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Performance Evaluation of Three Sugar Cane Varieties under Different Levels of Nitrogen Fertilization and Two Seeding Rates

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Abstract

Field trials including two plant cane crops and one 1st ratoon were conducted in El-Mattana Agric. Res. Station, (latitude of 25.17° N and longitude of 32.33° E), Esna, Luxor Governorate, Egypt, during the two successive seasons of 2013/2014 and 2014/2015 to find out the performance of three sugar cane varieties (G.T. 54-9, G. 2003-47 and G.2003-49), which were planted using two planting densities (1.5 drills "37800 buds/fed" and 2 drills "50400 buds/fed") and fertilized with three nitrogen levels (180, 210 and 240 kg N/fed "fed = 0.42 ha-1"). A randomized complete block design (RCBD) using split-plot arrangement with three replications was used. The varieties were allocated in the main plots, mean while planting densities and nitrogen levels were randomly distributed in the sub–plot.

The important results could be summarized as follow:

Variety G.T.54-9 over passed the two promising varieties in length, diameter and fresh weight/plant of stalks. The two promising varieties (G.2003-47 and G.2003-49) over passed the commercial variety (G.T.54-9) in brix, purity and sugar recovery percentages and number of millable in the three crops. Variety G.2003-47 gave the highest sugar yield in the two crops and ratoon.

Planting density 37800 buds/fed attained a significant increase in stalk diameter compared with planting by 50400 buds/fed, meanwhile, the same planting density *i.e.* 37800 buds/fed produced the higher stalk fresh weight in the two plant cane crops and 1st ratoon. Planting density 50400 buds/fed attained the highest taller stalks, brix, purity and sugar recovery percentages, number of millable cane/fed and cane and sugar yields/fed, meanwhile, the same density reduced glucose % in the different crops.

Increasing nitrogen levels up to 240 kg N/fed led to significantly increased in stalk length, stalk diameter, stalk fresh weight/plant, number of millable cane/fed, cane yield/fed and sugar yield/fed for the three cane crops. Increased nitrogen levels from 180 to 210 and 240 kg N/fed caused significant increase sugar yield/fed in the three cane crops, this increment amounted by 15.67 and 23.24 % in the 1st planted cane, 13.83 and 18.81% in the 1st ratoon and 6.45 and 8.10 % in the 2nd planted cane, respectively.

The highest number of millable cane/fed was recorded when sugar cane planted with 50400 buds/fed and fertilized by 240 kg N/fed.

Variety G.T.54-9 attained the highest stalk fresh weight values with the different nitrogen levels over the two promising varieties. The best interaction was between variety G.2003-47 and 210 kg N/fed to produce the highest purity % in the three crops. The interaction between the varieties and nitrogen levels attained a significant influence on sugar recovery % in the 1st ratoon and the 2nd planted cane.

The 2nd order interaction between varieties, seeding rates and nitrogen levels recorded the highest cane yield/fed, however, this difference was not enough to reach the level of significant in the three crops.

It could be noted that from the economical view of growers' benefit planting the promising sugar cane variety G.2003-47 is better, however the actual and the economical view growing the commercial variety with higher costs is better for the national economy where it will save about 2.49 ton/fed which represent a large amount of cane on the large area consequently a large amount of sugar production.

Keywords: *Sugar cane, varieties, seed setts rate, fertilization, yield.*

Introduction

According to Collins (2002), plant density is a function of inter and intra-row spacing. The individual and combined effects of certain management practices planting date, row spacing, planting depth, fertilizer rate, pest control and irrigation have a great impact on the growth and yield of sugar cane. This was a general recommendation to account for factors such as variety, branching ability, climate and soil conditions. If the plants are too close, there may be too many shoots which will reduce the efficiency of the parent plants and class 1 branches, as well as too large a space between rows will lead to a waste of the area and of solar energy. An experiment conducted on plant cane and ratoon cane with pre-seasonal planting indicated that cane girth, number of millable canes per clump and average cane weight were significantly higher at the intra-row spacing of 90 cm rather than at the intra-row spacing of 30 cm and 60 cm (Raskar and Bhoi, 2003). Furthermore, high density planting reduces the number of tillers produced per each planting material due to mutual shading and competition for light, nutrients and water (Verma, 2004).

On the other hand, sub-optimal density planting results in a loss of yield due to inefficient use of the land space (Azhar *et al.,* 2007). Some Studies in other countries indicated that with low density planting, it was possible to minimize the planting material required per unit area. Ayele *et al.* (2014) studied the effect of five intra-row sett spacings [10 cm between setts, 5 cm between setts, setts placed end to end, setts placed ear-to ear (5 cm overlapping) and setts placed ear-to-ear (10 cm overlapping)] on the performance of three sugarcane varieties (B52/298, NCo334 and B41227). They concluded that sucrose content, cane yield, and estimated commercial cane sugar were not statistically different from the control treatment, which indicates that closer sett spacing results in the same final yield as in wider sett spacing. The absence of interaction effect of sett spacing with varieties showed that none of the varieties needs different sett spacing for attaining its maximum cane and sugar yields. Therefore, they recommended that the intra-row spacing of 10 cm between setts for all three varieties should be used instead of the conventional ear-to-ear (5 cm overlapping) setts intra-row spacing because the former requires less planting materials without compromising cane and sugar yields. Furthermore, the study indicated the possibility of reducing the amount of seed cane from 21-33 %, by shifting from the 5 cm over-lapping to end to end (butt-to-butt) alignment. El-Geddawy, Dalia *et al.* (2015) reported that dual drilling of seed sett cane increased number of millable cane, cane yield and sugar yield.

As for the influence of cane varieties, Ahmed *et al.* (2011) reported that the promising sugar cane variety G.95–21 significantly surpassed G.95–19 in the number of millable cane/fed, stalk height, milable cane diameter, TSS% and cane yield/fed. Moreover, they showed that sugar cane varieties were significantly differed in stalk diameter, sucrose% and sugar yield ton/fed in the 2nd season only, however, cane yield was significantly affected by the grown varieties in both seasons. Phil 8013 variety showed superiority in all effective traits. El-Geddawy *et al.* (2012) showed that variety G.54-9 surpassed the other varieties in plant height, stalk fresh weight, number of millable canes/fed and cane and sugar yields (ton/fed), whereas, Giza 2000-5 variety gave the highest stalk diameter. Abd El-Aal *et al.* (2015) found that the tested sugar cane varieties differed significantly in their stalk number and diameter, sucrose % and cane and sugar yields whether they were grown as a plant cane or 1st and 2nd ratoon crops as well as sugar recovery % (in the 2nd crop). Promising variety G.2003-47 produced the highest sugar yield/fed. El-Geddawy, Dalia *et al.* (2015) found that the commercial sugar cane variety (G.T.54-9) is still over passed the other two promising varieties in stalk length and thickness and stalk weight/plant. The promising varieties *i.e.* G.2003-47 and G.2003-49 surpassed the commercial variety (G.T.54-9) in brix and sucrose percentages, however, purity % insignificantly affected by the examined varieties in both seasons. Sugar cane varieties G.2003-49 over passed the other varieties in the value of number of millable cane/fed. The two promising sugar cane varieties *i.e.* G.2003-49 and G.2003-47 significantly sure passed on the commercial one in respect to cane yield/fed, sugar recovery % and sugar yield/fed. Abd Elatif *et al.*(2016) cleared that there was a significant difference between the studied varieties in respect to their cane yield/fed., sugar cane variety G.99-103 over passed significantly the other two varieties in this respect. The promising sugar cane variety G.99-103 attained additional increase over the commercial one (G.T.54-9) amounted by 5.11 ton and 4.88 ton in the 1st and 2nd season, respectively.

Ismail *et al.* (2008) stated that increasing N levels up to 279 kg N/fed significantly increased number of millable cane and cane and sugar yields/fed in plant and first ratoon crops. Stalk length, number of internodes/stalk and quality traits were insignificantly affected by N levels. Mokadem *et al.* (2008) found that increasing N levels attained a positive and significant effect on stalk height, stalk diameter number of internodes and cane and sugar yields. Fertilizing sugarcane with 260 kg N/fed. recorded the highest values of these traits. Increasing nitrogen level up to 260 kg N/fed increased number of internodes/ plant, stalk length (cm), stalk diameter (cm), stalk weight(kg), number of millable cane/fed as well as millable cane and sugar yields (tons/fed), Juice quality traits in terms of Brix and reducing sugars percentages were gradually increased by increasing N rates. Sucrose and purity percentages decreased by increasing N rates. Moreover, N fertilizer rates had no significant effect on sugar recovery% either in plant cane and the first ratoon. El-Geddawy *et al.* (2012) found that increasing nitrogen levels from 170 to 230 kg N/fed increasing all studied traits. Fertilizing G.T.54-9 variety with 230 kg N/fed. and harvesting after 13 months from planting gave the highest productivity of cane and sugar yields. Abd Elatif *et al.* (2016) found that increasing nitrogen rate from 220 to 280 up to 340 attained a significant increment in cane yield amounted by 4.14 % and 12.64 % in the 1st season and 11.4 % and 14.35 % in the 2nd season, respectively. They added that the highest sugar yield was recorded with 340 kg N /fed. However, they stated that there was a gradual and significant decrease in the values of sugar recovery percentage as nitrogen fertilizer level increase.

Therefore, the objective of this study is to evaluate the performance of three sugar cane varieties to seeding rates and nitrogen fertilization.

Materials and Methods

Field trials including two plant cane crops and one 1st ratoon were conducted in El-Mattana Agricultural Research Station, (latitude of 25.17° N and longitude of 32.33° E), Esna, Luxor Governorate, Egypt, during the two successive seasons of 2013/2014 and 2014/2015 to find out the performance of three sugar cane varieties (G.T. 54-9, G. 2003-47 and G.2003-49), which were planted using two planting densities (1.5 drills "37800 buds/fed" and 2 drills "50400 buds/fed") and fertilized with three nitrogen levels (180, 210 and 240 kg N/fed "fed = 0.42 ha^{-1}").

Treatments were arranged in a split-plot design with three replications using randomized complete block design (RCBD). The varieties were allocated in the main plots. Meanwhile, the combinations among seed sett rates (planting densities) and nitrogen levels were randomly distributed in the sub–plots. Sub plot area was 35 m^2 including five rows of seven m in length and one m in width. Sugarcane varieties were planted in the 2nd week of March and harvested at twelve-month age, in both seasons. The preceding crop was maize followed by fallow.

Nitrogen fertilizer was applied as urea (46.5% N) in two equal doses; the 1st one after two months from planting and the 2nd one month later. Phosphorus fertilizer was added during seed bed preparation at 30 kg P_2O_5/fed as calcium super phosphate (15 % P_2O_5). Meanwhile, potassium fertilizer was added once at 48 kg K_2O/fed as potassium sulphate (48 % K_2O) with the first nitrogen dose.

The different other agricultural practices of growing sugar cane were carried out as usual according Sugar Crops Res. Inst. recommendations. Mechanical and chemical properties of the upper 40 cm of the experimental soil sites are presented in Table 1.

Table 1. Mechanical and chemical properties of the upper 40 cm of the experimental soil sites.

	Season	2013/2014	2014/2015
Mechanical analysis	Sand%	70.12	67.32
	Silt %	19.00	21.00
	Clay %	10.88	11.68
	Soil texture	Sandy loam	Sandy loam
Chemical analysis	Concentration of N (ppm)	20.0	30.0
	Concentration of P (ppm)	11.0	8.0
	Concentration of K (ppm)	35.1	31.2
	HCO_3 Meq/100g	0.59	0.69
	Cl^- Meq/100g	0.23	0.42
	$SO_4^{=}$ Meq/100g	0.27	0.37
	Ca^{++} Meq/100g	0.30	0.50
	Mg^{++} Meq/100g	0.19	0.30
	Na^+ Meq/100g	0.52	0.60
	K^+ Meq/100g	0.09	0.08
	EC(ds/m)	0.11	0.14
	pH	8.1	7.7

Recorded data:

At harvest, plants of each sub-plot were harvested, cleaned and toped to determine the following characteristics:

1. Number of millable cane (thousand/fed).
2. Cane yield (ton/fed).

A sample of 25 stalks from each sub-plot was randomly taken at harvest to determine the following parameters:

1. Stalk length (cm) was measured from land surface to the top visible dewlap.
2. Stalk diameter (cm) in the middle part of the stalk.
3. Stalk weight (kg/plant).
4. Brix percentage of juice was determined using "Brix hydrometer" standardized at 20 ^{0}C according to A.O.A.C. (1995).
5. Glucose percentage.
6. Purity percentage was calculated according to the following equation:

Purity % = sucrose / brix % x 100

7. Sugar recovery percentage was calculated by the following equation:

Sugar recovery % = richness % x purity %

Where Richness = (sucrose in 100 grams x factor) / 100

Factor = 100 - [fiber % + physical impurities % + percent water free from sugar].

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

Economical evaluation:

A simple economical evaluation had done - Based upon the price of the yield and the cost of agriculture practices were considered according to the Ministry of Agriculture, Agriculture Research Center, Central Admen of Agric, in 2010 and 2011.

Statistical analysis:

The collected data were statistically analyzed according to Snedecor and Cochran (1981). Least significant difference (LSD) method was used to compare the differences between treatment means at 5 % level of probability as mentioned by Waller and Duncan (1969).

Results and Discussion

A. Growth criteria:

1. Stalk length (cm):

Table 2 cleared the influence of plant population and nitrogen fertilizer levels on stalk length of some sugar cane varieties. The obtained results revealed that the examined varieties showed a significant effect on stalk length in the 1^{st} plant cane and its 1^{st} ratoon. However, the differences between varieties in such trait did not reach the level of significance in the 2^{nd} planted cane. Sugar cane variety viz G.T.54-9 over passed the two promising varieties in this respect. The difference between sugar cane varieties in stalk length was reported by Abd El-Aal *et al.* (2015).

With respect to the effect of plant density on sugar cane stalk length, the collected data showed that planting sugar cane varieties using the higher plant density (50400 buds/fed) produced taller sugar cane stalks compared to that planted with 37800 buds/fed. This finding was completely true in both planted cane and the 1^{st} ratoon of the 1^{st} plant cane. Collins (2002), claimed that plant density is a function of inter and intra-row spacing. The individual and combined effects of certain management practices planting date, row spacing, planting depth, fertilizer rate, pest control and irrigation have a great impact on the growth.

Concerning nitrogen fertilizer effect on stalk length, data in Table 2 pointed out that increasing the applied nitrogen levels led to a pronounced increase in the stalk length. This increase was significantly whether in the two plant cane crops and/or the 1^{st} ratoon. The influence of nitrogen levels on stalk length was found by Ismail *et al.* (2008).

Table 2. Stalk length (cm) of the tested sugar cane varieties as affected by planting densities, nitrogen levels and their involved interactions.

Treatments		Stalk length (cm)											
		First plant crop (2013/2014)				First ratoon (2014/2015)				Second plant crop (2014/2015)			
		Nitrogen levels (kg/fed) [C]											
Cane varieties [A]	Planting densities (buds/fed) [B]	180	210	240	Mean	180	210	240	Mean	180	210	240	Mean
G.T. 54-9	37800	273.00	282.67	289.67	281.78	291.33	302.67	308.67	300.89	277.33	291.67	295.67	288.22
	50400	283.00	292.00	305.00	293.33	296.67	308.00	322.00	308.89	291.00	302.67	312.00	301.89
Mean		278.00	287.33	297.33	287.56	294.00	305.33	315.33	304.89	284.17	297.17	303.83	295.06
G. 2003-47	37800	269.00	277.33	280.67	275.67	269.00	286.67	288.00	281.22	270.67	283.00	300.67	284.78
	50400	282.67	290.33	295.00	289.33	284.00	288.00	306.33	292.78	272.00	288.67	294.00	284.89
Mean		275.83	283.83	287.83	282.50	276.50	287.33	297.17	287.00	271.33	285.83	297.33	284.83
G. 2003-49	37800	250.33	273.33	279.00	267.56	270.67	287.00	289.33	282.33	263.67	270.00	277.00	270.22
	50400	279.67	289.67	299.00	289.44	283.00	293.00	316.67	297.56	282.67	290.00	297.33	290.00
Mean		265.00	281.50	289.00	278.50	276.83	290.00	303.00	289.94	273.17	280.00	287.17	280.11
B x C	37800	264.11	277.78	283.11	275.00	277.00	292.11	295.33	288.15	270.56	281.56	291.11	281.07
	50400	281.78	290.67	299.67	290.70	287.89	296.33	315.00	299.74	281.89	293.78	301.11	292.26
Mean		272.94	284.22	291.39	282.85	282.44	294.22	305.17	293.94	276.22	287.67	296.11	286.67
F. test & LSD at 0.05 level for:													
				F. test	LSD			F. test	LSD			F. test	LSD
A				*	6.59			*	14.13			NS	—
B				**	—			**	—			**	—
C				**	3.34			**	5.89			**	7.80
A x B				**	4.73			NS	—			*	11.04
A x C				*	5.79			NS	—			NS	—
B x C				NS	—			*	8.33			NS	—
A x B x C				NS	—			NS	—			NS	—

*,** indicated a significant and highly significant at 5% and 1% levels probability, respectively.
N S = Non-significant differences .

The interaction between the evaluated varieties and planting density gave a statistical effect on stalk length in the two plant cane crops. However, it could be noted that the higher planting density always had attained the highest values of stalk length under the various varieties. Moreover, the interaction between the studied varieties and nitrogen levels recorded a significant effect on stalk length in the 1st planted cane, meanwhile, the interaction between the planting density and nitrogen levels recorded a significant effect on this trait in the 1st ratoon, increasing the applied dose of nitrogen fertilizer was accompanied by an increase in stalk length under the different tested sugar cane varieties. Stalk length was in the highest mean values when the commercial variety viz G.T.54-9 was fertilized with 240 kg N/fed.

2. Stalk diameter (cm):

Results in Table 3 showed that stalk diameter insignificantly affected by the examined sugar cane varieties for the two plant crops, however this effect was significantly in the 1st ratoon of the 1st plant crop, the commercial sugar cane variety viz. G.T.54-9 surpassed the two promising varieties in this respect. This result is in agreement with El-Geddawy *et al.* (2012).

Planting sugar cane seed setts in 1.5 model (overlapping seed setts) *i.e* 37800 buds/fed attained a significant increase in the mean values of stalk thickness compared with planting by the dual seed setts 50400 buds/fed. This finding was completely true in the two plant crop as well as in the 1st ratoon. This result is in line with that reported by Raskar and Bhoi (2003). The relative advantage in stalk thickness under the low planting density may be due to low competition between the plant grown in the stool.

Increasing the applied dose of nitrogen from 180 to 240 kg N/fed gradually increase the values of stalk diameter in the two plant crops as well as in the 1st ratoon. It could be noted that the differences between 210 and 240 kg N/fed were insignificant in the 1st planted cane only with respect to sugar cane thickness. However, both levels of nitrogen significantly over passed 180 kg N/fed in the plant crops and in the 1st ratoon, the highest values of stalk diameter was recorded with 240 kg N/fed. The effective role of nitrogen on stalk diameter was reported by Ismail *et al.* (2008).

Most of the different combination between the studied factors insignificantly effected on stalk thickness of sugar cane. The interaction between the examined varieties and seed setts rates mostly significantly effected on stalk diameter, the low seed setts rate with the different varieties attained a positive response in stalk thickness, this effect was significantly in the two plant cane crops. However, the interaction between planting density and nitrogen fertilizer levels was significant in the 1st ratoon with respect to its influence on stalk thickness. Increasing the applied dose of nitrogen was accompanied by additional increase in stalk thickness. This finding was fairly true under the two plant densities. However, the highest stalk thickness was found with the combination between the low plant density (37800 buds/fed) and the highest nitrogen level (240 kg N/fed).

3. Stalk fresh weight (kg/plant):

Results in Table 4 revealed that stalk fresh weight (kg/plant) significantly affected by the studied sugar cane varieties, the commercial one *i.e.* G.T.54-9 recorded a superior value over the two promising varieties with respect to stalk fresh weight (kg/plant). This finding was fairly true in the two plant cane crops and the 1st ratoon. This results may be due to the relative superiority for sugar cane variety G.T.54-9 over the two varieties in stalk dimensions. This result is in agreement with that reported by El-Geddawy, Dalia *et al.* (2015).

Table 3. Stalk diameter (cm) of the tested sugar cane varieties as affected by planting densities, nitrogen levels and their involved interactions.

Treatments		Stalk diameter (cm)											
		First plant crop (2013/2014)				**First ratoon (2014/2015)**				**Second plant crop (2014/2015)**			
		Nitrogen levels (kg/fed) [C]											
Cane varieties [A]	Planting densities (buds/fed) [B]	180	210	240	Mean	180	210	240	Mean	180	210	240	Mean
G.T. 54-9	37800	2.66	2.70	2.81	2.72	2.75	2.79	3.00	2.84	2.65	2.72	2.82	2.73
	50400	2.39	2.66	2.65	2.57	2.65	2.76	2.83	2.75	2.70	2.59	2.69	2.66
Mean		2.53	2.68	2.73	2.65	2.70	2.77	2.92	2.80	2.68	2.66	2.76	2.70
G. 2003-47	37800	2.44	2.53	2.66	2.54	2.57	2.73	2.93	2.74	2.72	2.66	2.84	2.74
	50400	2.43	2.74	2.63	2.60	2.63	2.70	2.80	2.71	2.42	2.56	2.70	2.56
Mean		2.43	2.64	2.65	2.57	2.60	2.72	2.87	2.73	2.57	2.61	2.77	2.65
G. 2003-49	37800	2.62	2.67	2.72	2.67	2.62	2.71	2.89	2.74	2.58	2.62	2.63	2.61
	50400	2.53	2.56	2.55	2.55	2.57	2.72	2.59	2.63	2.48	2.66	2.60	2.58
Mean		2.58	2.62	2.64	2.61	2.59	2.72	2.74	2.68	2.53	2.64	2.62	2.60
B x C	37800	2.57	2.63	2.73	2.65	2.64	2.74	2.94	2.78	2.65	2.67	2.76	2.69
	50400	2.45	2.66	2.61	2.57	2.62	2.73	2.74	2.69	2.53	2.60	2.66	2.60
Mean		2.51	2.65	2.67	2.61	2.63	2.74	2.84	2.74	2.59	2.64	2.71	2.65
F. test & LSD at 0.05 level for:													
				F. test	LSD			F. test	LSD			F. test	LSD
A				NS	—			*	0.08			NS	—
B				*	—			*	—			**	—
C				**	0.08			**	0.07			**	0.06
A x B				*	0.12			NS	NS			*	0.08
A x C				NS	—			NS	—			NS	—
B x C				NS	—			*	0.11			NS	—
A x B x C				NS	—			NS	—			NS	—

Table 4. Stalk fresh weight (kg/plant) of the tested sugar cane varieties as affected by planting densities, nitrogen levels and their involved interactions.

Treatments		Stalk fresh weight (kg/plant)											
		First plant crop (2013/2014)				First ratoon (2014/2015)				Second plant crop (2014/2015)			
		Nitrogen levels (kg/fed) [C]											
Cane varieties [A]	Planting densities (buds/fed) [B]	180	210	240	Mean	180	210	240	Mean	180	210	240	Mean
G.T. 54-9	37800	1.135	1.247	1.285	1.222	1.185	1.244	1.261	1.230	1.165	1.213	1.224	1.201
	50400	0.980	1.140	1.220	1.113	1.025	1.254	1.300	1.193	1.132	1.112	1.209	1.151
Mean		1.057	1.194	1.253	1.168	1.105	1.249	1.280	1.212	1.148	1.163	1.217	1.176
G. 2003-47	37800	0.890	0.935	1.058	0.961	1.132	1.247	1.137	1.172	0.900	1.063	1.162	1.042
	50400	0.818	0.978	1.025	0.940	1.188	1.082	1.222	1.164	1.002	1.016	1.030	1.016
Mean		0.854	0.956	1.041	0.950	1.160	1.164	1.179	1.168	0.951	1.040	1.096	1.029
G. 2003-49	37800	0.903	0.838	1.095	0.945	0.988	1.161	1.162	1.104	0.910	1.125	1.172	1.069
	50400	0.740	0.928	0.930	0.866	1.085	1.098	1.168	1.117	0.953	1.021	1.130	1.035
Mean		0.821	0.883	1.013	0.905	1.036	1.130	1.165	1.110	0.932	1.073	1.151	1.052
B x C	37800	0.976	1.007	1.146	1.043	1.102	1.217	1.187	1.169	0.992	1.134	1.186	1.104
	50400	0.846	1.015	1.058	0.973	1.099	1.144	1.230	1.158	1.029	1.050	1.123	1.067
Mean		0.911	1.011	1.102	1.008	1.101	1.181	1.208	1.163	1.010	1.092	1.155	1.086
F. test & LSD at 0.05 level for:													
				F. test	LSD			F. test	LSD			F. test	LSD
A				**	0.090			*	0.067			*	0.118
B				*	—			NS	—			*	—
C				**	0.085			**	0.040			**	0.041
A x B				NS	—			NS	—			NS	—
A x C				NS	—			*	0.069			*	0.071
B x C				NS	—			*	0.056			*	0.058
A x B x C				NS	—			NS	—			NS	—

Regard to the effect of setts seeding rate, the obtained results cleared that the low plant density produced the higher stalk fresh weight (kg/plant). However, this effect was significantly for the two plant cane crops. This effect due to the pronounced influence on stalk dimensions (Tables 2 and 3) which in turn reflect on stalk fresh weight (kg/plant).

Data in Table 4 demonstrated that the higher the nitrogen level, the higher the stalk fresh weight (kg/plant). This finding was true in the two plant cane crops and the 1st ratoon. Application of 240 kg N/fed attained the highest mean values of stalk fresh weight (kg/plant). This result coincided with that found by Mokadem *et al*. (2008). This effect mainly due to the relative influence of nitrogen fertilization on stalk dimensions consequently stalk fresh weight (kg/plant).

As for the interaction effects on the stalk fresh weight, data in Table 4 cleared that the interaction between the tested varieties and nitrogen fertilizer levels significantly influenced on the values of stalk fresh weight in the 1st ratoon and the 2nd planted cane. Increasing the applied dose of nitrogen was accompanied by additional increase in the values of stalk fresh weight under the various varieties. Sugar cane variety G.T.54-9 attained the highest stalk fresh weight values with the different nitrogen levels over the two promising varieties.

The interaction between seeding rates and nitrogen fertilization attained a significant increment in stalk fresh weight in the 1^{st} ratoon and the 2^{nd} planted cane, increasing nitrogen level up to 240 kg N/fed increased stalk fresh weight under the various seeding rates. However, the difference between planting seed sett of 37800 buds/fed + 210 kg N/fed and planting seed sett of 50400 buds/fed + 240 kg N/fed was insignificant with respect to their influence on stalk fresh weight/plant.

B. Juice quality

1. Brix percentage:

Results illustrated in Table 5 showed that brix percentage significantly affected by the examined sugar cane varieties in the two plant cane crops and the 1^{st} ratoon. The promising sugar cane variety G.2003-47 surpassed the others two varieties and recorded the highest brix percentage in the three cane crops followed by G.2003-49 then the commercial variety (G.T.54-9). This result may be due to gene make up. The differences between varieties with respect to brix percentage was stated by Ahmed *et al*. (2011).

Belong to the previous findings, the influence of seeding rates on such trait, the collected data recorded that as the plant density increases (50400 buds/fed), the values of brix percentage increased significantly. This finding may be due to that under the higher plant density means higher plant population consequently thinner plants and lower moisture and higher total soluble solids in terms of brix percentage.

Regard to nitrogen fertilizer levels and their effect on brix percentage, the result demonstrated that brix percentage statistically affected by the applied levels of nitrogen in the two plant cane crops and the 1^{st} ratoon. The values of brix percentage positively and significantly responded to the additional nitrogen fertilizer up to 240 kg N/fed. This result is in accordance with that obtained by Mokadem *et al*. (2008) who found that brix percentages was gradually increased by increasing N rates .

Concerning the interactions effects, results in Table 5 pointed out that under the studied sugar cane varieties as the nitrogen levels increasing, the values of brix percentages was increased.

Table 5. Brix percentage of the tested sugar cane varieties as affected by planting densities, nitrogen levels and their involved interactions.

Treatments		Brix %											
		First plant crop (2013/2014)				First ratoon (2014/2015)				Second plant crop (2014/2015)			
		Nitrogen levels (kg/fed) [C]											
Cane varieties [A]	Planting densities (buds/fed) [B]	180	210	240	Mean	180	210	240	Mean	180	210	240	Mean
G.T. 54-9	37800	22.60	22.70	23.20	22.83	22.09	23.28	23.57	22.98	21.09	21.97	22.38	21.81
	50400	22.98	24.09	24.25	23.77	23.21	23.41	23.80	23.47	21.62	22.03	22.38	22.01
Mean		22.79	23.40	23.73	23.30	22.65	23.34	23.68	23.23	21.35	22.00	22.38	21.91
G. 2003-47	37800	22.74	24.93	25.27	24.31	24.68	25.29	24.20	24.72	23.44	23.56	23.98	23.66
	50400	23.75	23.61	24.83	24.06	24.94	24.99	25.12	25.02	23.50	23.62	24.57	23.90
Mean		23.24	24.27	25.05	24.19	24.81	25.14	24.66	24.87	23.47	23.59	24.27	23.78
G. 2003-49	37800	21.84	23.28	23.93	23.02	23.53	23.27	23.92	23.57	22.56	22.97	23.09	22.87
	50400	22.61	23.60	25.58	23.93	23.72	23.95	24.35	24.01	22.67	23.03	23.32	23.01
Mean		22.22	23.44	24.76	23.47	23.63	23.61	24.13	23.79	22.61	23.00	23.20	22.94
B x C	37800	22.39	23.64	24.13	23.39	23.43	23.94	23.89	23.76	22.36	22.83	23.15	22.78
	50400	23.11	23.76	24.89	23.92	23.96	24.12	24.42	24.17	22.60	22.89	23.42	22.97
Mean		22.75	23.70	24.51	23.66	23.69	24.03	24.16	23.96	22.48	22.86	23.29	22.87
F. test & LSD at 0.05 level for:													
				F. test	LSD			F. test	LSD			F. test	LSD
A				*	0.65			*	1.12			**	0.43
B				*	—			**	—			**	—
C				**	0.48			*	0.31			**	0.10
A x B				*	0.69			NS	—			NS	—
A x C				NS	—			*	0.54			**	0.18
B x C				NS	—			NS	—			NS	—
A x B x C				NS	—			NS	—			**	0.25

This results was almost fairly true in all cane crops and significantly in the 1st ratoon and the 2nd plant crop only. Moreover, the second order interaction between the three studied factors appeared a significant effect on the values of brix percentage in the 2nd plant crop. The highest values of brix percentage were recorded with sugar cane variety G.2003-47 when planted by 50400 buds/fed and 240 kg N/fed in the 2nd plant crop or planted by 37800 buds/fed and 210 kg N/fed in the 1st ratoon crop. This result reflects the differences between sugar cane crop in their fertilization requirements.

2. Glucose percentage:

It is well known that, the lower the reducing sugars (glucose), the higher sugar extraction. Table 6 demonstrated that the examined sugar cane varieties significantly effected the values of reducing sugars in the two plant cane crops. Sugar cane variety G.2003-47 attained the lowest significant glucose percentage. The differences between sugar cane varieties in juice quality was found by El-Geddawy, Dalia *et al.* (2015).

Regarding the influence of seeding rates, data illustrated in Table 6 pointed out that planting sugar cane by the higher density reduced glucose percentage. This finding was fairly true in the two plant crops and the 1st ratoon. This observation may be due to that the low planting densities allow the plant to grow vegetatively than that under the higher densities.

Here too, the data in Table 6 cleared that the lowest nitrogen level (180 kg N/fed) recorded the lowest significant values of glucose percentage in the two plant cane crops and the 1st ratoon. Increasing the applied nitrogen level over 180 kg N/fed raised the mean values of glucose percentage significantly. This result may be due to the additional nitrogen level leading the plant toward the vegetative growth consequently increasing the values of reducing sugars in terms glucose %. Mokadem *et al.* (2008) mentioned that brix and reducing sugars percentages were gradually increased by increasing N rates.

As for the influence of the interaction effect, the only significant interaction was that between the examined varieties and nitrogen levels in the two plant cane crops. Increasing the applied level of nitrogen almost increased the values of glucose percentage.

3. Purity percentage:

Results shown in Table 7 revealed that purity percentage affected by the examined sugar cane varieties; the two promising varieties (G.2003-47 and G.2003-49) overpassed the commercial variety (G.T.54-9) in purity percentage in the two planted crops and the 1st ratoon. However, this superiority was significant in two planed cane. These findings were not in agreement with El-Geddawy, Dalia *et al.* (2015) who pointed out that purity % insignificantly affected by the examined varieties in both seasons.

Planting sugar cane crop by the higher seeding rate (50400 buds/fed) attained the highest purity percentage. This influence was fairly true in the two plant cane crops as well as the 1st ratoon and significant in the 1st planted cane crop and its ratoon.

Concerning nitrogen fertilizer influence on purity percentage, the available results showed that the middle level of nitrogen over passed the lower and the higher nitrogen levels in purity percentage. This result was true in the two plant crops and the 1st ratoon. Application of 210 kg N/fed attained a significant effect on purity percentage over 240 kg N/fed in the two plant crop and the 1st ratoon.

Table 6. Glucose percentage of the tested sugar cane varieties as affected by planting densities, nitrogen levels and their involved interactions.

Treatments		Glucose %											
		First plant crop (2013/2014)				First ratoon (2014/2015)				Second plant crop (2014/2015)			
		Nitrogen levels (kg/fed) [C]											
Cane varieties [A]	Planting densities (buds/fed) [B]	180	210	240	Mean	180	210	240	Mean	180	210	240	Mean
G.T. 54-9	37800	0.54	0.61	0.78	0.64	0.49	0.57	0.60	0.55	0.51	0.52	0.60	0.55
	50400	0.51	0.55	0.72	0.59	0.51	0.56	0.52	0.53	0.46	0.50	0.51	0.49
Mean		0.52	0.58	0.75	0.62	0.50	0.57	0.56	0.54	0.49	0.51	0.56	0.52
G. 2003-47	37800	0.44	0.54	0.67	0.55	0.49	0.56	0.59	0.55	0.37	0.51	0.47	0.45
	50400	0.40	0.45	0.59	0.48	0.46	0.49	0.51	0.49	0.31	0.49	0.50	0.43
Mean		0.42	0.50	0.63	0.51	0.48	0.53	0.55	0.52	0.34	0.50	0.48	0.44
G. 2003-49	37800	0.53	0.58	0.63	0.58	0.40	0.52	0.42	0.45	0.44	0.50	0.59	0.51
	50400	0.51	0.59	0.57	0.56	0.40	0.41	0.47	0.43	0.43	0.46	0.53	0.47
Mean		0.52	0.59	0.60	0.57	0.40	0.46	0.44	0.44	0.43	0.48	0.56	0.49
B x C	37800	0.50	0.58	0.69	0.59	0.46	0.55	0.54	0.51	0.44	0.51	0.55	0.50
	50400	0.47	0.53	0.62	0.54	0.46	0.49	0.50	0.48	0.40	0.48	0.51	0.47
Mean		0.48	0.56	0.66	0.57	0.46	0.52	0.52	0.50	0.42	0.50	0.53	0.48
F. test & LSD at 0.05 level for:													
				F. test	LSD			F. test	LSD			F. test	LSD
A				*	0.04			NS	—			**	0.01
B				**	—			*	—			*	—
C				**	0.02			**	0.03			**	0.03
A x B				NS	NS			NS	—			NS	—
A x C				**	0.03			NS	—			*	0.06
B x C				NS	—			NS	—			NS	—
A x B x C				NS	—			NS	—			NS	—

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Table 7. Purity percentage of the tested sugar cane varieties as affected by planting densities, nitrogen levels and their involved interactions.

Treatments		Purity %											
		First plant crop (2013/2014)				First ratoon (2014/2015)				Second plant crop (2014/2015)			
		Nitrogen levels (kg/fed) [C]											
Cane varieties [A]	Planting densities (buds/fed) [B]	180	210	240	Mean	180	210	240	Mean	180	210	240	Mean
G.T. 54-9	37800	83.26	84.33	83.38	83.66	83.00	87.54	86.84	85.79	84.24	85.39	80.51	83.38
	50400	84.16	84.88	82.56	83.86	85.68	87.89	85.86	86.48	85.95	83.53	81.52	83.67
Mean		83.71	84.61	82.97	83.76	84.34	87.72	86.35	86.13	85.09	84.46	81.02	83.52
G. 2003-47	37800	84.24	86.99	85.43	85.55	87.03	86.87	84.28	86.06	84.28	84.79	86.15	85.07
	50400	87.40	86.19	87.40	86.99	88.95	90.35	87.76	89.02	85.86	85.93	84.41	85.40
Mean		85.82	86.59	86.42	86.27	87.99	88.61	86.02	87.54	85.07	85.36	85.28	85.24
G. 2003-49	37800	84.76	86.69	83.01	84.82	86.05	87.89	84.57	86.17	86.06	85.66	85.06	85.59
	50400	84.14	88.73	85.75	86.21	87.80	85.64	85.99	86.48	82.78	87.23	85.50	85.17
Mean		84.45	87.71	84.38	85.51	86.92	86.77	85.28	86.32	84.42	86.44	85.28	85.38
B x C	37800	84.09	86.00	83.94	84.68	85.36	87.43	85.23	86.01	84.86	85.28	83.91	84.68
	50400	85.23	86.60	85.23	85.69	87.47	87.96	86.54	87.32	84.86	85.56	83.81	84.74
Mean		84.66	86.30	84.59	85.18	86.42	87.70	85.88	86.67	84.86	85.42	83.86	84.71
F. test & LSD at 0.05 level for:													
				F. test	LSD			F. test	LSD			F. test	LSD
A				*	1.73			NS	—			*	1.44
B				**	—			**	0.85			NS	—
C				**	0.88			**	1.04			*	1.06
A x B				NS	—			*	1.48			NS	—
A x C				*	1.53			*	1.81			**	1.84
B x C				NS	—			NS	—			NS	—
A x B x C				*	2.16			NS	—			**	2.60

The relative effect of nitrogen elements on such trait lead to the inverse effect of nitrogen on purity percentage which due to the fact that the excess amount of nitrogen cause a continuous vegetative growth consequently raising the values of reducing sugars (Table 6) which negatively influence on purity percentage. Effect of nitrogen fertilizer on purity percentage had reported by Mokadem *et al*. (2008).

In general, increasing seeding rate of sugar cane crop increased the values of purity percentage. This result was true under the different sugar cane varieties, however, the significant interaction effect on this trait (89.02 %) was that with sugar cane variety G.2003-47 when planted with 50400 buds/fed in the 1st ratoon.

Moreover, the results in Table 7 pointed out that the interaction between sugar cane variety G.2003-47 and 210 kg N/fed was the best interaction to produce the highest values of purity percentage in the two plant crop and the 1st ratoon.

As for the 2nd order interaction among the three studied factors, the collected data indicated that planting sugar cane variety G.2003-49 with seeding rate of 50400 buds/fed and 210 kg N/fed statistically attained the highest values of purity percentage in the two plant cane crops. Meanwhile, the interaction among the studied factors did not reach the level of significant on purity percentage in the 1st ratoon crop.

4. Sugar recovery percentage:

Data presented in table 8 cleared that there were significant differences in the values of sugar recovery percentage in the three sugar cane crops. It could be noted that both of promising varieties attained a significant increase over that of the commercial variety G.T.54-9. However, the promising sugar cane variety G.2003-47 recorded the highest significant values (13.04, 13.58 and 12.77 % in the 1st planted cane, 1st ratoon and the 2nd planted cane, respectively). The differences between sugar cane varieties in respect to sugar recovery was reported by Abd El-Aal *et al.* (2015).

The differences between the examined varieties were mainly due to their differences in juice quality parameters which effect directly on the values of sugar recovery. It could be noted that the superior variety *i.e.* G.2003-47 in sugar recovery recorded the highest value in brix % (Table 5) as well as the purity % (Table 7) and lowest glucose % (Table 6). These parameters in addition to sucrose % are the main factors effecting purity %. And because the studied parameters of quality broadly affected by gene make up influence, so it could be decide that the differences between varieties in sugar recovery % mainly due to gene make up effect.

Also the exhibited data in table 8 revealed that the influence of sugar cane seeding rate on sugar recovery percentage. It is clearly showed that increasing seeding rate up to 50400 buds/fed significantly increased the values of sugar recovery percentage in the different crops of sugar cane. The relative advantage of the highest value in brix % (Table 5) as well as the purity % (Table 7) and lowest glucose % (Table 6) which in turn led to high values of sugar recovery. This finding is in line with that reported by Ayele *et al.* (2014) who studied the effect of five intra-row sett spacing, who mentioned that sucrose content, was not statistically different from the control treatment.

Concerning the influence of nitrogen fertilizer on sugar recovery %, it could be concluded that fertilizing sugar cane crop by 210 kg N/fed attained a significant increase over that of the lower (180 kg N/fed) and/or the higher (240 kg N/fed) nitrogen levels. This result was completely true in the two plant cane crops and 1st ratoon. This finding is in accordance with Abd Elatif *et al.* (2016) who stated that there was gradual and significant decrease in the values of sugar recovery percentage as nitrogen fertilizer level increase.

Table 8. Sugar recovery percentage of the tested sugar cane varieties as affected by planting densities, nitrogen levels and their involved interactions.

Treatments		Sugar recovery %											
		First plant crop (2013/2014)				First ratoon (2014/2015)				Second plant crop (2014/2015)			
		Nitrogen levels (kg/fed) [C]											
Cane varieties [A]	Planting densities (buds/fed) [B]	180	210	240	Mean	180	210	240	Mean	180	210	240	Mean
G.T. 54-9	37800	9.01	11.16	11.42	10.53	12.14	12.64	12.15	12.31	11.32	11.89	11.82	11.68
	50400	11.57	12.96	11.32	11.95	12.78	13.09	12.01	12.63	11.75	11.85	12.04	11.88
Mean		10.29	12.06	11.37	11.24	12.46	12.87	12.08	12.47	11.53	11.87	11.93	11.78
G. 2003-47	37800	11.91	12.89	12.63	12.48	13.07	13.10	13.79	13.32	12.43	13.01	12.63	12.69
	50400	12.79	14.67	13.34	13.60	13.39	14.30	13.86	13.85	12.53	13.38	12.66	12.86
Mean		12.35	13.78	12.99	13.04	13.23	13.70	13.82	13.58	12.48	13.20	12.65	12.77
G. 2003-49	37800	10.99	11.26	12.03	11.43	11.16	13.55	12.38	12.36	12.14	12.36	12.28	12.26
	50400	11.27	12.31	12.34	11.97	12.38	13.88	14.29	13.52	12.21	12.39	12.31	12.30
Mean		11.13	11.79	12.18	11.70	11.77	13.72	13.33	12.94	12.18	12.37	12.29	12.28
B x C	37800	10.64	11.77	12.03	11.48	12.12	13.09	12.77	12.66	11.96	12.42	12.24	12.21
	50400	11.88	13.31	12.33	12.51	12.85	13.76	13.39	13.33	12.16	12.54	12.34	12.35
Mean		11.26	12.54	12.18	11.99	12.49	13.43	13.08	13.00	12.06	12.48	12.29	12.28
F. test & LSD at 0.05 level for:													
				F. test	LSD			F. test	LSD			F. test	LSD
A				*	1.30			**	0.36			**	0.30
B				**	—			**	—			*	—
C				**	0.41			**	0.38			**	0.14
A x B				NS	—			NS	—			NS	—
A x C				NS	—			**	0.66			**	0.25
B x C				NS	—			NS	—			NS	—
A x B x C				NS	—			NS	—			NS	—

The pronounced influence of the middle level of nitrogen mainly due to its distinct effect on the values glucose, brix and purity percentages as well as the suitable level of nitrogen arrested the vegetative growth consequently pushing the plant grown toward maturity consequently high sugar recovery percentage.

The interaction between the studied varieties and nitrogen levels attained a significant influence on sugar recovery % in the 1st ratoon and the 2nd planted cane.

C. Cane yield and it components:

1. Number of millable cane (thousand/fed)

Results shown in Table 9 cleared that the studied sugar cane varieties differed in the number of millable cane /fed. The two promising sugar cane varieties recorded a relative increase over the commercial variety (G.T.54-9) in this respect, meanwhile, this increment was significant with 1st planted cane only. Sugar cane variety G.2003-49 surpassed G.T54-9 by 3.32, 1.98 and 1.64 thousand/fed for the 1stplanted cane, the 1st ratoon crop and the 2nd plated cane, successively. Ahmed *et al.* (2011) reported that the promising sugar cane variety G.95–21 significantly surpassed G.95–19 in the number of millable cane/fed The differences between varieties in the number of millable cane mainly due to their different in tellering capacity.

Furthermore, the effect of seeding rates on the number of millable cane/fed, the collected results revealed that increasing seeding rate of sugar cane buds/fed increased the number of millable cane/fed. This result is in agreement with El-Geddawy, Dalia *et al.* (2015). On the contrary, Raskar and Bhoi (2003) reported that high density planting reduces the number of tillers.

Here too, the given results in Table 9 cleared that increasing the additional level of nitrogen significantly increased number of millable cane/fed. Application of 240 kg N/fed attained additional increment in the values of millable cane amounted by 10.92, 5.33 % in the 1st planted cane, 13.27 and 7.14 % in the1st ratoon and 12.54 and 4.79 % in the 2nd planted cane as compared to 180 and 210 kg N/fed, respectively. The differences between nitrogen levels in their effect on this trait is mainly due to nitrogen fertilizer encouraged tellering growth to reach the millable cane status at harvest compared with the low nitrogen levels.

The interaction effect between seeding rate and nitrogen fertilizer showed that under the various seeding rate, increasing the applied nitrogen level increased the values of millable cane/fed. The highest number of millable cane/fed was recorded when sugar cane planted with 50400 buds/fed and fertilized by 240 kg N /fed.

2. Cane yield (ton/fed):

The presented data in Table 10 cleared that the commercial sugar cane variety G.T.54-9 and the promising sugarcane variety G.2003-47 over passed the promising variety G.2003-49 in cane yield and this advantage was significantly in the two plant cane crops. However, this difference was not enough to reach the level of significant in the 1st ratoon. The differences between varieties in respect to their cane yield was found by Abd El-Aal *et al.* (2015).

Also the data in Table 10 cleared that planting sugar cane crop by using 50400 buds/fed attained the highest cane yield for the three cane crops. This influence due to the different in the millable cane number at harvest, higher planting density, higher plant population consequently, higher cane yield. This finding was fairly true in the two plant cane crops and the 1st ratoon. This result is in agreement with that claimed by El-Geddawy, Dalia *et al.* (2015).

Table 9. Number of millable cane (thousand/fed) of the tested sugar cane varieties as affected by planting densities, nitrogen levels and their involved interactions.

Treatments		Number of millable cane (thousand/fed)											
		First plant crop (2013/2014)				First ratoon (2014/2015)				Second plant crop (2014/2015)			
		Nitrogen levels (kg/fed) [C]											
Cane varieties [A]	Planting densities (buds/fed) [B]	180	210	240	Mean	180	210	240	Mean	180	210	240	Mean
G.T. 54-9	37800	45.57	48.37	53.01	48.98	49.40	51.53	55.46	52.13	46.70	48.28	51.23	48.74
	50400	48.84	51.03	54.95	51.60	52.19	55.87	59.79	55.95	53.63	55.48	57.45	55.52
Mean		47.21	49.70	53.98	50.29	50.79	53.70	57.63	54.04	50.17	51.88	54.34	52.13
G. 2003-47	37800	47.59	54.15	52.61	51.45	49.71	52.35	55.53	52.53	40.45	53.58	53.05	49.03
	50400	52.20	51.43	54.41	52.68	54.10	56.26	60.51	56.96	57.25	53.42	60.35	57.01
Mean		49.89	52.79	53.51	52.07	51.91	54.30	58.02	54.74	48.85	53.50	56.70	53.02
G. 2003-49	37800	52.21	49.87	55.08	52.39	50.34	53.93	57.51	53.92	47.30	53.60	55.09	52.00
	50400	49.51	56.80	58.22	54.84	54.19	57.81	62.35	58.12	52.70	55.70	58.20	55.53
Mean		50.86	53.34	56.65	53.61	52.27	55.87	59.93	56.02	50.00	54.65	56.65	53.77
B x C	37800	48.46	50.80	53.57	50.94	49.82	52.60	56.16	52.86	44.82	51.82	53.13	49.92
	50400	50.18	53.08	55.86	53.04	53.49	56.64	60.88	57.01	54.53	54.87	58.67	56.02
Mean		49.32	51.94	54.71	51.99	51.66	54.62	58.52	54.93	49.67	53.34	55.90	52.97
F. test & LSD at 0.05 level for:													
				F. test	LSD			F. test	LSD			F. test	LSD
A				*	2.26			NS	—			NS	—
B				**	—			**	—			**	—
C				**	1.33			**	1.64			**	2.62
A x B				NS	—			NS	—			NS	—
A x C				NS	—			NS	—			NS	—
B x C				NS	—			NS	—			*	3.71
A x B x C				NS	—			NS	—			NS	—

Table 10. Cane yield (ton/fed) of the tested sugar cane varieties as affected by planting densities, nitrogen levels and their involved interactions.

Treatments		Cane yield (ton/fed)											
		First plant crop (2013/2014)				First ratoon (2014/2015)				Second plant crop (2014/2015)			
		Nitrogen levels (kg/fed) [C]											
Cane varieties [A]	Planting densities (buds/fed) [B]	180	210	240	Mean	180	210	240	Mean	180	210	240	Mean
G.T. 54-9	37800	46.90	51.47	56.76	51.71	51.90	52.42	54.72	53.01	51.13	52.42	54.45	52.67
	50400	51.49	53.81	58.51	54.60	50.24	55.66	59.29	55.06	51.87	53.17	57.53	54.19
Mean		49.20	52.64	57.63	53.16	51.07	54.04	57.01	54.04	51.50	52.79	55.99	53.43
G. 2003-47	37800	51.03	50.33	58.57	53.31	47.44	50.15	56.63	51.40	50.32	50.73	51.98	51.01
	50400	48.75	50.07	55.23	51.35	48.26	54.28	58.22	53.58	50.50	51.41	51.49	51.13
Mean		49.89	50.20	56.90	52.33	47.85	52.21	57.42	52.49	50.41	51.07	51.74	51.07
G. 2003-49	37800	46.21	49.45	51.31	48.99	49.00	50.47	52.82	50.76	47.44	50.38	50.80	49.54
	50400	51.02	51.84	56.85	53.24	52.28	53.51	57.07	54.28	49.43	51.61	53.19	51.41
Mean		48.62	50.65	54.08	51.11	50.64	51.99	54.94	52.52	48.44	51.00	52.00	50.48
B x C	37800	48.05	50.42	55.54	51.34	49.44	51.01	54.72	51.73	49.63	51.17	52.41	51.07
	50400	50.42	51.91	56.86	53.06	50.26	54.48	58.19	54.31	50.60	52.06	54.07	52.24
Mean		49.24	51.16	56.20	52.20	49.85	52.75	56.46	53.02	50.12	51.62	53.24	51.66
F. test & LSD at 0.05 level for:													
				F. test	LSD			F. test	LSD			F. test	LSD
A				*	1.39			NS	—			*	2.26
B				*	—			**	—			**	—
C				**	2.11			**	1.35			**	0.75
A x B				*	2.99			NS	—			NS	—
A x C				NS	—			*	2.34			**	1.30
B x C				NS	—			NS	—			NS	—
A x B x C				NS	—			NS	—			NS	—

Concerning the effect of nitrogen fertilizer on cane yield/fed, the available results pointed out that increasing the applied level of nitrogen was accompanied by continuous increment in the values of cane yield/fed. The pronounced influence of nitrogen fertilizer on cane yield mainly due to its effect on growth parameters in terms of stalk dimensions (Tables 2 and 3), individual stalk weight (Table 4) as well as number of millable cane (Table 9). This finding is in agreement with that reported by El-Geddawy *et al.* (2012).

As for the interaction effect of the studied factors, it could be noted that the interaction between the examined varieties and seeding rates significantly effected on the values of cane yield/fed in the 1^{st} planted cane. Increasing seeding rate recorded the highest value of cane yield/fed. This observation was completely true with respect to the commercial variety (G.T.54-9) and the promising one (G.2003-49) for the three sugar cane crops and significantly in the 1^{st} planted cane.

The interaction between the examined varieties and nitrogen fertilizer levels attained a significant increase in cane yield/fed, this observation was true with respect to the commercial variety (G.T.54-9) and the promising varieties (G.2003-47 and G.2003-49) and significantly in the 1st ratoon and 2nd planted cane, as well as this interaction was not enough to reach the level of significant in the 1st planted cane.

As for the 2nd order interaction between the sugar cane varieties, seeding rates and nitrogen fertilizer levels recorded the highest values of cane yield/fed, however, this difference was not enough to reach the level of significant in the three crops.

3. Sugar yield (ton/fed):

Data exhibited in Table 11 revealed that influence of seeding rate and nitrogen fertilization on sugar yield of some sugar cane varieties. Results illustrated that sugar cane variety G.2003-47 produced the highest values of sugar yield in the three cane crops. However, it could be noticed that the differences between varieties in this trait was significantly in the 1st planted cane only. Despite the two promising varieties recorded some what low cane yield, they produced higher sugar/fed than the commercial variety G.54-9, this result mainly due to that the two promising varieties attained low glucose % (Table 6), higher purity % (Table 7) and higher sugar recovery% (Table 8) compared with that of the commercial variety which positively reflected on sugar extraction inturn higher sugar yield. The difference between sugar cane varieties in sugar yield reported by Abd El-Aal *et al.* (2015).

Moreover, the given results in Table 11 cleared that the higher the seeding rate, the higher the sugar yield. These results mainly due to that planting sugar cane by the higher seeding rate (50400 buds/fed) produced the highest millable cane number (Table 9), the highest cane yield (Table 10) and the highest sugar recovery % (Table 8) consequently higher sugar yield/fed. The effect of seeding rate on sugar yield had reported by El-Geddawy,Dalia *et al.* (2015).

Also, the data in Table 11 showed that increasing the applied level of nitrogen fertilizer from 180 to 210 and 240 kg N/fed caused significant increase in the values of sugar yield in the two plant cane crops and the 1st ratoon. This increment amounted by 15.67 and 23.24 % in the 1st planted cane, 13.83 and 18.81% in the 1st ratoon and 6.45 and 8.10 % in the 2nd planted cane, respectively. This finding is in accordance with that found by El-Geddawy *et al.* (2012).

As for the interaction effect of the studied factors, it could be noted that the interaction between the examined varieties and nitrogen fertilizer levels significantly increased sugar yield/fed in the 1st ratoon and the 2nd planted cane, meanwhile, this interaction was not enough to reach the level of significant in the 1st planted cane.

Table 11. Sugar yield (ton/fed) of the tested sugar cane varieties as affected by planting densities, nitrogen levels and their involved interactions.

Treatments		Sugar yield (ton/fed)											
		First plant crop (2013/2014)				First ratoon (2014/2015)				Second plant crop (2014/2015)			
		Nitrogen levels (kg/fed) [C]											
Cane varieties [A]	Planting densities (buds/fed) [B]	180	210	240	Mean	180	210	240	Mean	180	210	240	Mean
G.T. 54-9	37800	4.20	5.74	6.46	5.47	6.30	6.62	6.64	6.52	5.79	6.23	6.44	6.16
	50400	5.95	6.98	6.62	6.52	6.43	7.28	7.12	6.94	6.10	6.30	6.94	6.45
Mean		5.08	6.36	6.54	5.99	6.36	6.95	6.88	6.73	5.94	6.27	6.69	6.30
G. 2003-47	37800	6.07	6.49	7.41	6.66	6.20	6.56	7.81	6.86	6.26	6.61	6.57	6.48
	50400	6.23	7.37	7.37	6.99	6.45	7.76	8.07	7.43	6.33	6.88	6.52	6.58
Mean		6.15	6.93	7.39	6.82	6.33	7.16	7.94	7.14	6.30	6.74	6.55	6.53
G. 2003-49	37800	5.08	5.57	6.16	5.61	5.48	6.84	6.54	6.28	5.76	6.22	6.24	6.07
	50400	5.76	6.37	7.01	6.38	6.47	7.44	8.16	7.35	6.04	6.39	6.55	6.33
Mean		5.42	5.97	6.59	5.99	5.97	7.14	7.35	6.82	5.90	6.31	6.40	6.20
B x C	37800	5.12	5.94	6.68	5.91	5.99	6.67	7.00	6.55	5.94	6.35	6.42	6.24
	50400	5.98	6.91	7.00	6.63	6.45	7.49	7.78	7.24	6.15	6.52	6.67	6.45
Mean		5.55	6.42	6.84	6.27	6.22	7.08	7.39	6.90	6.05	6.44	6.54	6.34
F. test & LSD at 0.05 level for:													
				F. test	LSD			F. test	LSD			F. test	LSD
A				*	0.69			NS	—			NS	—
B				**	—			**	—			**	—
C				**	0.34			**	0.28			**	0.11
A x B				NS	—			NS	—			NS	—
A x C				NS	—			*	0.49			**	0.19
B x C				NS	—			NS	—			NS	—
A x B x C				NS	—			NS	—			NS	—

Economical view and general discussion:

Results given in Table 12 pointed out that the total costs of the three varieties differed according to the used seeding rates as well as the quantities of nitrogen application, consequently the total revenue of the examined varieties had been differed. Based upon the results of net income, it could be noted that as the levels of nitrogen and seeding rates increased the total revenue mostly tended toward increasing as a results to the continuous increase in cane yield which corresponding to the increase in the seeding rates and nitrogen levels. However, the net income of the low planting density (37800 buds/fed) and nitrogen level (180 kg N/fed) attained the highest net income (LE 9672) with the promising sugar cane variety viz G.2003-47 as a result to the low costs under this treatment. As a matter of fact, despite of the high net income for sugar cane variety G.2003-47 for the growers, it could be decide that the commercial sugar cane variety viz G.T.54-9 is still recorded the highest cane yield (58.02 ton/fed) compared with G.2003-47 (55.28 ton/fed). A general view, it could be noted that from the economical view of growers' benefit planting the promising sugar cane variety G.2003-47 is better, however the actual and the economical view growing the commercial variety with higher costs is better for the national economy where it will save about 2.49 ton/fed which represent a large amount of cane on the large area consequently a large amount of sugar production.

The future view of the commercial variety status, it could be noted that it is tended to deteriorate as a results to its susceptibility by smut disease. So, it become necessary to carry out a concentrated study for the new promising variety such as G.2003-47 to found out the suitable package for higher yield and good quality to reduce sugar gap.

Table 12. Economical view for three sugar cane varieties (average of the two plant cane crops) under different planting densities and nitrogen levels.

Treatments		**Cane yield (ton/fed)**			**Total costs (L.E./fed)**			**Total revenue (L.E./fed)**			**Net income (L.E./fed)**		
		Nitrogen levels (kg/fed)											
Cane varieties	Planting densities (buds/fed)	180	210	240	180	210	240	180	210	240	180	210	240
G.T. 54-9	37800	49.02	51.95	55.61	10600	12100	13600	19608	20780	22244	9008	8680	8644
	50400	51.68	53.49	58.02	11400	12900	14400	20672	21396	23208	9272	8496	8808
G. 2003-47	37800	50.68	50.53	55.28	10600	12100	13600	20272	20212	22112	9672	8112	8512
	50400	49.63	50.74	53.36	11400	12900	14400	19852	20296	21344	8452	7396	6944
G. 2003-49	37800	46.83	49.92	51.06	10600	12100	13600	18732	19968	20424	8132	7868	6824
	50400	50.23	51.73	55.02	11400	12900	14400	20092	20692	22008	8692	7792	7608

- Based upon the average of total cost of one fed = L.E 12000 (average of the different locations).
- Nitrogen's price = L.E. 110/50 kg urea (46.5 % N).
- Total revenue (L.E./fed) = cane yield (tons/fed) x ton's price (LE 400)
- Net income (L.E./fed) = total revenue (L.E./fed) - total costs (L.E./fed).

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تقييم أداء ثلاث أصناف لقصب السكر تحت مستويات مختلفة من التسميد النيتروجيني ومعدلين من التقاوي

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الملخص

أقيمت ثلاث تجارب حقلية تمثل غرسين وخلفة اولى بمحطة البحوث الزراعية بالمطاعنه – اسنا – محافظة الأقصر خلال الفترة من ٢٠١٣/٢٠١٤ ، ٢٠١٤/٢٠١٥ لتقييم أداء ثلاث أصناف من قصب السكر (جيزة ٥٤–٩ ، جيزة ٢٠٠٣–٤٧ ، جيزة ٢٠٠٣–٤٩) والتي زرعت بمعدلين من التقاوي (١,٥ صف "٣٧٨٠٠ برعم/فدان" ، صفين "٥٠٤٠٠ برعم/فدان") وسمدت بثلاثة مستويات من النيتروجين (١٨٠ ، ٢١٠ ، ٢٤٠ كجم ن/فدان)، وذلك في تصميم القطاعات الكاملة العشوائية باستخدام قطع منشقة مرة واحدة وثلاث مكررات حيث وضعت الأصناف في القطع الرئيسية في حين وزعت التوافقات بين معدلات التقاوي ومستويات التسميد النيتروجيني عشوائيا في القطع الشقية، ويمكن اجمال اهم النتائج المتحصل عليها في النقاط التالية:

- أوضحت النتائج تفوق الصنف التجاري (جيزة ٥٤–٩) علي الصنفين المبشرين (جيزة ٢٠٠٣–٤٧ ، جيزة ٢٠٠٣–٤٩) في كل من الطول والقطر والوزن الغض/العود، بينما تفوق الصنفين المبشرين علي الصنف التجاري في النسب المئوية للنقاوة والبركس وناتج السكر وعدد العيدان القابلة للعصر/فدان وحقق الصنف المبشر جيزة ٢٠٠٣–٤٧ أعلي محصول سكر وذلك في الغرسين والخلفة.
- حققت الكثافة النباتية ٣٧٨٠٠ برعم/ فدان زيادة معنوية في قطر الساق مقارنة بالكثافة النباتية ٥٠٤٠٠ برعم/ فدان كما حققت الكثافة النباتية ألأقل أعلي وزن للعود وذلك في الغرسين والخلفة، بينما حققت الكثافة النباتية ٥٠٤٠٠ برعم/فدان أعلي قيم في طول الساق والنسب المئوية للنقاوة والبركس وناتج السكر وعدد العيدان القابلة للعصر ومحصولي العيدان والسكر/فدان وانخفاضاً في النسبة المئوية للجلوكوز وذلك في محصولي الغرس والخلفة الأولى.
- أدت زيادة مستويات التسميد النيتروجينى إلي ٢٤٠ كجم ن/ فدان الي زيادة معنوية في كل من طول وقطر ووزن العود وعدد العيدان القابلة للعصر ومحصولي العيدان والسكر/فدان وذلك في محصولي الغرس والخلفة، كما حقق كلا من التسميد بمعدلي ٢١٠ و٢٤٠ كجم ن/فدان زيادة معنوية في محصول السكر/فدان بمقدار ١٥,٦٧ ، ٢٣,٢٤ % وذلك في الغرس الأول ، ١٣,٨٣ ، ١٨,٨١ % في الخلفة الأولي ، ٦,٤٥ ، ٨,١٠ % في الغرس الثاني علي الترتيب مقارنة بالتسميد بمعدل ١٨٠ كجم ن/فدان.
- سُجلت أعلي قيم لعدد العيدان القابلة للعصر/فدان بالزراعة بكثافة نباتية ٥٠٤٠٠ برعم/فدان والمسمدة بمستوي نيتروجيني بمعدل ٢٤٠ كجم ن/فدان ، كما حقق الصنف التجاري جيزة ٥٤–٩ أعلي وزن للعود مع المستويات المختلفة من التسميد النيتروجينى متفوقا علي الصنفين المبشرين محل الدراسة ، وكان أفضل تفاعل بين الصنف جيزة ٢٠٠٣–٤٧ والمسمد بمستوي نيتروجيني ٢١٠ كجم ن/فدان والذي حقق أعلي نسبة مئوية للنقاوة وذلك في محصولي الغرس والخلفة الأولى.
- أثر التفاعل بين الأصناف ومستويات النيتروجين معنويا علي النسبة المئوية لناتج السكر في الخلفة الأولي والغرس الثاني ، كما أعطي التفاعل بين الأصناف ومعدلات التقاوي ومستويات النيتروجين أعلي محصول عيدان/فدان إلا أنه لم يصل إلي مستوي المعنوية وذلك في محصولى الغرس والخلفة الأولى.
- ومن الجدير بالذكر أن التقييم الإقتصادى يشير إلى تعارض بين منفعة المزارعين والمنفعة القومية ، حيث تشير النتائج إلى أربحية المزراعيين عند زراعة الصنف جيزة ٢٠٠٣–٤٧ ، بينما الواقع الإقتصادي لإنتاج السكر يشير إلى أن زراعة الصنف التجاري جيزة ٥٤–٩ مع ارتفاع تكاليف زراعته مازال يحقق وفرة فى الإنتاج تبلغ ٢,٤٩ طن عيدان/فدان تحقق ووفرة فى انتاج السكر على مستوى المساحة المنزرعة.