FACULTY OF AGRICULTURE

Minia J. of Agric. Res. & Develop.
Vol. (36), No. 4, pp. 635-651, 2016

ASSESSMENT OF THE OPTIMUM AGE FOR HARVESTING SOME PROMISING SUGARCANE VARIETIES

Ahmed A. Z. [(1)], A. El-Bakry[(1)] and Sakina, R. Abazied [(2)]

[(1)]Agronomy [(2)]Technology Res. Dept. Sugar Crops Res. Inst., ARC, Giza, Egypt

Received: 15 November (2016) Accepted: 28 December (2016)

ABSTRACT

The present work was conducted at El-Mattana Agricultural Research Station (latitude of 25.17^{o} N and longitude of 32.33^{o} E), Luxor Governorate, Upper Egypt during 2014/2015 (plant cane) and 2015/2016 (first ratoon crop) to find out the optimum harvesting age (11, 12, 13 and 14 months old) for three promising sugarcane varieties (G.98-28, G. 99-160 and G.2003-49) compared with the commercial variety (G.T. 54-9). A complete randomized block design with three replications was used. The results showed that all of the studied traits were significantly influenced by increasing the harvest age from 11 to 14 months. The four sugarcane varieties significantly differed in stalk cane length, diameter, weight as well as brix, sucrose purity, richness percentage, sugar recovery percentages, cane and sugar yields /fad. The promising sugar cane variety G.2003-49 showed superiority over the other varieties in cane and sugar yields /fad. Under the conditions of the present work, the results suggest that the best harvesting age for the studied cane varieties could be 14 months to obtain the best quality parameters as well as the maximum cane sugar yield.

INTRODUCTION

Sugar cane crop is the second source of sugar production in Egypt. It is considered the most important economic crop, in Upper Egypt. 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 from 11 to 14 months. Changes in quality, yield and its components of each one proved to be of vital importance for both cane grower and processor

(Jadhav, *et. al*., 2000; Kadam ***et. al.,*** 2004; Nevase, *et. al*., 2004 ; Gilbert, *et. al*., 2006 ; Ongin and Olweny 2011 ; Osman *et. al*., 2011; Abd El-Razek, and Besheit 2011; Hagos *et al.,* 2014 and Endris, *et al.,* 2016).

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 (El-Shafai and Ismail 2006; Ahmed *et al.,* 2008; Abo El-Hamd *et al.,* 2013; Yousif, *et. al*., 2015; El-Geddawy Dalia, *et. al*., 2015; Kamel 2015 and Mehareb, *et al.,* 2016).

The present work was carried out to determine the optimum age for harvesting some promising sugar cane varieties which might achieve higher cane and sugar yields, in addition to good juice quality characteristics.

MAT ERIALS AND METHODS

The present study was conducted at EL-Mattana Agricultural Research Station, (latitude of 25.17^{o} N and longitude of 32.33^{o} E), Luxor Governorate, Egypt including plant cane and the 1st ratoon crops grown during 2014/2015 and 2015/2016 seasons to investigate the appropriate harvesting age of four sugar cane varieties in relation to yield and juice quality.

The study included sixteen treatments represent the combination of four sugar cane varieties G.T.54-9, G.98-28, G.99-160 and G.2003-49, which were harvested at four ages (11, 12, 13 and 14 months). Factorial experiment conducted in randomized complete blocks design with three replications was used. Plot area was 42 m^2 (including six ridges of one meter apart and seven meters in length). Sugarcane varieties were planted in the 1st week of March. All plots received the recommended normal agronomic practices for the sugarcane crop.

The recorded data:

At each harvesting date, twenty five stalks cane from each plot were collected at random and cleaned to determine the following traits:

1. Stalk cane height (cm) was measured from soil surface up to the top visible dewlap.
2. Stalk cane diameter (cm) was measured at the middle part of the stalks.
3. Stalk cane weight (kg).
4. Brix percentage (total soluble solids, TSS %) in cane juice was determined using Brix Hydrometer according to A.O.A.C. (1995).
5. Sucrose percentage in juice was determined using Saccharemeter according to A.O.A.C. (1995).
6. Reducing sugars percentage: It was determined using Fehling method according to A.O.A.C. (1995).
7. Purity percentage was calculated according to the following formula described by Carruthers *et al* (1962).

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

8. Richness percentage was calculated according to the following formula described by Anonymous (1981):
   - Richness % = (sucrose % gm juice x richness factor) /100. Where:
   - Sucrose % gm juice= (sucrose % cm3 juice) / juice density
   - Juice density was taken from Schibler's Tables.
   - Richness factor = 100 - (fiber % x 1.3).
9. 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
10. Cane yield (ton/fad): it was determined from the weight of the three middle guarded rows of each plot converted into value per fad.
11. Sugar yield (tons/fad.): was calculated according to the following formula described by Mathur (1981). Sugar yield (ton /fad.) = 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. Stalks cane height:

Data presented in Table (1) revealed that the harvesting age of sugar cane plants had a significant effect on stalk cane height in the plant cane and the first ratoon crops. The increase in stalk cane height harvested at 14 months age amounted by 11.76 %, and 14.59 % over the harvested at 11 months in the plant cane and 1st ratoon crop, respectively. Such effect might be attributed to continue of plant growth as expressed in stalk cane height. These results are in accordance with those obtained by Kadam *et al.,* (2004), Ongin and Olweny (2011), Osman *et al.,* (2011); Hagos *et el.,* (2014) who reported that stalk height significantly increased with increasing plant age at harvesting.

Data in the same Table showed that the tested sugarcane varieties differed significantly in stalk cane height in both cane crops. It is clear from the data that the commercial sugar cane variety G.T 54-9 had the highest stalks canes, while the shortest ones were produced by G.98-28 variety in the first and second seasons. These results may be due to the genetic differences among varieties in their ability of the formation of internodes and /or determination of their stalk length. These results are in the same line with those obtained by El-Shafai and Ismail (2006), Abo El-Hamd *et al.,* (2013), Yousif, *et al.,* (2015) and Mehareb, *et al.,* (2016) who recorded significant differences among the evaluated varieties in stalk length.

Data revealed also that the stalk cane height was significantly affected by the interaction between sugar cane varieties and their harvesting age in the plant cane and 1st ratoon cane crops. This means that the cane varieties did not behave the same at the different harvesting age, in plant cane crop, stalk cane height of G.T. 54-9 and G.2003-49 varieties were significantly increased by delaying harvesting age from 13 to 14 months but this was not the case with the other two varieties. In general the tallest cane were recorded with commercial varieties G T 54-9 and/or G.2003-49 promising variety, when harvested at 14 months age in both cane and 1st ratoon crops.

Table (1) Stalk cane height of sugarcane varieties as affected by harvesting age in 2014/2015 and 2015/2016.

Harvest age (Months)	Plant crop					First ratoon crop				
	G.T. 54-9	G. 98-28	G. 99-160	G .2003-49	Mean	G.T. 54-9	G. 98-28	G .99-160	G. 2003-49	Mean
11	250	226	235	242	238	245	231	233	221	233
12	252	240	245	248	246	255	241	241	244	245
13	258	246	252	260	254	264	249	257	273	261
14	277	252	263	273	266	282	266	272	283	276
Mean	259	241	249	256		262	247	251	255	
L.S.D. at 0.05 level for:										
Harvest age (H)					6					7
Varieties (V)					6					7
H x V					12					14

2. Stalk cane diameter:

Data in Table (2) revealed that harvesting ages significantly affected in stalk cane diameter of the studied varieties in the plant cane as well as the 1st ratoon crops. Harvesting at 14 months age recorded the highest mean values of cane diameter, whereas 11 months age recorded the lowest ones, in the plant cane and 1st ratoon crops. Generally, stalk cane diameter was increased gradually as harvesting delayed to reach its maximum values at the age of 14 months. These data are in partial agreement with those obtained by Osman *et al.,* (2011); Ongin and Olweny (2011) and Abd El-Razek and Besheit (2011) they reported that harvesting dates significantly affected stalk diameter in both seasons.

Results in the same Table showed clearly significant differences were obtained among the studied varieties in their stalk diameters. The varieties G.T 54-9 and G.98-28 showed significant superiority in their cane diameter over the other two varieties i. e. G.99-160 and G. 2003-49. These findings haled fairly in booth cane plant and 1st ratoon crops. These results may be due to the genetic differences among varieties in their ability of the formation of internodes and/or

determination of their stalk diameter. These results are in agreement with those obtained by Ahmed *et al.*, (2008), Abo El-Hamd, *et al.,* (2013) and Yousif, *et al.,* (2015) who found that significant variation among the evaluated cane varieties in millable cane diameter.

In respect to the effect of the interaction between varieties and harvesting age was significant on this trait. The varieties did not behave the same under the four harvesting ages. The highest values of cane diameter were recorded with varieties G.T.54-9 and G. 98-28 at 13 month age, while with the other two varieties were recorded at 14-month age.

Table (2) Stalk cane diameter of sugarcane varieties as affected by harvesting age in 2014/2015 and 2015/2016.

Harvest age (months)	Plant crop					First ratoon crop				
	G.T. 54-9	G. 98-28	G. 99-160	G. 2003-49	Mean	G.T. 54-9	G. 98-28	G. 99-160	G. 2003-49	Mean
11	2.63	2.80	2.60	2.77	2.70	2.47	2.60	2.43	2.60	2.53
12	2.98	2.97	2.80	2.76	2.88	2.63	2.70	2.57	2.70	2.65
13	3.00	3.00	2.85	2.81	2.92	2.83	2.79	2.50	2.63	2.69
14	2.99	2.97	2.90	2.96	2.96	2.88	2.67	2.77	2.72	2.76
Mean	2.90	2.94	2.79	2.83		2.70	2.69	2.57	2.66	
L.S.D. at 0.05 level for:										
Harvest age (H)					0.10					0.14
Varieties (V)					0.10					0.14
H x V					0.20					0.31

3. Millable cane weight:

Data given in Table (3) reveled that millable cane weight was significantly increased by increasing plant age from 11-14 months in the two crops, these increments amounted by 0.221, 0.165 and 0.095 kg /plant compared with harvest at age of 11, 12 and 13 months in the plant cane crop, while these increases were 0.120, 0.098 and 0.065 kg /plant in 1st ratoon crop respectively. The increase in millable cane weight by delaying harvest date is due to the increase in stalks cane height and thickness (Tables 1, 2) These results are in the same line with those obtained by Abd El-Razek, and Besheit (2011), Ongin and Olweny (2011) and Osman *et al.*, (2011) who reported that 14 months harvest age recorded the highest values of , millable cane weight.

Data presented in Table (3) reveled that sugar cane varieties had significant effect on stalk cane weight. Stalks cane of the commercial variety G.T.54-9 was heavier than that of the other three varieties in plant cane and 1st ratoon crops. The superiority of G.T.54-9 over the other three sugarcane varieties in stalks cane weight may be due to its superiority in stalks cane height and stalk diameter (Tables 1and 2). This result is in agreement with those obtained by Abo El-Hamd *et al.*, (2013); EL

Geddawy, Dalia, *et al.,* (2015), and Yousif *et al.,* (2015) who reported that differences in stalk weight among varieties could be attributed to the differences in stalk height and diameter.

The interaction between varieties and harvesting age had a significant effect on stalk cane weight. In general, the maximum values of stalk cane weight was obtained from harvesting all varieties at 14-month old in the two seasons, but the effect of harvest age was not the same was the studied varieties. In 1st season the increase in stalk cane weight of G. T. 54-9 variety was about double of that obtained with G.98-28 variety due to delaying the harvest date from 11 to 14 months old.

Table (3): Stalk cane weight of sugarcane varieties as affected by harvesting age in 2014/2015 and 2015/2016.

Harvest age (months)	Plant crop					First ratoon crop				
	G.T. 54-9	G. 98-28	G. 99-160	G. 2003-49	Mean	G.T. 54-9	G. 98-28	G. 99-160	G. 2003-49	Mean
11	0.977	0.910	0.927	0.943	0.939	0.990	0.903	0.910	0.930	0.933
12	1.050	0.927	0.953	1.050	0.995	0.993	0.913	0.940	1.027	0.968
13	1.153	0.980	0.993	1.133	1.065	1.073	0.937	0.953	1.003	0.992
14	1.283	1.063	1.073	1.220	1.160	1.097	1.043	1.007	1.063	1.053
Mean	1.116	0.970	0.987	1.087		1.038	0.949	0.953	1.006	
L.S.D. at 0.05 level for:										
Harvest age (H)					0.017					0.0.34
Varieties (V)					0.017					0.034
H x V					0.035					0.068

4. Brix percentage:

During growth, maturing and harvesting stages the brix value is an important character which gives good information's about the maturity and juice quality can predict the sugar content by measuring the brix degree. The collected data in Table (4) showed that brix percentages were significantly affected by delaying harvest age in the plant cane and the 1st ratoon crops. The brix % of the studied varieties gradually increased as harvesting delayed to reach its highest values at the age of 14 months in both plant cane and first ratoon crops. The increases in brix values of juice at the end of the harvesting season may be due to the continuous accumulation of solids as harvest age progress towards the end (from 11 to 14 month old) and/or due to that sugar cane harvested at the age of 11 months still immature. Similar results were reported by Jadhav, *et al.,* (2000), Kadam *et al.,* (2004), 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 the plant cane and its first ratoon crops. The G.2003-

49 variety had the highest value of total soluble solids in the plant crop, while in the 1st ratoon crop G.99-160 variety recorded the best brix percentage followed by G.2003-49 without significant difference. The variation between the examined varieties in total soluble solids may be due to the differences in growth and response to the surrounding environmental conditions prevailing during the formation of soluble solids in the plants. Differences among cane varieties in this trait were also found by Ahmed *et al.*, (2008), Abo El-Hamd *et al.*, (2013), Kamel (2015) and Mehareb, *et al.*, (2016) they found that significant differences among evaluated genotypes for total soluble solids.

Table (4) Brix percentage of sugarcane varieties as affected by harvesting age in 2014/2015 and 2015/2016.

Harvest age (Months)	Plant crop					First ratoon crop				
	G. T.54-9	G. 98-28	G. 99-160	G. 2003-49	Mean	G.T. 54-9	G. 98-28	G. 99-160	G. 2003-49	Mean
11	14.12	16.12	15.49	17.53	15.82	16.26	18.14	17.66	18.51	17.64
12	15.35	17.07	17.34	18.65	17.10	19.75	19.45	19.85	19.43	19.62
13	18.22	18.76	18.32	19.10	18.60	20.34	20.01	21.0 7	21.39	20.70
14	20.42	20.17	20.51	21.45	20.64	22.42	21.96	22.67	21.60	22.16
Mean	17.03	18.03	17.91	19.18		19.69	19.89	20.31	20.23	
L.S.D. at 0.05 level for:										
Harvest age (H)					0.48					0.67
Varieties (V)					0.48					0.67
H x V					0.96					1.35

Also data showed that brix percentage was significantly affected by the interaction between the two studied factors in the two seasons. In plant cane crop, the increase in brix percentage of G. T. 54-9 variety was time and a half of that obtained with G.98-28 variety due to delaying the harvest date from 11 to 14 months old.

5. Sucrose percentage:

Sucrose is the major component of soluble solids at maturity and the economically most important constituent of sugar cane. The results presented in Table (5) cleared that sucrose content significantly increased by increasing harvest age from 11 up to 14 months old in the plant cane and the 1st ratoon crops, harvesting at 14 months recorded the highest mean values in both plant cane and first ratoon crops whereas the lowest values were recorded with harvest at 11 months. The increase in sucrose% at the age of 14- month 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. These results are also in the same line with those found by Kadam *et al.*, (2004), Gilbert, *et al.*,

(2006), Osman *et al.*, (2011) and Hagos *et al.*, (2014) they found that increasing harvest age significantly influenced sucrose percentage.

Results also indicated that the evaluated cane varieties differed significantly in sucrose percentage in the plant and first ratoon crops. Sugarcane G.2003-49 variety recorded the highest value of sucrose percentage in the plant cane and 1st ratoon crop. As well as the first ratoon crop. The differences among the studied varieties in sucrose percentage are mainly due to their gene make-up. These results are in agreement with those obtained by El-Shafai and Ismail (2006), Ahmed et al., (2008), El-Geddawy, Dalia, et al., (2015) and Yousif et al., (2015) who noted that sucrose percentage in juice was significantly affected by cane varieties.

Sucrose percentage was significantly affected by the interaction between the studied factors in both cane crops. This means that the cane varieties did not behave the same at the different harvesting age. In plant cane crop, sucrose percentage of G.99-160 and G.2003-49 varieties were significantly increased by delaying harvesting age from 11 to 12 months but this was not the case with the other two varieties.

Table (5) Sucrose percentage of sugarcane varieties as affected by harvesting age in 2014/2015 and 2015/2016.

Harvest age (Months)	Plant crop					First ratoon crop				
	G.T. 54-9	G. 98-28	G. 99-160	G. 2003-49	Mean	G.T. 54-9	G. 98-28	G. 99-160	G. 2003-49	Mean
11	11.86	13.71	12.80	14.86	13.31	13.29	14.74	14.51	15.75	14.47
12	11.98	13.83	14.61	16.49	14.23	16.89	16.46	17.05	16.99	16.85
13	15.61	15.78	16.08	16.93	16.10	17.64	17.21	18.36	18.62	17.96
14	17.55	16.43	17.02	18.01	17.25	19.75	18.99	19.67	19.03	19.36
Mean	14.25	14.94	15.13	16.57		16.89	16.85	17.40	17.60	
L.S.D. at 0.05 level for:										
Harvest age (H)					0.78					0.74
Varieties (V)					0.78					0.74
H x V					1.56					1.48

6. Reducing sugars percentage:

It is clear from Table (6) that harvest date along crushing season (from11 to 14 months old) had a significant effect on reducing sugars percentage, the lowest mean values (0.243 % and 0.218 %) were recorded at the age of 14 months, whereas their values were (1.046 % and 0.852 %) at the age of 11 months. These results are in harmony with those obtained by Jadhav, *et al.*, (2000) who noted significant differences between harvesting ages in reducing sugars percentage.

Data in the same Table indicated that G.2003-49 variety was considerably lower in reducing sugars contents (0.326% and 0.300%) than the other varieties in both plant cane

and first ratoon crops, respectively. On the other hand G.T.54-9 variety recorded the highest values of reducing sugars (0.981% and 0.604%) in both plant crop and first ratoon crop, respectively. The variation of reducing sugar content between the studied varieties may be due to varietal characteristic. It is known that each molecule of the reducing sugars prevent crystallization of di-sucrose molecules during sugar extraction process from sugar cane syrup. This result coincides with that obtained by Abo El-Wafa *et al.*, (2006) and Kamel (2015) who reported that the tested sugar cane varieties differed significantly in reducing sugars percentage.

Reducing sugars percentage was significantly affected by the interaction between the two studied factors. This means that the depression rate of reducing sugars through the harvest ages was not the same in the studied varieties. Variety G. T. 54-9 and variety G.2003-49 recorded that highest and the lowest rates of depression respectively.

Table (6) Reducing sugar percentages of sugarcane varieties as affected by harvesting age in 2014/2015 and 2015/2016.

Harvest age (Months)	Plant crop					First ratoon crop				
	G.T. 54-9	G. 98-28	G. 99-160	G. 2003-49	Mean	G.T. 54-9	G. 98-28	G. 99-160	G. 2003-49	Mean
11	1.613	0.960	1.030	0.580	1.046	1.467	0.527	0.927	0.487	0.852
12	1.230	1.117	0.760	0.330	0.859	0.400	0.443	0.363	0.350	0.389
13	0.820	0.907	0.377	0.157	0.565	0.253	0.197	0.290	0.187	0.232
14	0.260	0.247	0.227	0.237	0.243	0.297	0.197	0.200	0.177	0.218
Mean	0.981	0.807	0.598	0.326		0.604	0.341	0.445	0.300	
L.S.D. at 0.05 level for:										
Harvest age (H)					0.20					0.11
Varieties (V)					0.20					0.11
H x V					0.39					0.21

7. Purity percentage:

The high purity is considered an encouragement and careful factor for sugar industry. It could be noticed that significant and gradually increase in purity percentage as harvest age increase to reach its highest mean values (86.72% and 87.35%) at the age of 13 and 14- month in the plant crop and 1st ratoon crop, respectively (Table 7). These results are due to the increase in sucrose and total soluble solids contents with increasing sugar cane age at harvest according to the positive relationship between sucrose percentage and total soluble solids percentage. Appreciable reduction in purity was observed at harvest age of 14 month in the plant crop (83.52%) may be due to the highly and rapidly increased in total soluble solids content compared to the sucrose increase (Tables 4 and 5). The lowest mean values of purity (80.09% and

81.75%) were obtained at the age of 11 month; this was quite expected since sugar cane varieties did not reach the state of optimum maturity till this age. These results are in agreement with those mentioned by Nevase, *et al.*, (2004), Ongin and Olweny (2011) and Abd El-Razek, and Besheit (2011) they found that increasing the harvest age from 10 to 13-month significantly increased juice purity.

Results in the same Table showed that purity percentage in juice was significantly affected by varieties in the two seasons. In general, purity percentage of G. 2003-49 was slightly higher than other varieties in both seasons. While the variety of G. 98 -28 gave the lowest purity percentage in first and second seasons. The varietal differences may be attributed to the genetic constitutes of varieties and its interaction with environmental conditions. The effective role of sugarcane varieties on purity percentage has been reported by Osman *et al.*, (2011), Abo El-Hamd *et al.*, (2013), El-Geddawy, Dalia, *et al.*, (2015) and Mehareb, *et al.*, (2016) who found significant differences among the evaluated promising sugarcane varieties for juice purity.

Table (7): Purity percentage of sugarcane varieties as affected by harvesting age in 2014/2015 and 2015/2016.

Harvest age Months	Plant crop					First ratoon crop				
	G. T.54-9	G. 98-28	G. 99-160	G. 2003-49	Mean	G. T.54-9	G. 98-28	G. 99-160	G. 2003-49	Mean
11	77.74	80.23	79.89	82.51	80.09	78.62	81.18	82.11	85.10	81.75
12	77.81	81.03	84.22	88.41	82.87	85.52	84.63	85.90	87.43	85.87
13	86.31	84.12	87.79	88.66	86.72	86.70	86.04	87.11	87.05	86.72
14	85.80	81.46	82.96	83.87	83.52	88.08	86.46	86.78	88.09	87.35
Mean	81.92	81.71	83.71	85.86		84.73	84.58	85.47	86.92	
L.S.D. for										
Harvest age (H)					2.08					1.46
Varieties (V)					2.08					1.46
H x V					4.16					2.91

Moreover, data in the same table showed that purity percentage of two seasons was significantly affected by the interaction between age of harvesting and varieties. This means that the cane varieties did not behave the same at the different harvesting date. In 1st ratoon crop, sucrose percentage of G.2003-49 varieties was insignificantly increased by delaying harvesting age from 11 to 13 months but this was not the case with the other three sugar cane varieties. In general the highest purity percentage (88.66 and 88.09) was recorded by harvesting G.2003-49 promising variety at 13 and 14 months old in plant cane and first ratoon crops, respectively.

8. Richness percentage:

Results presented in Table (8) revealed that Richness percentage (Pol %) was significantly affected by increasing harvest age. Richness percentage gradually increased and reached to its maximum mean values (14.43% and 16.26%) at the harvesting date of 14 months, in the plant crop and 1st ratoon crop, respectively. The increase in Richness % is mainly due to the increase in sucrose content (Table 5). Pol % (sucrose% cane) of sugar cane depends on its content of sucrose and fiber. Ongin and Olweny (2011) and Hagos *et al.,* (2014) reported that increasing levels of harvest age significantly influenced pol % parameters.

Data in the same Table showed that Richness % was significantly affected by the examined sugar cane varieties. The highest mean values of pol% (13.99% and 14.83%) were scored by G.2003-49 variety followed by G. 99-160 (12.70 % and 14.66%) in the plant crop and 1st ratoon crop, respectively. The lowest mean of pol % (12.14%) was obtained from G.T.54-9 variety in plant crop and (14.22 %) from G. 98-28 in 1st ratoon crop. The variation in richness % between varieties could be correlated to the variation in their sucrose and fiber content. These findings are in line with those reported by Ongin and Olweny (2011), Abo El-Hamd *et al.,* (2013) and Kamal (2015) who reported that tested sugar cane varieties differed significantly in richness percentage.

Concerning the interaction effect, it could be noted that the effect of the interaction between sugar cane varieties and harvesting age in the two seasons was significant. but the effect of harvest age was not the same was the studied sugar cane varieties. The increase in richness percentage of G. T. 54-9 variety was about double of that obtained with G.2003-49 variety due to delaying the harvest age from 11 to 14 months. Generally the highest values of pol. percentage (15.18 and 16.62 %) were obtained from harvesting sugar cane varieties G2003-49 and G.T 54-9 at age of 14-month 1st and 2nd seasons respectively.

Table (8) Richness percentage of sugarcane varieties as affected by harvesting age in 2014/2015 and 2015/2016.

Harvest age (Months)	Plant crop					First ratoon crop				
	G.T. 54-9	G. 98-28	G. 99-160	G. 2003-49	Mean	G.T. 54-9	G. 98-28	G. 99-160	G. 2003-49	Mean
11	10.38	11.63	10.81	12.61	11.36	11.04	12.48	12.26	13.34	12.28
12	10.41	11.71	12.27	13.94	12.08	14.38	13.94	14.39	14.34	14.26
13	13.22	13.32	13.45	14.22	13.55	14.91	14.52	15.47	15.67	15.14
14	14.55	13.74	14.25	15.18	14.43	16.62	15.95	16.50	15.96	16.26
Mean	12.14	12.60	12.70	13.99		14.24	14.22	14.66	14.83	
L.S.D. at 0.05 level for:										
Harvest age (H)					0.67					0.63
Varieties (V)					0.67					0.63
H x V					1.34					1.26

9. Sugar recovery percentage:

Results presented in Table (9) demonstrated that the harvesting age of cane plants at had significant effect on sugar recovery % in the two seasons, it could be found that sugar recovery percentage was increased by increasing the harvest age of cane plant from 11 to 14 months. The highest mean values (11.60 % and 13.31%) were found at the age of 14 months in plant cane and 1st ratoon crops respectively. The increase in sugar recovery is mainly due to the increase in sucrose % in sugar cane plants (Table 5). These results are in harmony with those obtained by Kadam *et al.,* (2004), Abd El-Razek, and Besheit (2011), Hagos *et al.,* (2014) and Endris, *et al.,* (2016) who found significant increase in sugar recovery percentage by delaying the harvesting age.

Data in the same Table disclose that sugarcane varieties varied significantly in sugar recovery percentage in both seasons. The highest values of this trait were obtained from G.2003-49 variety in plant and first cane ratoon crops. This result is probably due to higher sucrose percentage recorded by G.2003-49 (Table 5). Varietal differences in this trait were also found by El-Shafai and Ismail (2006), El-Geddawy dalia, *et al.,* (2015) and Mehareb, *et al.,* (2016) they found that sugarcane varieties differed significantly in sugar recovery percentage.

Also data clearly showed that sugar recovery percentage was significantly affected by the interaction between the studied two factors in the two seasons. Generally the highest sugar recovery (11.97 and 13.64) as well as the lowest recovery (7.68 and 8.41) was recorded by harvesting G.T.54-9 variety at 14 and 11 months age in first and second seasons respectively.

Table (9) Sugar recovery percentage of sugarcane varieties as affected by harvesting age in 2014/2015 and 2015/2016.

Harvest age (Months)	Plant cane crop					First ratoon crop				
	G.T. 54-9	G. 98-28	G. 99-160	G. 2003-49	Mean	G.T. 54-9	G. 98-28	G. 99-160	G. 2003-49	Mean
11	7.68	9.03	8.40	9.93	8.76	8.41	9.77	9.67	10.69	9.64
12	7.76	9.15	10.30	11.40	9.65	11.45	11.14	11.63	11.69	11.48
13	10.67	10.65	11.08	11.73	11.03	12.09	11.75	12.61	12.79	12.31
14	11.97	10.90	11.40	12.14	11.60	13.64	13.00	13.48	13.14	13.31
Mean	9.52	9.93	10.30	11.30		11.40	11.41	11.85	12.08	
L.S.D. at 0.05 level for:										
Harvest age (H)					0.67					0.57
Varieties (V)					0.67					0.57
H x V					1.33					1.13

10. Net cane yield:

Results illustrated in Table (10) revealed that increasing harvest age up to 14 months significantly increased cane yield in the two seasons. These increments amounted by 9.164, 7.080 and 4.050 Ton/fad. compared with harvest at age of 11, 12 and 13 months in plant cane, while these increases were 5.662, 4.059 and 2.955 Ton/fed. in 1st ratoon crop respectively. The increase in cane yield of cane plant by delaying harvest date is due to the increase in millable cane length, thickness and weight (Tables 1, 2 and 3). These results are in agreement with those obtained by Nevase, *et al.*, (2004), Gilbert, *et al.*, (2006), Hagos, *et al.*, (2014) and Endris, *et al.*, (2016) who reported that there is a significant increase in cane yield with an increase in harvest age from 12 to 14 months.

Also data showed that the examined cane varieties varied significantly in cane yield, these results were true in the two seasons. The commercial cane variety G. T. 54-9 out yielding G.98-28,G. 99-160 and G.2003-49 varieties by 15.352 , 18.096 and 3.699 ton/fad in the plant cane crop, corresponding to 10.146, 11.687 and 2.780 Ton/fed in 1st ratoon crop, respectively. Superiority of G. T. 54-9 may be due to its better millable cane traits. These results are in line with those obtained by Ahmed *et al.*, (2008). Ongin and Olweny (2011)، Abo El-Hamd *et al.*, (2013) and Yousif, *et al.*, (2015) who found that significant differences among tested sugar cane varieties in cane yield.

Table (10) Cane yield (Ton/fad.) of sugarcane varieties as affected by harvesting age in 2014/2015 and 2015/2016.

Harvest age (Months)	Plant crop					First ratoon crop				
	G.T. 54-9	G. 98-28	G. 99-160	G. 2003-49	Mean	G.T. 54-9	G. 98-28	G. 99-160	G. 2003-49	Mean
11	47.003	36.000	33.410	45.600	40.503	52.347	42.660	41.000	48.023	46.008
12	50.677	36.690	34.393	48.590	42.588	52.677	42.757	42.183	52.827	47.611
13	55.537	38.780	35.843	52.313	45.618	55.620	43.827	43.590	51.823	48.715
14	61.640	41.977	38.827	56.227	49.668	57.973	48.790	45.093	54.823	51.670
Mean	53.714	38.362	35.618	50.683		54.654	44.508	42.967	51.874	
L.S.D. at 0.05 level for:										
Harvest age (H)					3.37					1.07
Varieties (V)					3.37					1.07
H x V					6.74					2.15

Concerning the interaction effect between the two studied factors was significant in both plant cane and 1st ratoon crops. Cane yield of varieties G.T. 54-9 and G.2003-49 was significantly affected by harvesting age in plant cane crop, but this was not the case with the other two varieties. The highest yield (61.714, and 57.973 Ton/fed.) was obtained from G.T. 54-9 variety when it was harvested at 14 month old. While, cane variety G. 99-160 recorded the lowest cane yield (33.410 and 4100 Ton/fed.) it was

harvested at 14 month age, in the virgin cane and its 1st ratoon crops, respectively. (Table 10). Osman *et al.*, (2011) noted that the interaction between cane variety G.99-80 and 14 months harvest age gave the highest cane yields.

11. Sugar yield:

Data in Table (11) showed that delaying sugarcane harvest up to 14 months old resulted in increasing sugar yield by 2.206, 1.693, and 0.732 Ton/fad compared with harvest at age of 11, 12 and 13 months in plant cane, corresponding to 2.482, 1.415 and 0.884 Ton/fad in 1st ratoon crop, respectively. The increase in sugar yield is obtained due to the increasing effect of longer harvest ages on all yield components and quality parameters (sucrose % and purity %). The obtained results are in line with those found by Jadhav, *et al.*, (2000) Nevase, *et al.*, (2004), Gilbert, *et al.*, (2006), Osman *et al.*, (2011), Hagos, *et al.*, (2014 and Endris, *et al.*, (2016) who reported that there is a significant increase in sugar yield with an increase in harvest age from 12 to 14 months.

Table (11) Sugar yield (Ton/fad.) of sugarcane varieties as affected by harvesting age in 2014/2015 and 2015/2016.

Harvest age (Months)	Plant crop					First ratoon crop				
	G.T. 54-9	G. 98-28	G. 99-160	G. 2003-49	Mean	G.T. 54-9	G. 98-28	G. 99-160	G. 2003-49	Mean
11	3.670	3.273	2.803	4.537	3.571	4.340	4.173	3.963	5.133	4.402
12	3.887	3.357	3.550	5.540	4.084	6.033	4.763	4.903	6.177	5.469
13	5.937	4.133	3.973	6.137	5.045	6.723	5.150	5.497	6.630	6.000
14	7.327	4.520	4.433	6.827	5.777	7.903	6.347	6.083	7.203	6.884
Mean	5.205	3.821	3.690	5.760		6.250	5.108	5.112	6.286	
L.S.D. at 0.05 level for:										
Harvest age (H)					0.42					0.36
Varieties (V)					0.42					0.36
H x V					0.84					0.72

Moreover tested sugarcane varieties differed significantly in sugar yield in the 1st and 2nd seasons. In plant cane crop, G.2003-49 variety out yielded G.T.54-9, G.98-28 and G.99-160 varieties by 0.555, 1.939 and 2.070 tons/fad, respectively. Meanwhile, in the first ratoon, G.2003-49 produced 0.036, 1.178 and 1.174 tons sugar/fad higher than those obtained from G.T.54-9, G.98-28 and G.99-160 varieties. The superiority of G.2003-49 variety in sugar yield is probably attributed to the increase in sucrose % and sugar recovery (Tables 5 and 9). These findings are in agreement with those reported by El-Shafai and Ismail (2006), Abo El-Hamd *et al.*, (2013) and El-Geddawy dalia *et al.*, (2015) who reported that promising sugar cane varieties G.2003049 sure passed the commercial varieties in sugar yield/fad.

The effect of the interaction among cane varieties and the studied harvest ages was significant in the 1st virgin cane and the 1st ratoon crops. Sugar yield of G.T 54-9 was significantly increased by delaying harvesting age from 13 to 14 months but this was not the case with the other three varieties. These findings hold fairly true in both plant cane and 1st ratoon crops. Generally the highest sugar yield (7.327 and 7.903) was recorded by harvesting commercial variety G. 54-9 at 14 months old. Kadam *et al.,* (2004) noticed that, the highest sugar yield was obtained from Co 86032 and CoC 671 varieties with harvesting at 14 and 16 months, respectively.

CONCLUSION

Under the conditions of the present work, the results suggest that the best harvesting age for the studied cane varieties could be at the 14-month age to obtain the best quality traits and the maximum cane and sugar yield/fad.

REFERENCES

Abo El-Hamd, 1. A. S.; M. A. Bekheet and A. F. I. Gadalla (2013): Effect of chemical ripeness on juice quality, yield and yield components of some sugarcane varieties under the Conditions of Sohag Governorate. American-Eurasian J. Agric. & Environ. Sci., 13 (11): 1458-1464.

Abo El-Wafa, A. M.; H. Ferweez, and K. E. Mohamed (2006): Effect of potassium fertilizer levels on the productivity, quality and profitability of promising Phil. 8013 sugarcane clone compared with the commercial G.T. 54-9 sugarcane cultivar. Bulletin Fac. Agric., Cairo Univ. 57 (3): 383-399.

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.

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, p. 34-39.

Anonymous (1981): Egyptian Sugar and Integrated Industries Company. Chemical control Lab. Jan., pp.232.

A.O.A.C. (1995): Official methods of analysis. Published by the A. O. A. C., Box 540, Washington, D. C.

Carruthers, A. ; J. F. Olldfieu and H. J. Teague (1962): Assessment of beet quality. Paper presented to XVth Ann. Tech. Conf. Br. Eng. Crop. PP 1-28

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

El-Geddawy, I. H. Dalia; B. S. I. Makhlouf and M. A. Bekheet (2015): Performance of some

sugar cane promising varieties under different seed sett rates and potassium fertiliz ation. Int. J. Curr. Microbiol. App. Sci. 4 (11): 92-110.

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.

Gilbert, R.A.; J.M. Shine Jr; J.D. Miller; R.W. Rice and C. R. Rainbolt (2006): The effect of genotype, environment and time of harvest on sugarcane yields in Florida, USA. Field Crop Res., 95: 156–170.

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.

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

Kadam, U. A; R. R. Hasure; J. P. Patil and B. R. Kanse (2004): Response of sugarcane varieties for different dates of harvesting under pre-seasonal conditions. Coop. Sugar, 35 (6): 471-473.

Kamel, A. E. (2015): Performance of some new sugar cane varieties under different seeding rates and potassium fertilization. M.Sc. Thesis, Fac. Agric., Al-Azhar Univ., Assiut, Egypt.

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

Mehareb E. M.; S. F. Abou Elwafa and M. O. A. Galal (2016): Mean performance and ratooning ability of sugar cane promising genotypes at early clonal selection. American-Eurasian J. Agric. & Environ. Sci., 16 (1): 20-27.

Nevase, V. B.; S.T. Thorat; A. J. Dixit; S. A. Chavan and M. S. Powar, (2004): Cane yield and juice quality of ratoon sugarcane as influenced by varieties, dates of planting, climatic parameters and harvesting. J. Agrometeorolo,6 (Special Issue): 92-94.

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.

Ongin jo E. and C. O. Olweny (2011): Determination of optimum harvesting age for sugar cane ratoon crop at the Kenyan Coast. Microbiol Biotech. Res.,1 (2):113-118.

Snedecor, G. W. and W. G. Cochran

(1981): Statistical Methods. Seventh Ed., Iowa State Univ. Press, Ames, Iowa, USA.

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

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., 50: 581-589.

Yousif, E. M. M.; M. M. IbrahIm; A. O. A. O. El-Aref Kh. and A. Z. Ahamed (2015): Management of nitrogen fertilization for sugar cane on a sandy Soil: I- yield and its components. Egypt. J. Appl. Sci., 30 (11):498-511.

تحديد العمر الأمثل لحصاد بعض أصناف قصب السكر المبشره

أحمد زكى أحمد[1]، عبد الناصر البكرى محمد[1]، سكينه رمضان أبازيد[2]

[1]قسم بحوث المعاملات الزراعية، [2] قسم بحوث تكنولوجيا المحاصيل السكرية،
معهد بحوث المحاصيل السكرية -مركز البحوث الزراعية -الجيزة -مصر

اجريت هذه الدراسة فى مزرعة محطة البحوث الزراعية بالمطاعنة (دائرة عرض 25,17 شمال و خط طول 32,33 شرق)، مركز اسنا، محافظة الأقصر، بمصر العليا خلال موسمى النمو (2015/2014) للقصب الغرس و (2016/2015) خلفة أولى لتحديد العمر الأمثل لحصاد ثلاثة أصناف مبشرة من قصب السكر (جيزة 98-28، جيزة 99-160 و جيزة 2003-49) مقارنة بالصنف التجارى جيزة- تايوان 54-9. والتى تم حصادها عند عمر (13,12,11 و 14 شهراً).

أظهرت النتائج أن صفات المحصول و مكوناته وصفات الجودة قد تأثرت معنوياً بزيادة عمر النباتات عند الحصاد من 11 الى 14 شهراً. أوضحت النتائج أن الأصناف الأربعة تباينت معنوياً فى طول و قطر ووزن العيدان الصالحة للعصر، كما تباينت صفات الجودة (النسبة المؤية لكل من البركس والسكروز والنقاوة والحلاوة و ناتج السكر النظرى و السكريات المختزلة و حاصلى القصب و السكر للفدان.

وبصفة عامة أعطى الصنف التجارى جيزة تايوان 54-9 يليه الصنف المبشر جيزة 2003-49 عند الحصاد عند عمر 14 شهراً أعلى محصول سكر/فدان. وتحت ظروف هذه الدراسة يمكن التوصية بحصاد الأصناف الأربعة عند عمر 14 شهراً للحصول على أفضل صفات جودة و محصولى قصب عيدان و سكر للفدان.