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EFFECT OF VARIETY, HARVEST TIME AND PROCESSING DELAY ON SUCROSE CONTENT OF SUGAR CANE

Hamam , A. M.[1]; M. N. Kenawi[1] ; H. Ferweez[2] and Noha, F. Gaber[2]

[1] Food Sci. Dept., Agric. Fac. Minia Univ. Minia, Egypt.

[2] Sugar Tech. Dept., Sugar Crops Res. Inst., Agric. Res. Centre, Giza, Egypt.

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ABSTRACT

Egypt depends only since more than twenty years on one variety of sugar cane namely, G.T.54-9 variety for sugar production. So, this study was carried out to study effect of variety (G.T.9-54, G. 98-28, G.84-47, Ph 8013 and G.99-103 varieties), harvest time (11 , 12 , 13 and 14 months) and the processing delay (i.e. zero, 3, 6 and 9 days) on sucrose% juice of sugar cane for confined the best cultivar for sugar manufacture and production beside the commecial variety(G.T.9-54). The obtained results showed that, there are significant ($P \leq 0.05$) differences among the studied sugarcane varieties during the sucrose accumulation periods from age 7-11 months, where, sucrose % juice of sugar cane increased with progress of the age till harvest. The promising varieties such as G.84-47 and G.98-28 contained the best sucrose % juice at different sucrose accumulation periods.Maximization of sucrose % juice of sugar cane was achieved when sugar cane was harvested at age 13 month, especially G.99-103 variety. Meantime, sucrose % juice of sugar cane at harvest after age 13 months was decreased in the all studied varieties .Also, the processing or delivery delay of sugarcane to the mill from at harvest up to nine days post- harvest led to decrement of sucrose% juice.Thereafter, G.84-47 variety recorded the highest rate of deterioration for sucrose% juice of sugar cane among the studied varieties when harvested after 11 month and Ph.8013 variety recorded the highest rate of deterioration

at most other harvesting times. Besides, the processing delay for cane stalks post-harvest was not preferable for both grower and sugar factory. Generally, G.T.54-9 variety had the lowest value of deterioration rate post-harvest for sucrose% juice among the studied varieties. So, G.T.54-9 variety for the sugar processing and production is preferable followed by G. 99-103and G.98-28 varieties especially harvested after 12 or 13 months under the experiment conditions.

Keywords: sugar cane, sucrose % juice, variety, post-harvest.

INTRODUCTION

Sugarcane is the main crop in the world for sugar production. It is one of the most valuable crops because of its economic importance. In Egypt, sugarcane has been planted since 1850. It is grown primarily in Upper Egypt, in the five Governorates of Aswan, Qena, Luxor, Sohag and El-Minia, where climate, type of soil and available water are conductive to give high yield. In Egypt, the total area of sugar cane in 2013 was estimated at 325742 fed. produced about 15.55 million tons. It produced approximately 46.90% of 2.0 million tons of local sugar production (ESST, 2014 and S.C.C., 2014).

Egypt depends only since more than twenty years on G.T.54-9 variety. Which occupies more than 95% from the area planted of sugarcane in Egypt. Therefore, sugar industry could face a high risk. Great policy needed for releasing a new variety to avoid this problem. Recently, sugar crops Research Institute succeeded in selecting some promising varieties of sugarcane, among them G84-47, G99-103, G98-28, and Ph.8013. As for varietals differences, it was demonstrated that sugarcane varieties are completely different in their performance, quality and yield due to great variation in their genetical background (Ahmed, 1998). These varieties differ significantly in quality parameters (TSS%, purity% and sugar recovery %) (Abd El-Azez, 2008; El.Sogheir and Ferweez, 2009 and Abd El-Fattah, 2010).

The extracted juice has high water content (about 85%) and contains mainly sucrose and reducing sugars like glucose and fructose. The sugar content is heavily influenced by the maturity time of the cane at harvest, sucrose content increasing as cane stalks reach maturity, glucose and fructose content generally decreasing (Qudsieh *et al.*, 2001). The upper immature internodes are the source of most of the impurities in whole-stalk juice, this increase in the proportion of sugar as the season advances improves juice quality in the stalk (Mathur 1990; Mackintosh 2000; Lontom *et al*, 2008).

Harvesting and milling season in Egypt generally extended yearly from January to June, during this period a large magnitude of changes in the

weather humidity and temperature takes place. Therefore, harvest the cane and left it for many days before crushing might be a cause of deleterious changes in its weight and quality. Furthermore, it cause many problems during cane processing. There are many factors effecting sugarcane quality (Azzazy *et al*., 2005; Bekheet, 2006; El-Shafai & Ismail, 2006; Ahmed *et al.*, 2008 and Ahmed & Khaled, 2009).

This work was undertaken to investigate the effect of variety (G.T.9-54, G.98-28, G.84-47, Ph.8013 and G.99-103 varieties) , harvest time (11 , 12 , 13 and 14 months) and processing delay (i.e. 3 , 6 and 9 days) on sucrose% juice of sugar cane for confined the best cultivar for sugar manufacture and production beside the commecial variety (C9).

MATERIALS AND METHODS

This study was carried out in Upper Egypt at El –Mattana Agricultural Research Station, Luxor, Egypt during 2010/2011 and 2011/2012 seasons to study effect of variety (G.T.9-54, G. 98-28, G.84-47, Ph 8013 and G.99-103 varieties), sucrose accumulation stage (7, 8, 9 and 10 months), harvest time (11, 12, 13 and 14 months) and processing delay (i.e. 3 , 6 and 9 days) on sucrose% juice of sugar cane for confined the best cultivar for sugar manufacture and production beside the commecial variety (C9).The studied varieties were planted during two successive seasons, 2010/2011 and 2011/2012 seasons (plant cane). and treated according to optimal traditional agricultural practices of the region

Sampling for study the effect of variety and the harvest time as well as sucrose accumulation stages on sucrose% of sugar cane:

Samples 20 stalks representing each variety were taken and replicated four times from different areas of the experimental field in order to avoid as much as possible, soil variations during the different stages sucrose accumulation , (i.e. 7 , 8 , 9 , 10 and 11 months)and differentages of harvest times 11, 12 , 13 and 14 months from planting. These times or dates represented suitable time for maturity of plant cane season. Healthy standing stalks which are homogenous in vegetative growth was used. Twenty stalks were collected randomly from each replicate in middle rows of plot. Stalks samples were stripped and weighted before taken for analysis.

Sampling for deterioration studies and sugar curve of sugar cane (post-harvest) :

On the harvest day, a samples of 500 stalks of each variety of sugar cane was taken. The healthy standing stalks homogenous in vegetative growth of the all studied sugarcane varieties, stripped and cleaned for plant cane season.

Sugarcane stalks of each variety were placed in five groups, each containing of 100 stalks of each variety. Sugarcane stalks piles or

groups for deterioration studies between harvest of sugarcane and processing were left under open field conditions for 0, 3 , 6 and 9 days post-harvest. Four groups of sugar cane were taken for the changes in the cane weight and one group for the changes in the cane quality. Samples representing each variety were taken after zero,3, 6 and 9 days of post-harvest and sent for analysis.

Necessary meteorological data at Luxor governorate were obtained from the Central Laboratory for Agricultural Climate (CLAC), Agriculture Research Center (ARC), and Ministry of Agriculture in Giza.

Table (1): Meteorological data during left sugar cane stalks under open field conditions, harvested at 11, 12, 13 and 14 months of age.

Month	Post-harvest period (day)	2011 Temperature °C			Relative Humidit %	Post-harvest period (day)	2012 Temperature °C			Relative Humidit %
		Max.	Min	Mean			Max.	Min.	Mean	
11	0	21.0	6.7	13.8	36.3	0	20.7	7.3	14.0	48.3
	3	28.7	8.7	18.7	30.3	3	28.0	9.7	18.9	39.3
	6	27.0	12.0	19.5	36.0	6	28.0	13.0	20.5	45.3
	9	24.0	9.3	16.7	32.7	9	23.3	16.3	19.8	45.0
	Average	25.2	9.2	17.2	33.8	Average	25.0	11.6	18.3	44.5
12	0	26.7	8.0	17.4	19.0	0	26.0	9.3	17.7	29.0
	3	27.7	11.3	19.5	17.7	3	28.0	12.7	20.4	26.3
	6	29.3	12.0	20.7	17.7	6	29.3	13.3	21.3	26.7
	9	27.7	11.7	19.7	19.7	9	28.0	12.3	20.2	28.3
	Average	27.9	10.8	19.3	18.5	Average	27.8	11.9	19.9	27.6
13	0	37.7	22.0	29.9	10.0	0	35.3	18.7	27.0	14.7
	3	30.7	18.0	24.4	10.7	3	35.7	17.7	26.7	13.7
	6	37.3	17.7	27.5	10.7	6	36.0	18.0	27.0	17.7
	9	36.0	19.3	27.7	7.7	9	37.3	18.0	27.7	11.7
	Average	35.4	19.3	27.3	9.8	Average	36.1	18.1	27.1	14.5
14	0	36.7	22.0	29.4	9.7	0	36.7	22.4	29.6	16.7
	3	40.0	22.0	31.0	9.0	3	40.7	22.0	31.4	15.4
	6	43.0	27.3	35.2	10.3	6	43.0	27.3	35.2	14.7
	9	41.7	27.7	34.7	12.0	9	41.7	28.0	34.9	18.4
	Average	40.4	24.8	32.6	10.3	Average	40.5	24.9	32.73	16.3

ANALYTICAL METHODS:

Stalks samples 20 stalks of sugarcane representing each variety were obtained at random ,brought immediately after cutting to the lab., topped, stripped, cleaned then squeezed by an electric pilot mill. The extracted juice was mixed thoroughly and a sample of one liter was poured in a graduated cylinder and left to settle down for 15-20 minutes to remove the foams and setting the sediments before starting analysis of the following determination.

Determination of sucrose percentage: sucrose percentage in juice was determined according to the

method of Meade and Chen (1977) as following:

50 ml of filter juice and 5 ml of neutral lead acetate 30% as a regent were putted into 250 measuring flask then, diluted to the mark with distilled water. The solution was filtrated and the supernatant was placed in saccarometer (West Germany INSTRNO.139582 Dr. WONFGANG) tube and take the reading, according to A.O.A.C. (2005). Moisture content was estimated by drying in electric oven at 105^{o}C until constant weight according to the recommended method in (A.O.A.C. 2005).

Cane yield (ton/fed): It was determined from the weight of the three rows of each plot which were harvested, topped, cleaned, weighted and converted into value per fed.

Sugar yield (ton/fed): It was estimated according to the following formula described by Mathur (1981) Sugar yield (tons/fed) = cane yield (ton/fed.) x sugar recovery%.

Data collected were subjected to Analysis of Variance (ANOVA). A split – plot design with four replicates used. Harvesting times, i.e., 11, 12, 13 and 14 months were arranged in the main plots (factor A). Sugarcane varieties (Factor B) as a split plot. In addition, delaying periods between the harvesting and processing (zero, 3, 6 and 9 days of harvest) were allocated in the main plots (factor A). The studied varieties (factor B) namely, G.84-47, G.98-28, G.99-103, Philli.8013 and G.T.9-54 were randomly distributed as a split plot. Differences among treatments were evaluated by the least significant difference test (L.S.D) according to procedure out lined by Snedecor & Cochran (1981) and Gomez & Gomez (1984). Significance of differences was defined at 5 percent level according to Waller & Duncan (1969).

RESULTS AND DISCUSSIONS

1. Effect of variety and harvest time on sucrose %juice of sugar cane during sucrose accumulation stages from 7 to 14 months at 2010/2011 and 2011/2012 seasons .

It is noteworthy to mention that sucrose % juice of sugarcane and storage it of cane stalks is one of the important technological traits for the sugar processing and production. The results given in Tables (2&3) and Figs. (1 &2) showed that there is a significant ($P \leq 0.05$) increase in sucrose% juice of sugarcane from 32.90 to 67.41% and from 39.98 to 68.64 % (on dry weight (DWB)* = % on dry weight basis) with progress the age of cane during the sucrose accumulation stages from 7 to 11 months at all studied sugarcane varieties in the 1st and 2nd seasons, respectively. The increase in sucrose% juice might have been due to better growth characters accompanying for progress the age. While, the increase in sucrose % juice of cane in the 2nd season was higher than the 1st season might be due to the differences in environmental conditions where, lower temperatures and higher relative

humidity percentage in the 2nd season than the 1st season were encouraged storage of sucrose in the stalk. These results are in accordance with those obtained by Ramesh and Mahadevaswamy (1996), El-Sogheir and Besheit (2003).

Table (2): Effect of sugar cane variety on sucrose % juice (on DWB)* during the sucrose accumulation periods at 2010/2011 season.

Sucrose accumulation stages (A)	2011/2012 season					Mean
	Sugarcane varieties (B)					
	G.T.54-9	G.98-28	G.84-47	Ph8013	G.99-103	
7 months	33.51	30.72	34.97	32.94	32.36	32.90
8 months	41.94	39.23	42.84	41.64	39.08	40.95
9 months	45.81	47.34	49.81	46.76	45.35	47.01
10 months	52.28	61.32	55.09	59.42	54.54	56.53
11 months	59.75	71.10	65.59	70.67	69.93	67.41
Mean	46.66	49.94	49.66	50.28	48.25	48.96
L.S.D at .05%	A					1.117
	B					0.926
	AB					2.068

Table (3): Effect of sugar cane variety on sucrose % juice (on DWB)* during the sucrose accumulation periods at 2011/2012 season.

Sucrose accumulation stages (A)	2011/2012 season					Mean
	Sugarcane varieties (B)					
	G.T.54-9	G.98-28	G.84-47	Ph8013	G.99-103	
7 months	40.54	39.24	42.07	39.27	38.80	39.98
8 months	43.84	42.22	44.91	44.02	44.95	43.99
9 months	50.92	51.60	55.73	50.12	46.07	50.89
10 months	60.54	65.57	61.19	62.28	62.84	62.49
11 months	66.99	71.02	65.12	67.44	72.62	68.64
Mean	52.567	53.93	53.81	52.63	53.06	53.20
L.S.D at .05%	A					1.055
	B					1.017
	AB					2.274

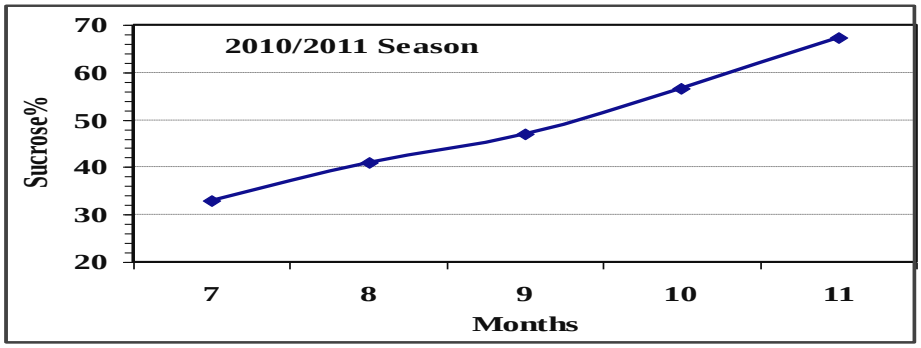

Fig. (1): Effect of sucrose accumulation periods on sucrose% juice of sugar cane

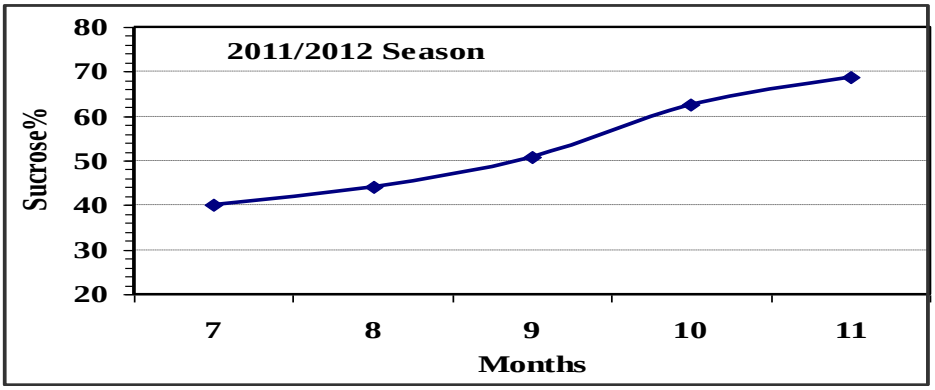

Fig. (2): Effect of sucrose accumulation periods on sucrose% juice of sugar cane during 2011/2012 season.

It could be noted from the data obtained in this study that there were significant differences in sucrose% juice of sugar cane among the studied promising sugarcane varieties at the sucrose accumulation stages in the two growing seasons. Ph.8013 and G.98-28 varieties surpassed the other varieties in sucrose content of cane juice (50.28 and 53.93%) while, the lowest values (46.66 and 52.57%) were recorded for G.T.54-9 cultivar in the 1st and 2nd seasons, respectively. These results are in accordance with those obtained by EL-Sogheir *et al.*, (2006); Nasser *et al.*, (2006); Mohamed & El-taib (2007); EL.Sogheir and Ferweez (2009); El-Zeny, *et al.* (2010) and Abd El-Razek and Besheit (2012) who mentioned that significant varietal differences in sucrose percentage among the tested sugarcane varieties in both seasons. They added that sucrose% juice is represent economically most constituent of cane juice and affected by cultivar. However, this contradict with the results obtained by Abd El-Fattah, (2010) and Ferweez *et al.* (2011) who revealed that G.84-47 variety recorded the lowest value of

this trait than the other varieties. The present differences among the scientists might be mainly due to the variation in variety, type of soil, season of agriculture, agricultural practices, harvest method and environmental conditions.

A significant interaction was recorded between the sucrose accumulation stages and varieties (AB) with respect to sucrose % juice of sugarcane in both seasons as shown in Tables (2&3) . G.98-28 and G.99-103 varieties with age of 11 month recorded the highest values of sucrose% juice (71.10 and 72.62%), respectively in the 1st and 2nd seasons, respectively. The lowest values of (59.75 and 65.12 %) were also recorded with G.T.54-9 and G.84-47 varieties after 11 month, respectively in the 1st and 2nd seasons. These results are in the same line with those reported by Besheit *et al.* (1998) and Abd El-Razek & Besheit (2012). These findings are probably due to genetic variation among varieties. The promising varieties such as G.84-47 and G.98-28 contained the best sucrose % juice at different sucrose accumulation periods.

2. Effect of harvest time and variety on sucrose % juice of sugar cane during 2010/2011 and 2011/2012 seasons.

The results given in Tables (4&5) and Figures (3&4) showed that harvest time had a significant effect on sucrose% juice of sugarcane in the two growing seasons. Delaying harvest time of sugar cane from 11 to 13 months caused the increase in sucrose% juice of sugar cane from 67.41 to 81.49% and from 68.64 to 84.61% (on D.W.basis) in the 1st and 2nd seasons, respectively. This increase might be due to the increase in sucrose transport and accumulation as well as reduced the respiration rate of millable cane stalks as a result of reach sugar cane to the maturity. The increase in sucrose% juice of sugar cane in the 2nd season was higher than the 1st season. This result might be due to the differences in the environmental conditions between the two seasons. These results are in accordance with those obtained by Ramesh and Mahadevaswamy (1996) and El-Sogheir and Besheit (2003) who reported that sucrose% juice of cane increased with delaying the harvest time. Thereafter, sucrose% juice of sugar cane decreased from 81.49 to 61.94 % and from 84.61 to 71.09 %(on D. W.basis) with delaying harvest from 13 to 14 months in the 1st and 2nd seasons, respectively. This decrease might be attributed mainly to the effect of high temperatures, especially night temperatures during the late harvest at 14 months, which increased respiration rate and sucrose inversion to invert sugars of sugar cane as a result of reach sugar cane to the over ripe. The over ripe of sugar cane is considered deterioration of sugar cane pre-harvest. The decrease in sucrose% juice of sugar cane in the 2nd season was lower than the 1st season. This finding might be due to the differences in the environmental conditions between the two seasons.

Table (4): Effect of harvest time and variety on sucrose% (juice on DWB)* of sugarcane during 2010/2011 season.

Harvest time (A)	2010/2011 season					Mean
	Sugarcane varieties (B)					
	G.T.54-9	G.98-28	G.84-47	Ph8013	G.99-103	
11 month	59.75	71.10	65.59	70.67	69.93	67.41
12 month	70.53	76.86	72.52	78.51	76.11	74.91
13 month	75.44	81.24	75.54	85.05	90.17	81.49
14month	60.77	57.44	50.20	66.20	75.11	61.94
Mean	66.62	71.66	65.96	75.11	77.83	71.44
L.S.D at .5%	A					1.642
	B					1.438
	AB					2.876

Table (5): Effect of harvest time and variety on sucrose% (juice on DWB)* of sugarcane during 2011/2012 season(% on dry weight basis).

Harvest time (A)	2011/2012 season					Mean
	Sugarcane varieties (B)					
	G.T.54-9	G.98-28	G.84-47	Ph8013	G.99-103	
11 month	66.99	71.02	65.12	67.44	72.62	68.64
12 month	75.28	77.35	75.14	74.33	80.68	76.56
13 month	81.26	84.46	80.32	83.74	93.29	84.61
14month	72.36	74.48	60.28	68.18	80.16	71.09
Mean	73.98	76.83	70.22	73.42	81.69	75.23
L.S.D at .5%	A					1.829
	B					1.712
	AB					3.421

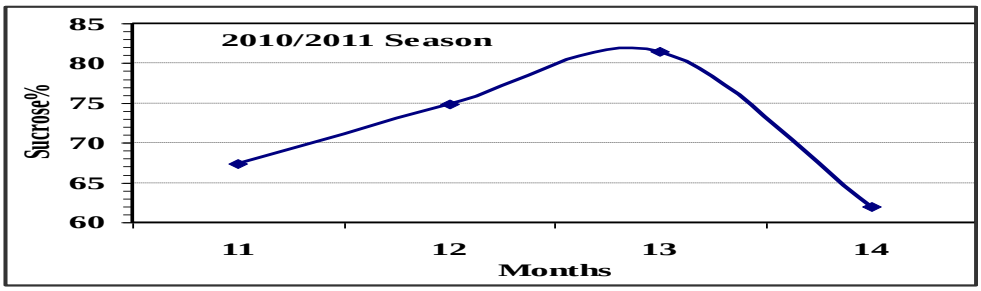

Fig (3): Effect of harvest time and variety on sucrose% juice of sugarcane during at 2010/2011 season.

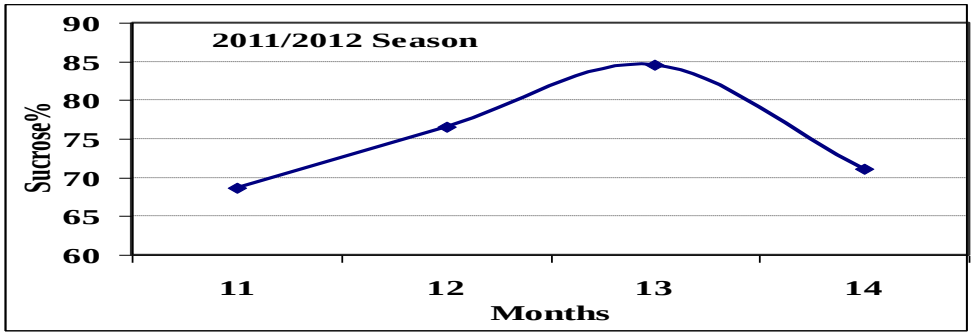

Fig. (4): Effect of harvest time and variety on sucrose% juice of sugarcane during at 2011/2012 season.

As shown in Tables (4&5) that there were significant differences in sucrose% juice of sugar cane among the studied promising varieties at different harvest times in the two growing seasons. G99-103 variety surpassed the other varieties in sucrose% juice of sugar cane by 77.83 and 81.69% , while , G.84-47 variety contained the lowest values (65.96 and 70.22% on D.W.B) at different harvest times in the 1st and 2nd seasons, respectively. Such effect give evidence to the genetic variation among the used varieties in their efficiently of sugar synthesis and translocation of assimilates to storage organs. G99-103 variety is considered a late maturity, while, the early maturity variety was G.84-47 variety. A varietal difference in sucrose% juice of sugar cane was also reported by Besheit *et al.* (1998).

A significant interaction was found between harvest date and varieties (AB) with respect to sucrose% juice of sugar cane in both seasons as shown Tables (4&5) . G.99-103 variety with age of 13 month recorded the highest increase values of sucrose% juice (90.17 and 93.29 %) as well as lowest decrease values with age of 14 months (75.11 and 80.16% on D.W.basis.), in the 1st and 2nd seasons , respectively. While, the lowest values of sucrose % juice of sugar cane (50.20 and 60.28%) (on D.W.B) with age of 14 month were recorded for G.84-47 variety in the 1st and 2nd seasons, respectively. These results are in the same line with those reported by Besheit *et al.* (1998) and Abd El-Razek & Besheit (2012). These findings are probably due to genetic variation among varieties.

3. Effect of the processing delay on sucrose% juice of sugarcane varieties at different harvest times during 2010/2011and 2011/2012 seasons.

It could be noted from the results in Tables (6-13) that delaying days of cane stalks delivery to the sugar factory had a significant effect on sucrose% juice of sugarcane at all studied harvest dates in the two growing seasons. There were a gradual

and significantly decrease in sucrose % juice of sugar cane from 67.41 to 40.94 % ; from 68.64 to 44.82 % for cane harvested after 11 month; from 74.91 to 46.83% ; from 76.56 to 46.97% for cane harvested after 12 month ; from 81.49 to 44.75% ; from 84.61 to 46.01% for cane harvested after 13 month; from 61.94 to 41.51 % ; from 71.09% to 50.01% (%on D.W.basis) for cane harvested after 14 month as the processing delay days increased from zero time (harvest time) up to 9 days in the 1st and 2nd seasons, respectively. This decrease might be attributed to the high inversion rate of sucrose, where the sucrose molecule splited into two new molecules ,i.e. glucose and fructose , picking up a molecule of water in the process as well as to the increase in the activity of degrading enzymes and higher rate of respiration under increasing post-harvest period and high temperature prevailing during harvest season. These results are in accordance with those obtained by (Ahmed and El-Sogheir 2002, Romero *et al.* 1993 and Sharma *et al.* 1991) who reported that the rate of sucrose deterioration varied according to weather conditions, being relatively slow in the cold period and most rapidly in the hot months. They reported that lost sucrose as a result of at least three different processes. One was spoilage by microorganisms. A second substantial source of sugar loss occurs through direct respiration by cane stalks. A third source of sugar loss was through biochemical transformation of sucrose into invert sugar and other carbohydrates.

Table (6): Effect of the processing delay on sucrose% juice (on DWB)* of sugarcane varieties at harvest after age 11 month during 2010/2011.

Processing Delay Days (A)	2010/2011season					Mean
	Sugarcane varieties (B)					
	G.T.54-9	G.98-28	G.84-47	Ph8013	G.99-103	
0	59.75	71.10	65.59	70.67	69.93	67.41
3	49.20	55.26	43.90	57.88	47.14	50.68
6	49.00	44.38	37.25	46.57	38.92	43.22
9	48.90	40.80	34.37	45.02	35.59	40.94
Mean	51.71	52.89	45.28	55.04	47.90	50.56
L.S.D at .5%	A					1.459
	B					1.078
	AB					2.159

Results presented in Tables (6-13) indicated that tested sugarcane varieties significantly differed in sucrose% juice of sugarcane at all studied harvest times in the two growing seasons as result of the processing delay. Ph 8013 variety had a highest main value of sucrose% juice of sugarcane (55.04%) for delaying

periods post-harvest in the 1st season and G.99-103 variety (55.44%) in the 2nd season, while the lowest main values of sucrose% juice of sugar cane (45.28 and 50.38%) for delaying periods post-harvest were recorded for G.84-47 variety at harvest after age 11 month in the 1st and 2nd seasons, respectively. G.T.54-9 variety had a highest main value of sucrose% juice of sugar cane (61.18%) for delaying days post-harvest in the 1st season and G.99-103 variety (62.88%) in the 2nd season, while the lowest main values of sucrose% juice of sugarcane (55.13 and 56.41%) for delaying periods post-harvest were recorded for Ph.8013 variety at harvest after age 12 month in the 1st and 2nd seasons, respectively. G.T.54-9 variety had a highest main values of sucrose% juice of sugar cane (60.47 and 61.45%) for cane harvested after age 13 month ; 55.13 and 64.31% for cane harvested after age 14 month) for delaying periods post-harvest in the 1st and 2nd seasons, respectively. While the lowest main values of sucrose% juice of sugar cane (55.07 and 55.79% for cane harvested after age 13 month) for delaying periods post-harvest were recorded for Ph8013 variety in the 1st and 2nd seasons , respectively. Also, the lowest main value of sucrose% juice of sugar cane (42.25%) were recorded for G.84-47 variety in the 1st season and 50.54 % for Ph.8013 variety for delaying periods post-harvest in the 2nd season for cane harvested after age 14 months. The variation among evaluated varieties in sucrose% juice of sugar cane could be attributed to their genetic structure. These results reported were similar with those mentioned by Besheit *et al.* (2003); Abazied (2005); El-Maghraby *et al.* (2009) and Saxena *et al.* (2010). They revealed that there were varietals differences in the relative decrease in sucrose% juice of sugar cane post – harvest.

In addition, the results in Tables (6-13) showed that highest main value of sucrose% juice of sugarcane (58.41% equal mean two seasons) for delaying periods post-harvest was recorded for sugarcane harvested after age 12 month followed by age 13 month (58.35% equal mean two seasons), age 14 month (54.68% equal mean two seasons) and age 11 months (51.90% equal mean two seasons). This means that harvest of sugar cane at age 13 month caused the lowest value of the relative decrease in sucrose% juice of sugar cane during post –harvest periods. So, harvest of sugar cane at age 12 or 13 months is preferable under the experiment conditions.

The results in Tables (6-13) indicated a significant interaction between the processing delaying times and sugar cane varieties (AB) with regard to sucrose% juice of sugar cane at all studied different harvest dates. The lowest deterioration rates of sucrose% juice were recorded in G.T.54-9 variety from (59.75 to 48.90%) in the 1st season and G.99-103 variety recorded values from (72.62 to 46.91%) in the 2nd season, while, the highest deterioration rates of sucrose% juice from (65.59 to 34.37%) for G.84-47 variety in the 1st

season and from (71.02 to 42.29 %) for G.98-28 variety in the 2nd season for cane harvested at age 11 month (Tables 6&7) as a result of delaying the processing from zero time (at harvest) for nine days, respectively.

Table (7): Effect of the processing delay on sucrose% juice (on DWB)*of sugarcane varieties at harvest after age 11 month during 2011/2012.

Processing Delay Days (A)	2011/2012 season					
	Sugarcane varieties (B)					
	G.T.54-9	G.98-28	G.84-47	Ph8013	G.99-103	Mean
0	66.99	71.02	65.12	67.44	72.62	68.64
3	53.25	48.68	47.93	52.53	53.01	51.08
6	51.27	46.29	44.96	50.43	49.22	48.43
9	45.30	42.29	43.50	46.09	46.91	44.82
Mean	54.20	52.07	50.38	54.12	55.44	53.24
L. S. D at .5%	A					0.953
	B					1.277
	AB					2.554

Table (8): Effect of the processing delay on sucrose% juice (on DWB)*of sugarcane varieties at harvest after age 12 month during 2010/2011.

Processing Delay Days (A)	2010/2011season					Mean
	Sugarcane varieties (B)					
	G.T.54-9	G.98-28	G.84-47	Ph8013	G.99-103	
0	70.53	76.86	72.52	78.51	76.11	74.91
3	60.41	59.10	56.84	57.70	59.79	58.77
6	58.25	51.74	48.57	46.55	50.15	51.05
9	55.53	50.52	45.91	37.74	44.45	46.83
Mean	61.18	59.56	55.96	55.13	57.63	57.89
L.S.D at .5%	A					0.918
	B					1.061
	AB					2.118

Table (9): Effect of the processing delay on sucrose% juice (on DWB)*of sugarcane varieties at harvest after age 12 month during 2011/2012.

Processing Delay Days (A)	2011/2012season					Mean
	Sugarcane varieties (B)					
	G.T.54-9	G.98-28	G.84-47	Ph8013	G.99-103	
0	75.28	77.35	75.14	74.33	80.68	76.56
3	59.78	58.42	59.04	57.77	62.98	59.60
6	51.40	49.70	55.08	50.03	56.60	52.56
9	44.15	42.58	53.40	43.50	51.24	46.97
Mean	57.65	57.02	60.67	56.41	62.88	58.92
L.S.D at .5%	A					1.022
	B					0.640
	AB					2.510

The lowest deterioration rates of sucrose% juice were recorded in G.T.54-9 variety from (70.53 to 55.53%) in the 1st season and G.84-47 variety from (75.15 to 53.40%) in the 2nd season, while, The highest deterioration rates of sucrose% juice from (78.52 to 37.74%) for Ph8013 variety in the 1st season and from (77.36 to 42.58%) for G.98-28 variety in the 2nd season for cane harvested at age 12 month Tables (8&9) as a result of delaying the processing from zero time (at harvest) for nine days, respectively. The lowest deterioration rates of sucrose% juice were recorded in G.T.54-9 variety from (75.44 to 52.96%) in the 1st season and from (81.26 to 52.08%) in the 2nd season, while the highest deterioration rates of sucrose% juice from (85.05 to 34.43%) and from (83.74 to 40.31%) recorded for Ph8013 variety in 1st and 2nd seasons for cane harvested at age 13 month (Tables 10&11) as a result of delaying the processing from zero time (at harvest) for nine days, respectively.

Table (10): Effect of the processing delay on sucrose% juice (on DWB)* of sugar cane varieties at harvest after age 13 month during 2010/2011.

Processing Delay Days (A)	2010/2011season					Mean
	Sugarcane varieties (B)					
	G.T.54-9	G.98-28	G.84-47	Ph8013	G.99-103	
0	75.44	81.24	75.54	85.05	90.17	81.49
3	56.99	55.75	53.70	52.46	56.08	54.99
6	56.49	45.72	49.95	48.35	49.49	50.00
9	52.96	45.46	46.92	34.43	43.96	44.75
Mean	60.47	57.04	56.53	55.07	59.93	57.81
L.S.D at .5%	A					2.030
	B					1.026
	AB					2.049

Table (11): Effect of the processing delay on sucrose% juice (on DWB)* of sugar cane varieties at harvest after age 13 month during 2011/2012.

Processing Delay Days (A)	2011/2012season					Mean
	Sugarcane varieties (B)					
	G.T.54-9	G.98-28	G.84-47	Ph8013	G.99-103	
0	81.26	84.46	80.32	83.74	93.29	84.61
3	56.88	56.01	55.43	51.71	56.54	55.31
6	55.59	46.01	48.53	47.40	50.39	49.58
9	52.08	45.42	46.96	40.31	45.30	46.01
Mean	61.45	57.98	57.81	55.79	61.38	58.88
L.S.Dat .5%	A					0.475
	B					1.107
	AB					2.216

These results are in agreement with those obtained by Besheit (1996), Ahmed and El-Sogheir (2002), Mohamed (2001). G.T.54-9 variety, locally known among growers as C9 that occupied about 95% of the total cane area, had the lowest value of the relative deterioration or decrease in sucrose% juice post-harvest among the studied promising sugar cane varieties, especially harvested after age 12 or 13 months. So, G.T.54-9 variety for the sugar processing and production is preferable under the experiment conditions. The lowest deterioration rates of sucrose% juice were recorded in G.T54-9 variety from (70.53 to 55.53%) in the 1st season and G.84-47 variety from (75.15 to 53.40%) in the 2nd season, while, the highest deterioration rates of sucrose% juice from (78.52 to 37.74%) for Ph.8013 variety in the 1st season and from (77.36 to 42.58%) for G.98-28 variety in the 2nd season for cane harvested at age 12 month Tables (8&9) as a result of delaying the processing from zero time (at harvest) for nine days, respectively. The lowest deterioration rates of sucrose% juice were recorded in G.T.54-9 variety from (75.44 to 52.96%) in the 1st season and from (81.26 to 52.08%) in the 2nd season, while the highest deterioration rates of sucrose% juice from (85.05 to 34.43%) and from (83.74 to 40.31%) were recorded for Ph8013 variety in 1st and 2nd seasons, respectively for cane harvested at age 13 month (Tables 10&11) as a result of delaying the processing from zero time (at harvest) for nine days, respectively. The lowest deterioration rates of sucrose% juice were recorded in G.T.54-9

Table (12): Effect of the processing delay on sucrose% juice (on DWB)* of sugar cane varieties at harvest after age 14 month during 2010/2011.

Processing Delay Days (A)	2010/2011season					Mean
	Sugarcane varieties (B)					
	G.T.54-9	G.98-28	G.84-47	Ph8013	G.99-103	
0	60.77	57.44	50.20	66.20	75.11	61.94
3	54.28	55.48	44.84	51.90	56.48	52.60
6	53.55	53.48	39.33	48.86	46.01	48.25
9	51.91	43.30	34.61	37.80	39.94	41.51
Mean	55.13	52.43	42.25	51.19	54.39	51.08
L.S.D at .5%	A					0.572
	B					1.115
	AB					2.231

Variety from (60.77 to 51.91%) in the 1st season and from (72.37 to 58.84%) in 2nd season, while, the highest deterioration rates of sucrose% juice from (50.20 to 34.61%) for G.84-47 variety in the 1st season and from (68.18 to 40.58%) for Ph8013 variety in the 2nd season for cane harvested at age 14 month (Tables12&13) as a result of delaying the processing from zero time (at harvest) up to nine days,

respectively. These results are in agreement with those obtained by Besheit (1996), Ahmed and El-Sogheir (2002), Mohamed (2001). G.T.54-9 variety, locally known among growers as C9 that occupied about 95% of the total cane area, had the lowest value of the relative deterioration or decrease in sucrose% juice post-harvest among the studied promising sugar cane varieties, especially harvested after age 12 or 13 months. So, G.T.54-9 variety for the sugar processing and production is preferable under the experiment conditions.

Table (13): Effect of the processing delay on sucrose% juice (on DWB)* of sugar cane varieties at harvest after age 14 month during 2011/2012.

Processing Delay Days (A)	2011/2012 season					Mean
	Sugarcane varieties (B)					
	G.T.54-9	G.98-28	G.84-47	Ph8013	G.99-103	
0	72.36	74.49	60.28	68.18	80.16	71.09
3	65.26	64.75	60.00	51.71	56.84	59.71
6	60.76	56.26	55.15	41.69	47.45	52.26
9	58.84	49.24	53.95	40.58	47.43	50.01
Mean	64.31	61.19	57.35	50.54	57.97	58.27
L.S.D at .5%	A					1.244
	B					1.375
	AB					2.750

4. Productivity characters:

4.1. Effect of harvest time and variety on cane yield (ton / fed) of sugarcane during 2010/2011 and 2011/2012 seasons .

The results given in Tables (14&15) showed that harvest time had a significant effect on cane yield of sugarcane in the two growing seasons. Delaying harvest time of sugar cane from 11 to 14 months caused the increase in cane yield of sugar cane from 51.42 to 61.23 ton /fed and from 58.37 to 63.35 tons/fed in the 1st and 2nd seasons, respectively. This increase might be due to better growth of cane in terms of stalks length and diameter. The data are in agreement with Nassar (1996), and El-Sogheir and Besheit (2003) they found that delaying harvest up to 14 months from planting date increased cane yield by 2.125 and 1.953 ton / fed in the 1st and 2nd seasons as compared with 10 months of age. Khandadagave (1999) and Arumugam *et al.* (2002) who found that cane yield increased with the increase in crop age from 11 to 12 month

From the results presented in Table (14&15) it could be observed that there were significant differences in cane yield (ton / fed) of sugar cane among the studied promising varieties at different harvest times in the two

growing seasons. G99-103 variety surpassed the other varieties in cane yield of sugar cane by 65.21 and 77.39, while, Ph.8013 variety contained the lowest values (38.28 and 40.68 ton / fed) at different harvest times in the 1st and 2nd seasons, respectively. The superiority of G.99-103 might be attributed to their better growth characteristics in terms of length and diameter of stalk. Varietal differences in cane yield were reported by Nassar (1996) and El-Sogheir and Besheit (2003).

Table (14): Effect of harvest time and variety on cane yield (ton \fed) of sugarcane during 2010/2011 season.

Harvest time (A)	2010/2011 season					Mean
	Sugarcane varieties (B)					
	G.T.54-9	G.98-28	G.84-47	Ph8013	G.99-103	
11 month	54.36	52.64	47.82	38.57	63.69	51.42
12 month	61.94	59.02	60.08	39.02	64.78	56.99
13 month	64.85	72.35	60.35	37.21	65.91	60.13
14 month	67.76	72.89	60.68	38.35	66.48	61.23
mean	62.23	64.23	57.23	38.28	65.21	57.43
L.S.D.5:						
A						0.734
B						1.394
AB						2.787

Table (15): Effect of harvest time and variety on cane yield (ton \ fed) of sugarcane during 2011/2012 season.

Harvest time (A)	2011/2012 season					Mean
	Sugarcane varieties (B)					
	G.T.54-9	G.98-28	G.84-47	Ph8013	G.99-103	
11 months	60.14	62.53	59.43	38.27	71.47	58.37
12 months	64.30	67.31	60.00	40.98	78.79	62.28
13 months	65.14	67.86	60.34	41.51	79.35	62.84
14 months	65.97	68.28	60.58	41.96	79.95	63.35
mean	63.88	66.49	60.08	40.68	77.39	61.71
L.S.D.5:						
A						0.946
B						0.697
AB						1.395

A significant interaction was found between harvest time and varieties (AB) with respect to cane yield of sugar cane in both seasons as shown Tables (14&15). G.98-28

variety with age of 14 month recorded the highest increase values of cane yield (72.89 ton /fed) in 1st season, while G.99-103 variety recorded the highest one (79.95 ton / fed) in 2nd season. The lowest values of cane yield of sugar cane (38.35 and 41.96 ton / fed) with age of 14 month were recorded for Ph.8013variety in the 1st and 2nd seasons, respectively. The differential yield response of sugarcane varieties to harvest times was reported by Nassar (1996) El-Sogheir and Besheit (2003).

4.2. Effect of harvest time and variety on sugar yield (tons / fed) of sugarcane during 2010/2011 and 2011/2012 seasons.

Results in Tables (16&17) revealed that harvest time had a significant effect on sugar yield of sugarcane in the two growing seasons. Delaying harvest time of sugar cane from 11 to 13 months caused the increase sugar yield of sugar cane from (5.83 to 7.76 ton / fed) and from (6.98 to 8.30) in the 1st and 2nd seasons, respectively. The increase in sugar yield of sugar cane in the 2nd season was higher than the 1st season. This result might be due to the differences in the environmental conditions between the two seasons. The obtained finding were completely in accordance with those of Nassar (1996), Ramesh and Mahadevaswamy (1996) and Suresh and Saini (1997). Thereafter, sugar yield (ton / fed) of sugarcane decreased from (7.76 to 6.47 ton /fed) and from (8.30 to 7.63 ton / fed) with delaying harvest from 13 to 14 months in the 1st and 2nd seasons, respectively. The reduction of sugar yield may be due to the observed reduction in sucrose and purity percentages and the increase in reducing sugars which accompanied with increase in sucrose loss in molasses and hence decrease in extractable sugar.

Table (16): Effect of harvest time and variety on sugar yield (ton \ fed) of sugarcane during 2010/2011 season.

Harvest time (A)	2010/2011 season					Mean
	Sugarcane varieties (B)					
	G.T.54-9	G.98-28	G.84-47	Ph8013	G.99-103	
11 month	5.92	6.15	5.52	4.43	7.13	5.83
12 month	7.57	7.20	8.18	4.76	7.68	7.08
13 month	8.30	8.95	7.92	4.75	8.89	7.76
14 month	6.71	7.92	6.02	4.08	7.62	6.47
mean	7.13	7.56	6.91	4.51	7.83	6.79
L.S.D.5:						
A						0.243
B						0.242
AB						0.484

Table (17): Effect of harvest time and variety on sugar yield (ton \ fed) of sugarcane during 2011/2012 season.

Harvest time (A)	2011/2012 season					Mean
	Sugarcane varieties (B)					
	G.T.54-9	G.98-28	G.84-47	Ph8013	G.99-103	
11 months	7.28	7.49	7.63	4.43	8.06	6.98
12 month	8.22	8.47	8.76	4.95	9.58	7.99
13 months	8.91	8.63	7.80	5.45	10.69	8.30
14 months	8.13	8.40	7.76	4.58	9.26	7.63
mean	8.14	8.25	7.99	4.85	9.40	7.73
L.S.D.5:						
A						0.260
B						0.170
AB						0.337

Data presented in Tables (16&17) revealed that there were significant differences in sugar yield of sugar cane among the studied promising varieties at different harvest times in the two growing seasons. G99-103 variety surpassed the other varieties in sugar yield of sugar cane by (7.83 and 9.40 ton/ fed), while, Ph.8013 variety contained the lowest values (4.51 and 4.85 ton / fed) at different harvest times in the 1st and 2nd seasons, respectively. The superiority of G.99-103 may be due to better stalk diameter which was reflected in higher cane yield as well as to the increase in juice quality traits in terms of sucrose % and purity %. Many workers reported differences in sugar yield among varieties, (Nassar, 1996; Besheit *et a*l., 1998, El-Sogheir and Besheit, 2003 and Abd El-Razek and El-Soghier 2007).

The interaction between harvest times and varieties (AB) had a significant effect on sugar yield in both seasons as shown Tables (16&17). G.98-28 variety with age of 13 month recorded the highest increase values of sugar yield (8.95 ton / fed) in 1st season and G.99-103 variety recorded the highest one (10.69 ton /fed) in 2nd season as well as lowest decrease values with age of 14 months (7.92 and 9.26 ton/fed) in the 1st and 2nd seasons, respectively. While, the lowest values of sugar yield of sugar cane (4.08 and 4.58 ton /fed) with age of 14 month were recorded for Ph.8013 variety in the 1st and 2nd seasons, respectively. The differential sugar yield response of sugarcane varieties to harvest times was reported by Nassar (1996) and El-Sogheir and Besheit (2003). They reported that sugar cane gave the highest sugar yields when harvested after 13 months from planting date.

CONCLUSIONS

In general, G.T.54-9 variety had the lowest value of the relative deterioration or decrease in sucrose% juice post-harvest among the studied promising sugar cane varieties. So, G.T.54-9 variety for the sugar processing and production is preferable followed by G.98-28 and G.99-103 varieties especially harvested after age 12 or 13 under the experiment conditions. Besides, the processing delay for cane stalks post-harvest was not preferable for both grower and sugar factory.

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الملخص العربي

تأثير الصنف، ميعاد الكسر و تاخير التصنيع على نسبة سكروز عصير القصب

أحمد محمود همام[1]، محمد نجيب قناوى[1]، حسين فرويز محمد[2]، نها فؤاد جابر[2]

[1]. قسم الصناعات– كلية الزراعة– جامعة المنيا.

[2]. قسم تكنولوجيا السكر –معهد بحوث المحاصيل السكرية –مركز البحوث الزراعية –الجيزة.

تعتمد جمهورية مصر العربية فى انتاج السكر على صنف واحد من القصب يسمى جيزة – تايوان 54– 9 ، لذا اجريت هذة الدراسة بمحطة البحوث الزراعية بالمطاعنة، محافظة الاقصر، مصر، خلال موسمي 2010 /2011 و 2012/2011 لدراسة تأثير أصنفاف القصب (جيزة– تايوان 54–9 ، جيزة 98 – 28، جيزة 84 – 47، فليبنى 8013، جيزة 99 – 103) وفترات تجميع السكر (عمر 7 ، 8 ، 9 و 10 شهور) وميعاد الكسر (عمر 11 ، 12 ، 13 و 14 شهر) وفترات تاخير التصنيع (وهى صفر ، 3 ، 6 و9 أيام من الكسر) على نسبة سكروز عصير القصب لتحديد الصنف الامثل لتصنيع وانتاج السكر بجانب الصنف التجارى جيزة– تايوان 54–9.

أوضحت النتائج المتحصل عليها ما يلى:

1. وجود اختلافات معنوية فى نسبة سكروز عصير القصب بين اصناف قصب السكر المدروسة اثناء فترات تجميع السكر من عمر 7 – 11 شهر ، حيث زادت هذه النسبة مع تقدم العمر حتى الكسر .
2. احتواء أصناف قصب السكر المبشرة وهى اصناف جيزة 84 – 47 و جيزة 98 – 28 على اعلى نسبة من سكروز العصير عند فترات تجميع السكروز المختلفة .
3. تحقق اعلى نسبة سكروز عصير القصب عندما تم كسر القصب على عمر 13 شهر خاصة لصنف جيزة 99– 103 ، بعد ذلك تناقصت هذه النسبة عند الكسر بعد عمر 13 شهر لجميع الاصناف المدروسة .
4. ادى تاخير توريد او تصنيع القصب بعد الكسر حتى تسعة أيام الى تناقص نسبة سكروز عصير القصب .
5. سجل صنف جيزة 84–47 اعلى معدل تدهور لنسبة سكروز عصير القصب ضمن الاصناف المدروسة عند الكسر على عمر 11 شهر ، بينما سجل الصنف فيلبنى 8013 أعلى معدل التدهور لنسبة السكروز عند الكسر فى معظم مواعيد الكسر المدروسة الاخرى .
6. تاخير تصنيع عيدان القصب بعد الكسر غير مفضلة لكلا من المزارع ومصنع السكر .
7. عموما سجل الصنف جيزة – تايوان 54–9 أقل معدل للتدهور بالنسبة لسكروز عصير القصب بعد الكسر من بين الاصناف المدروسة ، لذا يعد هذا الصنف هو المفضل لتصنيع وانتاج السكر يليه صنف جيزة 99 –103 وصنف جيزة 98 – 28 بصفة خاصة عند الكسر على اعمار 12 او 13 شهر تحت ظروف التجربة .