10 and Fig. 4). Similar results were obtained by **Bissessur**

Table 10. Stability parameters for cane yield, brix and sucrose of 11 genotypes over 12 environments.

No.	Pedigree	Cane yield			Brix			Sucrose		
		Means ($\bar{X}$)	b_i	S^2d	Means ($\bar{X}$)	b_i	S^2d	Means ($\bar{X}$)	b_i	S^2d
1	G.84-47	56.76	1.45	117.41**	21.00	1.13	0.430**	17.49	1.13	1.40**
2	G.99-103	63.20	1.13	89.86**	19.33	1.03	0.136	16.07	0.88	0.04
3	G.2003-44	50.60	1.59	40.75**	20.60	0.63*	0.230*	17.51	0.69	0.10
4	G.2003-47	57.17	0.88	14.28	21.31	1.03	-0.063	18.48	1.05	-0.04
5	G.2003-49	54.32	0.52	51.34**	20.99	1.06	0.134	18.34	1.09	0.54**
6	G.2004-27	57.01	1.00	7.05	20.00	0.98	0.533**	16.31	0.94	0.73**
7	G.2007-61	57.13	1.07	74.51**	20.60	0.91	0.242*	17.15	0.97	0.56**
8	G.2010-7	57.32	0.55	48.96**	18.58	0.64*	0.813**	15.04	0.47**	1.39**
9	G.2010-26	43.84	0.89	48.97**	20.86	0.93	0.069	17.32	0.93	0.12
10	G.2011-82	54.38	0.95	3.19	20.82	1.37*	0.224*	17.28	1.55**	-0.05
11	G.T.54-9 (control variety)	56.46	0.98	37.10**	20.05	1.30	0.369**	16.97	1.29	0.36
Mean		55.29	-	-	20.38	-	-	17.09	-	-
R. L. S. D. 0.05		2.46	-	-	0.0.51	-	-	0.39	-	-
R. L. S. D. 0.01		3.49	-	-	0.70	-	-	0.55	-	-

***, ** Significantly from unity for (b_i) and from zero for (S^2d) at 0.05 and 0.01 probability levels, respectively.**

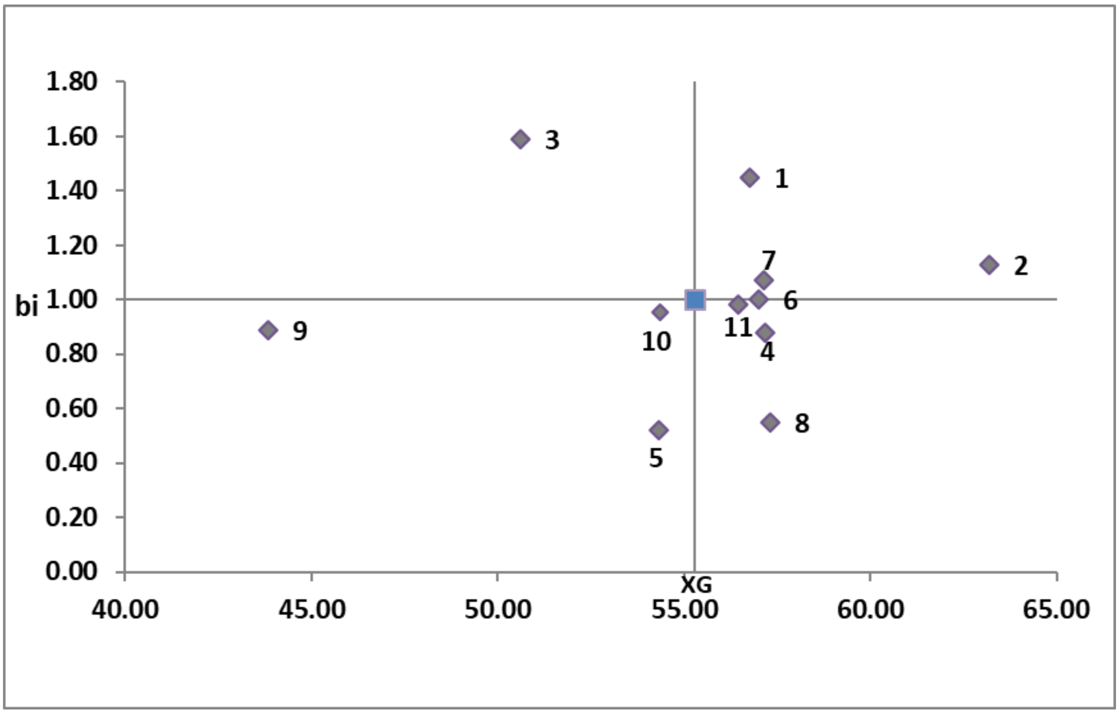

Fig. 4. Graphical illustration of the stability parameter (b_i) and the mean performance of individual genotypes ($\overline{X}$) for cane yield.

et al. **(2001), Imtiaz *et al.* (2002), Jun *et al.* (2009), Rea *et al.* (2011), Tiawari *et al.* (2011), Dutra *et al.* (2014), Jun *et al.* (2014), Rea *et al.* (2015**), **Anand *et al.* (2016)** and **Prema *et al.* (2017). Klomsa *et al.* (2013)** noticed that the genotype K88-92 was the most superior genotype in cane yield. **Alida *et al.* (2013)** obtained three varieties; V98-62, V99- 236 and V00-50 were the most promising ones in all four agro-ecological zones. These sugarcane varieties were excellent yield potential, adaptation, and stability in different environments tested. **Imtiaz *et al.* (2013)** indicated that the clone NIA0819/P5 produced maximum stable cane yield and sugar yield compared to the commercial varieties. **Otieno (2016)** indicated that the five from 33 cultivars were considered ideal cultivars where exhibited stable and high yielding.

5-Brix:

The estimates of various stability parameters i.e.; regression coefficient (b_i), deviation from regression (S^2d_i) and the mean performance ($\overline{X}$) of the individual genotype for percentage of brix are presented in Table 10 and Fig 5.

The data in Table 10 showed that the b_i for brix percentage of the genotypes ranged from 0.63 (G.2003-44) to 1.37 (G.2011-82).

Regarding the second stability parameter (S^2d_i), the genotypes varied from -0.063 (G.2003-47) to 0.813 (G.2010-7).

The results of the stability parameters (Table 10 and Fig. 5) indicated that that the four genotypes (G.99-103, G.2003-47, G.2003-49 and G.2010-26) were stable and gave regression coefficients insignificantly deviated from the unit slope and S^2d_i, which did not deviate significantly from zero. The four stable genotypes ranged in percentage of brix from 19.33 to 21.33%.

According to **Eberhart & Russell (1966)** two genotypes (G.2003-47 and G.2003-49) considered to be superior because the regression coefficient of these genotypes equal one (b_i = 1), the deviation from regression (S^2d_i) was insignificant from zero and had a high mean percentage of brix when compared with the mean overall genotypes. The genotype G.2010-26 performed consistently less in favourable environments (b_i < 1.0). The genotype G.2003-47 was also stable for cane yield (Table 10 and Fig. 5).

The remainder seven genotypes (G.T.54-9, G.84-47, G.2003-44, G.2004-27, G.2007-61, G.2010-7 and G.2011-88) were unstable and gave highly significant $S^2d_{i,}$ irrespective of the four genotypes that showed regression coefficient, which did not differ significantly from unit slope

(Table 10 and Fig. 5). **Irlane *et al.* (2009)** found that in plant-cane and first-ratoon for brix tons per hectare, the clones RB947653 and RB957575 presented specific adaptability to unfavorable and favorable environments, respectively. The control variety RB72454 presented general adaptability, while, RB835486 presented specific adaptability to unfavorable environments.

6-Sucrose:

The estimates of various stability parameters i.e.; regression coefficient (b_i), deviation from regression (S^2d_i) and the mean performance ($\overline{X}$) of the individual genotype are presented in Table 10 and Fig 6.

The data in Table 10 showed that the b_i for sucrose for the genotypes ranged from 0.47 (G.2010-7) to 1.55 (G.2011-82).

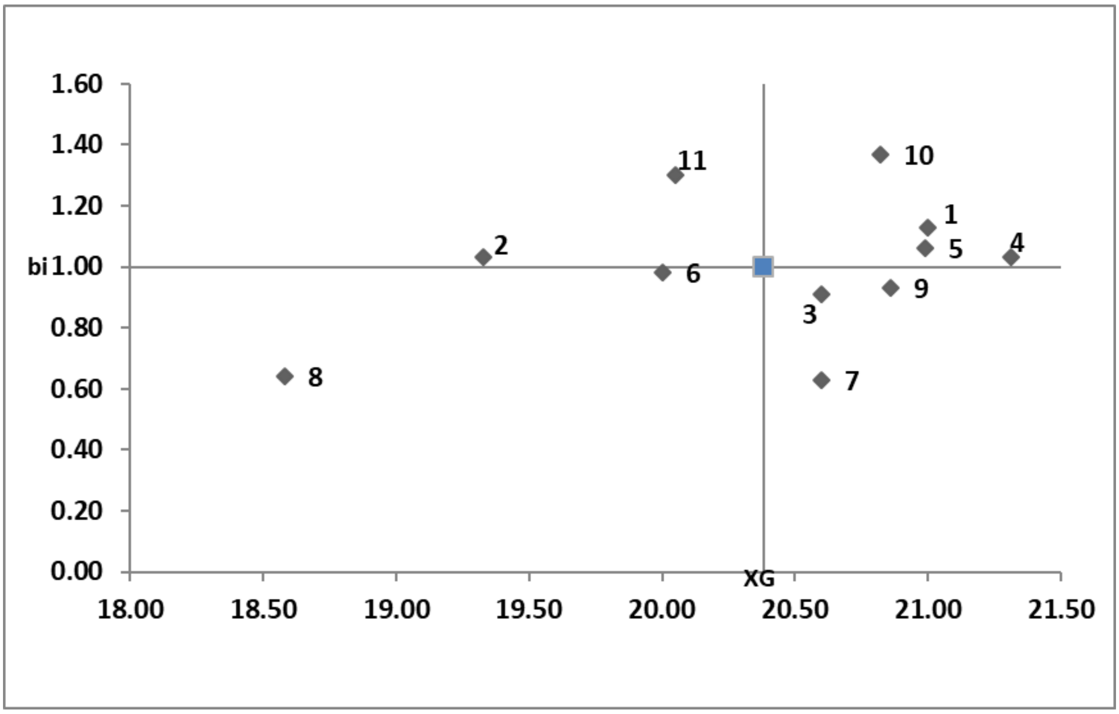

Fig. 5. Graphical illustration of the stability parameter (b_i) and the mean performance of individual genotypes ($\overline{X}$) for brix.

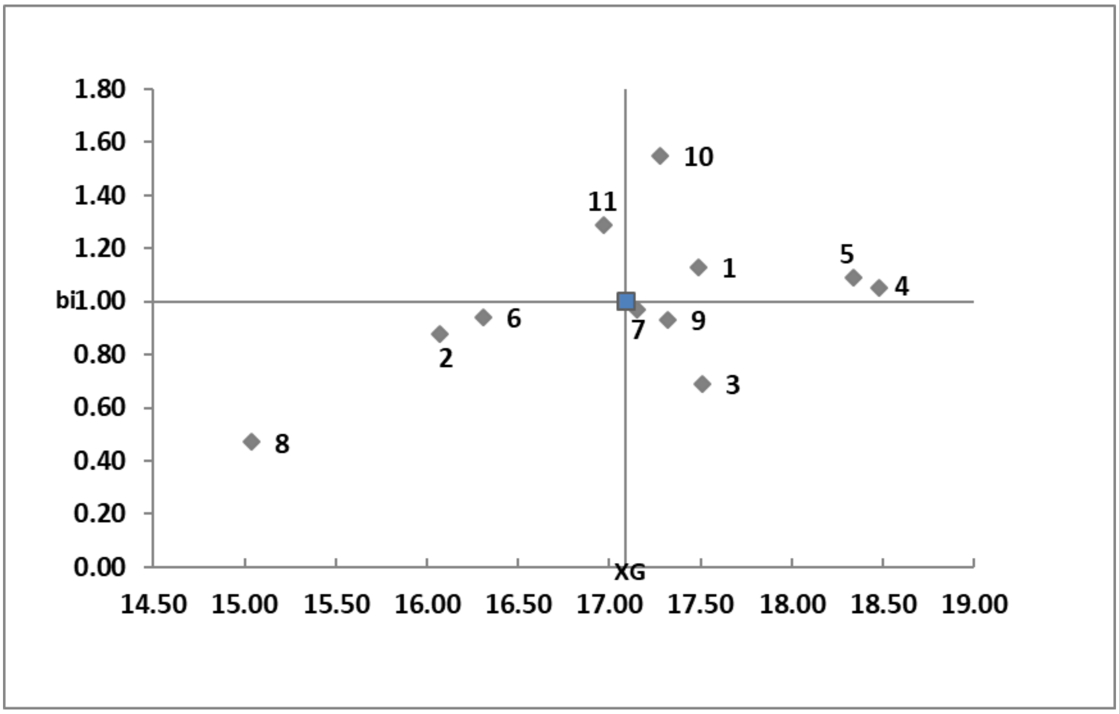

Fig. 6. Graphical illustration of the stability parameter (b_i) and the mean performance of individual genotypes ($\overline{X}$) for sucrose.

Regarding the second stability parameter (S^2d_i), the genotypes varied from -0.05 (G.2011-82) to 1.40 (G.84-47).

As shown in Table 10 and Fig. 2, the regression coefficient (b_i) for five genotypes (G.T.54-9, G.99-103, G.2003-44, G.2003-47 and G.2010-26) were insignificant from unity and the deviation from regression (S^2d_i) were also insignificant from zero. This indicates that these genotypes considered being stable for such trait. These genotypes ranged in sucrose from 16.07 to 18.48% for sucrose.

According to **Eberhart & Russell (1966)** one genotype (G.2003-47) was the only genotype considered to be superior because the regression coefficient of this genotype equal one (b_i = 1), the deviation from regression (S^2d_i) was insignificant from zero and had a high mean percentage of sucrose when compared with the mean overall genotypes. This genotype was also stable for cane yield. However, two genotypes

(G.2003-44 and G.2010-26) performed consistently less in favourable environments ($b_i < 1.0$) (Table 10 and Fig. 6).

The other six genotypes; G.84-47, G.2003-49, G.2004-27, G.2007-61, G.2010-7 and G.2011-82 were unstable (S^2d_i significantly different from zero), irrespective of the four genotypes, which showed regression coefficients that did not differ significantly from unit slope (Table 10 and Fig. 6). Similar results obtained by **Bissessur *et al.* (2001), Imtiaz *et al.* (2002), Jun *et al.* (2009), Rea *et al.* (2011) and Tiawari *et al.* (2011)**. **Imtiaz *et al.* (2013)** indicated that the clone NIA0819/P5 produced maximum stable sucrose percentage compared to the commercial varieties. **Guddadamath *et al.* (2014)** and **Rajesh and Sinha (2015)** found that two were found stable for sucrose percentage. Moreover, one genotype showed adaptation to unfavorable environment for sucrose as evident by its deviation from regression and regression coefficient.

7- Purity:

The estimates of various stability parameters i.e.; regression coefficient (b_i), deviation from regression (S^2d_i) and the mean performance ($\overline{X}$) of the individual genotype are presented in Table 11 and Fig. 7.

The results in Table 10 showed that the (b_i) for purity of the genotypes ranged from 0.29 (G.2010-7) to 1.62 (G.84-47).

Regarding the second stability parameter (S^2d_i), the genotypes varied from -0.92 (G.99-103) to 15.76 (G.84-47).

The data of percentage of purity (Table 11 and Fig 7) exhibited that the nine genotypes (G.99-103, G.2003-44, G.2003-47, G.2003-49, G.2004-27, G.2007-61, G.2011-82 and G.T.54-9) were stable because these genotypes have regression coefficients (b_i) that are not different from the unit slope and have S^2d_i, which are not significantly different from zero.

The stable genotypes ranged in percentage of purity from 81.61 to 87.25%. Three of them (G.2003-47, G.2004-27 and G.2011-82) were also stable for cane yield. The performance of G.T.54-9 was relatively better in favourable environments ($b_i > 1.0$). Two genotypes; G.84-47 and G.2010-7 were unstable (b_i and S^2d_i significantly differed from unit and zero, respectively) (Table 11 and Fig. 7).

8- Sugar recovery:

The estimates of various stability parameters i.e.; regression coefficient (b_i), deviation from regression (S^2d_i) and the mean performance ($\overline{X}$) of the individual genotype are presented in Table 11 and Fig. 8.

The results in Table 11 showed that the (b_i) forsugar recovery for the genotypes ranged from 0.36 (G.2010-7) to 1.50 (G.2011-82).

Regarding the second stability parameter (S^2d_i), the genotypes varied from -0.08 (G.2011-82) to 1.13 (G.84-47).

Table 11. Stability parameters for purity, sugar recovery and sugar yield of 11 genotypes over 12 environments.

No.	Pedigree	Purity			Sugar recovery			Sugar yield		
		Means ($\overline{X}$)	b_i	S^2d	Means ($\overline{X}$)	b_i	S^2d	Means ($\overline{X}$)	b_i	S^2d
1	G.84-47	83.17	1.62*	15.76**	11.71	1.16	1.13**	6.10	1.22	1.18**
2	G.99-103	83.15	1.04	-0.92	10.78	0.88	0.01	6.05	0.45**	0.25
3	G.2003-44	84.95	0.69	-0.48	11.90	0.71	0.06	5.71	0.62	1.02**
4	G.2003-47	86.68	0.89	1.67	12.62	1.15	-0.02	6.76	0.65	0.40*
5	G.2003-49	87.25	0.53	3.74	12.59	1.06	0.43**	6.61	0.61	1.10**
6	G.2004-27	81.61	1.17	0.66	10.83	0.97	0.21	5.91	1.17	-0.04
7	G.2007-61	83.21	1.20	4.50	11.52	1.04	0.41**	6.24	1.68**	0.48**
8	G.2010-7	80.48	0.29**	9.31**	9.87	0.36**	1.10**	5.38	1.03	0.37*
9	G.2010-26	82.94	1.08	1.01	11.55	0.87	0.16	4.85	1.09	0.67**
10	G.2011-82	82.90	1.32	0.35	11.54	1.50*	-0.08	5.73	1.19	0.16
11	G.T.54-9 (control variety)	84.50	1.18	0.05	11.49	1.29	0.18	6.20	1.30	1.05**
Mean		83.71	-	-	11.49	-	-	5.96	-	-
R. L. S. D. 0.05		1.37	-	-	0.59	-	-	0.89	-	-
R. L. S. D. 0.01		1.92	-	-	0.83	-	-	1.31	-	-

***, ** Significantly from unity for (b_i) and from zero for (S^2d) at 0.05 and 0.01 probability levels, respectively**

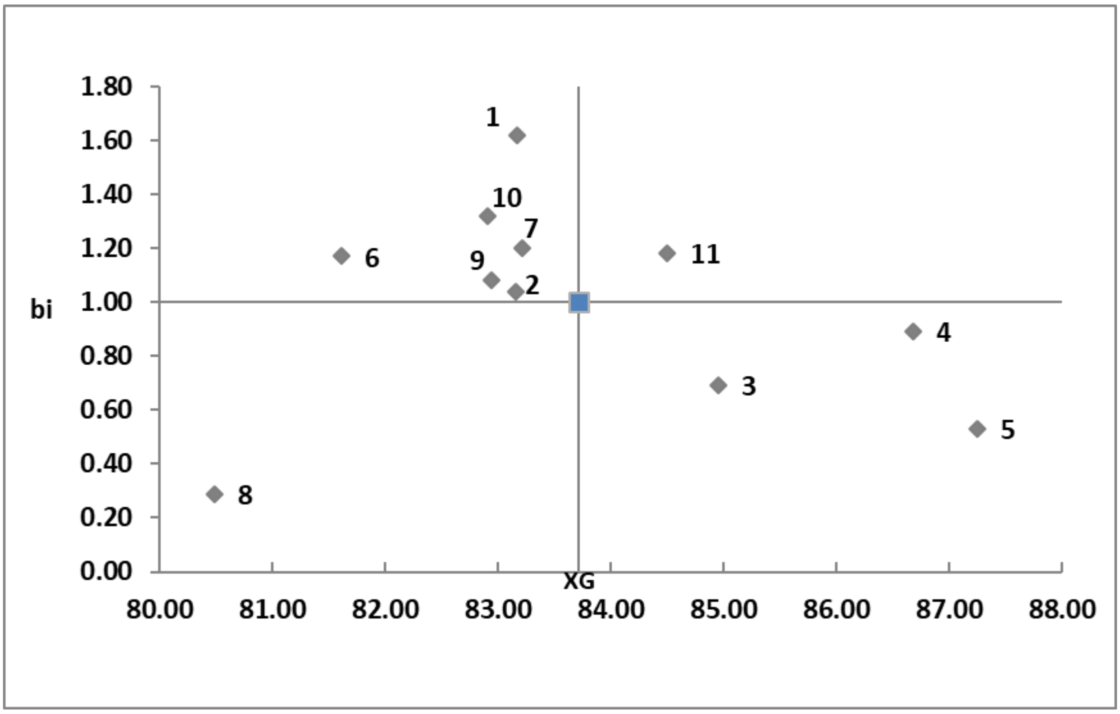

Fig. 7. Graphical illustration of the stability parameter (b_i) and the mean performance of individual genotypes ($\overline{X}$) for purity.

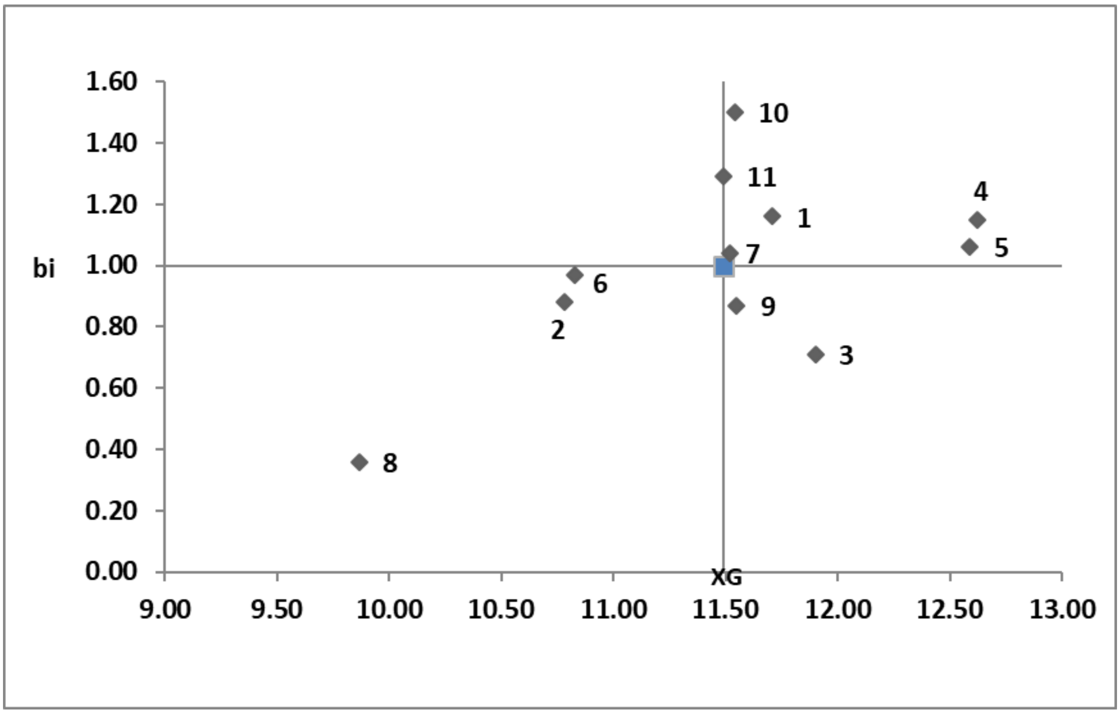

Fig. 8.Graphical illustration of the stability parameter (b_i) and the mean performance of individual genotypes ($\overline{X}$) for sugar recovery.

Respect to sugar recovery (Table 11 and Fig. 8), six genotypes (G.54-9, G.99-103, G.2003-44, G.2003-47, G.2004-27 and G.2010-26) were stable because these genotypes have regression coefficients (b_i) that are not different from the unit slope and have S^2d_i, which are not significantly different from zero. The stable genotypes ranged in percentage of purity from 9.87 to 12.62%. Two of them (G.2003-47 and G.2004-27) were also stable for cane yield. The performance of G.T.54-9 and G.2003-47 were relatively better in favourable environments ($b_i > 1.0$). In addition, the performance of G.2003-44 and G.2010-26 were relatively less in favourable environments ($b_i < 1.0$).

The remainder five genotypes were unstable and gave highly significant $S^2d_{i,}$ irrespective of the three genotypes, which showed $b_{i,}$ which did not differ significantly from unit slope (Table 11 and Fig. 8). Dutra *et al*. (2014) and Muhammad *et al.* (2018) obtained same results.

9- Sugar yield:

The estimates of various stability parameters i.e.; regression coefficient (b_i), deviation from regression (S^2d_i) and the mean performance ($\overline{X}$) of the individual genotype are presented in Table 11 and Fig. 9.

The data in Table 10 showed that the (b_i) forsugar yield for the genotypes ranged from 0.45 (G.99-103) to 1.68 (G.2007-61).

Regarding the second stability parameter (S^2d_i), the genotypes varied from -0.04 (G.2004-27) to 1.18 (G.84-47).

Regard to sugar yield (Table 11 and Fig. 9), the two of the studied genotypes (G.2004-27 and G.2011-82) were stable (b_i and S^2d_i not significantly differed from unit and zero, respectively). These genotypes were also stable for cane yield. The remainder nine genotypes were unstable and gave highly significant $S^2d_{i,}$ irrespective of the seven genotypes, which showed $b_{i,}$ which did not differ significantly from unit slope. The sugar yield ranged from 4.85 to 6.76 ton/fad. Similar results obtained by **Bissessur *et al.* (2001), Imtiaz *et al.* (2002),**

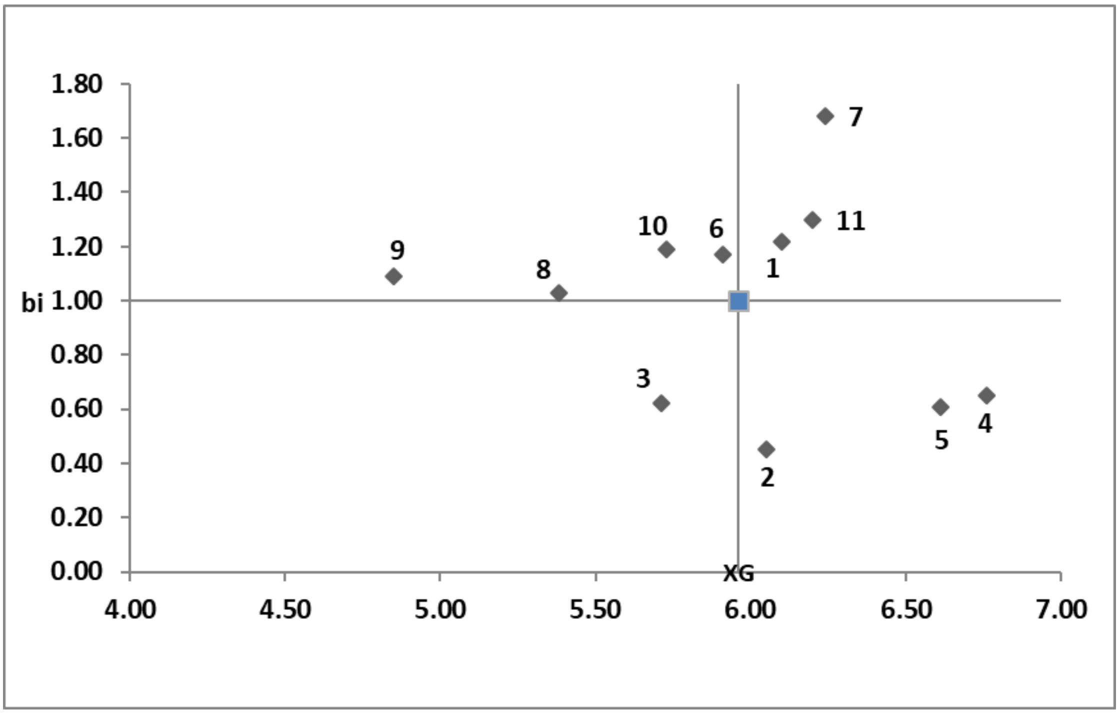

Fig. 9. Graphical illustration of the stability parameter (b_i) and the mean performance of individual genotypes ($\overline{X}$) for sugar yield.

Dutra *et al.* (2014), Jun *et al.* (2014), Sujeet *et al.* (2017), Prema *et al.* (2017), Muhammad *et al.* (2018) and Esayas *et al.* (2019). Klomsa *et al.* (2013) noticed that the genotypes Khon Kaen 3 and Kps94-13 were as the most superior genotypes for sugar yield, having consistent performance and stability of sugar yield across the two crop-classes. **Fooladvand *et al.* (2013) and Imtiaz *et al.* (2013)** showed that one clone only produced maximum stable sugar yield compared to the commercial varieties. **Guddadamath *et al.* (2014)** revealed that the genotypes SNK 07680 and SNK 07337 were stable for sugar yield (14.44 and 12.70 t ha^{-1}, respectively).

In general, the stability analysis revealed that the intermediate yielding genotypes, i.e. G.2003-47, G.2004-27 and G.2011-82 were stable for cane yield and most studied traits. Meanwhile, the highest yielding genotype (G.99-103) was unstable. However, the unstable high yielding genotype G.99-103 still have higher yield compared to the other stable genotypes under three locations.

SUMMARY

The present investigation was carried out under Upper Egypt conditions to study the performance and stability analysis of sugarcane genotypes.

The genetic materials consisted of eleven genotypes of sugarcane (ten new genotypes, in addition, G.T.54-9 as a control) were evaluated at twelve environments (six environments for each year). These environments included three locations, i.e., Kom-Ombo Agric. Res. Station, Aswan, governorate, El-Mataana Agric. Res. Station, Luxor governorate and Shandaweel Agric. Res. Station, Sohag governorate and two harvesting dates; first week of February and first week of March in 2015/2016 (plant-cane) and 2016/2017 (first-ratoon).

The genotypes were planted in first week of March in 2015/16 season. The harvesting dates of the plant-cane and its first-ratoon crops were 11 and 12 month-old from planting in plant crop, or from harvesting plant cane for the first ratoon crop.

The experimental design was a randomized complete block in split-plot arrangement with three replications at each location. The two harvesting dates were applied to the main plots, while the sugarcane genotypes were randomly distributed on the subplots. The experimental unit area was 56 m^2 including eight rows of 7 m long and one meter apart.

The following traits were studied at each harvesting date:

A. Cane yield and its components traits; stalk height, stalk diameter and stalk weight.

B. Sugar yield and juice quality traits; brix percentage, sucrose, purity percentage, sugar recovery and sugar yield.

The combined analysis of variance was computed over six environments for each year. Simple correlation coefficients between different pairs of the studied traits were estimated. Moreover, stability analysis was performed.

Results obtained could be summarized as follows:

Part I: Mean performance and simple correlation

a) Plant-cane

a_1- Mean performance

There were significant differences among genotypes for all studied traits. The genotype G.84-47 showed superiority over the other genotypes of stalk height. While, the highest mean values of stalk diameter, stalk weight and cane yield were recorded by the genotype G.99-103. The highest values of brix, sucrose, purity, sugar recovery and sugar yield were obtained by the genotype G.2003-47.

The differences between genotypes x locations were highly significant for all studied traits. At Kom-Ombo, the genotype G.99-103 had the highest value of stalk height, stalk diameter and stalk weight. While, the genotype 2003-47 recorded the highest mean values of cane yield, brix, sucrose, sugar recovery and sugar yield. However, the highest value of purity was obtained by the genotype G.2003-49.

Considering El-Mattana, the genotype G.84-47 gave the highest mean values for stalk height, sucrose, purity, sugar recovery and sugar yield. However, the highest values of stalk diameter, stalk weight and cane yield were recorded by the genotype G.99-103. Meanwhile, the genotype 2003-47 had the highest brix.

Concerning Shandaweel, the highest stalk height and brix were obtained by the genotype 84-47. While, the genotype G.99-103 had the highest values of stalk diameter and stalk weight. However, the genotype G.2003-49 recorded the highest values of cane and sugar yields. Meanwhile, the highest values of sucrose, purity and sugar recovery were resulted by the genotype G.2003-47.

Significant differences were found between harvesting dates for all studied traits except stalk diameter and purity. Harvesting sugarcane at date of 12 months-old resulted in higher values for most studied traits than the harvesting it at date of 11 month-old.

a_2- Simple correlation coefficient

The correlation coefficient between cane yield and each of stalk height and stalk weight was significantly positive, in addition, it was positive and non-significant with stalk diameter and sugar yield. But, cane yield was negative and insignificant with brix percentage, sucrose, purity and sugar recovery. Sugar yield were positive and significant correlated with sucrose, purity and sugar recovery, while, it was positive and non-significant with stalk height, stalk diameter and brix percentage.

b) First ratoon:

b_1- Mean performance

The results showed significant differences among the tested genotypes for all studied traits. The genotype G.2010-7 had the highest value of stalk height. While, the highest mean values of stalk diameter, stalk weight and cane yield were recorded by the genotype G.99-103. The highest value of brix was obtained by the genotype G.2003-47. However, the genotype G.2010-7 gave the highest values of sucrose, purity and sugar recovery. On the other hand, the highest value of sugar yield was recorded by the control variety G.T.54-9.

The interaction between genotypes x locations had significant effects for all studied traits. Under Kom-Ombo, the genotype G.99-103 had the highest values of stalk height and stalk diameter. While, the control variety G.T.54-9 had the highest stalk weight and sugar yield. However, the genotype 2007-61 was the highest value of cane yield. The highest mean values of sucrose, purity and sugar recovery were recorded by the genotype G.2003-47. However, the highest value of brix was obtained by the genotype G.2003-49.

Regarding El-Mattana, the genotype 2010-7 gave the highest value of stalk height. The highest value of stalk diameter was obtained by the genotype 2010-26. However, the genotype 99-103 gave the highest mean values of stalk weight, cane yield and sugar yield. In addition, the highest values of brix, sucrose and sugar recovery were recorded by the genotype G.2003-47. Moreover, the genotype 2003-49 had the highest purity.

Respect to Shandaweel, the highest stalk height was obtained by the genotype 2003-44. While, the genotype G.99-103 had the highest values of stalk diameter, stalk weight and cane yield. However, the genotype G.2003-49 surpassed significantly of brix, sucrose, purity, sugar recovery and sugar yield.

Significant differences between harvesting dates were noticed for all studied traits except stalk diameter. Harvesting sugarcane at date of 12 month-old resulted in higher values for most studied traits compared with harvesting it at date of 11 month-old.

b_2- Simple correlation coefficient

Cane yield possessed significantly positive correlated with stalk height, stalk weight and sugar yield, while, it was negative and insignificant with the other studied traits. The correlation between sugar yield and stalk height was significantly positive, while, it was positive and insignificant with the other traits except stalk diameter was negative and insignificant.

Part II: Stability analysis

The joint regression analysis of variance revealed highly significant differences among genotypes and environments (Linear) for all studied traits; stalk height, stalk diameter, stalk weight, cane yield, brix, sucrose, purity, sugar recovery and sugar yield. Moreover, the genotypes × environments interaction was highly significant for stalk height, stalk diameter and stalk weight, but it was significant for the remainder traits under study.

The genotypes considered to be superior were G.2004-27 for stalk weight and cane yield, G.2003-47 and G.2003-49 for brix and G.2003-47 for sucrose. The genotype G.2003-47 was stable for all studied traits, except stalk height and sugar yield was unstable. In addition, the genotype G.2004-27 was stable for all studied traits, except stalk height, brix and sucrose. The genotype G.2011-82 was stable for stalk diameter, stalk weight, cane yield, purity and sugar yield.

The genotype G.2003-47 performed consistently better in favourable environments for stalk diameter and stalk weight, cane yield and sugar recovery as well as G.T.54-9 for stalk weight, purity and sugar recovery. In addition, the genotype G.2010-26 was relatively better in less favourable environments for stalk diameter, brix, sucrose and sugar recovery.

The results of the stability analysis revealed that the promising sugarcane genotype G.2004-27 had higher cane and sugar yields than the grand mean; its regression coefficient was insignificant from unity and its deviation from regression insignificant from zero. This genotype was considered the best in terms of adaptation to all environments, indicating that it was the best stable genotype under study. However, the control variety G.T.54-9 was suitable for unfavorable environments due to its regression coefficient lower than unity and deviation from regression insignificant from zero for cane yield, but, it was suitable for favorable environments due to its regression coefficient greater than unity and deviation from regression insignificant from zero for sugar yield.

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Appendix 1. Average performance of 11 genotypes in two years, at three locations and two harvesting for stalk height.

Genotypes	2015/2016									2016/2017								
	Kom-Ombo			El-Mattana			Shandaweel			Kom-Ombo			El-Mattana			Shandaweel		
	H_1	H_2	Average	H_1	H_2	Average	H_1	H_2	Average	H_1	H_2	Average	H_1	H_2	Average	H_1	H_2	Average
G.84-47	305.3	307.7	306.5	329.3	331.0	330.2	298.0	300.3	299.2	304.3	305.0	304.7	314.0	315.0	314.5	284.7	286.0	285.3
G.99-103	325.3	335.0	330.2	315.0	321.0	318.0	271.0	277.0	274.0	319.3	321.0	320.2	300.7	305.0	302.8	270.0	274.0	272.0
G.2003-44	313.7	316.3	315.0	297.3	300.3	298.8	274.3	276.7	275.5	292.7	295.0	293.8	301.0	301.7	301.3	295.0	296.7	295.8
G.2003-47	301.7	304.7	303.2	267.3	270.7	269.0	266.0	271.0	268.5	285.3	286.7	286.0	284.7	288.3	286.5	283.7	285.3	284.5
G.2003-49	305.7	305.7	305.7	287.7	292.3	290.0	258.3	262.0	260.2	287.7	290.0	288.8	290.7	293.3	292.0	258.0	260.0	259.0
G.2004-27	312.7	315.7	314.2	300.3	305.0	302.7	278.3	283.7	281.0	301.0	305.0	303.0	303.7	306.7	305.2	292.3	293.3	292.8
G.2007-61	303.0	304.3	303.7	286.3	287.7	287.0	264.0	223.0	243.5	274.7	276.7	275.7	293.3	293.7	293.5	253.0	254.0	253.5
G.2010-7	310.0	313.3	311.7	298.3	301.7	300.0	286.0	289.7	287.8	304.0	305.0	304.5	314.3	315.7	315.0	290.0	290.7	290.3
G.2010-26	275.0	276.0	275.5	266.0	270.0	268.0	188.7	193.3	191.0	234.7	238.3	236.5	262.3	263.3	262.8	145.0	145.3	145.2
G.2011-82	309.0	311.0	310.0	299.0	304.0	301.5	247.0	249.7	248.3	310.7	313.3	312.0	290.7	291.7	291.2	233.3	233.7	233.5
G.T.54-9 (control variety)	308.0	312.0	310.0	277.0	281.7	279.3	286.3	289.3	287.8	305.7	306.7	306.2	291.3	293.3	292.3	285.3	286.7	286.0
Average	306.3	309.2	307.8	293.1	296.8	295.0	265.3	265.1	265.2	292.7	294.8	293.8	295.2	297.1	296.1	262.8	264.2	263.5

Appendix 2. Average performance of 11 genotypes in two years, at three locations and two harvesting for stalk diameter.

Genotypes	2015/2016									2016/2017								
	Kom-Ombo			El-Mattana			Shandaweel			Kom-Ombo			El-Mattana			Shandaweel		
	H_1	H_2	Average	H_1	H_2	Average	H_1	H_2	Average	H_1	H_2	Average	H_1	H_2	Average	H_1	H_2	Average
G.84-47	2.40	2.40	2.40	2.53	2.57	2.55	2.33	2.37	2.35	2.40	2.43	2.42	2.37	2.37	2.37	2.30	2.33	2.32
G.99-103	2.83	2.87	2.85	2.97	3.23	3.10	2.97	3.13	3.05	2.67	2.67	2.67	2.57	2.60	2.58	2.93	2.97	2.95
G.2003-44	2.43	2.47	2.45	2.67	2.67	2.67	2.43	2.53	2.48	2.40	2.47	2.43	2.47	2.40	2.43	2.50	2.50	2.50
G.2003-47	2.53	2.57	2.55	2.77	2.73	2.75	2.57	2.67	2.62	2.50	2.53	2.52	2.50	2.53	2.52	2.67	2.60	2.63
G.2003-49	2.60	2.60	2.60	2.67	2.77	2.72	2.63	2.60	2.62	2.40	2.47	2.43	2.40	2.40	2.40	2.63	2.63	2.63
G.2004-27	2.63	2.57	2.60	2.63	2.67	2.65	2.57	2.50	2.53	2.60	2.57	2.58	2.50	2.57	2.53	2.50	2.53	2.52
G.2007-61	2.43	2.43	2.43	2.60	2.63	2.62	2.33	2.33	2.33	2.37	2.50	2.43	2.23	2.30	2.27	2.57	2.60	2.58
G.2010-7	2.47	2.53	2.50	2.57	2.50	2.53	2.37	2.37	2.37	2.43	2.43	2.43	2.47	2.57	2.52	2.30	2.40	2.35
G.2010-26	2.63	2.67	2.65	2.73	2.73	2.73	2.60	2.67	2.63	2.63	2.63	2.63	2.63	2.70	2.67	2.60	2.57	2.58
G.2011-82	2.40	2.40	2.40	2.47	2.47	2.47	2.40	2.33	2.37	2.37	2.30	2.33	2.33	2.33	2.33	2.40	2.40	2.40
G.T.54-9 (control variety)	2.57	2.60	2.58	2.53	2.67	2.60	2.37	2.43	2.40	2.57	2.57	2.57	2.57	2.57	2.57	2.67	2.70	2.68
Average	2.54	2.55	2.55	2.65	2.69	2.67	2.51	2.54	2.52	2.48	2.51	2.50	2.46	2.48	2.47	2.55	2.57	2.56

Appendix 3. Average performance of 11 genotypes in two years, at three locations and two harvesting for stalk weight.

Genotypes	2015/2016									2016/2017								
	Kom-Ombo			El-Mattana			Shandaweel			Kom-Ombo			El-Mattana			Shandaweel		
	H_1	H_2	Average	H_1	H_2	Average	H_1	H_2	Average	H_1	H_2	Average	H_1	H_2	Average	H_1	H_2	Average
G.84-47	1.18	1.24	1.21	1.42	1.44	1.43	1.10	1.15	1.13	0.98	1.21	1.10	1.10	1.13	1.12	1.02	1.08	1.05
G.99-103	1.87	1.81	1.84	1.75	2.04	1.90	1.30	1.42	1.36	1.29	1.37	1.33	1.20	1.30	1.25	1.67	1.73	1.70
G.2003-44	1.19	1.24	1.22	1.45	1.48	1.47	0.96	1.04	1.00	1.00	1.22	1.11	0.89	0.94	0.92	1.02	1.13	1.07
G.2003-47	1.41	1.49	1.45	1.36	1.41	1.39	1.17	1.25	1.21	1.16	1.32	1.24	1.10	0.94	1.02	1.23	1.28	1.25
G.2003-49	1.48	1.52	1.50	1.24	1.32	1.28	1.07	1.18	1.13	0.95	1.27	1.11	1.02	1.04	1.03	1.23	1.31	1.27
G.2004-27	1.72	1.41	1.56	1.19	1.29	1.24	0.99	1.12	1.06	1.28	1.44	1.36	1.05	1.01	1.03	1.10	1.21	1.15
G.2007-61	1.21	1.23	1.22	1.42	1.43	1.43	0.92	0.94	0.93	1.05	1.34	1.20	0.83	0.80	0.81	1.10	1.21	1.16
G.2010-7	1.46	1.83	1.65	1.40	1.48	1.44	1.16	1.36	1.26	1.29	1.21	1.25	1.09	1.11	1.10	0.97	1.06	1.01
G.2010-26	1.09	1.20	1.14	1.28	1.39	1.34	0.90	1.19	1.05	1.07	1.32	1.20	1.16	1.07	1.12	0.63	0.65	0.64
G.2011-82	1.21	1.23	1.22	1.13	1.25	1.19	0.90	0.94	0.92	1.11	1.27	1.19	1.07	1.01	1.04	0.92	1.00	0.96
G.T.54-9 (control variety)	1.34	1.89	1.62	1.52	1.38	1.45	1.08	1.28	1.18	1.35	1.40	1.38	0.78	0.98	0.88	1.20	1.29	1.24
Average	1.38	1.46	1.42	1.38	1.45	1.41	1.05	1.17	1.11	1.14	1.31	1.22	1.03	1.03	1.03	1.10	1.18	1.14

Appendix 4. Average performance of 11 genotypes in two years, at three locations and two harvesting for cane yield.

Genotypes	2015/2016									2016/2017								
	Kom-Ombo			El-Mattana			Shandaweel			Kom-Ombo			El-Mattana			Shandaweel		
	H_1	H_2	Average	H_1	H_2	Average	H_1	H_2	Average	H_1	H_2	Average	H_1	H_2	Average	H_1	H_2	Average
G.84-47	46.84	49.51	48.17	77.68	78.67	78.18	40.22	42.51	41.36	52.35	64.60	58.48	66.82	68.86	67.84	45.09	47.93	46.51
G.99-103	64.34	63.47	63.91	73.91	85.98	79.95	46.55	50.26	48.41	52.06	55.71	53.88	69.65	75.93	72.79	59.19	61.32	60.26
G.2003-44	48.66	51.65	50.16	69.11	70.32	69.72	32.49	34.53	33.51	47.91	58.52	53.22	50.85	53.78	52.31	42.52	46.88	44.70
G.2003-47	65.13	68.86	67.00	55.50	57.23	56.37	45.54	48.28	46.91	57.39	64.58	60.99	59.37	50.31	54.84	55.82	58.04	56.93
G.2003-49	65.85	67.84	66.85	48.78	49.11	48.95	48.30	53.19	50.74	47.43	63.50	55.47	45.98	46.73	46.36	55.76	59.35	57.55
G.2004-27	70.42	59.80	65.11	57.93	63.03	60.48	43.33	48.64	45.99	54.55	61.36	57.96	59.33	57.40	58.37	51.56	56.71	54.13
G.2007-61	65.49	66.61	66.05	57.02	57.14	57.08	48.22	49.27	48.75	62.20	79.75	70.97	42.86	42.45	42.65	54.49	60.05	57.27
G.2010-7	62.20	70.45	66.32	50.04	53.41	51.73	53.77	62.40	58.09	65.34	61.35	63.35	58.38	59.86	59.12	43.44	47.13	45.29
G.2010-26	49.78	54.69	52.24	44.36	48.14	46.25	39.36	51.77	45.56	40.84	50.49	45.66	47.79	44.52	46.15	26.73	27.60	27.17
G.2011-82	56.95	60.01	58.48	54.27	60.13	57.20	45.54	47.73	46.64	54.45	62.05	58.25	61.23	58.26	59.75	43.98	48.00	45.99
G.T.54-9 (control variety)	59.40	66.67	63.04	59.53	58.19	58.86	42.98	51.61	47.30	66.14	68.52	67.33	41.25	52.25	46.75	53.27	57.69	55.48
Average	59.55	61.78	60.67	58.92	61.94	60.43	44.21	49.11	46.66	54.61	62.77	58.69	54.87	55.48	55.18	48.35	51.88	50.12

Appendix 5. Average performance of 11 genotypes in two years, at three locations and two harvesting for brix.

Genotypes	2015/2016									2016/2017								
	Kom-Ombo			El-Mattana			Shandaweel			Kom-Ombo			El-Mattana			Shandaweel		
	H_1	H_2	Average	H_1	H_2	Average	H_1	H_2	Average	H_1	H_2	Average	H_1	H_2	Average	H_1	H_2	Average
G.84-47	19.62	22.01	20.81	18.33	20.57	19.45	20.80	21.99	21.40	22.00	23.50	22.75	18.87	22.13	20.50	20.19	21.95	21.07
G.99-103	18.03	19.50	18.77	17.13	18.57	17.85	18.24	20.40	19.32	18.67	21.05	19.86	18.63	20.47	19.55	19.83	21.46	20.65
G.2003-44	19.56	21.13	20.35	19.17	19.70	19.43	20.13	21.11	20.62	22.50	21.41	21.95	20.07	20.37	20.22	20.84	21.27	21.06
G.2003-47	20.56	21.84	21.20	19.27	19.97	19.62	20.15	22.32	21.24	21.86	23.13	22.50	20.07	21.83	20.95	21.83	22.87	22.35
G.2003-49	20.26	21.73	21.00	19.00	19.13	19.07	19.67	21.75	20.71	21.83	22.61	22.22	19.90	21.00	20.45	22.11	22.91	22.51
G.2004-27	20.08	19.89	19.99	17.33	19.50	18.42	18.71	21.27	19.99	21.05	22.13	21.59	18.77	21.67	20.22	19.07	20.50	19.79
G.2007-61	19.70	21.32	20.51	18.13	19.70	18.92	20.80	21.36	21.08	20.49	22.13	21.31	19.60	19.93	19.77	21.59	22.39	21.99
G.2010-7	16.72	19.31	18.01	17.13	17.23	17.18	17.70	18.95	18.33	18.13	19.33	18.73	19.93	20.57	20.25	18.73	19.27	19.00
G.2010-26	20.06	20.70	20.38	18.97	19.37	19.17	20.23	22.44	21.34	21.22	21.99	21.61	19.77	21.13	20.45	21.91	22.48	22.20
G.2011-82	19.81	21.31	20.56	17.23	20.20	18.72	20.62	22.01	21.31	20.85	23.45	22.15	18.57	21.33	19.95	21.48	22.96	22.22
G.T.54-9 (control variety)	19.71	20.20	19.96	16.57	17.23	16.90	19.61	21.30	20.46	20.64	21.21	20.93	19.40	21.73	20.57	20.99	22.05	21.52
Average	19.46	20.81	20.14	18.02	19.20	18.61	19.70	21.35	20.53	20.84	22.00	21.42	19.42	21.11	20.26	20.78	21.83	21.30

Appendix 6. Average performance of 11 genotypes in two years, at three locations and two harvesting for sucrose.

Genotypes	2015/2016									2016/2017								
	Kom-Ombo			El-Mattana			Shandaweel			Kom-Ombo			El-Mattana			Shandaweel		
	H_1	H_2	Average	H_1	H_2	Average	H_1	H_2	Average	H_1	H_2	Average	H_1	H_2	Average	H_1	H_2	Average
G.84-47	16.88	18.83	17.86	16.30	18.10	17.20	17.04	18.24	17.64	18.60	21.21	19.91	13.66	18.30	15.98	15.55	17.12	16.34
G.99-103	15.67	16.99	16.33	14.62	15.37	15.00	14.76	16.87	15.82	15.87	18.00	16.94	14.11	16.74	15.43	16.19	17.62	16.91
G.2003-44	17.49	18.46	17.98	15.84	16.37	16.11	17.26	17.65	17.45	19.29	18.88	19.09	16.57	16.75	16.66	17.61	17.91	17.76
G.2003-47	18.09	19.47	18.78	17.15	16.05	16.60	17.92	18.88	18.40	19.75	20.62	20.19	16.39	19.23	17.81	18.57	19.58	19.07
G.2003-49	18.03	19.31	18.67	16.54	16.10	16.32	16.70	18.34	17.52	19.17	19.96	19.57	16.32	18.65	17.48	20.02	20.92	20.47
G.2004-27	17.52	16.65	17.09	13.81	16.63	15.22	14.91	17.22	16.07	18.03	18.61	18.32	14.26	16.73	15.50	14.94	16.46	15.70
G.2007-61	16.94	17.51	17.23	15.19	16.38	15.79	18.19	17.76	17.98	17.78	19.41	18.60	14.07	16.13	15.10	17.89	18.58	18.23
G.2010-7	13.39	16.22	14.81	13.46	13.69	13.58	13.96	14.30	14.13	14.90	16.64	15.77	16.54	17.27	16.91	14.81	15.25	15.03
G.2010-26	17.24	17.83	17.54	16.13	14.89	15.51	17.06	18.95	18.00	18.19	19.13	18.66	15.35	17.49	16.42	17.40	18.15	17.78
G.2011-82	16.98	18.43	17.71	14.04	15.50	14.77	16.87	18.15	17.51	18.11	21.21	19.66	14.19	17.38	15.79	17.59	18.94	18.26
G.T.54-9 (control variety)	17.01	17.74	17.38	13.81	14.07	13.94	16.13	17.71	16.92	18.32	18.71	18.52	15.10	18.85	16.98	17.60	18.64	18.12
Average	16.84	17.95	17.40	15.17	15.74	15.46	16.44	17.64	17.04	18.00	19.31	18.66	15.14	17.59	16.37	17.10	18.11	17.61

Appendix 7. Average performance of 11 genotypes in two years, at three locations and two harvesting for purity.

Genotypes	2015/2016									2016/2017								
	Kom-Ombo			El-Mattana			Shandaweel			Kom-Ombo			El-Mattana			Shandaweel		
	H_1	H_2	Average	H_1	H_2	Average	H_1	H_2	Average	H_1	H_2	Average	H_1	H_2	Average	H_1	H_2	Average
G.84-47	86.06	85.55	85.81	88.87	87.99	88.43	81.92	82.91	82.41	84.55	90.26	87.41	72.40	82.55	77.48	77.03	78.01	77.52
G.99-103	86.89	87.14	87.01	85.36	82.80	84.08	80.92	82.71	81.81	85.01	85.69	85.35	75.74	81.76	78.75	81.64	82.13	81.88
G.2003-44	89.42	87.35	88.38	82.70	83.08	82.89	85.80	83.61	84.71	85.90	88.21	87.05	82.56	82.19	82.38	84.45	84.16	84.31
G.2003-47	87.99	89.15	88.57	88.96	80.42	84.69	89.04	84.60	86.82	90.33	89.14	89.74	81.69	88.18	84.93	85.06	85.60	85.33
G.2003-49	88.99	88.85	88.92	87.07	84.09	85.58	84.90	84.31	84.61	87.82	88.28	88.05	82.00	88.81	85.40	90.50	91.32	90.91
G.2004-27	87.24	83.68	85.46	79.67	86.23	82.95	79.66	81.21	80.43	85.67	84.09	84.88	76.01	77.29	76.65	78.30	80.28	79.29
G.2007-61	86.03	82.11	84.07	83.62	83.17	83.39	87.48	83.21	85.34	86.77	87.69	87.23	71.80	80.89	76.34	82.84	82.96	82.90
G.2010-7	80.08	83.86	81.97	78.55	79.31	78.93	75.00	75.62	75.31	82.18	86.10	84.14	82.98	84.00	83.49	79.03	79.09	79.06
G.2010-26	85.95	86.11	86.03	85.03	76.63	80.83	84.82	83.58	84.20	85.70	86.96	86.33	77.67	82.75	80.21	79.37	80.74	80.05
G.2011-82	85.73	86.50	86.12	81.28	76.73	79.01	81.79	83.05	82.42	86.88	90.46	88.67	76.50	81.46	78.98	81.89	82.50	82.20
G.T.54-9 (control variety)	86.30	87.68	86.99	83.40	81.65	82.53	82.06	83.11	82.59	88.76	88.20	88.48	77.77	86.75	82.26	83.82	84.52	84.17
Average	86.43	86.18	86.30	84.05	82.01	83.03	83.04	82.54	82.79	86.33	87.74	87.03	77.92	83.33	80.62	82.17	82.85	82.51

Appendix 8. Average performance of 11 genotypes in two years, at three locations and two harvesting for sugar recovery.

Genotypes	2015/2016									2016/2017								
	Kom-Ombo			El-Mattana			Shandaweel			Kom-Ombo			El-Mattana			Shandaweel		
	H_1	H_2	Average	H_1	H_2	Average	H_1	H_2	Average	H_1	H_2	Average	H_1	H_2	Average	H_1	H_2	Average
G.84-47	11.52	12.84	12.18	11.30	12.50	11.90	11.34	12.22	11.78	12.62	14.82	13.72	8.45	11.77	10.11	10.00	11.09	10.54
G.99-103	10.75	11.67	11.21	9.94	10.29	10.12	9.76	11.29	10.52	10.77	12.34	11.55	8.98	11.14	10.06	10.75	11.74	11.25
G.2003-44	12.16	12.70	12.43	10.72	10.98	10.85	11.76	11.88	11.82	13.30	13.05	13.18	11.07	11.18	11.12	11.91	12.09	12.00
G.2003-47	12.49	13.52	13.00	11.33	10.58	10.95	12.43	12.78	12.61	13.80	14.35	14.08	10.90	13.37	12.13	12.60	13.33	12.97
G.2003-49	12.51	13.09	12.80	11.39	10.86	11.13	11.32	12.39	11.86	13.22	13.80	13.51	10.87	12.93	11.90	14.00	14.69	14.35
G.2004-27	12.04	11.21	11.63	9.21	10.91	10.06	9.77	11.40	10.59	12.28	12.55	12.41	9.09	10.92	10.01	9.70	10.83	10.27
G.2007-61	11.56	11.67	11.62	10.22	10.99	10.61	12.51	11.92	12.22	12.19	13.37	12.78	8.66	10.66	9.66	11.98	12.45	12.21
G.2010-7	8.81	10.94	9.88	8.75	8.96	8.86	8.21	9.08	8.64	9.94	11.36	10.65	11.08	11.65	11.37	9.67	9.95	9.81
G.2010-26	11.76	12.18	11.97	10.95	9.57	10.26	11.52	12.53	12.03	12.39	13.12	12.76	10.07	11.14	10.61	11.38	11.99	11.69
G.2011-82	11.63	12.61	12.12	9.31	9.94	9.63	11.22	12.12	11.67	12.42	14.21	13.32	9.08	11.54	10.31	11.70	12.65	12.18
G.T.54-9 (control variety)	11.63	12.23	11.93	9.27	9.34	9.31	10.75	11.88	11.32	12.70	12.93	12.82	9.76	12.92	11.34	11.86	12.61	12.23
Average	11.53	12.24	11.89	10.22	10.45	10.33	10.96	11.77	11.37	12.33	13.26	12.80	9.82	11.75	10.78	11.41	12.13	11.77

Appendix 9. Average performance of 11 genotypes in two years, at three locations and two harvesting for sugar yield.

Genotypes	2015/2016									2016/2017								
	Kom-Ombo			El-Mattana			Shandaweel			Kom-Ombo			El-Mattana			Shandaweel		
	H_1	H_2	Average	H_1	H_2	Average	H_1	H_2	Average	H_1	H_2	Average	H_1	H_2	Average	H_1	H_2	Average
G.84-47	5.40	6.36	5.88	7.27	7.75	7.51	4.56	5.25	4.90	6.10	8.98	7.54	5.30	7.34	6.32	4.44	4.50	4.47
G.99-103	6.56	7.02	6.79	5.35	6.44	5.89	4.54	5.67	5.11	5.18	6.41	5.80	5.90	7.27	6.58	5.93	6.34	6.13
G.2003-44	5.89	6.53	6.21	7.41	7.33	7.37	3.83	4.09	3.96	5.83	7.12	6.48	5.55	5.62	5.58	4.59	4.78	4.68
G.2003-47	8.14	8.86	8.50	6.32	6.05	6.18	5.69	6.17	5.93	6.47	8.23	7.35	6.01	5.76	5.89	6.27	7.20	6.74
G.2003-49	8.24	8.45	8.34	5.55	5.30	5.43	5.47	6.58	6.02	5.74	8.21	6.97	4.92	5.52	5.22	7.24	8.12	7.68
G.2004-27	8.04	6.69	7.37	5.35	6.52	5.93	4.25	5.55	4.90	6.17	7.17	6.67	5.00	6.17	5.59	4.64	5.34	4.99
G.2007-61	7.19	7.37	7.28	5.83	6.26	6.04	6.07	5.87	5.97	7.09	8.79	7.94	3.36	5.52	4.44	6.21	5.31	5.76
G.2010-7	5.49	7.03	6.26	4.34	4.78	4.56	4.35	5.66	5.00	6.42	6.51	6.47	6.03	6.12	6.08	3.49	4.31	3.90
G.2010-26	5.86	6.66	6.26	4.14	4.71	4.42	4.58	6.47	5.53	4.56	6.10	5.33	4.42	4.89	4.65	2.96	2.85	2.90
G.2011-82	6.65	6.72	6.69	4.76	5.35	5.05	5.11	5.79	5.45	6.27	7.30	6.78	5.49	5.86	5.67	3.90	5.57	4.73
G.T.54-9 (control variety)	6.66	7.74	7.20	4.59	4.49	4.54	4.62	6.12	5.37	8.32	8.35	8.34	3.63	7.27	5.45	5.84	6.79	6.31
Average	6.74	7.22	6.98	5.54	5.91	5.72	4.82	5.75	5.28	6.20	7.56	6.88	5.05	6.12	5.59	5.05	5.55	5.30

الملخص العربي

أجريت هذه الدراسة تحت ظروف مصر العليا لتقييم أداء وثبات عشرة سلالات خضرية جديدة من قصب السكر بالإضافة الى الصنف التجاري جيزة- تايوان ٥٤-٩ (س٩). هذه الدراسة أقيمت في اثنتي عشرة بيئة (ست بيئات لكل سنة)، هذه البيئات تمثل ثلاث مواقع (كوم امبو- محافظة أسوان، المطاعنة- محافظة الأقصر، شندويل- محافظة سوهاج) وعمرين للحصاد هما، ١١ و ١٢ شهر لمحصول الغرس ٢٠١٦/٢٠١٥ ومحصول الخلفة الأولى ٢٠١٧/٢٠١٦. تمت زراعة هذه التراكيب الوراثية في الأسبوع الأول من شهر مارس لسنة ٢٠١٦/٢٠١٥. وكان التصميم التجريبي المستخدم هو القطع المنشقة مرة واحدة في ثلاثة مكررات حيث وضعت مواعيد الحصاد بالقطع الرئيسية والتراكيب الوراثية بالقطع المنشقة. وكانت الصفات المدروسة هي (ارتفاع النبات، قطر الساق، وزن العود، محصول العيدان، البركس، السكروز، النقاوة، ناتج السكر، محصول السكر) في كل ميعاد حصاد. وتم اجراء التحليل المشترك للست بيئات لكل سنة، وحساب معامل الارتباط بين الصفات. كما تم اجراء تحليل الثبات باستخدام طريقة ابرهارت وراشيل (١٩٦٦).

- وكانت أهم النتائج كما يلي:

١- تقييم اداء التراكيب الوراثية وارتباط الصفات:

١- أ- محصول الغرس:

أظهرت النتائج وجود اختلافات معنوية بين التراكيب الوراثية في كل الصفات، فقد سجل التركيب الوراثي جيزة ٩٩-١٠٣ أعلى القيم في صفات قطر الساق ووزن العود ومحصول العيدان، كما سجل التركيب الوراثي جيزة ٨٤-٤٧ أعلى القيم في صفة ارتفاع النبات، بينما سجل التركيب الوراثي جيزة ٢٠٠٣-٤٧ أعلى القيم في صفات البركس والسكروز والنقاوة وناتج السكر ومحصول السكر.

أما عن تأثير التفاعل بين التراكيب والمواقع فقد كان معنوياً في جميع الصفات، ففي كوم امبو سجل التركيب الوراثي جيزة ٩٩- ١٠٣ أعلى القيم في صفات ارتفاع النبات وقطر الساق ووزن العود، بينما سجل التركيب الوراثي جيزة ٢٠٠٣-٤٧ أعلى القيم في صفات محصول العيدان والبركس والسكروز وناتج السكر ومحصول السكر، وسجل التركيب الوراثي جيزة ٢٠٠٣-٤٩ اعلى القيم في صفة النقاوة.

بينما في المطاعنة، سجل التركيب الوراثي جيزة ٩٩-١٠٣ أعلى القيم في صفات قطر الساق ووزن العود ومحصول العيدان، وسجل التركيب الوراثي جيزة ٨٤-٤٧ أعلى القيم في صفات ارتفاع النبات والسكروز والنقاوة وناتج السكر ومحصول السكر، بينما سجل التركيب الوراثي جيزة ٢٠٠٣-٤٧ أعلى القيم في صفة البركس.

أما في شندويل، سجل التركيب الوراثي جيزة ٩٩- ١٠٣ أعلى القيم في صفتي قطر الساق ووزن العود، وسجل التركيب الوراثي جيزة ٨٤-٤٧ أعلى القيم في صفتي ارتفاع النبات والبركس، بينما سجل التركيب الوراثي جيزة ٢٠٠٣-٤٩ أعلى القيم في صفتي محصول العيدان ومحصول السكر، بينما سجل التركيب الوراثي جيزة ٢٠٠٣-٤٧ أعلى القيم في صفات السكروز والنقاوة وناتج السكر.

تأثرت النتائج باختلاف مواعيد الحصاد و كانت الفروق معنوية في جميع الصفات عدا صفتي قطر الساق والنقاوة. وكان التفوق لصالح موعد الحصاد الثاني (بعد ١٢ شهر) لكل الصفات.

كان الارتباط بين محصول القصب وكل من الطول ووزن العود موجب معنوي بينما كان موجب غير معنوي بينه وبين كل من قطر الساق ومحصول السكر.

بينما الارتباط بين محصول السكر وكل من السكروز والنقاوة وناتج السكر كان ايجابي معنوي وكان ايجابي غير معنوي بينه وبين كل من ارتفاع النبات وقطر الساق و البركس.

١-ب- محصول الخلفة:

أظهرت النتائج وجود فروق معنوية بين التراكيب الوراثية في كل الصفات، فقد سجل التركيب الوراثي جيزة ٩٩-١٠٣ أعلى القيم في صفات قطر الساق ووزن العود ومحصول العيدان، وسجل التركيب الوراثي جيزة ٢٠١٠-٧ أعلى القيم في صفة ارتفاع النبات، وسجل التركيب الوراثي جيزة ٢٠٠٣-٤٧ أعلى القيم في صفة البركس، وسجل التركيب الوراثي جيزة ٢٠٠٣-٤٩ أعلى القيم في صفات السكروز والنقاوة وناتج السكر، بينما سجل الصنف التجاري جيزة- تايوان ٥٤-٩ (س٩) أعلى القيم في صفة محصول السكر.

أما عن تأثير التفاعل بين التراكيب والمواقع فقد كان معنوياً في جميع الصفات، ففي كوم امبو فقد سجل التركيب الوراثي جيزة ٩٩-١٠٣ أعلى القيم في صفات ارتفاع وقطر الساق، بينما سجل الصنف التجاري جيزة- تايوان ٥٤-٩ (س٩) أعلى القيم في صفتي وزن العود ومحصول السكر، وسجل التركيب الوراثي جيزة ٢٠٠٧-٦١ أعلى القيم في صفة محصول القصب، بينما

سجل التركيب الوراثي جيزة ٢٠٠٣-٤٧ أعلى القيم في صفات السكروز والنقاوة وناتج السكر، وسجل التركيب الوراثي جيزة ٨٤-٤٧ أعلى القيم في صفة البركس.

في المطاعنة، سجل التركيب الوراثي جيزة ٢٠١٠-٧ أعلى القيم في ارتفاع النبات، وسجل التركيب الوراثي جيزة ٢٠١٠- ٢٦ أعلى القيم في صفة قطر الساق، وسجل التركيب الوراثي جيزة ٩٩-١٠٣ أعلى القيم في صفتي وزن العود ومحصول العيدان ومحصول السكر، بينما سجل التركيب الوراثي جيزة ٢٠٠٣-٤٧ أعلى القيم في صفات البركس والسكروز وناتج السكر، وسجل التركيب الوراثي جيزة ٢٠٠٣-٤٩ أعلى القيم في صفة النقاوة.

أما في شندويل، سجل التركيب الوراثي جيزة ٩٩- ١٠٣ أعلى القيم في صفات قطر الساق ووزن العود ومحصول العيدان، وسجل التركيب الوراثي جيزة ٢٠٠٣-٤٤ أعلى القيم في صفة ارتفاع النبات، بينما سجل التركيب الوراثي جيزة ٢٠٠٣-٤٩ أعلى القيم في صفات البركس والسكروز والنقاوة وناتج السكر ومحصول السكر.

تأثرت النتائج باختلاف مواعيد الحصاد و كانت الفروق معنوية في جميع الصفات عدا صفة قطر الساق. وكان التفوق لصالح موعد الحصاد الثاني (بعد ١٢ شهر) لكل الصفات.

كان الارتباط بين محصول القصب وبين كل من ارتفاع النبات ووزن العود ومحصول السكر ايجابي معنوي، بينما كان ايجابي غير معنوي بينه وبين الصفات الاخرى.

أما الارتباط بين محصول السكر والطول كان ايجابي ومعنوي، بينما كان سلبي غير معنوي مع قطر الساق، وكان ايجابي غير معنوي بينه وبين باقي الصفات.

٢- تحليل الثبات:

لقد أظهرت النتائج أن تأثيرات التراكيب الوراثية، والبيئات كانت معنوية جدا لكل الصفات المدروسة. بينما التفاعل بين التراكيب الوراثية x البيئات كان عالي المعنوية لصفات ارتفاع النبات وقطر الساق ووزن العود، وكان معنوي لباقي الصفات.

كما أظهرت تحليلات الثبات تفوق التركيب الوراثي جيزة ٢٠٠٤-٢٧ في صفتي وزن العود ومحصول العيدان، بينما التراكيب الوراثية جيزة ٢٠٠٣-٤٧ وجيزة ٢٠٠٣-٤٩ تفوقتا في صفة البركس، وتفوق التركيب الوراثي جيزة ٢٠٠٣-٤٧ في صفة السكروز.

أيضا أظهرت تحليلات الثبات أن التركيب الوراثي جيزة ٢٠٠٣-٤٧ ثابت في البيئات الجيدة لصفات قطر الساق ووزن العود ومحصول العيدان وناتج السكر.

بينما التركيب الوراثي جيزة ٢٠٠٤-٢٧ كان عالي المحصول وثابت في صفتي محصول العيدان والسكر. بينما الصنف التجاري جيزة- تايوان ٥٤-٩ (س٩) كان ثابت في البيئات الغير جيدة لصفة محصول العيدان وثابت في البيئات الجيدة لصفة محصول السكر.

كما أظهرت تحليلات الثبات أن التركيب الوراثي جيزة ٢٠١١-٨٢ ثابت في صفات قطر الساق ووزن العود ومحصولي العيدان والسكر، والنقاوة.

بينما التركيب الوراثي جيزة ٢٠١٠-٢٦ ثابت في البيئات الغير جيدة لصفات قطر الساق والبركس والسكروز وناتج السكر.

تقييم وتحليل الثبات لبعض التراكيب الوراثيه لقصب السكر خلال بيئات مختلفه

رسالة مقدمة من

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للاستيفاء الجزئى لمتطلبات الحصول على درجة

الماجستير فى العلوم الزراعية

(محاصيل)

من

قسم المحاصيل

كلية الزراعة- جامعة جنوب الوادى

٢٠٢١

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