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Yield and Quality of Some Sugar Cane Varieties as Affected by Harvesting Age and Phosphorus Fertilization Levels

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Abstract

The present study was conducted at district Kom Ombo sugar cane farms, (latitude of 24° 28° N and longitude of 32° 57° E), Aswan Governorate, in the two seasons of 2015/2016 and 2016/2017 including plant cane and 1st ratoon crops, respectively. To study the effect of harvesting age and phosphorus fertilization levels on yield and quality of some sugar cane varieties. Field experiment included twenty-seven treatments represented the combinations among three harvesting ages (10, 11 and 12 months) three phosphorus fertilization levels [30, 45 and 60 kg P_2O_5/fad.] and three sugar cane varieties [G.T. 54-9, G.2003-47 and G.2004-27]. Randomized complete block design with three replications laind aut in split-split plots arrangement.

The results showed that all of the studied traits were significantly influenced by the harvesting ages. The three sugar cane varieties significantly differed in all studied traits. The new commercial sugar cane variety G.2003-47 showed superiority over the other varieties in brix sucrose purity cane and sugar recovery percentages. Increasing phosphorus level from 30 up to 60 kg P_2O_5/fad. increased significantly brix, sucrose, purity and sugar recovery percentages, while cane and sugar yield tons/fad., in plant cane crop, only.

Our data suggest that farmers should attempt to harvest the majority of their crop at age of 12 months. With fertilization by 60 kg P_2O_5/fad. to maximize yield.

Keywords: *Sugar cane, varieties, phosphorus fertilization levels, harvesting date.*

Introduction

Sugar cane is the second sugar crop in Egypt. It is a large grass cultivated in tropical and subtropical regions and belongs to the genus Saccharum, poaceae family. Sugar cane is a C_4 plant that is able to maintain higher rates of photosynthesis compared to C_3 plants. Sugar cane plants, depending on the availability of water and nutrients, the rate of photosynthesis will vary according to light intensity. Under conditions of good supply of nutrients, sugar cane plant can express the best genetic characteristics and produce highest yields of cane and sugar which is the main goal of sugar cane cultivation.

The extracted sugar basically starts from the field and depends upon age of varieties at harvesting. Sugar cane varieties differ in their maturity ages which extend to be of vital importance for both cane grower and processor Jadhav *et al.* (2000), Ahmed (2003), Abd El-Razek and Besheit (2011), Osman *et al.* (2011), Hagos *et al.* (2014), Ahmed and

Awadalla (2016), Endris *et al*. (2016), Mehareb and Abazied (2017) and Vajantha *et al.* (2019).

A new sugar cane variety is considered one of the essential wings for production. Sugar cane varieties differ in their ability to mature at different ages. Many investigators pointed out the important role of varieties in respect to their variation in yield, its components and quality (Kumara and Bandara (2002), Sohu *et al.* (2008), El-Shafai and Ismail (2006), Mohamed *et al.* (2012), Abazied (2018), Abd El-Azez *et al*. (2018) and Abo El-hamd *et al.* (2019).

Phosphate compounds in plants are called the energy currency where they are involved in the formation of ATP. It occupies a critical position both in the plant and soil biology. The necessity of phosphorus as a plant nutrient is emphasized by the fact that it is an essential constituent of many organic compounds that are very important for metabolic processes. Many investigators pointed out the importance of the role of phosphorus in respect to its influence on yield and quality characteristics of sugarcane Chaudhery and Chatta (2000), Ismail *et al*. (2000), El-Tilib *et al.* (2004), Ahmed *et al.* (2008) and Mehareb *et al*. (2018).

The main objective of this investigation was to determine the optimum phosphorus level and optimum age for harvesting giving the highest yield and quality of the tested varieties.

Materials and Methods

The study was carried out at district Kom Ombo sugar cane farms, (latitude of 24°28″N and longitude of 32°57″E), Aswan Governorate, Egypt. Including plant cane and the first tratoon crops grown during 2015/2016 and 2016/2017 seasons to study the effect of harvesting age and phosphorus levels on yield and quality of some sugar cane varieties. Field experiment included twenty-seven treatments represented the combinations among three harvesting ages (10, 11 and 12 months) three phosphorus fertilization levels [30, 45 and 60 kg P_2O_5/fad.] and three sugar cane varieties [G.T. 54-9, G.2003-47 and G.2004-27]. In plant cane crop, phosphorus fertilizer was added as ordinary super phosphate, 15.5% P_2O_5 in furrows before drilling cane seed cuttings. Seed cuttings were covered with soil from next ridges. In the 1st ratoon, phosphorus fertilizer was added after furrowing (earthling-up soil) between rows.

Randomized complete block design with three replications laid aut in split-split plots arrangement was used. Harvesting ages were arranged in the main plots, while cane varieties were randomly distributed in sub-plots and the sub-sub plots were assigned for phosphorus levels. Plot area was 35 m^2 (including five ridges of seven meters in length and one meter apart). Sugar cane varieties were planted in mid-March with the dry method, and the field was irrigated right after planting, Harvest took place 10, 11, 12 months after planting. All other agronomic practices were carried out as recommended under Aswan region conditions.

Table 1. Mechanical and chemical properties of the upper (30-60) cm of the experimental soil sites.

Season		2015/2016	2016/2017
Mechanical analysis	Sand %	69.16	69.16
	Silt %	20.00	20.00
	Clay %	11.84	11.84
Soil texture		Sand loam	Sand loam
Chemical analysis	pH	7.7	7.9
	Concentration of N (ppm)	26	29
	Concentration of P (ppm)	7.00	8.00
	Concentration of K (ppm)	31.1	33.2
	Cations meq/100g		
	Na^{+} Meq/100g	0.51	0.55
	K^{+} Meq/100g	0.08	0.09
	Ca^{++} Meq/100g	0.36	0.35
	Mg^{++} Meq/100g	0.21	0.22
	Anions meq/100g		
	Cl^{-} Meq/100g	0.23	0.42
	$So_4^{=}$ Meq/100g	0.29	0.28
	HCo_3 Meq/100g	0.53	0.61

The recorded data:

At each harvesting date, twenty-five millable cane was collected immediately after harvest, stripped and squeezed then juice was extracted using three-rool lab mill, filtrated and weighed to determine the following quality traits:

1. Brix percentage (total soluble solids, TSS %) in cane juice was determined using Brix Hydrometer according to A.O.A.C. (2005).
2. Sucrose percentage was determined using Sacharemeter according to the method of A.O.A.C. (2005).
3. Juice Purity percentage was calculated according to the following

$$\text{Juice purity percentage} = \frac{\text{sucrose percentage}}{\text{Brix percentage}} \times 100$$

4. Sugar recovery percentage was calculated according to the following formula described by Yadav and Sharma (1980).

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

5. Cane yield (ton/fad.): it was determined from the weight of the three middle guarded rows of each plot converted into value per fad.
6. Sugar yield (tons/fad.): was calculated according to the following formula described by Mathur (1981). Sugar yield = cane yield (ton/fad.) x sugar recovery %.

The collected data were statistically analyzed according to the method described by Snedecor and Cochran (1981). Treatment means were compared using LSD at 5% level of difference as outlined by Steel and Torrie (1980).

Results and Discussion

1- Brix percentage

Data in Table 1 show that the harvesting ages had significant effect on brix percentage in both seasons. Highest value of brix percentage

(22.70 and 23.64) in two respectively seasons were recorded when plants harvested at ages of 12 months in the plant cane and the first ratoon crops, respectively. The increases in brix% was increased gradually as harvesting delayed to reach its maximum values at the age of 12 months may be due to the continuous accumulation of solids as harvest age. Similar results were reported by Jadhav *et al.*(2000), Ahmed (2003), Hagos *et al.* (2014) and Endris *et. al.*(2016). Who reported that, harvest age showed highly significant influence on brix % values.

The data in the same Table demonstrated that brix percentage was significantly affected by the tested sugar cane varieties in both crops. The G.2003-47 variety had the highest value of brix percentage (21.40 and 23.26) followed by G.2004-27 and G.T.54-9 in the plant cane and the its 1st ratoon crops, respectively. The variation between the examined varieties in brix percentage may be due to the differences in growth and response to the surrounding environmental conditions prevailing during the formation of soluble solids in the cane plants. These results confirmed with those obtained by El-Shafai and Ismail (2006), Mehareb *et al.* (2018) and Abd El-Azez *et al*. (2018). Found that brix % was significantly affected by the examined sugar cane varieties.

Table 1. Brix percentage of sugar cane varieties as affected by harvesting age and phosphorus fertilization levels in plant cane and its first ratoon crops

Harvesting age	Varieties	Plant cane season				First ratoon season			
		Kg P_2O_5/fad.			Mean	Kg P_2O_5/fad.			Mean
		30	45	60		30	45	60	
10 months	G.2003-47	19.97	20.25	20.25	20.16	21.87	21.96	22.16	21.98
	G. 2004-27	19.26	19.76	19.86	19.62	19.89	20.46	21.14	20.50
	G.T. 54-9	18.68	18.86	18.95	18.84	20.76	20.90	21.02	20.89
Mean		19.30	19.62	19.69	19.54	20.84	21.10	21.44	21.13
11 months	G.2003-47	20.29	20.91	21.65	20.95	23.31	23.68	23.83	23.61
	G. 2004-27	20.10	20.89	20.62	20.54	21.82	21.28	21.67	21.59
	G.T. 54-9	19.77	20.30	20.88	20.32	21.97	22.31	22.64	22.31
Mean		20.04	20.70	21.05	20.60	22.37	22.43	22.72	22.50
12 months	G.2003-47	22.21	22.82	24.27	23.10	24.64	23.60	24.24	24.17
	G. 2004-27	22.29	22.91	23.22	22.81	23.59	22.90	23.02	23.17
	G.T. 54-9	22.13	21.28	23.13	22.18	24.05	23.14	23.59	23.59
Mean		22.21	22.34	23.54	22.70	24.10	23.22	23.62	23.64
B x C	G.2003-47	20.82	21.33	22.06	21.40	23.27	23.08	23.41	23.26
	G. 2004-27	20.55	21.18	21.24	20.99	21.77	21.55	21.95	21.75
	G.T. 54-9	20.19	20.15	20.99	20.44	22.26	22.12	22.42	22.27
Mean		20.52	20.89	21.43		22.43	22.25	22.59	
LSD at 5% level of significant									
Harvest age (A)					0.22				0.29
Varieties (B)					0.23				0.19
Phosphorus on levels (C)					0.18				0.18
(A)x(B)					0.40				0.33
(A)x (C)					0.30				0.31
(B)x (C)					0.30				0.31
(A)x(B)x (C)					0.53				0.53

Brix percentage responded significantly to phosphorus fertilization levels in both seasons. The highes values of brix % was recorded when

cane plants received (60 Kg P_2O_5/fad.) in both seasons. The fact that phosphorus increases the vegetative growth of plants and consequently resulted in more metabolites required for the formation of soluble solids Ahmed and Awadalla (2016). These finding are in a good line with those obtained by Ismail *et al*. (2000) and Hadush *et al.* (2014). They reported that phosphorus, addition by rates of 30 kg P_2O_5/fad. resulted in a significant increase in brix percentage in both seasons.

Brix percentage, responded significantly to all interactions among the studied factors in both seasons. Generally, the maximum brix % was obtained from G. 2003-47 variety when it was harvested at age of 12 months as well as fertilized with 60 and 30 kg P_2O_5/fad., in 1st and 2nd seasons respectively.

2- Sucrose percentage

Data in Table 2 result that sucrose percentage significantly increased by increasing harvest age from 10 up to 12 months old in the two seasons, harvesting at 12 months recorded the highest mean values (19.70 and 20.50%) in plant cane and first ratoon crops respectively. The increase in sucrose% at the age of 12 months might be due to the enzymes which change the reducing sugars to sucrose or it could be due to positive impact of cane maturity which allow translocation and accumulation of additional sucrose on the harvest age. Differences among cane varieties in this trait were also found by Ahmed (2003), Abd El-Razek and Besheit (2011), Osman *et al.* (2011), and Vajantha *et al.* (2019). Who found the data indicated that age of harvest showed significant influence on sucrose percent.

Furthermore, data in the same Table show that sucrose percentage was significantly affected by sugar cane varieties in both seasons. The highest mean values of this trait (18.39% and 20.08%) were obtained by (G.2003-47) variety in the first and second seasons respectively, while variety of G. 2004- 27 gave the lowest values in the two seasons. These results may be due to the genetic differences among varieties in their ability of the formation of internodes. Differences among varieties in sucrose % depend on the interaction between varieties and environmental factors during growth and maturing stage. Ahmed (2003). This result is in agreement with those obtained by Mohamed *et al.* (2012), Kumara and Bandara (2002), Sohu *et al.* (2008) and Abd El-Azez *et al*. (2018). Who found that sucrose percentage was differed significantly by the tested sugar cane varieties.

Table 2. Sucrose percentage of sugar cane varieties as affected by harvesting age and phosphorus fertilization levels in plant cane and its first ratoon crops

Harvesting age	Varieties	Plant cane season				First ratoon season			
		Kg P_2O_5/fad.			Mean	Kg P_2O_5/fad.			Mean
		30	45	60		30	45	60	
10 months	G.2003-47	16.60	16.84	17.28	16.91	18.40	18.69	19.15	18.75
	G. 2004-27	14.95	15.26	15.50	15.24	16.24	16.85	17.56	16.88
	G.T. 54-9	15.70	15.55	15.64	15.63	17.41	17.69	17.87	17.66
Mean		15.75	15.88	16.14	15.91	17.34	17.74	18.19	17.76
11 months	G.2003-47	17.11	17.80	18.94	17.95	20.18	20.58	20.79	20.52
	G. 2004-27	15.90	16.56	17.47	16.63	18.36	18.48	18.39	18.41
	G.T. 54-9	16.67	17.16	17.67	17.14	18.89	19.34	19.56	19.26
Mean		16.56	17.14	18.02	17.24	19.14	19.47	19.58	19.39
12 months	G.2003-47	18.91	20.57	21.53	20.34	21.33	20.51	21.06	20.97
	G. 2004-27	19.22	20.07	20.13	19.81	20.23	19.61	19.93	19.92
	G.T. 54-9	18.80	18.16	19.90	18.96	20.91	20.29	20.63	20.61
Mean		18.98	19.60	20.52	19.70	20.83	20.14	20.54	20.50
B x C	G.2003-47	17.54	18.40	19.25	18.39	19.97	19.93	20.33	20.08
	G. 2004-27	16.69	17.30	17.70	17.23	18.28	18.31	18.63	18.41
	G.T. 54-9	17.06	16.93	17.74	17.24	19.07	19.11	19.35	19.18
Mean		17.10	17.54	18.23		19.11	19.12	19.44	
LSD at 5% level of significant									
Harvest age (A)					0.89				0.46
Varieties (B)					0.27				0.31
Phosphoruson levels (C)					0.19				0.16
(A)x(B)					0.46				0.53
(A)x (C)					0.34				0.27
(B)x (C)					0.34				0.27
(A)x(B)x (C)					0.58				0.47

Also data given in the same Table (2) reveled that sucrose percentage was significantly affected by phosphorus fertilization levels in the both seasons. Sucrose % was significantly increased by increasing phosphorus fertilization levels from 30 up to 60 kg P_2O_5/fad. Applying phosphorus fertilization 60 kg P_2O_5/fad. resulted in 1.13% and 0.76% higher than that found with 30 and 45 kg P_2O_5/fad. in the plant cane, corresponding to 0.33% and 0.32% in first ratoon, respectively. These results may be due to that the phosphorus is essential for cell division and enhances photosynthetic activity, it also regulates synthesis of sugar and storage. These results confirmed with those obtained by Ismail *et al*. (2000), Elamin *et al*. (2007), Ahmed *et al.* (2008) and Mehareb *et al*. (2018). They noted that phosphorus fertilizer affected sucrose% in two seasons.

Sucrose percentage was responded significantly to all possible interactions among the three studied factors in plant cane seasons as well as the interaction between harvesting age and phosphorus fertilization levels in the 1st ratoon crop. In general, the maximum sucrose % (21.53and 21.33%) was obtained from G.2003-47 variety when it was fertilized with 60 and 30 kg P_2O_5 and harvested at age of 12 months respectively.

3-Purity percentage

Data in Table 3 result that the harvesting ages had significant effect on purity percentage in bot plant cane and 1st ratoon crops. It could be noticed that significant and gradually

increase in purity percentage as harvest age increase to reach its highest mean values (87.16% and 86.96%) at the age of 12 months in the plant crop and 1st ratoon crop, respectively. The increase in on purity percentage is mainly due to the increase in sucrose % trait discussed before (Table 2). These results confirmed with those obtained by Ahmed (2003), Abd El-Razek and Besheit (2011) and Mehareb and Abazied (2017). Who found that harvest ages significantly differed in purity percentage.

Data in the same Table disclose that sugar cane varieties varied significantly in purity percentage. In general, purity percentage of G. 2003-47 was slightly higher than other varieties (85.85and 86.31%) in both seasons. While the cane variety of G. 2004-27 gave the lowest purity percentage (81.86 and 84.54%) in both seasons respectively. The varietal differences may be attributed to the genetic constitutes of varieties and its interaction with environmental conditions. These results confirmed with those obtained by El-Shafai and Ismail (2006), Ahmed *et al*. (2008), Mohamed *et al.* (2012), Mehareb *et al*. (2018) and Abazied (2018). They found that significant differences among the tested varieties for juice purity percentage.

Purity percentage was significantly affected by phosphorus fertilizer levels in both seasons. Increasing the phosphorus dose to 60 kg P_2O_5/fad., increased purity percentage.

Table 3. Purity percentage of sugar cane varieties as affected by harvesting age and phosphorus fertilization levels in plant cane and its first ratoon crops.

Harvesting age	Varieties	Plant cane season				First ratoon season			
		Kg P_2O_5/fad.			Mean	Kg P_2O_5/fad.			Mean
		30	45	60		30	45	60	
10months	G.2003-47	83.03	83.14	85.32	83.85	84.15	85.11	86.41	85.23
	G. 2004-27	77.73	77.35	78.04	77.71	81.63	82.33	83.08	82.35
	G.T. 54-9	83.98	82.47	82.53	82.99	83.86	84.61	85.02	84.50
Mean		81.59	81.60	80.99	81.97	81.52	83.21	84.02	84.84
11 months	G.2003-47	84.34	85.11	87.49	85.65	86.59	86.91	87.24	86.91
	G. 2004-27	79.15	79.25	84.69	81.03	84.17	86.82	84.88	85.29
	G.T. 54-9	84.39	84.08	84.62	84.36	85.96	86.68	86.39	86.35
Mean		82.62	82.63	82.81	85.60	83.48	85.57	86.81	86.17
12 months	G.2003-47	85.18	90.19	88.76	88.04	86.58	86.93	86.85	86.79
	G. 2004-27	86.23	87.60	86.69	86.84	85.76	85.63	86.58	85.99
	G.T. 54-9	84.99	85.35	86.04	85.46	86.99	87.68	87.45	87.37
Mean		84.99	85.47	87.71	87.16	86.78	86.45	86.75	86.96
B x C	G.2003-47	84.21	86.15	87.19	85.85	85.77	86.32	86.83	86.31
	G. 2004-27	81.04	81.40	83.14	81.86	83.86	84.93	84.85	84.54
	G.T. 54-9	84.45	83.97	84.40	84.27	85.60	86.33	86.29	86.07
Mean		83.23	83.84	84.91		85.08	85.86	85.99	

LSD at 5% level of significant		
Harvest age (A)	5.10	2.14
Varieties (B)	1.71	1.35
Phosphoruson levels (C)	0.98	0.75
(A)x(B)	2.97	2.33
(A)x (C)	1.70	1.30
(B)x (C)	1.70	1.30
(A)x(B)x (C)	2.97	2.26

The highest mean values of purity (84.91% and 85.99%) in two respectively seasons were obtained sprayed it by (60 Kg P_2O_5/fad.). These results are probably attributed to the content of both sucrose and reducing sugars in cane juice, where the higher the sucrose percentage and the lower the reducing sugars. These results confirmed with those obtained by Ismail *et al*. (2000), Elamin *et al*. (2007) and Bekheet *et al*. (2018). Super phosphate addition by rates 30 kg P_2O_5/fad. resulted in a significant increase in purity percentages.

Purity percentages responded significantly to all interactions among the studied factors in the both season.

4. Sugar recovery percentage

Results presented in Table 4 revealed that sugar recovery percentage was significantly affected by increasing harvest age. Sugar recovery percentage gradually increased and reached to its maximum mean values (13.51% and 14.05%) at the harvesting age of 12 months, in the 1st and 2nd seasons, respectively. The increase in recovery percentage is mainly due to the increase in sucrose content in cane juice. These results similar as Osman *et al.* (2011), Hagos *et al.* (2014) and Ahmed and Awadalla (2016). They reported that the harvesting age of cane plants at had significant effect on sugar recovery %in the two seasons.

Also, results in the same Table indicated that sugar cane varieties varied significantly in sugar recovery percentage in both seasons. The highest values of this trait were obtained from G.2003-47 variety in both plant cane and first cane ratoon crops. This result is probably due to higher sucrose percentage recorded by G.2003-47 variety differences in this trait were also found by Kumara and Bandara (2002), El-Shafai and Ismail (2006), Mehareb *et al.* (2016), Abazied (2018), and Abo El-hamd *et al.* (2019). They found that studied cane varieties differed significantly in sugar recovery percentage.

The results pointed out that the studied phosphorus fertilization levels had a significant influence on sugar recovery percentage in both seasons. Increasing phosphorus on levels to 45 and 60 Kg P_2O_5/fad. led to increase in sugar recovery percentage by 0.35 and 0 .89 as compared to that obtained by fertilization with of 30 Kg P_2O_5/fad. respectively, in the 1st season, being 0.07 and 0.30 in the 2nd one. These results are probably attributed to the content of both sucrose and reducing sugars in cane juice, where the higher the sucrose percentage and the lower the reducing sugars recorded by the studied in sugar recovery with the increasing phosphorus fertilization levels. These finding are in a good line with those obtained by Ahmed *et al*. (2008) and Bekheet *et al.* (2018). Who reported that phosphorus fertilization levels had significantly affected sugar recovery%.

Table 4. Sugar recovery % of sugar cane varieties as affected by harvesting age and phosphorus fertilization levels in plant cane and its first ratoon crops.

Harvesting age	Varieties	Plant cane season				First ratoon season			
		Kg P_2O_5/fad.			Mean	Kg P_2O_5/fad.			Mean
		30	45	60		30	45	60	
10 months	G.2003-47	11.14	11.29	11.74	11.39	12.42	12.69	13.10	12.74
	G. 2004-27	9.65	9.83	10.04	9.842	10.78	11.24	11.78	11.27
	G.T. 54-9	10.58	10.39	10.46	10.48	11.73	11.97	12.12	11.94
Mean		10.46	10.51	10.75	10.57	11.65	11.97	12.33	11.98
11 months	G.2003-47	11.56	12.09	13.03	12.23	13.82	14.12	14.29	14.08
	G. 2004-27	10.39	10.82	11.83	11.01	12.39	12.67	12.47	12.51
	G.T. 54-9	11.27	11.51	11.96	11.58	12.89	13.25	13.38	13.17
Mean		11.07	11.46	12.27	11.61	13.03	13.35	13.38	13.25
12 months	G.2003-47	12.84	14.35	14.92	14.04	14.61	14.07	14.44	14.37
	G. 2004-27	13.13	13.82	13.79	13.58	13.79	13.35	13.65	13.59
	G.T. 54-9	12.76	12.35	13.59	12.90	14.36	13.98	14.19	14.18
Mean		12.91	13.51	14.10	13.51	14.25	13.80	14.10	14.05
B x C	G.2003-47	11.85	12.58	13.23	12.55	13.62	13.63	13.94	13.73
	G. 2004-27	11.06	11.49	11.89	11.57	12.32	12.42	12.63	12.46
	G.T. 54-9	11.53	11.42	12.00	11.65	12.99	13.07	13.23	13.09
Mean		11.48	11.83	12.37		12.97	13.04	13.27	

LSD at 5% level of significant		
Harvest age (A)	0.96	0.46
Varieties (B)	0.29	0.30
Phosphorus on levels (C)	0.19	0.15
(A)x(B)	0.51	0.53
(A)x (C)	0.32	0.26
(B)x (C)	0.32	NS
(A)x(B)x (C)	0.56	0.44

Sugar recovery percentage responded significantly to all interactions except the interaction between cane varieties and phosphorus fertilization levels in 1st ratoon crops. The maximum sugar recovery % was obtained from G.2003-47 variety when it was fertilized with 60 and 30 kg P_2O_5/fad., and harvesting at age of 12 months in both plant and first ratoon crops respectively.

5- Cane yield (Ton/fad.)

Data in Table 5 found that the harvesting times had a highly significant effect on cane yield in the plant cane only, there is a significant increase in cane yield with an increase in harvest age from 10 to 11 months, the highest mean values on cane yield (Ton/fad.) (58.136) was obtained by harvest at age of (11 months). These results confirmed with those obtained by Jadhav *et al.* (2000), Osman *et al.* (2011), Hagos *et al.* (2014), Ahmed and Awadalla (2016). Who noted that significant differences between harvesting ages in cane yield.

Data in the same Table resuld that cane yield was significantly affected by the examined sugar cane varieties in both seasons. The variety G.2004-27 surpassed the others two

tested varieties in the first and second plant crops seasons. The variation of cane yield between the studied varieties may be due to varietal characteristic. These finding are in a good line with those obtained by Kumara and Bandara (2002), El-Shafai and Ismail (2006), Ahmed *et al*. (2008), and Abd El-Azez *et al.* (2018). They found that a significant variance among the tested sugar cane varieties in cane yield.

Also data showed that phosphorus levels significantly affected cane yield in plant cane crop only. Applying phosphorus fertilization 60 kg P_2O_5/fad. gave significant higher 8.498 and 4.639 ton/fad. compared than levels of phosphorus 30 and 45 kg P_2O_5/fad., respectively. These results are in harmony with those obtained by Chaudhery and Chatta (2000) and Mehareb *et al*. (2018). Who found that phosphorus fertilization levels had significant effect on cane yield.

Also, cane yield was significantly affected by the 1st and 2nd order interactions in both seasons. In general, the highest value of cane yield was obtained by harvesting varity of G.T.54-9 at age of 11 and 10 months when it was fertilized with 45 and 30 kg P_2O_5/fad. in both plant and first ratoon cane crops respectively.

Table 5. Cane yield of sugarcane varieties as affected by harvesting age and phosphorus fertilization levels in plant cane and its first ratoon crops

Harvesting age	Varieties	Plant cane season				First ratoon season			
		Kg P_2O_5/fad.			Mean	Kg P_2O_5/fad.			Mean
		30	45	60		30	45	60	
10 **months**	G.2003-47	42.945	38.834	38.263	40.014	34.123	35.695	42.343	37.387
	G. 2004-27	41.910	49.824	58.493	50.076	42.858	58.607	56.154	52.536
	G.T. 54-9	42.974	51.089	45.275	46.446	63.294	51.167	57.328	57.263
Mean		42.610	46.582	47.344	45.512	46.755	48.490	51.942	49.062
11 **months**	G.2003-47	49.785	53.433	50.247	51.155	45.259	47.532	35.317	42.703
	G. 2004-27	58.710	64.768	64.895	62.791	61.723	53.390	53.281	56.131
	G.T. 54-9	56.498	68.973	55.915	60.462	59.185	49.391	49.901	52.826
Mean		54.998	62.392	57.019	58.136	55.389	50.104	46.166	50.553
12 **months**	G.2003-47	46.563	53.076	53.603	51.281	42.298	48.275	47.540	46.037
	G. 2004-27	60.133	55.491	57.938	57.854	52.715	51.561	53.396	52.557
	G.T. 54-9	59.89	58.660	66.264	61.606	49.757	49.072	49.091	49.307
Mean		55.520	55.742	59.268	56.847	48.257	49.636	50.009	49.300
B x C	G.2003-47	46.431	48.448	47.371	47.417	40.560	43.834	41.733	42.042
	G. 2004-27	53.584	56.694	60.442	56.907	52.429	54.520	54.277	53.742
	G.T. 54-9	53.122	59.574	55.818	56.172	57.412	49.877	52.107	53.132
Mean		51.046	54.905	59.544		50.134	49.410	49.372	

LSD at 5% level of significant

Harvest age (A)	3.68	NS
Varieties (B)	3.85	2.28
Phosphorus on levels (C)	2.44	NS
(A)x(B)	6.67	3.93
(A)x (C)	4.23	3.85
(B)x (C)	4.23	3.85
(A)x(B)x (C)	7.32	6.66

6- Sugar yield (Tons/fad.)

Data in Table 6 resuld that the harvesting ages had asignificant effect on sugar yield in both seasons. Delaying harvest up to 12 months old resulted in increasing sugar yield by 2.920 and 2.163 Ton/fad. compared with harvest at age of 10 and 11 months in plant cane, corresponding to 1.065 and 0.804 Ton/fad. in 1st ratoon crop, respectively. The increase is obtained due to the increasing effect of longer harvest ages on sucrose, and purity percentages Table (2 and 3). These finding are in a good line with those obtained by Jadhav *et al.* (2000), Ahmed (2003), Hagos *et al.* (2014) and Vajantha *et al.* (2019). Who reported that harvest age significantly influenced sugar yield.

Table 6. Sugar yield of sugarcane varieties as affected by harvesting age and phosphorus fertilization levels in plant cane and its first ratoon crops

Harvesting age	Varieties	Plant cane season				First ratoon season			
		Kg P_2O_5/fad.			Mean	Kg P_2O_5/fad.			Mean
		30	45	60		30	45	60	
10 **months**	G.2003-47	5.847	5.363	5.327	5.512	4.243	4.530	5.557	4.777
	G. 2004-27	5.360	6.533	7.733	6.542	4.620	6.590	6.620	5.943
	G.T. 54-9	5.477	6.530	5.830	5.946	7.417	6.123	6.953	6.831
Mean		5.651	6.142	6.297	6.000	5.427	5.748	6.377	5.850
11 **months**	G.2003-47	6.917	7.673	7.540	7.377	6.257	6.713	5.047	6.006
	G. 2004-27	7.890	9.060	9.173	8.708	7.647	6.770	6.637	7.014
	G.T. 54-9	7.643	9.573	7.993	8.403	7.627	6.543	6.653	6.941
Mean		7.483	8.769	8.236	8.163	7.173	6.676	6.112	6.654
12 **months**	G.2003-47	7.093	8.493	9.070	8.219	6.177	6.790	6.867	6.611
	G. 2004-27	9.250	8.823	9.313	9.129	7.270	6.873	7.290	7.144
	G.T. 54-9	9.093	8.580	10.567	9.413	7.147	6.860	6.960	6.989
Mean		8.479	8.632	9.650	8.920	6.864	6.841	7.039	6.915
B x C	G.2003-47	6.619	7.177	7.312	7.036	5.559	6.011	5.823	5.798
	G. 2004-27	7.500	8.139	8.740	8.126	6.509	6.744	6.849	6.701
	G.T. 54-9	7.404	8.228	8.130	7.921	7.397	6.509	6.856	6.920
Mean		7.174	7.848	8.061		6.488	6.421	6.509	

LSD at 5% level of significant		
Harvest age (A)	0.52	0.33
Varieties (B)	0.60	0.34
Phosphorus on levels (C)	0.35	NS
(A)x(B)	1.04	0.59
(A)x (C)	0.61	0.54
(B)x (C)	0.61	0.54
(A)x(B)x (C)	1.05	0.94

The obtained revealed that the tested sugar cane varieties differed significantly in sugar yield in both seasons. In plant cane crop, G.2004-27 variety out yielded G. 2003-47 and G.T.54-9 varieties by 1.9 and 0.205 tons/fad., respectively. Meanwhile, in the first ratoon, G.T.54-9 produced 1.122 and 0.219 tons' sugar/fad higher than those obtained from, G.2003-47 and G.2004-27 varieties. The superiority of G.2004-27 and G.T.54-9 varieties in sugar yield is probably attributed to the increase sugar recovery% and cane yield Tables (4 and 5). These findings are in agreement with those reported by Mohamed *et al.* (2012), Mehareb *et al*. (2018) and Abo El-hamd *et al.* (2019). They found that the studied sugarcane varieties differed significantly in sugar yield.

Also, the data denote that the studied phosphorus fertilization levels had significant influence on sugar yield in the plant cane only. The highest mean values on sugar yield (8.061 Ton/fad.) was obtained by (60 Kg P_2O_5/fad.). These results confirmed with those obtained by Pawar *et al.* (2003), El-Tilib *et al.* (2004), Shahid *et al*. (2012) and Mehareb *et al*. (2018). Who reported that phosphorus levels significantly affected sugar yield.

Results in the same Table cleared a significant effect of the first and second order interactions among the studied factors. Generally, the maximum values of sugar yield (10.567 and 7.647ton/fad.) were harvesting sugar cane variety G.T-54-9 and G.2004-27 at age of 12 and 11 months with fer-

tilizer by 60 and 30 Kg P_2O_5/fad. respectively.

Conclusion

Our data suggest that farmers should attempt to the majority of their crop at age of 12 months, with fertilization by 60 Kg P_2O_5/fad., to maximize cane and sugar yields.

References

Abazied, S.R. (2018). Influence of delivery delay on quality of some promising sugar cane varieties under Aswan condition. Egypt. J. Agron. The 15th Int. Conf. Crop Sci., 21–29.

Abd El-Azez, Y.M.; S.R. Nagib and A.M. Elwan (2018). Yield and yield components of some sugar cane varieties (*Saccharum officinarum L.*) as affected by different nitrogen fertilization levels. J. Plant production, Mansoura Univ., 9(6):553-557.

Abd El-Razek, A.M. and S.Y. Besheit (2011). Effect of genotype, environment and time of harvest on sugarcane yields at middle and Upper Egypt. J. Southern Agric. China. 43 (6):294-301.

Abo El-Hamd, A.S.; M.M. Ibrahim; A.Z. Ahamed and A.E. Kamel (2019). Evaluation of some promising sugar cane varieties under different planting dates and seeding rates in upper Egypt. J. Biol. Chem. Environ. Sci.,14 (4):137-154.

Ahmed, A.Z. (2003). Harvesting age with relation to yield and quality of Some promising sugarcane varietes. Egypt. J. Appl. Sci.18 (7):114-124.

Ahmed, A.Z. and A.O. Awadalla (2016). Effect of harvesting age on yield, yield components and quality of some promising sugar cane varieties. J. Plant Production, Mansoura Univ.,7(12):1501-1507.

Ahmed, A.Z.; M.S.H. Osman and A.M. Ahmed (2008). Effect of excessive nitrogen application on yield and quality of three sugar cane varieties. Proc.3rd. Inter. Conf. IS..Sinai Univ., Al Arish, Egypt,.3(31):34-39.

A.O.A.C. (2005). Official methods of analysis puplished by the Association of Official Agricultural Chemist Box 540, Washington.

Bekheet, M.A. ; A.F.I. Gadallah and Y.A.M. Khalifa (2018). Enhancement of yield an quality of sugarcane by applied nitrogen, phosphorus and filter cake. Egypt. J. Agro. 2(40): 207-221.

Chaudhery, A.U. and F.A. Chatta (2000). Determination of optimum level of phosphorus and its effect on growth yield and quality of ratoon sugar cane. Pakistan. J. Biol. Sci.,3(3):483-484.

Elamin, E.A.; M.A. El-Tilib; M.H. Elnasikh; S.H. Ibrahim; M.A. Elsheikh and E.E. Babiker (2007). Influence of phosphorus and potassium fertilization on quality of sugar of two sugarcane varieties grown on three soil series of Sudan. J. Applied Sci.,.7(16):2345-2350.

El-Shafai, A.M.A. and A.M.A. Ismail (2006). Effect of row spacing on yield and quality of some promising sugarcane varieties. Egypt J. Appl. Sci., 21(11): 32-46.

El-Tilib, M.A.; M.H. Elnasikh and E.A. Elamin (2004). Phosphorus and potassium fertilization effects on growth attributes and yield of two sugar cane varieties grown on three soil Series, J. Plant Nutrition, 27(4):663-699.

Endris, Y.; Z. Wolde; A. Getaneh and T. Negi (2016). Determination of optimum harvesting age for the existing sugarcane varieties at amibara/middle awash agricultural development enterprise, Ethiopia. Res. Develop, and Manage. J. (25):24-30.

Hagos H.; L. Mengistu and Y. Mequanint (2014). Determining optimum harvest age of sugar cane varieties on the newly establishing sugar project in the tropical areas

of tendaho, Ethiopia. Adv. Crop Sci. Tech.; 2(5):156-159.

Hadush, H.; W. Walelign and T. Abuhay (2014). Effect of drying of period and harvest age on quality and yield of ratoon cane (*Saccharium Officinarium*) crop Sci 1-5.

Ismail, A.M.A.; A.M. Hagrus; M.M. El-Sonbaty and S.H. Farrag (2000). Effect of phosphobacterin and phosphorus levels on yield and quality of sugarcane. Sugar Crops Res. Inst., Agric. Res. Center, Giza, Egypt. 2 (1):20-28.

Jadhav, H.D.; T.S. Mungara; J.P. Patil; R.R. Hasure; B.S. Jadhav and S. Jaswant (2000). Effect of harvesting age on juice and Jaggery quality and yield of different sugar cane varieties under pre-seasonal planting. Coop Sugar, 32(2):113-117.

Kumara, A.D.S. and D.C. Bandara (2002). Effect of nitrogen fertilizer on yield and quality parameters of three sugarcane varieties. Tropi. Agric. Res., 14(2):117-127

Mathur, R.B. (1981). Handbook of cane sugar technology. Oxford & IBH Publishing Co.

Mehareb, E.M.; A. El-Bakry and H.Y. Mohamed (2018). Performance of the new sugar cane variety G.2003-47 (GIZA 3) under different levels of phosphorus fertilizer. J. Biol. Chem. Environ. Sci., 13(1):161-178.

Mehareb, E.M. and R.A. Abazied (2017). Genetic variability of some promising sugarcane varieties (*Saccharum spp*) under harvesting ages for juice quality traits, cane and sugar yield. J. Agri. Res., Vol. 2(2):1-14.

Mohamed, K.h.; E.M. Elwan; A.M. Tawfik and F. Sahar (2012). The effect of cultivar and harvest time on yield and quality of sugar cane. Minia J. Agric. Res. Develop. 32 (5):35-48.

Osman, M.S.H.; A.H.S.A. Allabbody and A.M.H. Osman (2011). Performance of two promising sugarcane varieties under different harvesting dates. J. Plant Production, Mansoura Univ.,.2(2):289-296.

Pawar, M.W.; S.S. Joshi and V.T. Amodkar (2003). Effect of foliar application of phosphorus and micronutrients on enzyme activities and juice quality in sugar cane.18(2):222-226.

Shahid, P.; F. Naeem; G. Abdul and K. Farhan (2012). Ratooning ability of sugarcane genotypes at different harvesting dates. International Sugar Journal.,1(14):13-60.

Steel, R.G.D. and J.H. Torrie (1980). Principles and procedures of statistics. Mc Grow-Hill Book Co. Inc., New York.

Snedecor, G.W. and W.G. Cochran (1981). Statistical Methods. Seventh Ed., Iowa State Univ. Press, Ames, Iowa, USA.

Sohu, I.A.; A.H. Memon and B.A. Abro (2008). Performance of sugarcane varieties in comparison with commercial varieties. L.S.I. J.,2(3): 760-764.

Vajantha, B.; M.K. Hemanth; K.R. Tagore; N.V. Sarala and T.M. Hemalatha (2019). Effect of delayed harvesting and crushing on yield and juice quality of promising sugarcane clones. Int. J., Curr., Microbiol., App., Sci., l8(11):1745-1754.

Yadav, R.L. and R.K. Sharma (1980). Effect of nitrogen level and harvesting date on quality characteristics and yield of four sugar cane genotypes. Indian J. Agric. Sci., 1 (5)0:581-589.

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تأثر حاصل وجودة بعض اصناف قصب السكر بميعاد الحصاد ومستويات التسميد الفوسفاتى

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الملخص

أجريت هذه الدراسة بمزارع قصب السكر بكوم أمبو (خط عرض ٢٤ درجة و٢٨ درجة شمالاً وخط طول ٣٢ درجة و ٥٧ درجة شرقاً) محافظة أسوان خلال موسمي ٢٠١٥/٢٠١٦ و٢٠١٦/٢٠١٧ محصولى قصب غرس والخلفة الاولى. وذلك بهدف دراسة تأثير ميعاد الحصاد ومستويات التسميد الفوسفاتى على حاصل وجودة بعض أصناف السكر. تضمنت التجربة سبعة وعشرين معاملة تمثل التوافيق بين ثلاثة أعمار للحصاد (١٠ و ١١ و ١٢ شهر) ثلاثة مستويات للتسميد الفوسفاتى (٣٠ و ٤٥ و ٦٠ كجم / خامس اكسيد فوسفور للفدان) وثلاثة من أصناف من قصب السكر جيزة تايوان ٥٤-٩ و جيزة ٢٠٠٣-٤٧ (جيزة ٣) و جيزة ٢٠٠٤-٢٤ (جيزة ٤). تم استخدام تصميم القطاعات الكاملة العشوائية مرتبة فى قطع منشقة مرتين فى ثلاث مكررات.

أظهرت النتائج أن جميع الصفات المدروسة تأثرت معنوياً بمواعيد الحصاد. كما اختلفت أصناف قصب السكر الثلاثة اختلافاً معنويا في جميع الصفات المدروسة. أظهر الصنف التجاري الجديد جيزة ٢٠٠٣-٤٧ تفوقًا على الأصناف الأخرى في النسبة المئوية لكلا من المواد الصلبة الذائبة الكلية (البركس) والسكروز والنقاوة. أدت زيادة مستوى الفسفور من ٣٠ إلى ٦٠ كجم من خامس اكسيد الفوسفور فدان إلى زيادة معنوية في كل من النسبة المئوية للمواد الصلبة الذائبة الكلية (البركس) والسكروز والنقاوة وناتج السكر النظرى فى الموسمين ومحصولى القصب والسكر بالطن للفدان فى الموسم الاول فقط.

تشير بياناتنا إلى أنه يجب على المزارعين محاولة حصاد محصول القصب السكر في عمر ١٢ شهرًا. مع تسميد ٦٠ كجم من خامس اكسيد الفوسفور فدان. لتعظيم محصولى القصب و السكر.