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Quality and Yield Traits of Three Sugar Cane Varieties as Affected by Different Levels of Nitrogen and Potassium Fertilizations in Egypt

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ABSTRACT

To evaluate the performance of three sugar cane varieties as affected by nitrogen and potassium fertilizations, field experiment was carried out at Malawy Agricultural Research Station in the two successive seasons of 2012/2013 and 2013/2014. Each field trail included twenty seven treatments, three sugarcane varieties (G.T.54-9 the commercial variety as a control, G.2001-79and G. 99 -103), three nitrogen levels (220, 280 and 340 kg N/fed.) and three potassium levels (24, 48 and 72 K_2O kg/fed.). Results indicated that the increasing of nitrogen rate from 220 to 280 up to 340 attained a significant increment in cane yield. Also, the increasing of potassium level slightly increased cane yield /fed, in the 1st season only. Sugar cane variety G.99-103 over passed significantly the other two varieties and the promising variety G.99-103 attained additional increase over the commercial one by 5.11 and 4.88 ton/fed in the 1st and 2nd seasons respectively. The sugar yield increased significantly by increasing of nitrogen rates and the highest sugar yield was recorded with 340 kg N /fed. There is a positive and significant increase in sugar recovery percentage in the 1st season, where increasing of potassium was accompanied by significant decrease in the values of sugar recovery percentage.

Key words: sugar cane, nitrogen, potassium, yield, Juice quality

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INTRODUCTION

Sugar is considered as one of the most important strategic commodities for people all over the world and comes at the second order after wheat in Europe, North and South America and Australia, and it comes also after rice in Asian countries. Sugar industry depends largely on sugarcane crop. Sugarcane (*Saccharum officinarum,* L.) is considered the first important sugar crops in Egypt and Egypt has the first position in sugar production per unit area and the fourth position in the world sugar consumption.

It is well known that nitrogen has a strong relationship with cane yield and its components, where it plays a direct role on growth behavior and juice quality of sugar cane. Nitrogen unites with carbonic compounds to produce a hundred of different organic compounds like chlorophyll, protoplasm, proteins, nucleic acids, vitamins and enzymes. Also nitrogen is responsible for growth and development of all living tissues of cane plants. Is this regard, Ahmed et al. [1] 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, total soluble solids percentage and cane yield/fed. Moreover, El-Geddawy et al. [2] indicated that variety G.T. 54-9 surpassed the other varieties in plant height, stalk fresh weight, number of millable canes/feddan, cane yield and sugar yield (ton/fed.). Whereas, Giza2000-5 variety was gave the highest stalk diameter. Also, Abd El-Aal et al.[3]found that the tested sugar cane varieties differed significantly in their stalk number and diameter, sucrose %, cane and sugar yields whether they were grown as a plant cane or 1st and 2ndratoon crops as well as sugar recovery % (in the 2ndcrop). Regarding nitrogen role in sugarcane production, Mokadem, et al. [4] found that increasing N levels attained a positive and significant effect on stalk height, stalk diameter number of internodes, cane and sugar yields. Fertilizing sugarcane with 260 kg N/fed. However, El-Geddawy et al. [2] found that the increasing of nitrogen levels from 170 to 230 kg N/fed increasing all studied traits. Fertilizing Giza-Taiwane54-9 variety with 230 kg N/fed. and harvesting after 13 months from planting gave the highest productivity of cane and sugar yields. Also, Abd El-Aal et al. [3] showed that increasing nitrogen level from 180 to 210 and 240 kg. N/fed. resulted in a significant increase in stalk diameter and cane yield of plant cane,1st and 2ndratoon. On other hand, the sucrose and sugar recovery, purity percentages decreased by increasing N rates (Mokadem, et al. 2008 and Abd El-Aal et al. 2015).

Elamin et al. [5] reported that potassium fertilizers did not significantly affect the fiber content of plant cans, while sucrose and brix percentages were noted to be positively affected by potassium fertilizer application ‘of high rates of potassium adversely affected the purity of juice. However, Sanjay-Kumar et al. [6] studied the effect of (P and K) fertilizer application and found that P: K at 120:80 kg/ha gave the highest mean number of millable canes, cane yield. Also, Mahmoud et al. [7] found that increasing potassium fertilizer levels significantly increased stalk length, stalk diameter, stalk weight, millable cane, cane and sugar yields.

The commercial variety G.T.54-9 occupies more than 90 % of the area planted with sugarcane in Egypt for more than twenty years and the depending on just one sugarcane variety represents a high risk that may face sugar industry. Therefore, releasing new sugarcane varieties is considered a vital need. However, selecting the promising varieties is the best way to get high production and quality of sugar. The Egyptian sugarcane breeding and selection program places considerable emphasis on producing varieties with high yielding potential high sugar content, resistance to diseases and pests and a good rationing ability.

Recently, Sugar Crops Research Institute, Agriculture Research Centre, Egypt succeeded in selecting some promising varieties of sugarcane. These differences are due to the great variation in their gene structure and weather factors affecting growth criteria and quality characteristics. Therefore, the present study was aimed to evaluate the performance of two promising sugar cane varieties compared to commercial variety under different levels of nitrogen and potassium fertilizations to obtain the highest qualitative and quantitative criteria.

MATERIALS AND METHODS

A field experiment was carried out at Malawy Agricultural Research Station, El-Menia governorate, Middle Egypt during two successive seasons of 2012/2013 and 2013/2014. The chemical and physical properties of the experimental soil are presented in Table (1) for two seasons.

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Table 1: Physical and chemical properties of the upper 40 cm of the experimental soil sites*

Properties	2011/2012	2012/2013
Texture analysis		
Clay %	44.30	47.40
Silt %	32.20	38.60
Sand %	23.60	24.00
Texture grade	Clay	Clay
pH (1:1 suspension)	7.50	7.50
EC m. mohs (1:1)	1.32	1.15
Organic matter %	1.18	1.24
Soluble cations		
$Ca^{++}Mg^{+}$ meq/100 g. soil	0.96	0.84
Na meq/100 g. soil	0.37	0.44
K^{+} meq/100 g. soil	0.09	0.11
Soluble anions		
CO_3 + HCO_3 meq/100 g. soil	0.33	0.36
Cl^{-} meq/100 g. soil	0.84	0.91
Available N mg. / kg. soil	21.1	19.38
Available P mg. / kg. soil	8.50	7.85
Available K mg. / kg. soil	175	180

Each value represents the mean of five samples

Each field trail included twenty seven treatments represent the combinations among three sugarcane varieties(G.T.54-9 known as C9 the commercial variety as a control, G.2001-79 and G. 99 -103), three nitrogen levels (220, 280 and 340 kg N/fed.) and three levels of potassium fertilization (24, 48 and 72 kg K_2O/fed.) as a potassium sulphate. Phosphorus fertilizer was added at a rate of 60 kg P_2O_5/fed. once during land preparation.

Sugarcane varieties were planted in rows (dual seed setts) one meter apart during the first week of March and harvested after 10, 12 and 13 months from planting in both seasons. Nitrogen fertilizer was added as urea (46% N). Each N-level was split into two equal doses. The first one was added after 45 days from planting, while the second one was applied 45- day later.

A split plot design with three replications was used in both seasons. Sugarcane varieties were allocated in the main plots, the combination between nitrogen fertilizer and potassium were randomly distributed in the sub plots. The experimental unit area was 21 m² six ridges of 1-m apart and 3.5 m in length.

Data recorded:

A-Yield comments

At harvest, sugarcane plants of the four guarded rows were harvested, cleaned, topped and the following parameters were recorded:

1. Cane yield (ton/fed).
2. Sugar yield (ton/fed) was calculated according to the following equation:
   Sugar yield (ton/fed) = cane yield (ton/fed) x sugar recovery %.
   B- Juice quality and chemical constituents:

At harvest, a sample of 20 stalks from each treatment was taken at random and the following traits were determined:

3- Reducing sugars % was determined according An………

4- Juice purity percentage was calculated according to the following equation: Purity % = sucrose % x 100 / brix %
5- Sugar recovery percentage was calculated according to the following equation as described by Yadav and Sharma [8].

Sugar recovery % = [sucrose % - 0.4 (brix % - sucrose %)] x 0.73.

Statistical analysis:

The collected data were subjected to the proper statistical analysis of split-split plot design according to the procedure outlined by Snedecor and Cochran [9]. Treatment means were compared using LSD at 5% level of difference as outlined by Steel and Torrie [10].

RESULTS AND DISCUSSION

Sugar cane juice quality:
1-Reducing sugar percentage :

Reducing sugars is considered one of the very important measurements which negatively affected on juice quality in terms of purity and sugar recovery percentage and increasing the values of reducing sugar decreased juice quality in turn sugar extraction. Data shown in Table (2) clear the influence of nitrogen and potassium fertilization rates on the values of reducing sugar percentage for sugar cane juice varieties and the results that the reducing sugars percentage significantly and positively increased as the applied dose of nitrogen increased. This result was fairly true in both seasons that may be due to the enhanced role of nitrogen fertilization on the vegetative growth which reflected negatively on juice quality. Supporting results found by Singh, et al. [11] who mentioned that cane quality was not affected by N rate.

Table 2: Effect of nitrogen and potassium fertilization on reducing sugars % of some sugar cane varieties

Nitrogen (N)	Potassium (K)	2012/2013				2013/2014			
		Sugar cane varieties (V)				Sugar cane varieties (V)			
N/Fed. (Kg)	K_2O_5 /Fed. (Kg)	G.T.54-9	G.99-103	G.2001-79	Mean	G.T.54-9	G.99-103	G.2001-79	Mean
220	24	0.293	0.300	0.260	0.284	0.313	0.330	0.290	0.311
	48	0.297	0.287	0.253	0.279	0.313	0.310	0.293	0.306
	72	0.260	0.283	0.253	0.266	0.293	0.313	0.283	0.297
Mean		0.283	0.290	0.256	0.276	0.307	0.318	0.289	0.304
280	24	0.320	0.323	0.283	0.309	0.353	0.340	0.300	0.331
	48	0.310	0.297	0.250	0.286	0.333	0.313	0.283	0.310
	72	0.283	0.293	0.247	0.274	0.307	0.327	0.290	0.308
Mean		0.304	0.304	0.260	0.290	0.331	0.327	0.291	0.316
340	24	0.353	0.377	0.307	0.346	0.373	0.400	0.323	0.336
	48	0.323	0.327	0.277	0.309	0.337	0.347	0.300	0.328
	72	0.283	0.317	0.270	0.290	0.307	0.343	0.297	0.316
Mean		0.320	0.340	0.284	0.315	0.339	0.363	0.307	0.336
K x V	24	0.322	0.333	0.283	0.313	0.347	0.357	0.304	0.336
G. mean	48	0.310	0.303	0.260	0.29	0.328	0.323	0.292	0.314
	72	0.276	0.298	0.257	0.27	0.302	0.328	0.290	0.307
Mean		0.303	0.311	0.267		0.326	0.336	0.296	

LSD (5%)		
Nitrogen (N)	0.007	0.006
Potassium (K)	0.007	0.006
N x K	0.012	0.011
Varieties (V)	0.014	0.016
N x V	0.012	0.006
V x K	0.012	0.011
N x V x K	N.S	N.S

Increasing the applied rates of potassium significantly decreased the values of reducing sugars percentage in the two growing seasons, consequently improved juice quality. The lowest reducing sugars percentage was recorded with 72 Kg K_2O. The role of potassium in juice quality was reported by EL-Geddawy et al.[12]. Concerning the interaction between nitrogen and potassium fertilization on reducing sugar percentage, the results in Table (2) showed that reducing sugar % significantly affected by the interaction between nitrogen and potassium fertilization. It could be noted that increasing the applied rates of potassium under the various level of nitrogen improved juice quality (decrease the values of reducing sugars %), the lowest reduction was that under 220 kg N/fed. where recorded the lowest reducing sugar % with 72 kg. K_2O /fed. It is well known the positive role of potassium in juice quality as a catalyst in sucrose transportation.

Results obtained showed that sugar cane varieties significantly differed in their influence on reducing sugar percentage in the two growing seasons. Sugar cane variety G.2001-79 significantly produced the lowest value of reducing sugars percentage followed by sugar cane variety G.T.54-9 then G.99-103. This result was completely true in both seasons. Effect of sugar cane varieties on reducing sugar percentage had been reported by EL-Geddawy et al. [13] who mentioned that the used varieties did not differ significantly in reducing sugar percentage.

As to, the influence between nitrogen rates and the studied varieties, the results in Table (2) revealed that increasing the applied rate of nitrogen was accompanied by additional increase in the values of reducing sugars %. This finding was true not only under the examined sugar cane varieties, but also in the two growing seasons.

Varieties proved that there was a negative response in the values of reducing sugars % under the different varieties, sugar cane variety 2001-79 recorded the lowest reducing sugars % in the two growing seasons with 72 Kg K_2O/fed.

The 2^{nd} order interaction between the studied factors had no significant effect on the values of reducing sugars.

2. Juice purity percentage:

Results given in Table (3) demonstrated the values of juice purity percentages as affected by nitrogen, potassium fertilization and sugar cane varieties. Figures obtained in Table (3) obviously show that as the applied dose of nitrogen increased the values of purity % decreased in both seasons. The negative effect of the additional nitrogen dose may be due to the excess amount of nitrogen delayed maturity in turn cause depression in the purity %. Effect of nitrogen fertilization on purity % had been reported by Mokadem et al. [4] who stated that sucrose and purity percentages decreased by increasing N rates. On other hand, Hemalatha [14] reported that The N uptake, enhanced the quality parameters viz., brix, sucrose, commercial cane sugar and purity per cent @ 195.5 kg Nitrogen ha^{-1}.

Data in Table (3) pointed out that the additional application of potassium significantly improved the values of purity % in the two growing seasons. The highest significant value of purity (84.93 and 85.41 %) was recorded with 72 Kg. K_2O/fed. in the 1^{st} and 2^{nd} season respectively. The positive effect of potassium fertilization may be due to its important in sucrose accumulation in turn reflected positively on the values of purity percentage [12].

As to, the influence of the interaction between nitrogen and potassium fertilization rates, the collected data cleared that increasing the applied dose of potassium under the various levels of nitrogen let to additional improve in the values of purity % . This observation was true in both seasons, but significant in the 1^{st} season only.

Data in Table (3) revealed a significant difference between the examined varieties with respect to purity %. Sugar cane variety G.2001-79 over passed significantly the others varieties followed by the commercial variety *i.e.*G.T.54-9, whereas G.99-103 recorded the lowest value of purity %. This finding was fairly true in the two growing seasons.

Table 3: Effect of nitrogen and potassium fertilization on purity % of some sugar cane varieties

Nitrogen (N)	Potassium (K)	2012/2013				2013/2014			
		Sugar cane varieties (V)				Sugar cane varieties (V)			
N/Fed. (Kg)	K_2O_5 /Fed. (Kg)	G.T.54-9	G.99-103	G.2001-79	Mean	G.T.54-9	G.99-103	G.2001-79	Mean
220	24	85.23	84.02	85.26	84.84	85.68	84.59	85.68	85.32
	48	85.52	84.39	85.56	85.15	85.79	84.84	86.10	85.57
	72	85.24	84.89	85.61	85.24	85.63	86.00	86.07	85.90
Mean		85.33	84.43	85.47	85.08	85.70	85.14	85.95	85.60
280	24	84.59	83.97	84.95	84.50	85.00	84.25	85.37	84.87
	48	84.66	83.82	85.46	84.64	85.23	84.35	85.79	85.12
	72	85.12	84.76	85.74	85.21	85.45	85.14	86.03	85.55
Mean		84.79	84.18	85.38	84.78	85.23	84.58	85.74	85.18
340	24	84.21	83.17	84.50	83.96	84.69	83.14	84.96	84.26
	48	84.35	83.38	84.91	84.21	84.72	83.95	85.37	84.68
	72	84.50	83.43	85.07	84.33	84.87	83.94	85.54	84.78
Mean		84.35	83.33	84.83	84.17	84.67	83.68	85.29	84.57
K x V G. mean	24	84.68	83.72	84.90	84.43	82.12	83.99	85.34	84.82
	48	84.84	83.86	85.31	84.67	82.25	84.38	85.75	85.13
	72	84.95	84.36	85.47	84.93	85.32	85.03	85.89	85.41
		84.82	83.98	85.23		85.23	84.47	85.66	

LSD (5%)	2012/2013	2013/2014
Nitrogen (N)	0.107	0.168
Potassium (K)	0.107	0.168
N x K	0.186	N.S
Varieties (V)	0.343	0.126
N x V	0.186	0.291
V x K	0.186	0.291
N x V x K	0.322	N.S

Regarding the influence of the interaction between nitrogen and varieties with respect to its effect on purity %, the available results pointed out that increasing the applied dose of nitrogen was accompanied by significant reduction in the values of purity % in both seasons. In this regard, Kumara and Bandara[15] showed that the luxury consumption of N increased biomass production and fresh millable cane yield, however decreased partitioning of biomass to millable cane yield, juice quality (brix and pol%) and commercial cane sugar percentage. On other hand, Singh, et al. [16] found that nitrogen had an adverse effect on juice quality attributes.

Once more, the 1st order interaction between sugar cane varieties and potassium rates, the collected figures cleared that under the examined sugar cane varieties, the additional dose of potassium significantly raised the value of purity % in both seasons.

As to, the 2nd order interaction between the studied factors, it could be noted that increasing the applied dose of potassium under the different level of nitrogen raised the value of purity percentage. This finding was true under the various sugar cane varieties in both seasons; however, this significance was in the 1st season only.

3-Sugar recovery of sugar cane juice:

Table (4) shows the effect of nitrogen and potassium fertilization and their interaction on sugar recovery percentage of some sugar cane varieties.

Table 4: Effect of nitrogen and potassium fertilization on sugar recovery %

Nitrogen (N)	Potassium (K)	2012/2013				2013/2014			
		Sugar cane varieties (V)				Sugar cane varieties (V)			
N/Fed. (Kg)	K_2O_5 /Fed. (Kg)	G.T.54-9	G.99-103	G.2001-79	Mean	G.T.54-9	G.99-103	G.2001-79	Mean
220	24	11.78	11.46	12.00	11.75	13.22	13.32	13.26	13.27
	48	12.07	11.60	12.38	12.01	13.05	13.10	13.13	13.09
	72	12.59	11.90	12.29	12.26	12.84	12.58	13.00	12.80
Mean		12.14	11.65	12.22	12.01	13.03	13.00	13.13	13.05
280	24	11.53	11.31	11.74	11.53	12.90	12.84	12.94	12.89
	48	11.83	11.77	12.07	11.89	12.69	12.75	12.83	12.76
	72	12.49	12.01	12.36	12.29	12.36	12.61	12.78	12.58
Mean		11.95	11.70	12.06	11.90	12.65	12.73	12.85	12.74
340	24	11.33	10.39	11.31	11.01	12.78	12.88	12.69	12.78
	48	11.72	10.65	11.61	11.33	12.51	12.80	12.56	12.62
	72	12.15	10.94	11.90	11.66	12.40	12.78	12.54	12.57
Mean		11.73	10.66	11.60	11.33	12.56	12.82	12.60	12.66
K x V	24	11.55	11.05	11.68	11.43	12.97	13.01	12.96	12.98
	48	11.87	11.34	12.02	11.74	12.75	12.88	12.84	12.82
	72	12.41	11.62	12.18	12.07	12.53	12.65	12.77	12.65
Mean		11.94	11.34	11.96		12.75	12.85	12.86	

LSD (5%)	2012/2013	2013/2014
Nitrogen (N)	0.058	0.080
Potassium (K)	0.058	0.080
N x K	0.101	N.S
Varieties (V)	0.287	0.072
N x V	0.101	0.139
V x K	0.101	N.S
N x V x K	0.174	N.S

Results obtained in Table (4) revealed that there was a gradual and significant decrease in the values of sugar recovery percentage as nitrogen fertilizer level increase. This finding was fairly true in both growing seasons. The negative response in the values of sugar recovery percentage mainly due to the undesirable effect of the excess amount of nitrogen which increase the reducing sugars (Table 2) consequently caused the reduction obtained in sugar recovery percentage. Effect of nitrogen on sugar recovery % had been reported by Mokadem et al. [4].The lower the nitrogen fertilization rate, the higher the juice purity (Table 3), the higher the sugar recovery percentage. As to the influence of potassium fertilization rate on the values of sugar recovery percentage, the collected data proved that there is a positive and significant increase in the values of sugar recovery percentage in the 1st season, on the contrary the results in the 2nd season, where increasing the applied dose of potassium was accompanied by significant decrease in the values of sugar recovery percentage. The difference between the two seasons may be due to the difference in the taken samples for the 2nd season. In general it could be assured that the positive effect of potassium fertilization on juice purity % (Table 3) and the negative effect of potassium in reducing sugars % (Table 2) which assured the positive effect of potassium on sugar recovery % as it is in the 1st season. The increasing of K levels from 0.0 up to 75 kg K_2O/fed improved stalk length, sucrose percentage, sugar recovery percentage, cane yield and sugar yield [17]. On other hand, El-Sayed et al. [18] concluded that potassium fertilizer levels insignificantly affected sugar recovery percentage, cane and sugar yields in both seasons.

Concerning the interaction effect between nitrogen and potassium fertilization on sugar recovery%, the available results in Table (4) clearly show a positive response in the values of sugar recovery % was noted by increasing the applied dose of potassium fertilization rate under the various level of nitrogen, on the other hand the interaction effect between potassium and nitrogen rates was insignificantly in the 2nd season.

Belong to the 1st order interaction between the examined varieties and potassium fertilization; the collected data appeared a significant and positive response in the values of sugar recovery % in the 1st season only. Increasing the additional rates of potassium resulted in an increase in sugar recovery %. This finding was completely true under the different varieties.

Concerning the 2nd order interaction between the studied factors, the available results showed that this interaction had a significant influence on the values of sugar recovery percentage in the 1st season only. It could be noted that the highest values of sugar recovery % were found under the low level of nitrogen (200 kg N/fed.) with various rate of potassium for sugar cane variety G.2001-79 in the 1st season and with the same nitrogen level of nitrogen with 24 Kg kg K_2O /fed. in the 2nd season.

4-Sugar cane stalk yield (tons/fed.):

Data in Table (5) show the influence of nitrogen and potassium fertilization on millable cane yield ton/fed, of some sugar cane varieties. Results given pointed out that cane yield /fed, significantly and positively responded to the additional application of nitrogen fertilization. This observation was fairly true in both growing seasons. Increasing the 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. This result is in agreement with that reported by EL-Geddawy et al. [2]. In addition, Madhuri, et al. [19] showed that the application of nitrogen 280 kg/ha is the most economically viable fertilizer level for the plant cane in sandy loam soils. Also, Srinivas, et al. [20] found that the increase in N rate resulted in the increase in the number of shoots and millable canes, cane yield and sugar yield

Table 5: Effect of nitrogen and potassium fertilization on milliable cane yield ton-fed of some sugar cane varieties

Nitrogen (N)	Potassium (K)	2012/2013				2013/2014			
		Sugar cane varieties (V)				Sugar cane varieties (V)			
N/Fed. (Kg)	K_2O_5 /Fed. (Kg)	G.T.54-9	G.99-103	G.2001-79	Mean	G.T.54-9	G.99-103	G.2001-79	Mean
220	24	45.20	49.05	44.11	46.12	47.30	51.68	46.29	48.42
	48	46.20	48.83	46.14	47.06	46.20	48.83	46.74	47.26
	72	44.95	47.62	47.10	46.56	46.09	49.06	46.22	47.12
Mean		45.45	48.50	45.78	46.58	46.53	49.86	46.42	47.60
280	24	46.89	51.74	46.17	48.27	49.13	54.71	47.92	50.59
	48	48.21	49.39	48.02	48.54	50.12	52.00	49.83	50.65
	72	48.24	49.73	48.22	48.73	49.81	51.95	49.68	50.48
Mean		47.78	50.29	47.47	48.51	49.69	52.89	49.14	50.57
340	24	48.30	57.31	48.74	51.45	49.88	59.28	49.94	53.03
	48	49.99	60.17	46.66	52.27	52.79	62.15	49.12	54.68
	72	51.39	61.53	48.13	53.68	53,46	62.98	50.28	55.57
Mean		49.89	59.67	47.84	52.47	52.04	61.47	49.78	54.43
K x V	24	46.80	52.70	46.34	48.61	48.77	55.22	48.05	50.68
	48	48.14	52.79	46.94	49.29	49.70	54.33	48.56	50.86
	72	48.19	52.96	47.82	49.66	49.78	54.66	48.72	51.06
Mean		47.71	52.82	47.03		49.42	54.74	48.45	

LSD (5%)	2012/2013	2013/2014
Nitrogen (N)	0.399	0.353
Potassium (K)	0.399	N.S
N x K	0.691	0.612
Varieties	1.615	0.090
N x V	0.690	0.612
V x K	0.691	0.612
N x V x K	1.197	1.061

Concerning potassium effect on cane yield, the results obtained in Table (5) cleared that increasing the applied level of potassium slightly increased cane yield /fed., however, this increasing was significantly in the 1st season only. Effect of potassium on cane yield had been reported by Sanjay-Kumar et al.[6] who mentioned that potassium fertilizer levels were significantly affected on cane yield. Also, Mahmoud et al. [7] found that increasing potassium fertilizer levels significantly increased stalk length, stalk diameter, stalk weight, number of stalk/m^2, millable cane, cane and sugar yields. However, Flores et al. [21] found that soil K application increased K concentration in soil and plant and was reflected in the production of stalks.

As for the influence of varietal effect on cane yield, the results in Table (5) revealed 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. Sugar cane varieties greatly differed in their potentiality in this respect. This result is in line with Abd El-Aal et al. [3].

Concerning the 1st order interaction between nitrogen and potassium, the available data pointed out that increasing the applied dose of potassium almost increased the values of root yield .This finding was true under the various level of nitrogen in the 1st season and with the highest level of nitrogen in the 2nd season.

Results given in Table (5) the interaction between varieties and nitrogen fertilization appeared that the examined varieties attained a significant increase with the different levels of nitrogen fertilization; however, the most effectiveness was shown with sugar cane variety G.99-103 .The highest cane yield was recorded with sugar cane variety fertilized by 340 kg N/fed. in both seasons.

The 1st order interaction between varieties and potassium fertilization rates significantly affected on cane yield, it could be noted that increasing the applied dose of potassium fertilization significantly increased sugar cane stalk yield. This observation was almost true in both seasons, however, it could be noted that the highest response for this combination was between sugar cane variety G.99-103 under the different levels of potassium with no significant difference between potassium fertilization rate under this variety., so it could be recommended by any of the examined potassium rate to attain the highest cane yield with sugar cane variety G.99-103.

The 2nd order interaction between the studied factors significantly influenced on sugar cane stalks yield in the two growing seasons. It is obviously clear that the different sugar cane varieties appeared a positive response and significant increase in cane yield with the various combination s between nitrogen and potassium fertilization rates, however the fruitfully combination was between 340 kg .N/fed and 72 kg K_2O /fed. with all varieties in the two season, meanwhile the highest cane yield was recorded with sugar cane variety G.99-103 in combination with 340 kg. N/fed and 72 kg K_2O /fed.

Sugar yield (tons/fed.):

Results given in Table (6) reveal the influence of nitrogen and potassium fertilization and their interactions on the values of sugar yield / fed. of some sugar cane varieties. The collected data pointed out that the values of sugar yield increased significantly by increasing the additional rates of nitrogen. The highest sugar yield was recorded with 340 kg. N/fed. This result was true in the two growing seasons. The pronounced effect of nitrogen fertilizer on sugar yield mainly due to the positive effect of nitrogen fertilizer on cane yield (Table 5). This result is in accordance with that reported by Mokadem et al. [4] and Vitti et al. [22] who mentioned that the N rate showed a highly significant linear effect on cane production. Contrary, Choudhary and Sinha [23] revealed that cane and sugar yields increased with increasing N rates. However, results were similar with 150 and 200 kg N/ha application. Also, Singh et al. [11] mentioned that cane yield increased with increasing N and was the highest with 225 kg N.

Regarding the influence of potassium fertilization on sugar yield of sugar cane crop, the results obtained cleared that potassium application attained a significant influence on the values of sugar yield /fed .in the 1st season, however, increasing the applied dose of potassium let to negative response in sugar yield. This results reassured that the values of sugar yield attributed by the values of cane yield as it shown in Table (5). The positive effect of potassium on sugar yield had been reported by several authors Pérez and Melgar [24], Mahmoud et al. [7]. Bekheet [17], Flores et al. [21] and El-Tilib [25] who indicated that potassium application affected significantly on plant density, stalk diameter, cane and sugar yield.

Table 6: Effect of nitrogen and potassium fertilization on recoverable sugar yield ton/fed

Nitrogen (N)	Potassium (K)	2012/2013				2013/2014			
		Sugar cane varieties (V)				Sugar cane varieties (V)			
N/Fed. (Kg)	K_2O_5 /Fed. (Kg)	G.T.54-9	G.99-103	G.2001-79	Mean	G.T.54-9	G.99-103	G.2001-79	Mean
220	24	5.32	5.61	5.29	5.41	6.04	6.65	5.87	6.18
	48	5.57	5.66	5.71	5.65	5.90	6.25	5.87	6.00
	72	5.65	5.69	5.79	5.71	5.71	6.26	5.79	5.92
Mean		5.52	5.65	5.60	5.59	5.84	6.39	5.84	6.02
280	24	5.41	5.85	5.42	5.56	6.33	7.02	6.20	6.51
	48	5.66	5.81	5.79	5.76	6.36	6.63	6.39	6.46
	72	6.02	5.97	5.96	5.98	6.15	6.55	6.34	6.34
Mean		5.70	5.88	5.72	5.77	6.28	6.73	6.31	6.44
340	24	5.47	5.96	5.51	5.65	6.59	7.89	6.62	7.03
	48	5.86	6.41	5.41	5.89	6.88	8.14	6.45	7.15
	72	6.24	6.73	5.72	6.23	6.86	7.92	6.53	7.10
Mean		5.86	6.36	5.55	5.92	6.78	7.99	6.54	7.10
K x V	24	5.40	5.80	5.41	5.54	6.32	7.18	6.22	6.57
	48	5.70	5.96	5.64	5.76	6.33	6.99	6.24	6.52
	72	5.97	6.13	5.82	5.97	6.23	6.91	6.22	6.45
Mean		5.69	5.96	5.62		6.19	7.03	6.23	

LSD (5%)	2012/2013	2013/2014
Nitrogen (N)	0.052	0.058
Potassium (K)	0.052	0.058
N x K	0.090	0.150
Varieties	0.226	0.310
N x V	0.090	0.150
V x K	0.090	0.150
N x V x K	0.156	0.210

As to, the interaction between nitrogen and potassium fertilizer on sugar yield , under the different levels of nitrogen the collected data cleared that as the potassium rate increase , the values of sugar yield increased significantly in the 1st season, however, the highest sugar yield was recorded with the combination between 72 kg.K_2O/fed with 340 kg, N /fed. in both seasons.

Results in Table (6) revealed that there was a significance difference between the examined sugar cane varieties with respect to sugar yield. Sugar cane variety G.99-103 attained the highest sugar yield in the two growing seasons. Varietal influence on sugar yield had been recorded by Abe El-Razek and El-Sogheir [26].

The 1st order interaction between nitrogen rates and sugar cane varieties had a significant effect on the values of sugar yield in both seasons. The highest sugar yield was obtained by the combination between 340 kg N /fed. and sugar cane variety G.99-103.

Regarding the influence between potassium rates and the examined sugar cane varieties, the collected data pointed out under the various varieties, increasing the applied rate of potassium fertilization raised the value of sugar yield in the 1st season. However, in the 2nd season, the examined varieties differed in their response to the applied rates of potassium, as sugar cane varieties G.54-9 and G2001-79 attained the highest sugar yield with 48.kg. K_2O /fed, sugar cane variety G-99-103 attained the highest sugar yield with 24 kg. K_2O /fed.

Concerning the 2nd order interaction of the three factors on sugar yield, the results obtained showed that sugar yield significantly affected by this interaction in both growing seasons. The most effective combination on sugar yield was found with sugar cane variety G.99-103 with 72 kg. K_2O /fed. and 340 kg N /fed. Supporting results found by Pérez and Melgar [24] who suggested that K improves N utilization by the plant and may be a limiting factor for sugar production. Also, Taha et al. [27] cleared that stalk length, stalk diameter, number of internodes, brix%, sucrose%, sugar recovery, fiber percentages, millable cane, cane and sugar yields per feddan were significantly affected by nitrogen + potassium fertilization level in both seasons.

However, Chohan et al. [28] observed that fertilizer dose @ 200+80+80 kg $N+P_2O_5+K_2O$ $ha^{-1}$was suitable fertilizer treatment for obtaining maximum cane and sugar yield in genotype HoTh-300.

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