

# Impact the age at harvest on yield and quality of some promising sugarcane varieties

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## ABSTRACT

The current research was conducted at El-Mattana Agricultural Research Station (latitude: 25.25°N and longitude: 32.31°E). Luxor Governorate, Egypt during 2020/2021 and 2021/2022 (two plant cane crops). This research aimed to assess the optimum age at harvest (11, 12, 13 and 14 months old) for six promising sugarcane varieties (G.2003-47, G.2004-27, G.2005-47, G.2000-5, G.2009-11 and G.2015-37) compared with the commercial variety (G.T. 54-9). The examined treatments were distributed in a split-plot design with three replications. Sugarcane varieties were assigned to the main plots while the ages at harvest were distributed in the sub-plots. The results indicated that sugarcane varieties significantly differed in all studied traits. G.2004-27 variety recorded the highest millable cane length and cane yield in both seasons, while variety G.2005-47 gave the highest values of millable cane diameter, weight and sugar yield. However, the differences in millable cane weight between the sugarcane variety G.2005-47 and variety G.2004-27 were insignificant, in the second season only. Sugar cane variety G.2003-47 recorded the highest sucrose, purity and sugar recovery in both seasons. Also, variety G.2000-5 gave the highest values of brix% in both seasons. Harvesting at 14 months old recorded the highest mean values of millable cane length, diameter, weight, brix and cane yield in both seasons, as well as sugar yield in the second season. The highest mean values of sucrose, purity, and sugar recovery in both seasons, as well as sugar yield in the first season, were recorded at 13-month-old. Under this investigation, the maximum cane and sugar yield was obtained by G.2004-27 and G.2005-47 varieties when they were harvested at 14 and 13 months old, respectively.

**Keywords:** sugarcane, varieties, harvesting, age

## INTRODUCTION

Sugar cane crop is cultivated in five Sugarcane producing Governorates in Egypt (Minya, Sohag, Qena, Luxor and Aswan) for sugar production and other utilizations. Sugar cane yield and quality metrics are mostly influenced by varieties and their age at the harvesting time. The sugar cane variety is considered the most important item of production. Cane varieties differ in their maturity date which controlling by their ages. Many investigators pointed out the role of sugar cane varieties in respect to their variation in quality, yield and yield components (Abo El-hamd, *et al.*, 2013; Yousif, *et al.*, 2015; Mehareb, *et al.*, 2016; Abazied 2018; Abo El-hamd, *et al.*, 2019; Abu-Ellail *et al.*, 2020 and Ahmed *et al.*, 2020).

Harvesting Sugarcane in peak maturity stage is necessary to obtain the maximum sucrose content and the highest sugar recovery. This stage could be determined by monitoring brix, sucrose, purity, pol and Sugar recovery parameters and determining the age of canes in which the maximum percentage of these parameters is achieved and recommending this age as appropriate age for harvesting. Significant effect of varieties by ages at harvest interaction in quality, yield and yield components was widely reported (Hagos, *et al.* 2014; Ahmed and Awadalla, 2016; Endris, *et al.* 2016; Ahmed, *et al.*, 2016; Mequantent, 2016; Mehareb and Abazied 2017; Teama, *et al.*, 2020; Gamechis and Ebisa, 2021 and Ali, *et al.* 2022).

The information on maturity status and exact time of ripping for promising Sugarcane varieties is essential for Sugar industries to avoid poor quality during the crashing season. Therefore, the objective of this study was to determine the optimum age at harvest for six promising varieties compared with the commercial variety (G.T.54-9) which might achieve maximum juice quality characteristics as well as higher cane and sugar yields.

## MATERIALS AND METHODS

The current research was conducted at El-Mattana Agricultural Research Station, (latitude: 25.25°N and longitude: 32.31°E), Luxor Governorate, Egypt. Two plant cane crops (2020/2021 and 2021/2022) were used to assess the optimum age at harvest (11, 12, 13 and 14 months) of six promising sugarcane varieties (G.2003-47, G.2004-27, G.2005-47, G.2000-5, G.2009-11, G.2015-37) compared with the commercial variety (G.T. 54-9). This study included 28 treatments which were the combination of seven sugar cane varieties and four ages at harvest. The experimental design was split plot with three replications, sugar cane varieties were assigned to the main plots, while ages at harvest were distributed in the sub-plots.

The sub-plot area was 42 m<sup>2</sup> and contained six rows that were 7 m long and 1 m wide each. In the first week of March, various sugar cane varieties were planted.

The other agronomic practices for growing sugarcane were done as recommended by the Sugar Crops Research Institute.

### For each age at harvest, the following data were taken:

In the four ages at harvest, twenty-five millable canes from each sub-plot were collected at random and cleaned to determine the following traits:

1. Millable cane length (cm) was measured from soil surface to the top visible dewlap.
2. Millable cane diameter (cm) was measured at the middle part of the stalks.
3. Millable cane weight (kg) was determined by dividing cane weight of the one-meter sample by its corresponding number of millable cane.

The primary juice was extracted by electric pilotmill (Sabri, 1966) screened and mixed thoroughly, one liter of juice was taken in glass cylinder to determine the following juice quality characteristics:

4. Total soluble solids (TSS %) in cane juice (Brix percent) was determined in the laboratory using Brix hydrometer standardized at 20°C. (A.O.A.C. 1995).
5. Sucrose percent was determined using Sacharemeter according to (A.O.A.C. 1995).
6. Juice purity percent was calculated according to the following formula:

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

7. Sugar recovery percent: it was calculated as follows:

$$\text{Sugar recovery \%} = [\text{Sucrose \%} - 0.4 (\text{Brix \%} - \text{Sucrose \%}) \times 0.73].$$

Where B = Brix reading, S = Sucrose percent, 0.4 and 0.73 constants. (Yadav and Sharma 1980).

8. Cane yield (Ton/fad) was determined from the weight (kg) of millable canes of each plot, which was converted into Ton/fad.

9. Sugar yield (Ton/fad) was estimated as follows:

$$\text{Sugar yield (Ton/fad)} = \text{cane yield (Ton/fad)} \times \text{sugar recovery \%}.$$

### Statistical analysis:

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

## RESULTS

### 1. Millable cane length (cm):

The obtained data in table (1) showed that the evaluated varieties significantly differed in millable cane length. Sugar cane variety G.2004-27 had the tallest stalks, while G.2000-5 had the shortest ones compared with other varieties in both seasons.

Data in the same table showed that millable cane length was significantly affected by age at harvest. The millable cane length significantly increased with increasing age at harvest until 14 month of the seven tested varieties. Also, result cleared that the increase in millable cane length at age of 14 months amounted to 4.54 % and 4.88 % over that of 11-month in the first and second seasons, respectively.

Millable cane length was significantly influenced by the interaction between the tested cane varieties and age at harvest. The highest value obtained from G.2004-27 variety when harvested after 14 month, while the lowest value recorded by harvesting G.2000-5 variety after 11 month from planting in both seasons.

**Table 1.** Millable cane length (cm) of seven sugar cane varieties as affected by the age at harvest during 2020-2021 and 2021-2022 seasons

Seasons	first season 2020-2021					second season 2021-2022				
	age at harvest in months					age at harvest in months				
	11	12	13	14	Mean	11	12	13	14	Mean
<b>G.T.54-9</b>	274.33	280.33	284.00	289.33	282.00	279.00	283.00	284.67	289.67	284.08
<b>G.2003-47</b>	260.33	264.67	265.12	266.80	264.23	260.33	263.67	264.00	265.33	263.33
<b>G.2004-27</b>	279.33	285.33	304.00	309.33	294.50	283.33	286.00	305.00	312.00	296.58
<b>G.2005-47</b>	267.33	272.33	287.33	289.18	279.05	266.33	268.67	288.33	291.00	278.58
<b>G.2000-5</b>	252.67	253.33	254.67	256.25	254.23	251.00	254.33	254.67	259.00	254.75
<b>G.2009-11</b>	255.00	257.00	257.67	258.33	257.00	251.33	253.67	254.67	257.00	254.17
<b>G.2015-37</b>	265.00	266.00	268.33	269.00	267.08	261.00	264.67	267.33	268.67	265.42
<b>Mean</b>	264.86	268.43	274.45	276.89		264.62	267.71	274.10	277.52	

LSD at 0.05 level of significance

Varieties(V)	1.90	1.29
Age at harvest(A)	1.48	0.78
VXA	3.90	2.07

**2. Millable cane diameter (cm):**

Results illustrated in table (2) cleared that tested sugar cane varieties varied significantly in millable cane diameter. G.2005-47 variety recorded a significant superiority in this trait over the other tested varieties in both seasons.

Furthermore, results revealed that the millable cane diameter was significantly affected by the age at harvest in both seasons. Results also indicated that millable cane diameter increased gradually by delaying the harvesting up to 14 month-old.

Millable cane diameter was significantly influenced by the interaction between the tested cane varieties and age at harvest in both seasons. The highest value obtained from G.2005-47 variety when it harvested after 14 month from planting, while the lowest value recorded by harvesting G.2009-11 variety after 11 month from planting in both seasons.

**Table 2.** Millable cane diameter (cm) of seven sugar cane varieties as affected by the age at harvest during 2020-2021 and 2021-2022 seasons

Seasons	first season 2020-2021					second season 2021-2022				
	age at harvest in months					Age at harvest in months				
	11	12	13	14	Mean	11	12	13	14	Mean
<b>G.T.54-9</b>	2.50	2.58	2.76	2.79	2.66	2.33	2.49	2.55	2.59	2.49
<b>G.2003-47</b>	2.47	2.52	2.58	2.60	2.54	2.37	2.47	2.50	2.54	2.47
<b>G.2004-27</b>	2.61	2.68	2.70	2.73	2.68	2.53	2.63	2.70	2.73	2.65
<b>G.2005-47</b>	2.83	2.84	2.84	2.85	2.84	2.69	2.78	2.83	2.85	2.79
<b>G.2000-5</b>	2.57	2.57	2.57	2.63	2.58	2.50	2.55	2.56	2.57	2.54
<b>G.2009-11</b>	2.27	2.33	2.37	2.40	2.34	2.23	2.33	2.35	2.37	2.32
<b>G.2015-37</b>	2.64	2.67	2.68	2.70	2.67	2.58	2.59	2.60	2.63	2.60
<b>Mean</b>	2.56	2.60	2.64	2.67		2.46	2.55	2.58	2.61	

LSD at 0.05 level of significance

Varieties(V)	0.05	0.03
Age at harvest(A)	0.03	0.02
VXA	0.08	0.06

**3. Millable cane weight (kg):**

Results in table (3) showed that the evaluated sugar cane varieties significantly varied in millable cane weight in the two seasons. It is clear that the promising sugarcane variety G.2005-47 gave the highest millable cane weight (1.38 and 1.40 kg in 1st and 2nd seasons, respectively) compared with the other varieties, except G.2004-27 variety in 2<sup>nd</sup> season.

Also, data in the same table showed that increasing age at harvest up to 12, 13 and 14 months led to a significant increases in millable cane weight by 0.05, 0.08 and 0.12 kg as compared to that obtained by 11 months ages at harvest respectively, in the first season, corresponding to 0.04, 0.08 and 0.11 kg in the second season.

Interaction between tested sugar cane varieties and ages at harvest had a significant effect on millable cane weight in both seasons. Generally, the highest values of millable cane weight were recorded by G.2005-47 variety when harvested after 14 month in both seasons.

**Table 3.** Millable cane weight (kg) of seven sugar cane varieties as affected by the age at harvest during 2020-2021 and 2021-2022 seasons

Seasons	first season 2020-2021					second season 2021-2022				
	age at harvest in months					age at harvest in months				
	11	12	13	14	Mean	11	12	13	14	Mean
G.T.54-9	1.21	1.27	1.37	1.40	1.31	1.19	1.25	1.34	1.42	1.30
G.2003-47	1.17	1.19	1.20	1.22	1.20	1.13	1.16	1.19	1.20	1.17
G.2004-27	1.31	1.31	1.34	1.37	1.33	1.37	1.40	1.41	1.42	1.40
G.2005-47	1.34	1.36	1.40	1.43	1.38	1.38	1.39	1.41	1.43	1.40
G.2000-5	0.96	0.97	0.99	1.00	0.98	0.97	0.98	0.98	0.99	0.98
G.2009-11	0.93	1.11	1.13	1.22	1.10	0.90	1.05	1.08	1.12	1.04
G.2015-37	1.23	1.25	1.27	1.30	1.26	1.18	1.20	1.24	1.29	1.23
Mean	1.16	1.21	1.24	1.28		1.16	1.20	1.24	1.27	

LSD at 0.05 level of significance

Varieties(V)	0.02	0.02
Age at harvest(A)	0.01	0.01
VXA	0.03	0.02

#### 4. Brix percent:

Results in table (4) indicated that significant differences among the examined sugar cane varieties in their brix percent. Variety G.2000-5 significantly recorded superiority over the other varieties in brix % (21.81% and 22.99% in 1<sup>st</sup> and 2<sup>nd</sup> seasons, respectively) compared with that of the other varieties in the two seasons.

**Table 4.** Brix percent of seven sugar cane varieties as affected by the age at harvest during 2020-2021 and 2021-2022 seasons

Seasons	first season 2020-2021					second season 2021-2022				
	age at harvest in months					age at harvest in months				
	11	12	13	14	Mean	11	12	13	14	Mean
G.T.54-9	19.90	19.90	20.83	21.23	20.47	20.37	20.97	21.57	21.90	21.20
G.2003-47	20.53	20.80	21.77	22.10	21.30	21.37	21.77	22.80	23.03	22.24
G.2004-27	19.77	19.83	20.90	21.07	20.39	19.57	20.43	21.10	21.60	20.67
G.2005-47	20.00	20.63	21.03	21.10	20.69	21.07	21.50	21.83	22.07	21.62
G.2000-5	21.60	21.87	21.83	21.93	21.81	22.47	23.10	23.17	23.23	22.99
G.2009-11	18.93	18.97	19.27	19.33	19.13	18.47	18.90	19.13	20.40	19.23
G.2015-37	20.50	20.57	20.60	20.97	20.66	21.43	22.30	22.57	22.87	22.29
Mean	20.18	20.37	20.89	21.10		20.68	21.28	21.74	22.16	

LSD at 0.05 level of significance

Varieties(V)	0.12	0.09
Age at harvest(A)	0.07	0.05
VXA	0.19	0.13

Also, results showed that increasing ages at harvest from 11 to 12, 13 and 14 month lead to a significant and gradual increases in brix % by 0.19, 0.71 and 0.92 in the first season, being 0.60, 1.06 and 1.48 in the second season.

Brix percent was significantly influenced by the interaction between the two tested factors in both seasons. Generally the highest brix percent (22.10% and 23.23) was recorded by harvesting G.2003-47 variety at 14 months age in the first and second seasons, respectively.

#### 5. Sucrose percent:

Data in table (5) showed that sucrose percent significantly affected by the tested sugarcane varieties, variety G.2003-47 recorded the highest sucrose % (18.24% and 18.57%) followed by G.2000-5 (17.99% and 18.57%) in the first and second seasons, respectively. Moreover, it can be noticed that the difference in sucrose % between the sugarcane variety G.2004-27 and the commercial variety G.T.54-9 was insignificant, in the first and second seasons while the promising variety of G.2009-11 gave the lowest sucrose percent (15.13% and 15.57%) in both seasons.

Results given in table (5) indicated that sucrose percent was significantly affected by increasing age at harvest. Sucrose percent gradually increased and reached to its maximum mean values (17.25% and 17.81%) at harvest of 13 months, in both seasons, respectively. These results indicated that 13 months old is optimum to harvest sugarcane under the conditions of this study.

Interaction between tested sugar cane varieties and age at harvest had a significant effect on sucrose percent in both seasons. Generally, the highest values of sucrose percent were recorded by the following varieties (G.2003-47, G.2000-5 and G.2005-47) under 13-month old at harvest in the both seasons, while the following varieties (G.T.54-9, G.2004-27, G.2009-11 and G.2015-37) recorded the highest sucrose percent under 14 month old at harvest.

**Table 5:** Sucrose percent of seven sugar cane varieties as affected by the age at harvest during 2020-2021 and 2021-2022 seasons

Seasons	first season 2020-2021					second season 2021-2022				
	age at harvest in months					age at harvest in months				
	11	12	13	14	Mean	11	12	13	14	Mean
G.T.54-9	15.90	16.52	16.76	17.62	16.70	14.98	16.02	17.31	17.69	16.50
G.2003-47	17.91	18.28	18.91	17.84	18.24	18.22	18.57	19.62	17.86	18.57
G.2004-27	15.70	16.21	16.57	17.47	16.49	16.51	16.52	16.51	18.10	16.91
G.2005-47	17.17	17.33	17.93	16.95	17.35	17.51	17.59	18.27	17.52	17.72
G.2000-5	17.65	18.36	18.77	17.18	17.99	17.88	18.60	19.89	17.95	18.58
G.2009-11	15.10	15.15	15.08	15.21	15.13	15.41	15.44	15.55	15.87	15.57
G.2015-37	16.02	16.53	16.74	16.94	16.56	16.29	16.73	17.51	18.42	17.24
Mean	16.49	16.91	17.25	17.03		16.68	17.07	17.81	17.63	

LSD at 0.05 level of significance

Varieties(V)	0.05	0.20
Age at harvest(A)	0.02	0.17
VXA	0.06	0.46

#### 6. Purity percent:

Data in table (6) showed that the evaluated sugar cane varieties significantly differed in purity % in both seasons. It is clear from the data that promising sugarcane variety G.2003-47 gave the highest purity% (85.69% and 83.54%) followed by G.2005-47 (83.86 % and 82.01%) in the first and second season, respectively, compared with the other varieties.

Results in the same Table indicated that purity percent was significantly affected by the age at harvest. The highest values (82.98% and 81.85%) were recorded when plants harvest at 12 and 13 months in the first and second seasons, respectively.

**Table 6.** Purity percent of seven sugar cane varieties as affected by the age at harvest during 2020-2021 and 2021-2022 seasons

Seasons	first season 2020-2021					second season 2021-2022				
	age at harvest in months					age at harvest in months				
	11	12	13	14	Mean	11	12	13	14	Mean
G.T.54-9	79.90	83.01	80.43	83.01	81.59	73.56	76.39	80.26	80.77	77.74
G.2003-47	87.24	87.91	86.90	80.72	85.69	85.26	85.33	86.05	77.54	83.54
G.2004-27	79.42	81.73	79.30	82.93	80.84	84.38	80.88	78.26	83.78	81.82
G.2005-47	85.87	83.97	85.26	80.34	83.86	83.14	81.82	83.67	79.41	82.01
G.2000-5	81.73	83.98	85.98	78.32	82.50	79.57	80.54	85.85	77.28	80.81
G.2009-11	79.73	79.89	78.25	78.69	79.14	83.42	81.70	81.29	77.79	81.05
G.2015-37	78.13	80.35	81.26	80.79	80.13	75.99	75.01	77.57	80.57	77.29
Mean	81.72	82.98	82.48	80.69		80.76	80.24	81.85	79.59	

LSD at 0.05 level of significance

Varieties(V)	0.59	0.87
Age at harvest(A)	0.33	0.82
VXA	0.88	2.17

Also data clearly showed that purity percent was significantly affected by the interaction between the studied two factors in the two seasons. Generally the highest purity (87.91% and 86.05%) were recorded by harvesting G.2003-47 variety at 12 and 13 month old in the first and second seasons, respectively. Meanwhile, purity percent of G.2003-47 variety was insignificantly affected when it was harvested at 11, 12 and 13 month old.

Moreover, the difference between promising varieties G.2003-47 and G.2005-47 in purity % was insignificant when they were harvested at 11, 13 and 14 month old in both seasons.

### 7. Sugar recovery percent:

Data presented in table (7) indicated that sugar cane varieties significantly varied in sugar recovery percent in both seasons. The highest values of this trait (12.42% and 12.48%) were obtained from G.2003-47 variety followed by G.2000-5 (12.02% and 12.28%) while the lowest values (9.88% and 10.30%) were obtained from G.2009-11 variety in first and second seasons, respectively. This result is probably due to the higher sucrose percent recorded by G.2003-47 and G.2000-5 (Table 5). However, the difference in sugar recovery percent between the commercial variety G.T.54-9 and sugarcane variety G.2004-27 was insignificant in the first season only.

**Table 7.** Sugar recovery percent of seven sugar cane varieties as affected by the age at harvest during 2020-2021 and 2021-2022 season

Seasons	first season 2020-2021					second season 2021-2022				
	age at harvest in months					age at harvest in months				
	11	12	13	14	Mean	11	12	13	14	Mean
G.T.54-9	10.44	11.07	11.04	11.81	11.09	9.36	10.25	11.39	11.68	10.67
G.2003-47	12.31	12.61	12.98	11.78	12.42	12.38	12.63	13.39	11.53	12.48
G.2004-27	10.27	10.77	10.83	11.70	10.90	11.16	10.92	10.71	12.19	11.25
G.2005-47	11.71	11.68	12.19	11.16	11.69	11.75	11.70	12.30	11.46	11.80
G.2000-5	11.73	12.38	12.81	11.15	12.02	11.71	12.27	13.56	11.57	12.28
G.2009-11	9.90	9.95	9.78	9.90	9.88	10.35	10.26	10.31	10.26	10.30
G.2015-37	10.38	10.88	11.09	11.19	10.89	10.39	10.58	11.30	12.15	11.11
Mean	10.96	11.34	11.53	11.24		11.01	11.23	11.85	11.55	

LSD at 0.05 level of significance

Varieties(V)	0.06	0.19
Age at harvest(A)	0.04	0.18
VXA	0.10	0.47

Also, data in the same table revealed that sugar recovery percent was significantly affected by the age at harvest. Also data showed that sugar recovery percent gradually increased and reached to its maximum values (11.53% and 11.85%) at 13 month old at harvest, in 1st and 2nd seasons, respectively. The increase in recovery percent is mainly due to the increase in sucrose content in cane juice (Table 5).

Also data clearly showed that sugar recovery percent was significantly affected by the interaction between the studied two factors in the two seasons. Generally the highest sugar recovery (12.98% and 13.39%) and (12.81% and 13.56%) were recorded by G.2003-47 and G.2000-5 varieties at 13 months age in the first and second seasons, respectively. Meanwhile, sugar recovery percent of G.2003-47 variety was insignificant when it was harvested at 12 and 13 months old.

### 8. Cane yield (ton/fad):

Results illustrated in table (8) revealed that promising sugarcane variety G.2004-27 exhibited the superiority in cane yield recording significant increases amounted to (4.39, 15.39, 0.6, 18.79, 17.90 and 10.43 ton/fad) higher than those produced by varieties (G.T.54-9, G.2003-47, G.2005-47, G.2000-5, G.2009-11 and G.2015-37), respectively, in the first season, corresponding to (4.92, 16.38, 0.90, 18.80, 18.20 and 10.75 ton/fad) in the second season.

Also data clearly showed that increasing age at harvest up to 14 months significantly increased cane yield in the both seasons. These increments amounted to 4.16, 1.74 and 0.52 ton/fad compared with that harvested at 11, 12 and 13 month in the first season, corresponding to 5.12, 3.08 and 1.75 ton/fad in the second season, respectively.

Cane yield was significantly influenced by the interaction between the tested cane varieties and age at harvest in both seasons, Generally the highest cane yield (59.73 and 59.97 ton/fad) was recorded by harvesting G.2004-27 variety at 14 month age in the first and second seasons, respectively. Where the differences between varieties G.2004-27 and G.2005-47 in cane yield (ton/fad) was insignificant when they were harvested 14 month in the first and second seasons.

**Table 8:** cane yield (ton/fad)of seven sugar cane varieties as affected by the age at harvest during 2020-2021 and 2021-2022 seasons

Seasons	first season 2020-2021	second season 2021-2022
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Varieties	age at harvest in months					age at harvest in months				
	11	12	13	14	Mean	11	12	13	14	Mean
G.T.54-9	44.81	53.19	57.46	59.20	53.67	45.17	51.11	54.77	59.27	52.58
G.2003-47	40.53	43.20	43.73	43.20	42.67	39.63	40.47	41.70	42.67	41.12
G.2004-27	55.68	57.87	58.93	59.73	58.05	53.60	56.95	59.47	59.97	57.50
G.2005-47	54.37	57.07	58.67	59.47	57.39	53.07	55.79	58.01	59.53	56.60
G.2000-5	38.77	38.93	39.47	39.87	39.26	38.33	38.40	38.47	39.57	38.69
G.2009-11	39.96	40.00	40.27	40.40	40.16	37.87	39.07	39.46	40.80	39.30
G.2015-37	41.33	42.13	42.40	42.72	42.15	40.80	41.00	41.47	42.50	41.44
Mean	45.07	47.48	48.70	49.23		44.07	46.11	47.62	49.19	

**LSD at 0.05 level of significance**

Varieties(V)	0.73	0.42
Age at harvest(A)	0.41	0.22
VXA	1.09	0.57

**9. Sugar yield (ton/fad):**

Data in table (9) indicated significant differences among the evaluated sugar cane varieties in their sugar yield. The highest values of this trait (6.71 and 6.68 ton/fad) were obtained from G.2005-47 variety followed by G.2004-27 (6.33 and 6.47 ton/fad) in the first and second seasons, respectively. The superiority of G.2005-47 and G.2004-27 varieties in sugar yield is probably attributed to the increase in cane yield and /or sugar recovery percent.

Results also revealed that sugar yield was significantly affected by delaying harvesting date. Sugar yield gradually increased by delaying the age at harvest to 13 and 14 months age, in the 1st and 2nd seasons, respectively.

Sugar yield was significantly influenced by the interaction between the examined cane varieties and age at harvest in both seasons, the highest values of sugar yield were recorded by the following varieties (G.2005-47, G.2004-27 and G.T.54-9) under 13 and 14 months old at harvest in the first season respectively, while G.2004-27 and G.2005-47 varieties were recorded the highest sugar yield under 14 and 13 months old at harvest in the second season respectively.

**Table 9.** Sugar yield (ton/fad) of seven sugar cane varieties as affected by the age at harvest during 2020-2021 and 2021-2022 seasons

Seasons	first season 2020-2021					second season 2021-2022				
	age at harvest in months					age at harvest in months				
	11	12	13	14	Mean	11	12	13	14	Mean
G.T.54-9	4.68	5.89	6.34	6.99	5.98	4.23	5.24	6.24	6.92	5.66
G.2003-47	4.99	5.45	5.67	5.09	5.30	4.91	5.11	5.58	4.92	5.13
G.2004-27	5.72	6.23	6.39	6.99	6.33	5.98	6.22	6.37	7.31	6.47
G.2005-47	6.37	6.67	7.15	6.64	6.71	6.23	6.53	7.13	6.82	6.68
G.2000-5	4.55	4.82	5.06	4.45	4.72	4.49	4.71	5.22	4.58	4.75
G.2009-11	3.96	3.98	3.94	4.00	3.97	3.92	4.01	4.07	4.19	4.05
G.2015-37	4.29	4.59	4.70	4.78	4.59	4.24	4.34	4.69	5.16	4.61
Mean	4.94	5.38	5.61	5.56		4.86	5.16	5.61	5.70	

**LSD at 0.05 level of significance**

Varieties(V)	0.09	0.09
Age at harvest(A)	0.05	0.08
VXA	0.14	0.22

**DISCUSSION****1. Millable cane length (cm):**

Sugar cane variety G.2004-27 had the tallest stalks. This outcome may be due to genetic variations in the varieties. This result is in line with those obtained by (Abo El-hamd *et. al.*, 2013; Yousif *et. al.*, 2015; Abo El-hamd, *et. al.*, 2019) they found significant variance among tested varieties in millable cane height in both seasons.

The millable cane length significantly increased with increasing age at harvest until 14 month of the seven tested varieties. Such effect might be attributed to demonstrate that there was a substantial amount of growth in terms of cane stalk height at the end of age at harvest for the promising varieties. These results are in agreement with those obtained by (Hagos *et. al.*, 2014; Ahmed and Awadalla 2016 ; Gamechis and Ebisa 2021) who reported that late harvest date significantly increased values of millable cane height.

Generally, the highest value obtained from G.2004-27 variety when harvested after 14 month.

## 2. Millable cane diameter (cm):

Sugar cane varieties varied significantly in millable cane diameter. G.2005-47 variety recorded a significant superiority in this trait over the other tested varieties in both seasons. These results may be due to the genetic differences among varieties in their ability to form internodes and/or determination of their stalk diameter (Ahmed *et. al.*, 2016). The variability among cane genotypes in diameter was also reported by (Abo El-hamd *et. al.*, 2013; Mehareb and Abazied 2017; Ahmed *et. al.*, 2020) who reported a significant differences among tested varieties in millable cane diameters.

Millable cane diameter increased gradually by delaying the harvesting up to 14 month-old. These results are in agreement with those found by (Yousif *et. al.*, 2015; Ahmed and Awadalla 2016; Ali *et. al.*, 2022) who found significant increases in millable cane diameter by delaying the harvest date.

Generally, the highest value obtained from G.2005-47 variety when it harvested after 14 month from planting.

## 3. Millable cane weight (kg):

Sugar cane varieties significantly varied in millable cane weight in the two seasons. Promising sugarcane variety G.2005-47 gave the highest millable cane. This result may be due to the genetic differences among varieties in their effect on stalk height, stalk diameter and stalk density which are the components of stalk weight. The results of the present investigation are in the same line with those of (Yousif *et. al.*, 2015; Abazied 2018; Abo El-hamd *et. al.*, 2019) who found that's cane varieties significantly differ in millable cane weight.

Increasing age at harvest up to 12, 13 and 14 months led to a significant increase in millable cane weight. The increase in millable cane weight by increasing age at harvest may be due to the increase in millable cane length and diameter (Table 1). These results are in coinciding with those mentioned by (Abo El-hamd *et. al.*, 2013; Ahmed and Awadalla 2016; Ahmed *et. al.*, 2016) who reported that millable cane weight was significantly increased by increasing age at harvest from 11 up to 14 month.

Generally, the highest values of millable cane weight were recorded by G.2005-47 variety when harvested after 14 month in both seasons.

## 4. Brix percent:

Variety G.2000-5 significantly recorded superiority over the other varieties in brix %. The difference among the evaluated sugarcane varieties may be attributed to their genetic structure. The same findings were early reported by (Mehareb *et. al.*, 2016; Abazied 2018; Abu-Ellail *et. al.*, 2020) who found significant differences of total soluble solids percent among sugarcane varieties in plant cane and first ratoon crops.

Increasing ages at harvest from 11 to 12, 13 and 14 month lead to a significant and gradual increase in brix %. This result may be due to the continuous accumulation of soluble solids as harvest date progress up to 14 month old. The results of the present study are in accordance with those of (Endris *et. al.*, 2016; Abu-Ellail *et. al.*, 2020; Gamechis and Ebisa 2021) who found that age at harvest significantly influence the brix percent.

Generally the highest brix percent was recorded by harvesting G.2003-47 variety at 14 months age.

## 5. Sucrose percent:

Sucrose percent significantly affected by the tested sugarcane varieties, variety G.2003-47 recorded the highest sucrose % followed by G.2000-5. The differences among sugar cane varieties obtained by (Abo El-hamd *et. al.*, 2013; Mehareb, *et. al.*, 2016; Abazied, 2018) who found significant differences among tested sugar cane varieties in sucrose %.

Sucrose percent gradually increased and reached to its maximum mean values at harvest of 13 months. The obtained result is in accordance with those reported by (Hagos *et. al.*, 2014; Endris *et. al.*, 2016; Abu-Ellail *et. al.*, 2020) who reported that age at harvesting time showed significant effect on sucrose percent.

Generally, the highest values of sucrose percent were recorded by the following varieties (G.2003-47, G.2000-5 and G.2005-47) under 13-month old at harvest in the both seasons, while the following varieties (G.T.54-9, G.2004-27, G.2009-11 and G.2015-37) recorded the highest sucrose percent under 14 month old at harvest.

## 6. Purity percent:

Sugar cane varieties significantly differed in purity % in both seasons. Promising sugarcane variety G.2003-47 gave the highest purity% followed by G.2005-47. The varietal differences may be attributed to the genetic constitutes of varieties. The effective role of sugarcane varieties on purity percent has been reported by (Mehareb *et. al.*, 2016; Abazied 2018; Ahmed *et. al.*, 2020) who found significant differences among evaluated varieties for purity percent.

Purity percent was significantly affected by the age at harvest. These results are due to the increase in sucrose % in total soluble solids % contents with increasing sugar cane age at harvest. These results are in agreement with those mentioned by (Mequanent 2016; Mehareb and Abazied 2017; Teama, et. al., 2020) who found that juice purity % was significantly influenced by the harvest ages.

Generally the highest purity was recorded by harvesting G.2003-47 variety at 12 and 13 month old.

#### **7. Sugar recovery percent:**

Sugar cane varieties significantly varied in sugar recovery percent in both seasons. The highest values of this trait were obtained from G.2003-47 variety followed by G.2000-5. Varietal differences in this trait were also found by (Mehareb, et. al., 2016; Abazied 2018; Ahmed et al., 2020)

Sugar recovery percent gradually increased and reached to its maximum values at 13 month old at harvest. These results are similar to results reported by (Hagos et al., 2014; Ahmed and Awadalla 2016; Gamechis and Ebisa 2021) who reported that age at harvesting significantly influenced sugar recovery percent.

Generally the highest sugar recovery were recorded by G.2003-47 and G.2000-5 varieties at 13 months age.

#### **8. Cane yield (ton/fad):**

Promising sugarcane variety G.2004-27 exhibited the superiority in cane yield. These results are in line with those obtained by (Abo El-Hamd et. al., 2013; Yousif, et. al., 2015; Abu-Elail, et. al., 2020) these found that tested varieties showed significant differences in cane yield.

Increasing age at harvest up to 14 months significantly increased cane yield in the both seasons. The increase in cane yield by increasing age at harvest may be due to the increase in millable cane weight (Tables 3). These results are in agreement with those obtained by (Hagos, et. al., 2014; Endris, et. al., 2016; Gamechis and Ebisa 2021).

Generally the highest cane yield was recorded by harvesting G.2004-27 variety at 14 month age.

#### **9. Sugar yield (ton/fad):**

The highest values of this trait were obtained from G.2005-47 variety followed by G.2004-27. These findings are in agreement with those reported by (Yousif et. al., 2015; Abazied 2018; Ahmed et. al., 2020) who reported that the examined cane varieties differed significantly in sugar yield.

Sugar yield gradually increased by delaying the age at harvest to 13 and 14 months age. The increases in sugar yield (ton/fad) could be due to the effect of delaying age at harvest on increasing cane yield and/or sugar recovery %. The obtained results are in line with those found by (Endris et. al., 2016; Mehareb and Abazied 2017; Ali et al., 2022) who reported significant increase in sugar yield with an increase in age at harvest.

Generally, the highest values of sugar yield were recorded by the following varieties (G.2005-47, G.2004-27 and G.T.54-9) under 13 and 14 months old at harvest in the first season respectively, while G.2004-27 and G.2005-47 varieties were recorded the highest sugar yield under 14 and 13 months old at harvest in the second season respectively.

## **CONCLUSION**

Under the conditions of this study, results suggested that G.2004-27 variety should be harvested at 14 month old and G.2005-47 variety should be harvested at 13 month old to obtain the maximum cane and sugar yield.

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## تأثير عمر الحصاد علي الحاصل والجودة لبعض أصناف قصب السكر المباشرة

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تم إجراء البحث الحالي في محطة البحوث الزراعية بالمطاعنة (خط العرض 25.25 درجة شمالا وخط الطول: 32.31 درجة شرقا). محافظة الأقصر ، مصر خلال موسمين 2021/2020 و 2022/2021 (غرس ربيعي) تهدف الدراسة لتقييم عمر الحصاد الأمثل (11 ، 12 ، 13 ، 14 شهرًا) لستة أصناف مباشرة من قصب السكر (جيزة 2003-47 ، جيزة 2004-27 ، جيزة 2005-47 ، جيزة 2000-5 ، جيزة 2009-11 ، جيزة 2015-37) مقارنة مع الصنف التجاري س9 (جيزة تاوان 54-9). تم توزيع المعاملات المدروسة في نظام القطع المنشقة في ثلاثة مكررات. تم وضع أصناف قصب السكر في القطعة الرئيسية بينما تم وضع أصناف قصب السكر في القطع المنشقة. أشارت النتائج إلى أن أصناف قصب السكر اختلفت معنوياً ، حيث سجل الصنف جيزة 2004-27 أعلى القيم في طول العيدان القابلة للعصر وحاصل القصب والسكر في كلا الموسمين ، بينما أعطى الصنف المباشر جيزة 2005-47 أعلى القيم في قطر ووزن العود. ومع ذلك ، لا توجد اختلافات معنوية في متوسط وزن العود ومحصول السكر بين صنف قصب السكر جيزة 2005-47 والصنف جيزة 2004-27 في الموسم الثاني فقط. سجل صنف قصب السكر جيزة 2003-47 أعلى نسبة سكر وبقاوة وناتج سكر نظري% في الموسمين. كما أعطى الصنف جيزة 2000-5 أعلى قيم البركس% في كلا الموسمين. عمر الحصاد عند 14 شهرًا سجل أعلى القيم في طول العيدان القابلة للعصر ، قطر العود ، وزن العود ، البركس% وحاصل القصب في كلا الموسمين ، وكذلك حاصل السكر في الموسم الثاني. بينما سجل عمر الحصاد عند 13 شهر أعلى القيم للسكر وبقاوة% ، النقاوة% وناتج السكر النظري% في الموسمين وكذلك محصول السكر في الموسم الأول. في ظل ظروف البحث الحالي ، يمكن الحصول على الحد الأقصى من حاصل القصب والسكر بواسطة صنف قصب جيزة 2004-27 و جيزة 2005-47 عند الحصاد في 14 و 13 شهرًا على التوالي.

الكلمات المفتاحية: أصناف قصب السكر ، عمر الحصاد.