SVU-International Journal of Agricultural Science
Volume 2 Issue (2) pp.: 144-165, 2020
Print ISSN 2636-3801 | Online ISSN 2636-381X
Doi: 10.21608/svuijas.2020.38830.1023

RESEARCH ARTICLE

# Yield and quality of some sugarcane varieties as affected by irrigation number

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## Abstract

Two field experiments were conducted at Shandaweel Agricultural Research Station, Sohag Governorate, Egypt (latitude of 26 61° N, longitude of 31 52° E) in 2018/2019 and 2019/2020 seasons to assess the effect of number of irrigations on yield and quality of some sugarcane varieties. This work included 12 treatments, represent the combinations among (16, 18 and 20 irrigations/season) and sugarcane genotypes namely G.2004-27, G.2003-47, G.T.54-9 and 2005-47 genotype. A randomized complete block design was used in a split plot arrangement. Phenotypic, genotypic coefficient of variation and heritability% of growth, quality traits and yields of cane varieties were studied. Supplying sugarcane with 20 irrigations significantly increased number of millable canes, cane and sugar yields/fed sucrose% and sugar recovery%. Sugarcane varieties differed markedly in all studied traits. Sugarcane G.T.54-9 variety recorded the highest cane yield/fed, while G.2003-47 was superior in sucrose% and sugar recovery% and sugar yield/fed. Stalk height recorded the highest values of genotypic (σ2g) and phenotypic (σ2p) followed by cane yield/fed. Sugar recovery% recorded the highest values of GCV and PCV. Significant and positive correlation was found between cane yield, cane weight and number of millable canes. Sugar yield/fed was significantly and positively correlated with juice purity%, followed by sugar recovery%, then sucrose%. Planting the commercial variety *viz.* G.T.54-9 given 20 irrigations is preferable to get the highest cane yield/fed, without significant difference with G.2004-27 at 16 irrigations. Planting G.2003-47 supplied with 16 irrigations can be recommended for the highest sugar yield/fed, without variance with G.T.54-9 at 20 irrigations.

**Key word:** Irrigation; PCV; GCV; Heritability; Sugarcane

## Introduction

Water is one of the main determining factors for sugarcane (*Saccharum spp.*) production. Also sugarcane plants may be adversely affected by wasteful irrigation water by percolation and the loss of available nutrients beyond root zone. In addition, excessive application of water causes inadequate soil aeration and low water potential. In this respect,

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Received: August 11, 2020;
Accepted: September 6, 2020;
Published: September 9, 2020.

El-Shafai (1996) cleared that applying irrigation at shorter intervals increased number of sugarcane plants/$m^2$ and stalk diameter, applying 26 irrigations/season produced the highest sugarcane yield without significant differences with applying 20 and 17 irrigations/season. Gomaa (2000) irrigated sugarcane every 14, 21, 28, 35 and 42 days. His results showed that stalk height and sucrose percentage increased as irrigation intervals decreased. Bekheet (2006) concluded that stalk length, stalk diameter and cane yield/fed increased significantly by decreasing irrigation intervals from 20 to 12 days. He added that applying irrigation water every 12 or 16 days attained significant increase in the number of millable canes/fed and sugar yield/fed. Wiedenfeld and Enciso (2008) found that increasing water application resulted in increasing growth of sugarcane but no significant differences in cane or sugar yields. Ahmed, *et al.* (2014) showed that increasing the number of irrigations from 14 to 18 and 22 increased considerably stalk height, number of millable canes/$m^2$, cane and sugar yields/fed. Meanwhile, sucrose, purity and sugar recovery percentages were insignificantly influenced by irrigation number. Shahrzad and Abd El Hak (2014) indicated that applying 25 irrigations increased in stalk length, stalk diameter, cane and sugar yields of sugarcane as well as brix, sucrose and purity % compared with 18 and/or 32 irrigations through the two successive seasons.

In Egypt, the commercial cane variety G.T.54-9 occupies most of the area planted with sugarcane. Recently, Sugar Crops Research Institute developed a lot of promising varieties of sugarcane, among them G.2003-47 (G. 3) and G.2004-27 (G. 4), which were registered in 2017, in addition to G.2005-47 genotype. The newly bred varieties showed variable response to different agronomic practices. In this respect, Gomaa (2000) found that stalk height and sucrose percentage of G.T.54-9, G.85-37, G.84-47 and F.153 sugarcane varieties differed significantly. Makhlouf, *et al.* (2016) found that sugarcane variety G.T.54-9 overpassed the two promising varieties (G.2003-47 and G.2003-49) in length, diameter and fresh weight/stalks, while they exceeded it in brix, purity and sugar recovery% and number of millable canes/fed. However, G.2003-47 gave the highest sugar yield/fed. Fahmy, *et al.* (2017) showed that sugarcane variety G.T.54-9 and G.2003-47 surpassed Phil. 8013 and Cu. 57-14 in number of millable canes/fed, cane and sugar yields/fed. El-Bakry (2018) revealed that the promising G.2003-47 sugarcane variety showed the significant superiority in juice quality traits over the other tested ones. Galal, *et al*. (2018) found that sugarcane G.2003-47 variety had a significant superiority in the number of millable canes/ha and quality traits. The promising sugarcane G.2004-27 variety surpassed the other ones in stalk length, stalk weight as well as cane and sugar yields/ha in the plant and 1st ratoon cane. Ali, *et al.* (2019) showed that sugarcane varieties G.T. 54-

9 and Cu. 57-14 were superior over the other varieties in cane and sugar yields/fad. Gadallah and Abd El-Aziz (2019) manifested that sugarcane variety G.T.54-9 surpassed the other varieties in stalk height and cane yield/fed, while, G.2003-47 variety was superior in stalk diameter, brix, sucrose, sugar recovery and sugar yields/fed. However, G.2004-27 variety attained the highest values of number of millable canes/fed.

High variation between 1st and 2nd seasons was existed in phenotypic coefficient of variation (PCV %), genotypic coefficient of variation (GCV) and heritability% for stalk diameter, stalk length, stalk weight, purity, sugar recovery, cane yield and sugar yield indicating the effect of environments in these traits as reported by Masri, *et al.* (2016), Mehareb and Galal (2017), Mehareb and and Abazied (2017), Mehareb, *et al.* (2017 and 2018) and Abo Elenen, *et al.* 2018 and Mehareb and Mensoub (2020). The estimates for phenotypic coefficient of variation (PCV%) were higher than genotypic coefficient of variation (GCV%) in all these traits.

Principal component analysis is a multivariate technique for examining the relationships among several quantitative variables (Johnson, 2012). It is the most common technique used in variability studies and numerical classification; it is useful in grouping varieties based on their similarities (Bello, 2004). Establishing suitable selection criteria for identifying genotypes with desirable traits is useful in developing improved varieties. Analysis of variability among traits and knowledge of associations among traits contributing to yield would be of great importance in planning a successful breeding program (Mary and Gopalan, 2006).

Principal component (PC) analysis that was used to explain the majority of the total variation **(**Abo Elenen, *et al.*, (2019).

The objective of this study was to evaluate the effect of irrigation scheduling on yield and quality traits of some sugarcane varieties.

**Materials and methods**

A field experiments was conducted at Shandaweel Agricultural Research Station, Sohag Governorate, Egypt (latitude of 26 33° N, longitude of 31 41° E and altitude of 69 m above sea level) during 2018/2019 and 2019/2020 seasons to assess the effect of number of irrigations on yield and quality of some sugarcane varieties. Field experiment this work included 12 treatments, represent the combinations among three irrigation number (16, 18 and 20 irrigations/season, *i.e.* average irrigation intervals of 20.6, 18.3 and 16.5 days along the season, respectively) and four sugarcane genotypes [two newly registered varieties namely G. 2004-27 (Giza-4) and G. 2003-47 (Giza-3) and the commercial variety, *viz.* G.T.54-9 (C-9), in addition to the promising G. 2005-47 genotype]. A randomized complete block design using a split plot arrangement and replicated three times, where the main plots were assigned for the number of irrigations, while sugarcane genotypes were distributed in the sub-plots. Each sub-plot area was 42 $m^2$ including 6 rows of 7 m in length and 1.0 m apart. Irrigation water was added to each experimental plot by a pipe of 4 inch diameter and 60 cm in length, which was equipped with a water meter to calculate the amount of water/plot, where its inlet was towards the main permanent canal and the outlet was directed to the lateral temporary field canal of the irrigated plots. Each plot was irrigated individually by allowing water to flow over the soil through an opening in the temporary field canal. After a complete saturation of the plot, the opening whole is closed and water allowed to flow over another plot. Plots were surrounded with borders of 2 m width to prevent the seepage of water among them. Sugarcane was planted in the last week of February and harvested after 12 months, in both seasons. Irrigation was withholded for one month before harvesting. Phosphorus fertilizer as calcium super phosphate (15% $P_2O_5$) was added once during seed bed preparation at the rate 30 kg $P_2O_5$/fed. Potassium fertilizer was added once as potassium sulfate (48% $K_2O$) with the 2nd dose of N fertilizer at the rate of 48 kg $K_2O$/fed. Chemical and mechanical properties of the experimental soil are presented in Table (1). Soil moisture characteristics are illustrated in Table (2). Meteorological data recorded at the experimental site are shown in in Table (3). The amounts of water ($m^3$/fed) applied to sugarcane throughout the two growing seasons are shown in Table (4).

**Data recorded during harvest as follow**:

1. Millable cane height (cm).

2. Millable cane diameter (cm).

3. Millable cane fresh weight (kg).

A sample of 20 millable canes from each treatment was taken at random, cleaned and crushed to extract the juice, which was analyzed to determine the following quality traits:

1. Brix% (total soluble solids of juice) was determined using "Brix Hydrometer" according to the method described by (Anonymous, 1981).

2. Sucrose% was determined using “Sacharemeter” according to A.O.A.C. (2005).

3. Sugar recovery% was calculated as follows:

Sugar recovery % = [sucrose % - 0.4 (brix % - sucrose %) × 0.73], as shown by Yadav and Sharma (1980).

Where: 0.4 and 0.73 are constants.

The harvested sugarcanes of the middle three rows of each experimental unit were cut, topped, cleaned up from trash and weighed and counted to estimate the following traits:

1. Number of millable canes/fed.

2. Cane yield/fed (ton).

3. Sugar yield/fed (ton), which was estimated according to the following equation:

Sugar yield/fed (ton) = cane yield/fed (ton) x sugar recovery%/100.

Table 1: Chemical and mechanical properties of the upper 40-cm of the experimental soil

| Soil property | | 2018/2019 | 2019/2020 |
|---|---|---|---|
| | Sand % | 56.34 | 59.20 |
| Physical analysis | Silt % | 28.44 | 24.30 |
| | Clay % | 15.22 | 16.50 |
| Soil texture | | Sandy loam | Sandy loam |
| | $Co_3^-$ | 0 | 0 |
| | $HCo_3^-$ | 0.30 | 0.33 |
| | $Cl^-$ | 0.89 | 0.89 |
| | $So4^{--}$ | 1.02 | 1.13 |
| Chemical analysis | $Ca^{++}$ | 0.53 | 0.54 |
| | $Mg^{++}$ | 0.27 | 0.35 |
| | $Na^+$ | 1.25 | 1.31 |
| | $K^+$ | 0.16 | 0.15 |
| | EC (dS/m) | 0.24 | 0.26 |
| | pH | 7.5 | 7.3 |

Table 2: Values of the field capacity, available soil moisture, welting point and bulk density for the experimental site (average of over 2018/2019 and 2019/2020 seasons)

| Soil depth (cm) | Field capacity (%) | Welting point (%) | Available soil moisture (%) | Bulk density ($g/cm^3$) |
|---|---|---|---|---|
| 0-15 | 36 | 18.50 | 17.50 | 1.19 |
| 15-30 | 34 | 17.20 | 16.80 | 1.22 |
| 30-45 | 32 | 16.50 | 15.50 | 1.26 |
| 45-60 | 30 | 15.45 | 14.55 | 1.32 |

Table 3: Meteorological data recorded at Shandaweel Agricultural Research Station (average of 2018/2019 and 2019/2020 seasons)

| Month | Temperature ($C^o$) | | | | | | Relative humidity (%) | | Wind speed (m/sec) | | Total radiation k.w.h/$m^2$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2018/2019 | | | 2019/2020 | | | Aver. | Aver. | Aver. | Aver. | |
| | Max. | Min. | Aver. | Max. | Min. | Aver. | 2018/19 | 2019/20 | 2018/19 | 2019/20 | |
| Mar. | 30.2 | 14.7 | 22.1 | 24.4 | 10.0 | 17.2 | 38.5 | 45.6 | 10.6 | 12.4 | 494 |
| Apr. | 32.1 | 15.8 | 24.2 | 29.6 | 14.2 | 21.6 | 38.1 | 38.8 | 11.5 | 13.4 | 547 |
| May | 37.6 | 22.0 | 29.5 | 37.3 | 22.3 | 29.8 | 30.3 | 30.2 | 11.0 | 11.6 | 604 |
| Jun. | 38.2 | 22.2 | 30.8 | 38.6 | 25.2 | 31.9 | 34.2 | 35.1 | 12.6 | 13.0 | 638 |
| Jul. | 37.7 | 25.1 | 31.4 | 38.5 | 24.3 | 32.0 | 42.6 | 35.9 | 11.8 | 10.6 | 630 |
| Aug. | 36.8 | 25.1 | 31.1 | 38.3 | 25.6 | 31.9 | 41.9 | 36.3 | 12.6 | 9.0 | 609 |
| Sep. | 35.1 | 22.2 | 28.4 | 34.7 | 21.2 | 28.4 | 48.0 | 47.0 | 12.8 | 11.5 | 540 |
| Oct. | 32.2 | 17.1 | 25.2 | 33.3 | 19.6 | 26.1 | 48.3 | 48.9 | 11.4 | 10.7 | 459 |
| Nov. | 26.3 | 12.9 | 18.9 | 28.1 | 14.0 | 20.5 | 56.2 | 53.7 | 9.1 | 8.9 | 379 |
| Dec. | 20.6 | 8.3 | 13.8 | 21.1 | 7.9 | 14.3 | 64.4 | 59.4 | 10.3 | 9.7 | 337 |
| Jan. | 19.0 | 6.2 | 11.9 | 18.1 | 6.1 | 11.8 | 55.2 | 61.3 | 8.8 | 10.4 | 350 |
| Feb. | 21.4 | 8.0 | 14.4 | 23.4 | 7.7 | 14.3 | 53.4 | 56.8 | 10.9 | 9.9 | 427 |

Table 4: Amounts of water ($m^3$/fed) applied to sugarcane throughout the two growing seasons

| Month | 2018/2019 season | | | 2019/2020 season | | |
|---|---|---|---|---|---|---|
| | Number of irrigations | | | | | |
| | 16 | 18 | 20 | 16 | 18 | 20 |
| February | 554 | 560 | 558 | 560 | 572 | 575 |
| March | 362 | 355 | 359 | 354 | 365 | 368 |
| | | 422 | 418 | | 414 | 415 |
| April | 481 | 436 | 441 | 471 | 449 | 448 |
| | 437 | | 412 | 449 | | 419 |

| | | | | | | |
|---|---|---|---|---|---|---|
| May | 395 | 443 | 430 | 387 | 429 | 425 |
| June | 418 | 426 | 419 | 426 | 430 | 430 |
| | 473 | 478 | 461 | 450 | 454 | 455 |
| July | 449 | 445 | 435 | 454 | 455 | 453 |
| | | 424 | 418 | | 430 | 428 |
| August | 428 | 420 | 414 | 420 | 410 | 408 |
| | 420 | 415 | 409 | 411 | 412 | 412 |
| September | 422 | 416 | 413 | 427 | 426 | 426 |
| | | 377 | 373 | | 368 | 366 |
| October | 452 | 433 | 429 | 444 | 327 | 327 |
| | 358 | | | 369 | | |
| November | 312 | 308 | 305 | 306 | 307 | 307 |
| | | 312 | 309 | | 318 | 315 |
| December | 336 | 316 | 313 | 325 | 299 | 301 |
| | | | 284 | | | 292 |
| January | 340 | 335 | 328 | 337 | 333 | 231 |
| Water ($m^3$/fed/season) | 6637 | 7321 | 7955 | 6590 | 7198 | 7801 |

**Statistical analysis:**

Analyses of variance were performed for the collected data according to Gomez and Gomez (1984) using MSTAT-C computer package by Freed, *et al.* (1989) and statistical analysis was done using GENSTAT software. The comparison among means was done using the least significant difference (LSD) test at 5% level of probability. Estimation of variance among components:

Variances among components were calculated by equating appropriate mean squares for the differences among genotypes to their expectations and solving for the components. Broad-sense heritability (H%) was estimated using variance components following the formula according to Johnson *et al* (1955):

$$H = \sigma 2g / (\sigma 2g + \sigma 2e / r + \sigma 2gy / ry).$$

Where: (σ2g) and (σ2e) refers to genotypic and error variance, respectively. The divisor (r) refers to number of replications. Where: σ2gy refers to genotype by year interaction variance. The divisor y refers to number of years.

Genetic coefficients of variance (GCV%) provides a measure of genetic variation relative to its mean estimated according to Burton and Devance (1953). The GCV facilitates comparisons among traits with different units and scales, and gives perspective to the variation:

GCV % = (σ2g/general mean) × 100.

Phenotypic Coefficient of Variation (PCV) % was estimated as follows:

PCV % = (σ2p / general mean) x 100.

Meanwhile, principal component analysis (PCA) was carried out as explained by Rao (1964).

**Results and discussion**

**1. Millable cane height:**

Data in Table 5 show that the used irrigation intervals significantly affected millable cane height, in both seasons. Sugarcane given 20 and/or 18 irrigations produced millable canes of 11.41 and 5.41 cm longer than that received 16 irrigations, respectively, in the $1^{st}$ one, corresponding to 12.08 and 4.83 cm, in the $2^{nd}$ one. These results may be due to the fact that water is an essential factor for the turgidity of leaf cells, lengthening of stalk cells as well as photosynthesis process, as mentioned by Van Dillewijn (1952), who also mentioned that water is the most quantitatively important food for sugarcane plants as water is the greatest solvent that helps plants absorb nutrients. Indeed, increasing irrigation frequency, *i.e.* increasing irrigation number, especially during tillering and grand growth stages, is of paramount importance for sugarcane growth. These findings coincide with those obtained by Gomaa (2000), Bekheet (2006), Wiedenfeld and Enciso (2008), Ahmed, *et al.* (2014) and Shahrzad and Abd El Hak (2014).

The results in Table 5 pointed to a significant superiority of the commercial G.T.54-9 variety over the other cane varieties, where it had the longest millable canes in both seasons. However, insignificant difference in millable canes length was observed between G.T.54-9 and the promising G.2004-27 variety in this trait, in the $1^{st}$ one. Meanwhile, it was found that G.2005-47 variety had the shortest millable canes, in the $1^{st}$ and $2^{nd}$ season. The variance between the studied sugarcane varieties may be due to their gene structure. Similar trends were reported by Makhlouf, *et al.* (2016) Fahmy, *et al.* (2017) and Gadallah and Abd El-Aziz (2019).

Millable cane length was significantly affected by the interaction between irrigation number and sugarcane varieties, in the $2^{nd}$ season. Regardless the gradual increase in cane length with increasing irrigation number from 16 to 18 and 20 irrigation, it can be noticed that the difference between the commercial G.T. 54-9 variety and each of the evaluated cane varieties was higher at 16 irrigations and lower at 20 irrigations, which showed the efficiency of G.T.54-9 to grow better than the other varieties even under conditions of water deficit, and that applying 18 and 20 irrigations was required to improve growth, in terms of cane length of G. 2003-47, G .2004-27 and G. 2005-47. The longest millable cane was obtained when G.T.54-9 variety was given 20 irrigations in both seasons.

Table 5: Effect of irrigation number on length and diameter of millable cane of the tested sugarcane varieties in 2018/2019 and 2019/2020 seasons

| Treatments | | Millable cane length (cm) | | Millable cane diameter (cm) | |
|---|---|---|---|---|---|
| | | 2018/2019 | 2019/2020 | 2018/2019 | 2019/2020 |
| Number of irrigation/season (A) | | | | | |
| 16 irrigation | | 289.42 | 282.92 | 2.50 | 2.48 |
| 18 irrigation | | 294.83 | 287.75 | 2.55 | 2.53 |
| 20 irrigation | | 300.83 | 295.00 | 2.57 | 2.55 |
| LSD at 0.5 level | | 1.28 | 1.89 | 0.02 | 0.02 |
| Sugarcane varieties (B) | | | | | |
| G.T. 54-9 | | 302.89 | 297.89 | 2.56 | 2.53 |
| G. 2003-47 | | 290.33 | 285.33 | 2.54 | 2.50 |
| G .2004-27 | | 298.22 | 291.44 | 2.55 | 2.54 |
| G. 2005-47 | | 288.33 | 279.56 | 2.53 | 2.50 |
| LSD at 0.5 level | | 1.71 | 1.75 | 0.01 | 0.02 |
| Interactions (A x B) | | | | | |
| 16 irrigation | G.T. 54-9 | 298.33 | 292.67 | 2.51 | 2.48 |
| | G. 2003-47 | 284.00 | 278.00 | 2.50 | 2.46 |
| | G .2004-27 | 293.00 | 285.33 | 2.51 | 2.52 |
| | G. 2005-47 | 281.33 | 275.67 | 2.49 | 2.45 |
| 18 irrigation | G.T. 54-9 | 302.33 | 298.00 | 2.57 | 2.55 |
| | G. 2003-47 | 290.67 | 285.00 | 2.55 | 2.51 |
| | G .2004-27 | 299.00 | 291.67 | 2.56 | 2.54 |
| | G. 2005-47 | 287.33 | 276.33 | 2.53 | 2.51 |
| 20 irrigation | G.T. 54-9 | 308.00 | 303.00 | 2.59 | 2.56 |
| | G. 2003-47 | 296.33 | 293.00 | 2.57 | 2.54 |
| | G .2004-27 | 302.67 | 297.33 | 2.58 | 2.56 |
| | G. 2005-47 | 296.33 | 286.67 | 2.56 | 2.53 |
| LSD at 0.5 level | | NS | 3.04 | NS | 3.04 |

**2. Millable cane diameter:**

Data in Table 5 indicate that increasing the number of irrigation from 16 to 18 up to 20 irrigations significantly resulted in a gradual increase in the thickness of millable canes, in both seasons. These results may be attributed to the fact that water is an essential factor for the turgidity of leaf cells, lengthening of stalk cells as well as photosynthesis process, as reported by Van Dillewijn (1952). These results are in harmony with those reported by Bekheet (2006), Wiedenfeld and Enciso (2008) and Shahrzad and Abd El Hak (2014).

The tested sugarcane varieties varied significantly in millable cane diameter in both seasons. The commercial variety G.T.54-9 had the widest thickness of cane stalk, in the 1st season, while G. 2004-27 variety exhibited the superiority in this growth trait over the other cane varieties, in the 2nd one. Meanwhile, G.2005-47 variety recorded the lowest value of this growth character in both seasons. The variance among cane varieties in this trait may be referred to their gene make-up. These findings coincide with those obtained by Makhlouf, *et al.* (2016) and Fahmy, *et al.* (2017).

The interaction between irrigation number and sugarcane varieties had a significant influence on cane diameter, in the 2nd season. Insignficant variance between G.T54-9 and 2003-47 varieties in this trait when were given the greatest and/or lowest irrigation number. Meantime, the difference between these two varieties in cane diameter was signinificant as they were irrigated 18 times. The highest thickness of millable cane was recorded by G.T.54-9 and G. 2004-27 varieties when they were fed with 20 irrigations, in 2nd season.

**3. Number of millable canes/fed:**

Data in Table 6 illustrated that increasing irrigation frequency to 18 and 20 irrigations substantially increased millable cane fresh weight by 0.788 and 1.092 thousand, compared to that obtained from sugarcane given 16 irrigations, successively, in the 1st season, corresponding to 0.980 and 1.141 thousand of millable stalks/fed, in the 2nd one. These results are probably due to the vital role of water on sugarcane growth stages, especially during germination and emergence, and most importantly on tillering, and in turn the number of harvestable canes, as explained by Humbert (1968), who stated that light frequent irrigations are preferable for young aged canes in the formative phase (the 1st four months of cane plant age). The results are in conformity with that of El-Shafai (1996), Bekheet (2006) and Ahmed, *et al.* (2014).

The results cleared that sugarcane G.2004-27 (G.4) markedly surpassed the commercial variety G.T.54-9, 2003-27 (G.3) and the promising genotype *viz.* 2005-47 in the number of millable canes/fed by 0.439, 1.147 and 0.235 thousand, respectively, in the 1st season, corresponding to 0.296, 0.666 and 0.264 thousand, in the 2nd one. The variance among cane varieties in this trait may be due to their gene make-up. These results are similar with those obtained by Gadallah and Abd El-Aziz (2019).

Millable cane number/fed was significantly affected by the interaction between irrigation number and sugarcane varieties in both seasons. In the 1st one, insignificant variance in the number of millable canes/fed was detected between 2004-27 and 2005-47 cane varieties in case of applying 16 irrigations. However, the difference between these two varieties in this trait reached the level of significance when canes were given 18 and/or 20 irrigations owing to higher millable canes produced by 2004-27 (G.4). In the 2nd season, 2004-27 exceeded the G.T.54-9 in this trait as they were irrigated 16 times. On the contrary, they were insignificantly differed under conditions of 18 and/or 20 irrigations.

Table 6: Effect of irrigation number on number of millable canes/fed and millable cane weight of the tested sugarcane varieties in 2018/2019 and 2019/2020 seasons

| Treatments | | Number of millable canes (1000/fed) | | Millable cane weight (kg) | |
|---|---|---|---|---|---|
| | | 2018/2019 | 2019/2020 | 2018/2019 | 2019/2020 |
| Number of irrigation/season (A) | | | | | |
| 16 irrigation | | 44.715 | 44.177 | 1.249 | 1.253 |
| 18 irrigation | | 45.503 | 45.157 | 1.291 | 1.291 |
| 20 irrigation | | 45.807 | 45.318 | 1.303 | 1.308 |
| LSD at 0.5 level | | 0.053 | 0.253 | 0.002 | 0.004 |
| Sugarcane varieties (B) | | | | | |
| G.T. 54-9 | | 45.358 | 44.894 | 1.326 | 1.335 |
| G. 2003-47 | | 44.650 | 44.524 | 1.259 | 1.255 |
| G .2004-27 | | 45.797 | 45.190 | 1.310 | 1.311 |
| G. 2005-47 | | 45.562 | 44.926 | 1.228 | 1.234 |
| LSD at 0.5 level | | 0.091 | 0.163 | 0.002 | 0.004 |
| Interactions (A x B) | | | | | |
| 16 irrigation | G.T. 54-9 | 44.843 | 44.276 | 1.278 | 1.280 |
| | G. 2003-47 | 43.890 | 43.383 | 1.135 | 1.242 |
| | G .2004-27 | 45.123 | 44.650 | 1.268 | 1.271 |
| | G. 2005-47 | 45.003 | 44.407 | 1.215 | 1.219 |
| 18 irrigation | G.T. 54-9 | 45.447 | 45.113 | 1.346 | 1.357 |
| | G. 2003-47 | 44.897 | 45.050 | 1.254 | 1.241 |
| | G .2004-27 | 45.950 | 45.370 | 1.331 | 1.330 |
| | G. 2005-47 | 45.720 | 45.093 | 1.231 | 1.237 |
| 20 irrigation | G.T. 54-9 | 45.783 | 45.303 | 1.354 | 1.369 |
| | G. 2003-47 | 45.163 | 45.140 | 1.288 | 1.283 |
| | G .2004-27 | 46.317 | 45.550 | 1.332 | 1.334 |
| | G. 2005-47 | 45.963 | 45.277 | 1.236 | 1.247 |
| LSD at 0.5 level | | 0.158 | 0.283 | 0.003 | 0.007 |

## 4. Millable cane weight:

Data in Table 6 pointed to a significant influence of increasing irrigation frequency on the single cane stalk weight at harvest. It was found that increasing irrigation number from 16 to 18 and 20 times resulted in increasing stalk weight by (0.042 and 1.054 kg) and (0.038 and 0.055 kg), in the 1st and 2nd season, successively. These results can be referred to the essential role of water in enhancing the photosynthesis process, which ultimately led to more translocation and accumulation of dry matter in cane stalks. Moreover, it may be due to higher water content in stalks. These findings were in line with that reported by Wiedenfeld and Enciso (2008), who found that increasing water application resulted in increasing growth of sugarcane.

There were sugarcane substantial variances among the tested sugarcane varieties in cane weight in both seasons (Table 6). The commercial G.T.54-9 variety surpassed G. 2003-47, G.2004-27 and 20056-47 cane varieties by 0.067, 0.016 and 0.98 kg, respectively, in the 1st season, corresponding to 0.080, 0.024 and 0.101 kg, in the 2nd one. The variance among cane varieties in this trait may be due to their gene make-up. Similar finding was reported by Makhlouf, *et al.* (2016).

Millable cane weight was markedly affected by the interaction between the studied factors in the 1st and 2nd season. It was found that the variance between G.T.54-9 and G.2003-47 in stalk weight tended to decrease gradually in response to increasing irrigation frequency from 16 up to 20 times, which may indicate that G.2003-47 relatively benefitted from

Table 7: Effect of number irrigations on brix% and sucrose% of the tested sugarcane varieties in 2018/2019 and 2019/2020 seasons

| Treatments | | Brix% | | Sucrose% | |
|---|---|---|---|---|---|
| | | 2018/2019 | 2019/2020 | 2018/2019 | 2019/2020 |
| Number of irrigation/season (A) | | | | | |
| 16 irrigation | | 19.99 | 20.49 | 16.72 | 17.25 |
| 18 irrigation | | 20.48 | 20.86 | 17.19 | 17.60 |
| 20 irrigation | | 20.53 | 20.99 | 17.25 | 17.74 |
| LSD at 0.5 level | | 0.26 | 0.13 | 0.22 | 0.11 |
| Sugarcane varieties (B) | | | | | |
| G.T. 54-9 | | 20.10 | 20.50 | 17.03 | 17.54 |
| G. 2003-47 | | 21.62 | 22.00 | 18.33 | 18.87 |
| G .2004-27 | | 18.53 | 18.97 | 15.35 | 15.71 |
| G. 2005-47 | | 21.10 | 21.65 | 17.51 | 18.00 |
| LSD at 0.5 level | | 0.10 | 0.13 | 0.09 | 0.11 |
| Interactions (A x B) | | | | | |
| 16 irrigation | G.T. 54-9 | 19.69 | 19.93 | 16.62 | 17.03 |
| | G. 2003-47 | 21.26 | 21.87 | 17.97 | 18.72 |
| | G .2004-27 | 18.24 | 18.71 | 15.09 | 15.46 |
| | G. 2005-47 | 20.78 | 21.45 | 17.21 | 17.79 |
| 18 irrigation | G.T. 54-9 | 20.25 | 20.71 | 17.18 | 17.73 |
| | G. 2003-47 | 21.76 | 22.02 | 18.46 | 18.90 |
| | G .2004-27 | 18.64 | 19.05 | 15.45 | 15.78 |
| | G. 2005-47 | 21.28 | 21.66 | 17.66 | 18.00 |
| 20 irrigation | G.T. 54-9 | 20.35 | 20.86 | 17.28 | 17.87 |
| | G. 2003-47 | 21.83 | 22.10 | 18.55 | 18.98 |
| | G .2004-27 | 18.70 | 19.16 | 15.52 | 15.90 |
| | G. 2005-47 | 21.25 | 21.83 | 17.66 | 18.22 |
| LSD at 0.5 level | | 0.18 | 0.22 | NS | 0.18 |

increasing the applied water, which may contributed to higher rate of its biological processes better than the commercial variety.

**5. Brix percentage:**

Data in Table 7 indicated that brix% was significantly affected by number of irrigations, in the 1st and 2nd seasons. Feeding sugarcane plants with 20 irrigations resulted in the highest brix% without significant difference with those given 18 irrigations in both seasons. These results are line with that shown by Ahmed, *et al.* (2014) and Shahrzad and Abd El Hak (2014).

The tested sugarcane varieties differed markedly in the brix%. The results in Table 7 manifested that G.2003-47 sugarcane variety had the highest brix%, while G.2004-27 variety recorded the lowest values in both seasons. The differences between the studied varieties in brix% may be due to their gene make-up. These results are in accordance with that obtained by Makhlouf, *et al.* (2016), Fahmy, *et al.* (2017), El-Bakry (2018) and Gadallah and Abd El-Aziz (2019).

Brix% was appreciablly affected by the interaction between irrigation number and sugarcane varieties in both seasons. The highest values of brix% were obtained by supplying G.2003-47 variety with 20 and/or 18 irrigations.

**6. Sucrose percentage:**

Data in Table 7 revealed that sucrose% was significantly affected by number of irrigations, in the 1st and 2nd seasons. Irrigating sugarcanes with 20 irrigations gave the highest sucrose%, with insignificant variance with those fed with 18 irrigations, in the 1st season. These results are harmony with those found by Bekheet (2006), Ahmed, *et al.* (2014) and Shahrzad and Abd El Hak (2014).

The results manifested that G.2003-47 promising variety gave the highest sucrose% in the 1st and 2nd season, compared with the other ones, while G.2004-27 variety recorded the lowest value of this trait. Such varietal differences among cane genotypes in sucrose% were reported by Makhlouf, *et al.* (2016), Fahmy, *et al.* (2017), El-Bakry (2018), Galal, *et al.* (2018), and Gadallah and Abd El-Aziz (2019). The interactions of irrigation rates x sugarcane varieties had a substantial influence on sucrose% in the 2nd season. The highest sucrose% was recorded by planting sugarcane G.2003-47 variety irrigated with 20 and/or 18 irrigations.

**7. Juice purity percentage:**

Data in Table 8 showed that juice purity% increased accompanying the increase in the number of irrigations up to 20 times in the 1st and 2nd seasons. These results are in agreement with those mentioned by Ahmed, *et al.* (2014) and Shahrzad and Abd El Hak (2014).

Data in the same Table pointed to a significant difference among the evaluated sugarcane varieties in juice purity percentage in both seasons. The highest mean value of purity% was recorded by the promising sugarcane G.2003-47 variety, while the lowest value from this trait was of G.2004-27. These results are probably attributed to the increase in sucrose% in cane juice (Table 7), where the higher of the sucrose%, the greater of juice purity %. The variance among varieties in this trait may be due to their gene structure. These results coincide with that obtained by Makhlouf, *et al.* (2016), Fahmy, *et al.* (2017), El-Bakry (2018) and Gadallah and Abd El-Aziz (2019).

Juice purity% was significantly affected by the interactions between the studied factors in the 1st and 2nd season. The highest sucrose% was recorded by planting sugarcane G.2003-47 variety irrigated with 20 and/or 18 irrigations.

Table 8: Effect of number irrigations on juice purity% and sugar recovery% of the tested sugarcane varieties in 2018/2019 and 2019/2020 seasons

| Treatments | | Juice purity% | | Sugar recovery% | |
|---|---|---|---|---|---|
| | | 2018/2019 | 2019/2020 | 2018/2019 | 2019/2020 |
| Number of irrigation/season (A) | | | | | |
| 16 irrigation | | 83.62 | 84.14 | 11.19 | 11.62 |
| 18 irrigation | | 83.89 | 84.36 | 11.54 | 11.89 |
| 20 irrigation | | 84.01 | 84.50 | 11.60 | 12.00 |
| LSD at 0.5 level | | 0.04 | 0.05 | 0.15 | 0.08 |
| Sugarcane varieties (B) | | | | | |
| G.T. 54-9 | | 84.72 | 85.57 | 11.54 | 12.01 |
| G. 2003-47 | | 84.79 | 85.78 | 12.43 | 12.95 |
| G .2004-27 | | 82.86 | 82.82 | 10.17 | 10.41 |
| G. 2005-47 | | 82.99 | 83.16 | 11.63 | 11.98 |
| LSD at 0.5 level | | 0.03 | 0.06 | 0.06 | 0.07 |
| Interactions (A x B) | | | | | |
| 16 irrigation | G.T. 54-9 | 84.43 | 85.42 | 11.23 | 11.64 |
| | G. 2003-47 | 84.52 | 85.61 | 12.15 | 12.82 |
| | G .2004-27 | 82.70 | 82.62 | 9.98 | 10.22 |
| | G. 2005-47 | 82.84 | 82.92 | 11.41 | 11.80 |
| 18 irrigation | G.T. 54-9 | 84.81 | 85.64 | 11.65 | 12.15 |
| | G. 2003-47 | 84.86 | 85.83 | 12.53 | 12.98 |
| | G .2004-27 | 82.89 | 82.85 | 10.24 | 10.46 |
| | G. 2005-47 | 83.00 | 83.10 | 11.73 | 11.97 |
| 20 irrigation | G.T. 54-9 | 84.93 | 85.67 | 11.74 | 12.25 |
| | G. 2003-47 | 84.99 | 85.88 | 12.61 | 13.04 |
| | G .2004-27 | 82.99 | 82.99 | 10.30 | 10.55 |
| | G. 2005-47 | 83.12 | 83.45 | 11.74 | 12.16 |
| LSD at 0.5 level | | 0.05 | 0.11 | NS | 0.12 |

**8. Sugar recovery%**

Data in Table 8 showed that sugar recovery% increased significantly accompanying the increase in the number of irrigations from 16 up to 20 irrigation, in the 1st and 2nd season. These results are in agreement with those reported by Ahmed, *et al.* (2014). Insignificant variance in this trait was noticed, in case of applying 18 and/or 20 irrigations, in the 1st season.

The tested sugarcane varieties varied significantly in sugar recovery%. Sugarcane G.2003-47 promising variety gave the highest sugar recovery%, while G.2004-27 recorded the lowest value of this trait, in both seasons. Such varietal differences can be referred to the same trend of both sucrose% (Table 7) and juice purity% (Table 8) recorded by the previously mentioned varieties. Similar results were reported by Makhlouf, *et al.* (2016) and Gadallah and Abd El-Aziz (2019).

Sugar recovery% was markedly affected by the interaction of irrigation number x sugarcane varieties in the 2nd season, where the highest sugar recovery% was recorded by planting sugarcane variety G.2003-47 and irrigating it with 20 irrigations.

**9. Millable cane yield/fed:**

Data in Table 9 revealed that millable cane yield/fed was significantly affected irrigation number, in both seasons. Applying 20 irrigations to sugarcane increased cane yield by 3.859 and 0.956 tons/fed, compared to that supplied 16 and 18 irrigations, respectively, in the 1st season, corresponding to 3.946 and 0.986 tons/fed, in the 2nd one. These results are probably due to the increase in stalk height and diameter of millable cane (Table 5), the number of millable canes/fed and millable cane weight (Table 6), accompanying the increase in irrigation frequency. Moreover, it was found that the increase in cane yield/fed was more distinguished when irrigation frequency was increased from 16 to 18 times, compared to that gained by increasing irrigation number from 18 to 20 irrigations. These results are in harmony with those mentioned by El-Shafai (1996), Bekheet (2006), Ahmed, *et al.* (2014) and Shahrzad and Abd El Hak (2014).

The results pointed out that the tested varieties differed significantly with respect to cane yield/fed. The commercial G.T.54-9 variety exhibited the superiority in cane yield over the other tested varieties, in both seasons. In the 1st one, G.T.54-9 produced 3.393 and 4.227 tons/fed over those gained from G. 2003-47 (G. 3) and 2005-47, respectively, without an appreciable variance between G.T.54-9 and G. 2004-27 (G. 4) in cane yield. In the 2nd season, G.T.54-9 out-yielded G. 2003-47, G. 2004-27 and G. 2005-47 by 4.057, 0.695 (less than one ton) and 4.516 ton/fed, successively. Similar findings were reviewed by Ali, *et al.* (2019) and Gadallah and Abd El-Aziz (2019).

Data in the same Table pointed to a substantial influence on cane yield/fed due to the interaction between irrigations and sugarcane varieties in both seasons. Insignificant variance was detected in cane yield/fed between G.T.54-9 and G.2004-27 varieties when they were given 16 and/or 18 irrigations, with significant difference between these two varieties at 20 irrigations, in the 1st season. In the 2nd one, again, the difference in cane yield between the same two varieties was insignificant under conditions of 16 irrigations. However, the variance between them reached the level of significance by supplying them with 18 and/or 20 irrigations because of higher cane yield produced by G.T. 54-9.

Table 9: Effect of number irrigations on cane and sugar yields/fed (ton) of the tested sugarcane varieties in 2018/2019 and 2019/2020 seasons

| Treatments | | Millable cane yield/fed (ton) | | Sugar yield/fed (ton) | |
|---|---|---|---|---|---|
| | | 2018/2019 | 2019/2020 | 2018/2019 | 2019/2020 |
| Number of irrigation/season (A) | | | | | |
| 16 irrigation | | 55.866 | 55.345 | 6.244 | 6.421 |
| 18 irrigation | | 58.725 | 58.305 | 6.762 | 6.919 |
| 20 irrigation | | 59.681 | 59.291 | 6.913 | 7.108 |
| LSD at 0.5 level | | 0.065 | 0.274 | 0.087 | 0.021 |
| Sugarcane varieties (B) | | | | | |
| G.T. 54-9 | | 60.167 | 59.964 | 6.948 | 7.209 |
| G. 2003-47 | | 56.228 | 55.907 | 6.994 | 7.240 |
| G .2004-27 | | 60.028 | 59.269 | 6.111 | 6.173 |
| G. 2005-47 | | 55.940 | 55.448 | 6.505 | 6.642 |
| LSD at 0.5 level | | 0.145 | 0.209 | 0.045 | 0.053 |
| Interactions (A x B) | | | | | |
| 16 irrigation | G.T. 54-9 | 57.326 | 56.645 | 6.436 | 6.591 |
| | G. 2003-47 | 54.199 | 53.880 | 6.586 | 6.910 |
| | G .2004-27 | 57.236 | 56.743 | 5.713 | 5.798 |
| | G. 2005-47 | 54.702 | 54.112 | 6.240 | 6.385 |
| 18 irrigation | G.T. 54-9 | 61.173 | 61.210 | 7.129 | 7.436 |
| | G. 2003-47 | 56.284 | 55.903 | 7.055 | 7.255 |
| | G .2004-27 | 61.162 | 60.325 | 6.264 | 6.309 |
| | G. 2005-47 | 56.282 | 55.783 | 6.601 | 6.675 |
| 20 irrigation | G.T. 54-9 | 62.002 | 62.038 | 7.279 | 7.600 |
| | G. 2003-47 | 58.200 | 57.938 | 7.342 | 7.555 |
| | G .2004-27 | 61.686 | 60.740 | 6.355 | 6.412 |
| | G. 2005-47 | 56.836 | 56.448 | 6.674 | 6.866 |
| LSD at 0.5 level | | 0.251 | 0.362 | 0.079 | 0.092 |

**10. Sugar yield/fed:**

Data in Table 9 revealed that irrigation number significantly affected sugar yield/fed, in both seasons. Applying 20 irrigations to sugarcane increased sugar yield by 0.669 and 0.151 tons/fed, compared to that with 16 and/or 18 irrigations, respectively, in the 1st one, corresponding to 0.687 and 0.189 tons/fed, in the 2nd one. The increase in sugar yield was associated with the increase in both cane yield (Table 9) and sugar recovery % (Table 8), which are the main components of sugar yield. These results are in harmony with those stated by Bekheet (2006), Ahmed, *et al.* (2014) and Shahrzad and Abd El Hak (2014).The evaluated sugarcane varieties varied markedly in sugar yield/fed in both seasons. Sugarcane G.2003-47 occupied the 1st order in sugar production over the other varieties in both seasons, without significant difference G.T.54-9 variety in the 2nd one. Moreover, the lowest sugar yield/fed was recorded by G. 2004-27 variety. These results were actually due to the same trend of the tested varieties with respect to their sugar recovery%, where it is well known that sugar yield is principally dependent on both cane yield and sugar recovery% percentage. Such varietal differences were reported by Makhlouf, *et al.* (2016) Fahmy, *et al.* (2017), El-Bakry (2018), Galal, *et al*. (2018), Ali, e*t al.* (2019) and Gadallah and Abd El-Aziz (2019).

Sugar yield was significantly affected by the interaction between irrigation number and sugarcane varieties in both seasons. The difference in sugar yield/fed between G.T.54-9 and G.2003-47 varieties were too small to reach the level of significance, when they were applied with 18 and/or 20 irrigations, with an appreciable variance under conditions of 16 irrigations, due to higher sugar production recorded by the latter. In the 2nd season, the above-mentioned two varieties varied markedly in sugar yield/fed when they were given 16 and/or 18 irrigations, without significant difference, in case of irrigating them frequently 20 times. The highest sugar production/fed was obtained by planting sugarcane G.2003-47 variety and/or the commercial variety G.T.54-9 and supplying any of them with 20 irrigations.

**Genetic parameters:**

The evaluated sugarcane varieties are commercial ones, except G. 2005-47 is a promising genotype that have elite traits. They were selected to begin a strong sugarcane breeding program. So, genetic parameters of ten traits of these varieties were estimated in 2018/2109 and 2019/2020 seasons. Genetic parameters are important as it present the amount of genetic diversity for the studied characters.

**Genotypic and Phenotypic Variance: Genotypic and Phenotypic Coefficients of Variation:**

Data in Table 10 indicated that sugar recovery% recorded the highest values of Genotypic coefficient of variation

The results in Tables 10 showed that stalk height recorded the highest values of genotypic ($\sigma^2$g) and phenotypic ($\sigma^2$ph) in both seasons, followed by cane yield. On the other hand, stalk diameter recorded the lowest values for $\sigma^2$g and $\sigma^2$ph. These results are in accordance with those obtained by Kumar, *et al*. (2010) and Pawar, *et al*. (2011), who found similar results for most of cane yield and its components.

Heritability:

Data in Table 10 revealed that all traits recorded high heritability %. Heritability of sucrose % recorded the highest value of this trait, in the 1st season, followed by stalk highest in the 1st and 2nd season, respectively, then sucrose in the 1st one.

Also, Agrawal (2003); Nagarajan, *et al*. (2006); Tawfic, *et al*. (2008) and Mehareb and Abazied (2017), who reported that sucrose % showed high heritability. Moderate values of GCV and PCV were coupled with high heritability for brix, sucrose, sugar recovery percentages and cane yield/fed. High heritability was detected for stalk diameter. These results are in harmony with those of Chaudhary (2001). Similarly, Jamoza, *et al*. (2014) found high heritability for stalk diameter and moderate heritability for cane yield. (GCV) and phenotypic coefficient of variation in the 1$^{st}$ and 2$^{nd}$ season, respectively, followed by sucrose% for PCV and GCV, respectively

Table 10: Variance components, heritability H%, phenotypic coefficient of variation PCV% and genotypic coefficient of variation GCV% for the studied traits

| | Stalk height | | Stalk diameter | | Brix% | | Sucrose% | | No. millable canes/fed | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 2018-19 | 2019-20 | 2018-19 | 2019-20 | 2018-19 | 2019-20 | 2018-19 | 2019-20 | 2018-19 | 2019-20 |
| Ơ$^{2}$g | 45.57 | 61.26 | 0.01 | 0.00 | 1.78 | 1.03 | 1.54 | 1.20 | 0.19 | 0.05 |
| ơ $^{2}$ ph | 46.19 | 62.19 | 0.01 | 0.00 | 1.85 | 1.12 | 1.58 | 1.22 | 0.24 | 0.07 |
| H% | 98.65 | 98.50 | 94.47 | 82.35 | 96.06 | 92.08 | 97.20 | 98.93 | 76.92 | 71.79 |
| GCV | 2.30 | 2.71 | 2.89 | 1.11 | 6.56 | 4.89 | 7.27 | 6.25 | 0.96 | 0.51 |
| PCV | 2.31 | 2.73 | 2.97 | 1.22 | 6.70 | 5.10 | 7.37 | 6.29 | 1.09 | 0.61 |
| MEAN | 294.00 | 288.56 | 2.50 | 2.52 | 20.33 | 20.78 | 17.05 | 17.53 | 45.34 | 44.88 |
| Ơ $^{2}$g y | 1.13 | 2.01 | 0.00 | 0.00 | 0.22 | 0.27 | 0.13 | 0.04 | 0.17 | 0.06 |
| | Cane yield/fed | | Stalk weight | | Juice purity% | | Sugar recovery% | | Sugar yield/fed | |
| | 2018-19 | 2019-20 | 2018-19 | 2019-20 | 2018-19 | 2019-20 | 2018-19 | 2019-20 | 2018-19 | 2019-20 |
| Ơ2g | 4.95 | 4.71 | 0.008 | 0.0018 | 1.08 | 2.32 | 0.82 | 1.00 | 0.16 | 0.23 |
| ơ $^{2}$ ph | 5.39 | 5.29 | 0.010 | 0.0022 | 1.13 | 2.43 | 0.88 | 1.11 | 0.17 | 0.26 |
| H% | 91.95 | 89.05 | 93.375 | 81.01 | 96.07 | 95.44 | 93.69 | 90.67 | 90.40 | 88.88 |
| GCV | 3.83 | 3.76 | 6.975 | 3.29 | 1.24 | 1.81 | 7.92 | 8.46 | 5.95 | 7.04 |
| PCV | 4.00 | 3.99 | 7.218 | 3.66 | 1.27 | 1.85 | 8.19 | 8.88 | 6.26 | 7.46 |
| MEAN | 58.09 | 57.65 | 1.300 | 1.28 | 83.84 | 84.33 | 11.44 | 11.84 | 6.64 | 6.82 |
| Ơ 2g y | 1.30 | 1.73 | 0.00 | 0.00 | 0.13 | 0.33 | 0.17 | 0.31 | 0.05 | 0.09 |

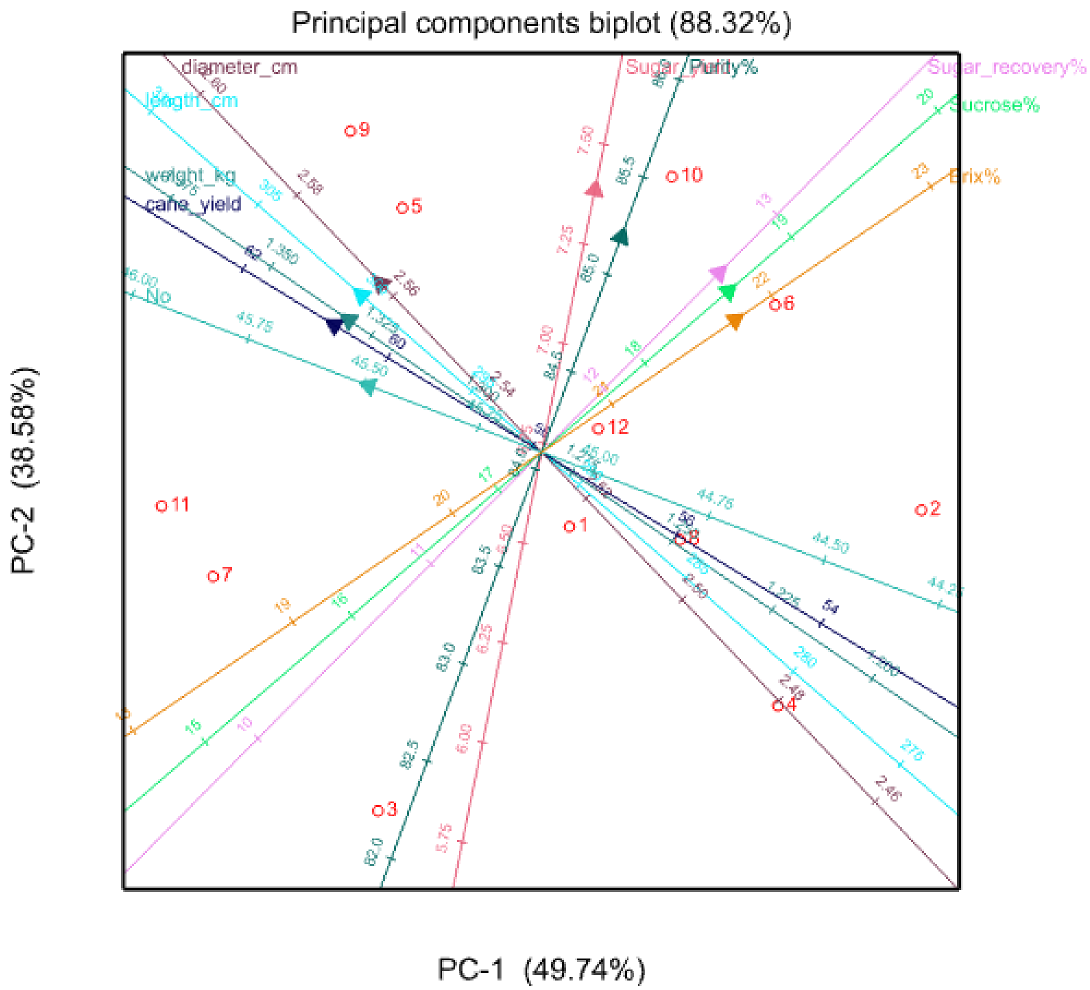


**Figure 1**. Biplot based on principal component analysis for cane and quality traits in sugarcane varieties (V1= G.T.54-9, V2 = G. 2003-47, V3 = G. 2004-27 and V4 = G. 2005-47 under three irrigation regimes (T1=16 irrigation, T2 = 18 irrigation and T3 = 20 irrigation) with 12 combinations; O1= (T1 , V1), O2 = (T1 , V2) and O3 = (T1 , V3), O4 = (T1 , V4), O5 = (T2 , V1), O6 = (T2 , V2), O7 =(T2 , V3), O8 = (T2 , V4), O9 = (T3 , V1), O10 = (T3 , V2), O11 = (T3 , V3) and O12 =(T3 , V4).

Figure (1) show highly significant and positive correlation between cane yield, millable cane weight and number of millable canes, followed by cane yield and stalk height then cane yield and stalk diameter. Jamoza, *et al.* (2014) found genotypic correlation among stalk weight and cane yield. Moreover, Kumar and Kumar (2014) observed that number of millable canes presented positively and highly direction effect on cane yield. In contrast, high positive correlation was also observed between stalk length and millable cane weight and between stalk diameter and millable cane weight. These results are in agreement with those stated by Singh, *et al*. (2005), who found that stalk weight and stalk height showed significant positive correlation.

Sugar yield was significantly and positively correlated with juice purity%, followed by sugar recovery%, then sucrose% and brix%. Negative correlation was detected between millable cane number and brix% and sucrose%. These results are in harmony with those reported by Tadesse and Dilnesaw (2014), who mentioned that millable cane number was negatively and significantly correlated with sucrose %. On the other hand, results in Figure 1 showed that O5 (T2, V1) and O9 = (T3, V1) were the highest varieties in cane yield, weight, stalk height and stalk diameter, while O10 = (T3, V2) was the highest one in juice purity% and sugar yield. In addition, O6 = (T2, V2) was the best variety in brix% and sucrose%.

## Conclusion

Under conditions of this work, planting the commercial variety *viz.* G.T.54-9 is preferable to get the highest cane yield/fed, in case of the abundance of water (20 irrigations), without any significant difference with G.2004-27 (G. 4) variety under conditions of water scarcity (16 irrigations). Planting G. 2003-47 (G. 3) can be recommended to produce the highest sugar yield/fed by applying 16 irrigations only, without variance with that obtained by G.T.54-9 at 20 irrigations.

Sugarcane G. 2003-47 variety can be selected for high juice quality and sugar yield/fed, while G.T.54-9 variety might be selected for its high cane yield/fed and its components.

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