YIELD AND QUALITY OF SOME SUGAR BEET VARIETIES AS AFFECTED BY SOWING DATE AND HARVEST AGE

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ABSTRACT

Two field experiments were conducted in 2008/2009 and 2009/2010 seasons in Sakha Agricultural Research Station, Kafr El-Shiekh Governorate. The main goal of this study was to investigate the response of five multigerm sugar beet varieties (Florima, Cleopatra, Heracule, Avantage and Alamas) to three sowing dates (1st Sept., 1st Oct. and 1st Nov.) and three harvest ages (180, 195 and 210 days after sowing). A split plot design with four replications was devoted for each sowing date where harvest age was allocated in the main plots and varieties in the sub-plots. A combined analysis over the three sowing dates and two seasons was undertaken.

Sowing dates markedly affected sucrose and purity percentages as well as root and sugar yields/fed. Over both seasons, sugar beet sown early on the 1st of Sept., and/or 1st Oct. recorded at par the highest root and sugar yields/fed. Sugar beet varieties differed significantly in their yield potential. Cleopatra variety recorded the highest sucrose %, while Florima and Heracule varieties produced the highest root and sugar yields/fed. Harvesting sugar beet after 210 days from sowing was the proper age to obtain the highest sucrose and purity percentages as well as root and sugar yields/fed. The interaction between sowing dates and varieties exerted a significant effect on root yield/fed. Florima variety recorded the highest root yield in the early sowing date (1st of Sept.), while Cleopatra and Avantage varieties recorded their maximum root yields when they were planted in the second sowing date (1st of Oct.). The interaction between sowing date and harvest age significantly affected almost all the studied traits.

Regarding this interaction effect on sugar yield/fed, the response equations indicated the need for more delay in harvest than 210 days after sowing particularly for the early sown sugar beet in 1st of September. Under the conditions of this work, sowing Florima and Heracule varieties on the 1st of Sept. or 1st Oct. and harvesting them after 210 days from sowing can be recommended to obtain the highest root and sugar yields/fed.

Key words: Sugar beet varieties, Sowing date and Harvest age.

INTRODUCTION

Sugar beet (*Beta vulgaris,* L.) is the second source of sugar all over the world. In Egypt, there are several advantages favouring sugar beet as a suitable crop to winter season, with a relatively short duration period which allows for growing a summer crop during the same season. Many agronomic factors are involved in influencing beet yield and quality, such as genotype and sowing date. Planting date is considered one of the most important factors for all field crops in general, and sugar beet in particular. It has an active role for growth, yield and root quality. In this respect, **Leilah *et al* (2005)** reported that sowing sugar beet on 1st of Oct. was the best time for maximizing sugar beet productivity. Many studies also, reported that sowing sugar beet in October

markedly increased weight of roots, sugar content as well as root and sugar yields, compared with the late sowing in November **Fayed *et al*, (2002)**.

The effect of sowing date on harvest date is not clearly understood **(Jaggard *et al*. 1983)**. One hypothesis is that early planted sugar beets mature early and should be harvested early, while late planted ones should be harvested later, after the field has undergone a more complete maturing process **(Draycott *et al* 1973)**. Another hypothesis is that early planted sugar beets have greater yield and quality potential and should be harvested after later planted sugar beets of lower potential **(Holmes** and **Adams**, **1966)**. Finally, **Hull** and **Webb (1970)** and **Scott *et al* (1973)** concluded that yield increases at the same amount fall harvest, regardless of sowing date. The controversy among authors in this respect could be attributed to the variation in sowing location and sensitivity of genotypes to day length.

As sugar beet processors lengthen the factory campaign of refining roots into sucrose, producers are being paid incentives to begin harvesting about one month earlier to optimize root yield and quality. Identifying agronomic practices that could improve yield and quality with an early harvest would benefit both producers and processors. The suitable date for sugar beet planting depends mainly on many factors such as the previous crop, weather conditions, contract conditions with sugar factories and cultivated cultivar. In this respect**, Ismail *et al* (2006)** found significant and positive effects among different sowing dates. The 1st of October gave the highest root fresh weight, sucrose%, purity%, root and sugar yields/fed compared with the 15th of October and 1st November. However, **El-Geddawy *et al* (2007)** revealed that sowing beet early on the 15th of September significantly attained higher values of sugar recovery, fresh weight/plant, root and sugar yields/fed compared with that sown on the 15th of October. **Mosa (2009)** found that sowing sugar beet on 15th of September increased significantly fresh weight of roots as well as root and sugar yields/fed compared with that planted on October 15th and November.

Some sugar beet genotypes have been promoted as high sugar content ones and are adapted for early harvest. Wide genotype differences in crown tissue production and development rate may cause quality differences among them and thus require different harvesting strategies. Most plant breeders would agree that genotype x harvest date interaction should exist for sugar beet performance, *i.e.* some genotypes should perform well early, while others genotypes would perform better later in the harvest season. Time of harvest is one of the factors affecting yield and quality of sugar beet crop **Ramadan and Nassar (2004)**, **Azzazy *et al* (2007)** and **Abd El-Aal *et al* (2010)** found great variation in yield, quality and its components among sugar beet varieties. The root dry matter percentage increases with passing growth period of plant and amount of sugar reaches 20-26% at the time of harvest. **Abo El-Magd *et al* (2003)** tested the effect of plant age at harvest sugar beet variety Gloria at age of 180, 195 and 210 days from sowing. The results indicated that plant age at harvest affected significantly root length and diameter, root fresh weight/plant, sugar yields/fed, as well as reducing sugar, total soluble solids, sucrose and juice purity percentages. The highest values of productivity and quality traits were recorded in beets harvested at 210 days from sowing. **Aly (2006)** studied the effect of harvesting sugar beet at ages of 170, 190 and 210 days. He found that delaying harvest dates up to 210 days from sowing increased significantly root length and diameter, sucrose%, root and sugar yields/fed. **Abd El-Razek**

(2006) and **Mahmoud *et al* (2008)** reported that the maximum root and sugar yields/fed were obtained when sugar beet was harvested at 180-210 days after sowing. They added that varying varieties and harvesting dates affected sucrose and juice purity percentages, root and sugar yields/fed. **El-Sheikh *et al* (2009)** reported that delaying harvest date from 180 to 210 days attained a gradual and significant effect on sucrose %, sugar yield as well as root fresh weight/plant and root yield. They added that the difference between 180 and 195 days was negligible.

The objective of this study was to define the relative response of yield and quality of some sugar beet genotypes to sowing date and plant age at harvest.

MATERIALS AND METHODS

Two field experiments were conducted in 2008/2009 and 2009/2010 seasons in Sakha Agricultural Research Station, Kafr El-Shiekh Governorate to study the effects of different planting dates and ages at harvest on yield and quality of newly five sugar beet varieties. The study included three sowing dates (1st September, 1st October and 1st November), three harvest ages (180, 195, 210 days) and five imported multigerm sugar beet varieties namely "Cleopatra" (from France), "Alamas" (from Germany), "Florima", "Avantage" (from France) and "Heracule" (from Netherlands). At each sowing date, a split plot design with four replications was used, where the main plots were assigned for harvest ages, while sugar beet varieties were randomly distributed in the sub plots. The physical and chemical analyses of the soil upper 30-cm depth of the experimental site showed that the soil was clay in texture containing (14.9 and 15.3 sand %, 26.2 and 24.6 silt % and 58.9 and 60.1 clay %. This soil depth contained 47.1 and 43.7 ppm of available nitrogen with pH of 7.9 and 8.2 in the 1st and 2nd seasons, respectively. Soil analysis was done according to the method described by **Jackson (1973)**. The plot area was 21 m^2 including six ridges of 7 m in length, 50-cm apart and 20 cm between hills. At harvest, plants of four guarded rows were taken from each plot to determine the following characteristics: Root fresh weight (kg/plant); root and sugar yields (ton/fed). Meantime, a sample of 10 roots from each plot was randomly taken to determine qualitative parameters in terms of sucrose and purity percentages.

Sucrose percentage was determined using Sacharometer according the method described by **Le-Dotce (1927)**.

Juice purity % was calculated by the equation:

Juice purity percentage = (sucrose % x 100)/ TSS%.

Theoretical sugar yield (ton/fed) was calculated according the following equation: Theoretical sugar yield (ton/fed) = Root yield (ton/fed) x sucrose % x purity %.

The other agricultural practices were done as recommended by Sugar Crops Research Institute. The meteorological data in 2008/2009 and 2009/2010 seasons are presented in Table 1.

Table 1: Monthly air temperature ^{0}C and monthly relative humidity % of Kafr El-Sheikh Governorate in 2008/2009 and 2009/2010 growing seasons.

Month	Day	Temperature ^{0}C		Relative humidity%		Temperature ^{0}C		Relative humidity %	
		Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
		2008-2009 season				2009-2010 season			
Sept.	1-15	32.7	20.0	95.1	37.2	31.3	19.6	92.4	38.2
	16-30	33.6	19.6	94.9	30.8	30.5	18.4	91.4	41.5
	Average	33.2	19.8	95.0	34.0	30.9	19.0	91.9	39.8
Oct.	1-15	29.5	17.9	94.3	41.0	28.9	15.8	95.5	38.0
	16-31	27.3	16.1	93.8	47.0	26.0	14.3	94.5	39.7
	Average	28.4	17.0	94.0	44.0	27.5	15.0	95.0	38.9
Nov.	1-15	25.2	12.8	94.9	41.9	24.3	12.3	93.8	41.0
	16-30	25.4	12.8	95.1	42.1	20.5	11.2	86.5	40.6
	Average	25.3	12.8	95.0	42.0	22.4	11.8	90.2	40.8
Dec.	1-15	21.0	9.7	94.8	46.3	17.2	7.8	93.8	51.3
	16-31	19.0	8.9	95.2	49.8	17.6	6.3	96.5	44.7
	Average	20.0	9.3	95.0	48.0	17.4	7.1	95.2	48.0
Jan.	1-15	20.5	8.6	93.6	44.2	14.0	4.7	94.1	49.1
	16-29	19.2	7.4	94.4	45.8	16.8	5.0	95.6	48.6
	Average	19.9	8.0	94.0	45.0	15.4	4.9	94.9	48.8
Feb.	1-15	17.9	6.5	93.1	45.5	17.4	6.9	89.0	58.6
	16-28	15.5	7.4	95.0	46.5	18.0	7.3	94.0	47.4
	Average	16.7	7.0	94.1	46.0	17.7	7.1	91.5	53.2
Mar.	1-15	22.0	9.5	96.1	41.2	20.5	7.6	95.0	41.0
	16-31	20.4	9.3	95.9	43.0	18.7	7.4	95.1	42.8
	Average	21.2	9.4	96.0	42.1	19.6	7.5	95.0	41.9
Apr.	1-15	24.2	11.4	95.2	38.9	23.6	10.5	89.3	34.4
	16-30	24.0	11.9	94.8	35.3	23.8	11.3	94.7	37.9
	Average	24.1	11.6	95.0	37.1	23.7	10.9	92.0	36.2
May	1-15	29.7	15.9	94.9	29.0	28.7	14.2	94.9	30.2
	16-31	30.0	17.8	95.1	33.2	27.5	16.3	93.1	33.5
	Average	29.9	16.8	95.0	31.1	28.1	15.2	94.0	31.9
Jun.	1-15	30.8	19.0	96.3	35.0	30.1	19.3	95.7	36.8
	16-30	31.6	20.7	95.6	37.4	30.3	20.7	96.3	45.6
	Average	31.2	19.8	96.0	36.2	30.2	20.0	96.0	41.2

Source: Central Laboratory for Agricultural Climate, Agricultural Research Center, Giza, Egypt.

Statistical analysis:

The collected data for each sowing date were subjected to the proper statistical analysis of split plot design according to the procedure outlined by **Gomez and Gomez (1984)**. A combined analysis over the two seasons for the three studied sowing dates was done according to **Le -Clerg *et al* (1966)**. To compare means LSD at 0.05% level of significance was used. Response equations were calculated for the response of sugar yield/fed to harvest age of

the three planting dates according to **Senedecor and Cochran (1967)**, as follow: $\hat{Y} = a + b\,x - c\,x^2$

RESULTS AND DISCUSSIONS

1. Root fresh weight:

Data in Table 2 cleared that the two earlier sowing dates, produced heavier at par root fresh weight/plant averages than that sown lately on the 1st of Nov. The relative increase in root fresh weight could be attributed to the enhanced influence of the early sowing date where plants experienced more favourable climatic conditions as expressed in better day and night temperatures particularly in the early season (Table 1). This in turn was reflected in high assimilation rate and finally good root weight. This result is in agreement with that reported by **Fayed *et al* (2002)**, **Leilah *et al* (2005)**, **Ismail *et al* (2006)** and **El-Geddawy *et al* (2007)**.

The results revealed that the examined varieties differed significantly in root fresh weight/plant. Sugar beet variety Florima surpassed the other varieties in root fresh weight/plant followed by Heracule, Avantage, Alamas and Cleopatra. This finding is in harmony with that obtained by **Ramadan and Nassar (2004)** and **Abd El-Aal *et al*. (2010)**. However, insignificant variances in this trait were detected among the tested varieties expect Cleopatra.

Delaying harvest age from 180 to 195 and 210 days gradually and significantly increased root fresh weight/plant. The relative advantage of increasing duration to harvest on root fresh weight/plant could be attributed to more dry matter accumulation with the advance of plant age.

As for the interaction between sowing date and sugar beet variety, the results showed that the difference in root fresh weight of Florima and/or Hercule was insignificant in case of sowing them on the 1st of Sept. or Oct. However, the variance in this trait between two varieties was significant when they were planted on the 1st of November.

Concerning the interaction between sowing date and plant age at harvest, the results in Table 2 showed that there were insignificant differences in root fresh weight/plant in sugar beet sown at any of the three studied sowing dates and harvested at ages of 180 and/or 195 days. Moreover, the difference in this trait was insignificant in beets sown in the 1st and middle sowing dates, while the difference was significant between these two sowing dates and the latest one in case of harvesting beets after 210 days from sowing.

2. Root yield/fed:

The results in Table 2 & Fig. 1 illustrate that sowing sugar beet early (1st Sept. and/or 1st Oct.) attained a significant influence on root yield/fed., compared with the latest one (1st Nov.). it was found that sowing sugar beet on the 1st of Sept. resulted in 0.30 and 4.2 ton/fed higher than that planted on the 1st of Oct. and Nov., respectively The pronounced effect of sowing dates on root yield/fed, is mainly due to the increase in the individual root fresh weight from one side and also due to the relative advantage of the appropriate monthly day and night temperatures (Table1) prevailed at the earlier sowing date, which consequently enhanced relative growth rate of roots through its effect on the assimilation rate which in turn was reflected on root yield. The effective role of sowing dates on root yield was also reported by many investigators such as **Fayed *et al* (2002)** and **Leilah *et al* (2005)** and **El-Geddawy *et al* (2007).**

Table 2: Root fresh weight (kg/plant) and root yield (ton/fed) of the five sugar beet varieties as affected by sowing dates and plant age at harvesting (combined over 2008/2009 and 2009/2010 seasons).

Sugar beet varieties	Harvesting age at (days)	Root fresh weight (kg/plant)				Root yield (ton/fed.)			
		Sowing date				Sowing date			
		1st Sept.	1st Oct.	1st Nov.	**Mean**	1st Sept.	1st Oct.	1st Nov.	**Mean**
Florima	180	0.959	0.980	0.803	0.914	28.3	28.9	23.7	**26.9**
	195	1.102	1.122	0.864	1.029	32.5	33.1	25.5	**30.4**
	210	1.217	1.159	0.925	1.101	35.9	34.2	27.3	**32.5**
	Mean	**1.093**	**1.087**	**0.864**	**1.015**	**32.2**	**32.1**	**25.5**	**29.9**
Cleopatra	180	0.692	0.715	0.675	0.694	20.4	21.1	19.9	**20.5**
	195	0.749	0.759	0.695	0.735	22.1	22.4	20.5	**21.7**
	210	0.858	0.837	0.715	0.803	25.3	24.7	21.1	**23.7**
	Mean	**0.766**	**0.771**	**0.695**	**0.744**	**22.6**	**22.7**	**20.5**	**21.9**
Hercule	180	0.942	0.905	0.783	0.877	27.8	26.7	23.1	**25.9**
	195	1.054	1.003	0.895	0.984	31.1	29.6	26.4	**29.0**
	210	1.132	1.098	0.875	1.035	33.4	32.4	25.8	**30.5**
	Mean	**1.043**	**1.002**	**0.851**	**0.965**	**30.8**	**29.6**	**25.1**	**28.5**
Avantage	180	0.892	0.912	0.824	0.876	26.3	26.9	24.3	**25.8**
	195	0.973	0.983	0.871	0.942	28.7	29.0	25.7	**27.8**
	210	1.054	1.047	0.956	1.019	31.1	30.9	28.2	**30.1**
	Mean	**0.973**	**0.981**	**0.884**	**0.946**	**28.7**	**28.9**	**26.1**	**27.9**
Alamas	180	0.908	0.878	0.790	0.859	26.8	25.9	23.3	**25.3**
	195	0.980	0.953	0.851	0.928	28.9	28.1	25.1	**27.4**
	210	1.088	1.108	0.919	1.038	32.1	32.7	27.1	**30.6**
	Mean	**0.992**	**0.980**	**0.853**	**0.942**	**29.3**	**28.9**	**25.2**	**27.8**
Overall mean of harvesting ages	180	0.878	0.878	0.776	0.844	25.9	25.9	22.9	**24.9**
	195	0.973	0.963	0.834	0.922	28.7	28.4	24.6	**27.2**
	210	1.071	1.051	0.878	1.000	31.6	31.0	25.9	**29.5**
Overall mean of sowing dates		**0.973**	**0.963**	**0.831**	**-**	**28.7**	**28.4**	**24.5**	**-**

LSD at 0.05 level for:		
Sowing date (A)	0.06	1.06
Varieties (B)	0.143	0.55
Harvest age (C)	0.042	0.89
A x B	0.19	0.92
A x C	0.17	0.87
B x C	NS	NS
A x B x C	NS	NS

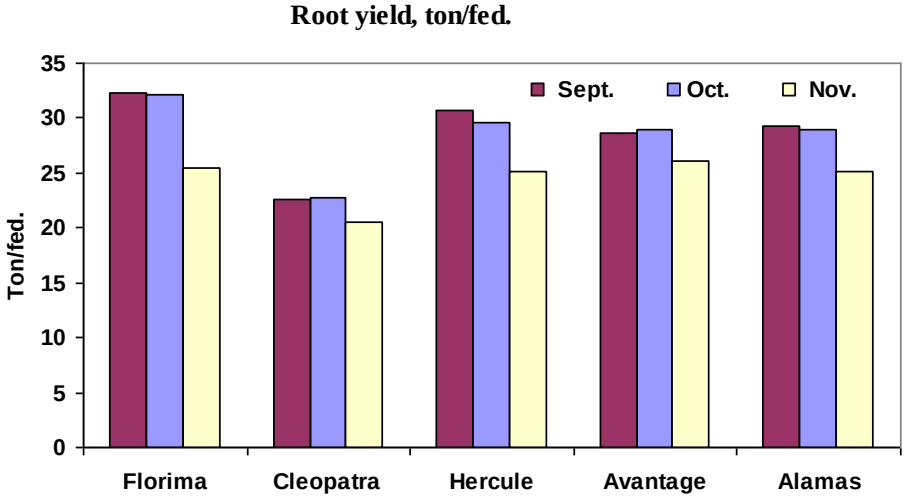

Fig. 1: Relationship between root yield and sowing dates of the five sugar beet varieties.

Data in Table 2 reveal that the tested sugar beet varieties differed significantly in their root yield. The results showed that Florima variety produced 7.99, 1.45, 2.03 and 2.15 tons/fed higher than that recorded by Cleopatra, Hercule, Avantage and Alamas, respectively. Moreover, there was insignificant difference in root yield/fed between Avantage and Alamas varieties. The values of root yield of the tested varieties had the same tendency of those of root fresh weight/plant. This observation assured that the final yield was affected by root weight of the individual plant as well as by gene make-up in addition to the surrounded environments. The obtained results are in coincidence with those obtained by **Ramadan and Nassar (2004)**, **Azzazy *et al* (2007)** and **Abd El-Aal *et al*. (2010)**.

Delaying plant age at harvesting up to 210 days positively and significantly increased sugar beet root yield/fed. This increment amounted to 18.47% and 8.45% compared with that recorded by harvesting beets after 180 and 195 days, respectively (Table 2 and Fig. 2). Similar results were obtained by **Aly (2006)** and **El-Sheikh *et al* (2009)**.

The interaction between sowing dates and varieties exerted a significant effect on root yield/fed. The results cleared that Florima variety recorded the highest root yield in the early sowing date (1st Sept.) while Cleopatra and Avantage varieties recorded their maximum root yields when they were planted on the 1st of Oct. on the other hand, the lowest root yield/fed was produced by sowing Cleopatra variety on the 1st of November. However, the interaction between varieties and plant age at harvesting and that between sowing date, varieties and plant age at harvesting had insignificant effect on root yield/fed., the insignificant of these interactions clearly indicate the dominate effect of sowing date and harvest age on root yield/fed where early sowing and late

harvest played independently the main role in governing the yield potentiality of the five tested varieties.

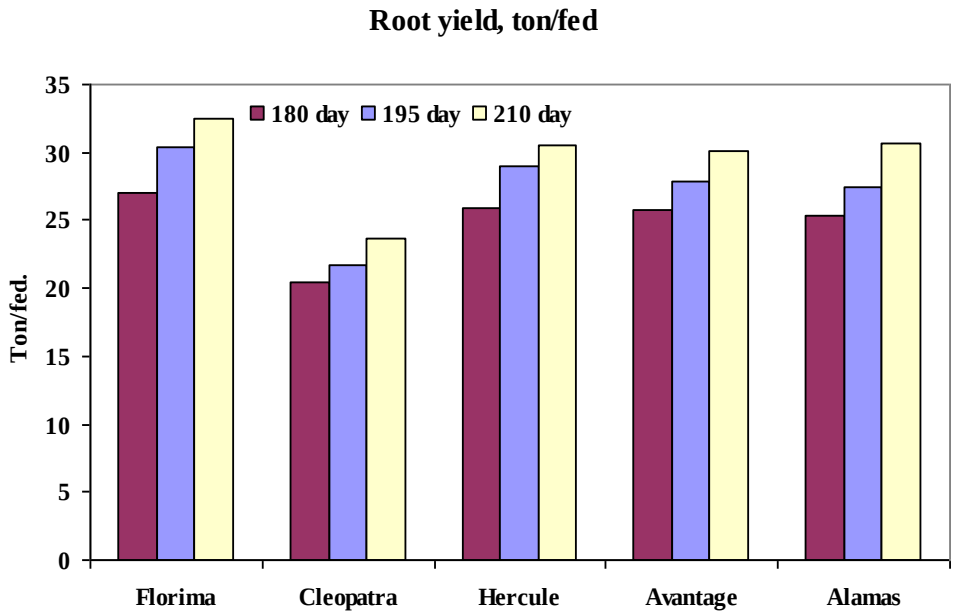

Fig. 2: Relationship between root yield and plant age at harvesting of the five sugar beet varieties.

3. Sucrose percentage:

Data in Table 3 show that the two earlier sowing dates (1st of Sept. and Oct.) recorded a significant increase in the values of sucrose %. The positive effect of the early sowing may be due to favourable conditions (Table 1) in respect to day, temperature prevailed during Sept. and Oct. which might increase canopy size and promoted plant growth**.** The relatively lower temperature during the later growth stages of early sowing dates might account for the increase of sugar accumulation as expressed herein in the higher sucrose percentage. Similar results were obtained by **Geddawy *et al* (2007)**.

Results given in Table 3 pointed out that the examined sugar beet varieties differed significantly in their sucrose%. Sugar beet variety Cleopatra attained the highest value of sucrose%, while, the lowest value of this trait was recorded by Avantage variety. This result reassured that this trait is strongly correlated with gene make-up **(Ramadan and Nassar**, **2004**, **Azzazy *et al,* 2007** and **Abd E-Aal *et al,* 2010)**.

The results cleared that delaying harvesting of sugar beet for 15 and 30 days resulted in 0.9 and 2.0 % higher in sucrose % compared with that harvested at 180 days from sowing. This result is probably due to prolonging the duration of sugar storage and accumulation in roots. This result is in line with those reported by **Abo El-Magd *et al* (2003), Abd El-Razek (2006), Mahmoud *et al* (2008)** and **El-Sheikh *et al* (2009)**.

The interaction between sowing date and plant age at harvesting had a significant effect on sucrose%. Insignificant variance in sucrose % was

recorded in sugar beet sown on the 1st of Sept. and Oct. when it was harvested at age of 180 and 195 days. However, the difference between these two sowing dates in this trait reached the level of significance when sugar beet was harvested at 210 days.

4- Juice purity percentage:

Data in Table 3 indicate that sowing date exhibited a significant effect on juice purity percentage. Purity% had the same trend of sucrose percentage as affected by sowing date. Delaying sowing of sugar beet from 1st Sept. to 1st Nov. decreased the value of purity percentage. However, the difference between the two earlier sowing dates 1st of Sept. and Oct. was insignificant, but both of them surpassed the latest one (1st Nov.).

Data in Table 3 show that the differences among sugar beet varieties in purity percentage were insignificant. The results show that delaying harvesting date *i.e.* increasing the plant age at harvest significantly improved juice purity percentage of sugar beet roots. This result is probably due to the increase in sucrose % as plant age to harvest increased

The interaction between sowing date and plant age at harvesting had a significant effect on purity%. Insignificant difference was found in purity% in case of sowing beets on the 1st of Oct. and Nov. and harvesting it at age of 195 days. However, the difference between these two sowing dates in their influence on this trait was significant when beets were harvested at 180 and/or 210 days.

Table 3: Sucrose and purity percentages of the five sugar beet varieties as affected by sowing dates and plant age at harvesting (combined over 2008/2009 and 2009/2010 seasons).

Sugar beet varieties	Harvesting age at (days)	Sucrose %				Purity %			
		Sowing date				Sowing date			
		1st Sept.	1st Oct.	1st Nov.	**Mean**	1st Sept.	1st Oct.	1st Nov.	**Mean**
Florima	180	14.9	14.3	13.9	**14.4**	79.1	78.2	75.9	**77.7**
	195	15.2	15.7	14.7	**15.2**	80.6	81.2	79.8	**80.5**
	210	17.3	16.3	15.5	**16.4**	83.2	81.6	80.0	**81.6**
	Mean	**15.8**	**15.4**	**14.7**	**15.3**	**80.9**	**80.3**	**78.6**	**79.9**
Cleopatra	180	17.8	17.5	16.7	**17.3**	84.9	85.1	84.6	**84.9**
	195	19.6	19.1	16.1	**18.3**	87.5	85.4	83.9	**85.6**
	210	22.3	21.4	15.5	**19.7**	88.3	86.9	82.7	**85.9**
	Mean	**19.9**	**19.3**	**16.1**	**18.4**	**86.9**	**85.8**	**83.7**	**85.5**
Hercule	180	14.5	14.1	13.7	**14.1**	78.5	78.0	74.8	**77.1**
	195	15.8	16.3	14.5	**15.5**	79.9	81.9	80.0	**80.6**
	210	16.9	16.9	16.1	**16.6**	83.2	82.9	81.7	**82.6**
	Mean	**15.7**	**15.8**	**14.8**	**15.4**	**80.5**	**80.9**	**78.8**	**80.1**
Avantage	180	14.1	14.6	13.2	**13.9**	78.2	78.2	77.9	**78.1**
	195	14.9	14.9	13.8	**14.5**	79.9	76.3	78.1	**78.1**
	210	15.8	15.5	14.6	**15.3**	84.8	80.9	81.1	**82.3**
	Mean	**14.9**	**15.0**	**13.9**	**14.6**	**80.9**	**78.5**	**79.0**	**79.5**
Alamas	180	15.1	15.0	14.6	**14.9**	80.1	81.3	79.8	**80.4**
	195	15.3	15.9	14.8	**15.3**	82.6	82.1	79.3	**81.3**
	210	16.8	16.2	15.8	**16.3**	84.6	85.1	83.6	**84.4**
	Mean	**15.7**	**15.7**	**15.1**	**15.5**	**82.4**	**82.8**	**80.9**	**82.1**
Overall mean of harvesting ages	180	15.3	15.1	14.4	**14.9**	80.2	80.2	78.6	**79.7**
	195	16.2	16.4	14.8	**15.8**	82.1	81.4	80.2	**81.2**
	210	17.8	17.3	15.5	**16.9**	84.8	83.5	81.3	**83.2**
Overall mean of sowing dates		**16.4**	**16.3**	**14.9**	-	**82.4**	**81.7**	**80.0**	-

LSD at 0.05 level for:		
Sowing date (A)	0.23	1.2
Varieties (B)	0.86	NS
Harvest age (C)	0.31	0.96
A x B	NS	NS
A x C	0.25	1.8
B x C	NS	NS
A x B x C	NS	NS

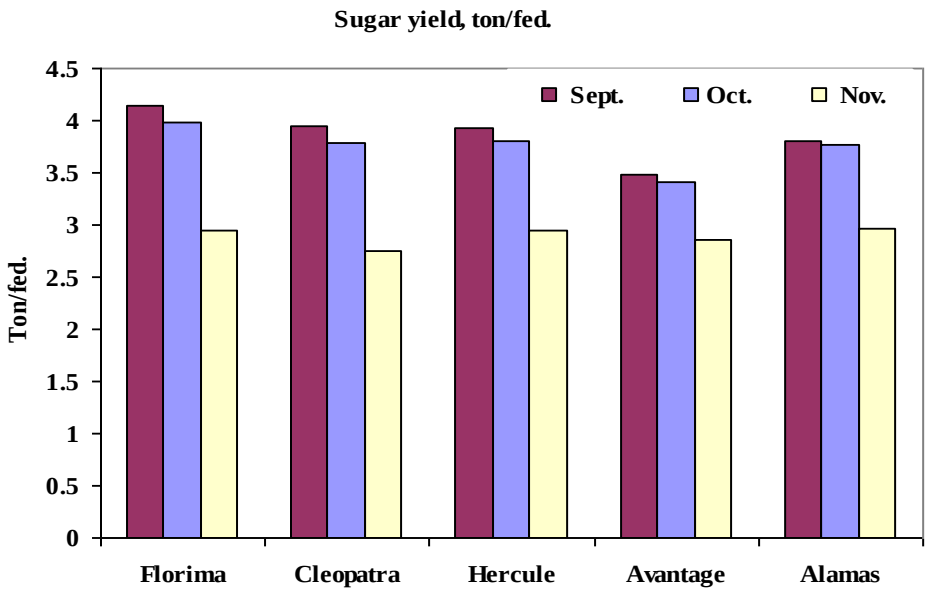

Fig. 3: Relationship between sugar yield and sowing dates for the five sugar beet varieties.

5- Sugar yield/fed:

Results in Table 4 & Fig. 3 show that sugar yield/fed was positively and significantly responded to the early sowing on the 1st of Sept. and 1st Oct. Sowing sugar beet on the 1st of October attained the highest sugar yield followed by 1st September without significant between them; however, both of them statistically surpassed the latest sowing date (1st November). This effect was observed in root yield/fed Table 2, sucrose % and purity Table 3, which could account for the significant increase in sugar yield/fed recorded for the two earlier sowing dates. This result is in agreement with **Mosa (2009)** and **Geddawy *et al* (2007)**.

Data in Table 4 cleared that the tested sugar beet varieties varied significantly in sugar yield/fed. The highest sugar yield was recorded by sugar beet variety Florima. Meantime, there were insignificant differences in sugar yield/fed among Cleopatra, Hercule and Alamas. This finding indicated that root yield played an important in governing the sugar production and hence the sugar yield/fed. Similar results were obtained by **Azzazy *et al*. (2007)**.

Data in Table 4 & Fig. 4 indicate that delaying sugar beet harvesting to 195 and 210 days resulted in a significant increase in sugar yield amounted to 0.53 and 1.01 ton/fed compared to that harvested at 180 days, respectively. The important effect of harvesting date on sugar yield was reported by **Abd El-Razek (2006)**, **Mahmoud *et al*. (2008)** and **El-sheikh *et al* (2009)**. This finding may be due to that increasing days to harvest might have had increased sugar accumulation and in turn sugar yield/fed.

Table 4: Sugar yield (ton/fed.) of the five sugar beet varieties as affected by sowing date and plant age at harvesting (combined over 2008/2009 and 2009/2010 seasons)

Sugar beet varieties	Harvesting age at (days)	Sugar yield (ton/fed.)			
		Sowing date			
		1st Sept.	1st Oct.	1st Nov.	**Mean**
Florima	180	3.33	3.23	2.50	3.02
	195	3.98	4.21	2.99	3.72
	210	5.16	4.54	3.38	4.36
	Mean	**4.15**	**3.99**	**2.95**	**3.70**
Cleopatra	180	3.08	3.14	2.81	3.01
	195	3.79	3.65	2.76	3.40
	210	4.98	4.59	2.70	4.09
	Mean	**3.95**	**3.79**	**2.75**	**3.50**
Hercule	180	3.16	2.93	2.36	2.81
	195	3.92	3.95	3.06	3.64
	210	4.69	4.53	3.39	4.20
	Mean	**3.92**	**3.80**	**2.94**	**3.55**
Avantage	180	2.89	3.07	2.50	2.82
	195	3.41	3.29	2.76	3.15
	210	4.16	3.87	3.33	3.78
	Mean	**3.48**	**3.41**	**2.86**	**3.25**
Alamas	180	3.24	3.15	2.71	3.03
	195	3.65	3.66	2.94	3.41
	210	4.56	4.50	3.57	4.11
	Mean	**3.81**	**3.77**	**2.97**	**3.51**
Overall mean of harvesting ages	180	3.14	3.10	2.57	**2.93**
	195	3.75	3.73	2.90	**3.46**
	210	4.17	4.40	3.27	**3.94**
Overall mean of sowing dates		**3.68**	**3.74**	**2.91**	-

LSD at 0.05 level for:	
Sowing date (A)	0.12
Varieties (B)	0.17
Harvest age (C)	0.04
A x B	NS
A x C	0.43
B x C	NS
A x B x C	NS

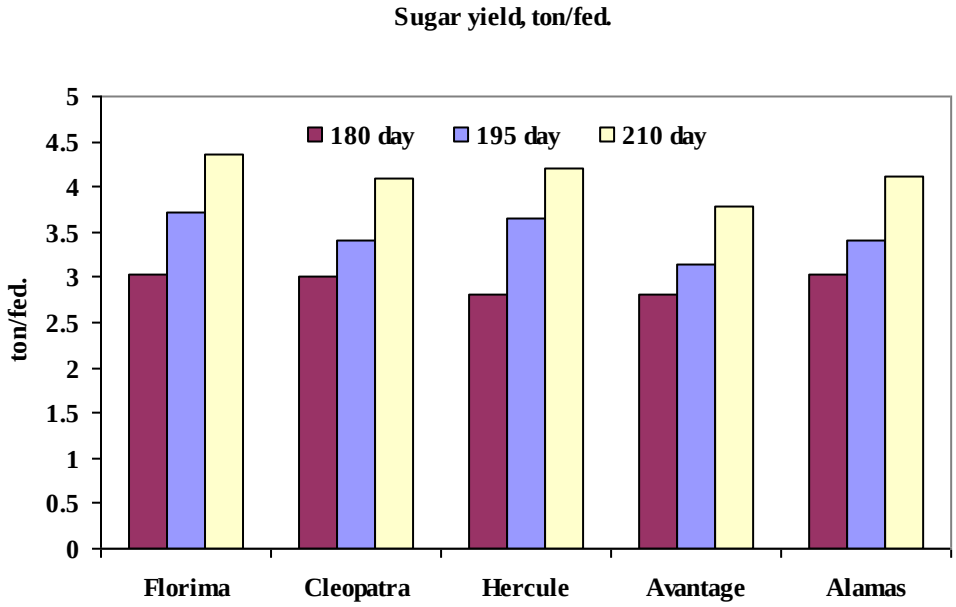

Fig. 4: Relationship between sugar yield and plant age at harvesting for some sugar beet varieties.

Regarding the interactions between the studied factors, it could be observed that the 1st order interaction between sowing date and plant age at harvesting was the only combination which reflected a significant effect on sugar yield/fed. Sowing sugar beet on 1st of September and/or October and harvesting after 210 days from sowing attained the highest at par sugar yield, which amounted to 4.17 and 4.40 ton/fed., respectively.

Since the sugar yield/fed is the main target for sugar beet industry, and hence sugar beet growers, the response equations were calculated to predict the effect of harvest age on sugar yield/fed for the three sowing dates, as indicated below:

$$\hat{Y} \text{ Sept.} = 3.14 + 0.71x - 0.09\ x^2$$
$$\hat{Y} \text{ Oct.} = 3.10 + 0.61x + 0.02\ x^2$$
$$\hat{Y} \text{ Nov.} = 2.57 + 0.31x + 0.02\ x^2$$

These equations clearly indicate a diminishing increase in sugar yield/fed for the early sowing in September, with the delay of harvest from 180 to 210 days after sowing. However, for the other two dates of planting, the increase in sugar yield/fed with the delay of harvest was no diminishing. Therefore, the first response equation of September planting predicted a response of 1.40 ton of sugar yield/fed with delay of harvest up to 239.2 days after sowing, where the sugar yield/fed could be maximized to 4.54 ton/fed instead of only 4.17 ton/fed due to trying harvest at 210 days after sowing. For the other two dates of planting, *i.e.* October and November plantings, the response equations indicated that harvest could have been delayed to more un-predicted days but more than 210 days of the planting as this response was linear.

According to these results, farmers are generally recommended to delay harvest to more than 210 days after planting when they plant sugar beet

particularly in 1st of September in order to maximize their sugar yield/fed. Further studies are needed where harvest is delayed to more than 210 days after sowing taking in consideration the economical point of view from the delay particularly on total net profit from the suggested crop rotation

The question which is raised, is the predicated increase of 0.37 ton of sugar yield/fed which could be obtained if the harvest is delayed to 240 days instead of 210 days after sowing economical? The answer needs further studies in this respect.

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تأثير ميعاد الزراعة والعمر عند الحصاد على محصول وجودة بعض أصناف بنجر السكر

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معهد بحوث المحاصيل السكرية – مركز البحوث الزراعية

أجريت تجربتان حقليتان فى موسمى ٢٠٠٨/٢٠٠٩ و ٢٠٠٩/٢٠١٠ فى محطة البحوث الزراعية بسخا محافظة كفر الشيخ بهدف دراسة إستجابة خمس أصناف عديدة الأجنة من بنجر سكر هى كليوباترا، ألماس، فلوريما، أفنتاج وهيرقل لثلاثة مواعيد زراعة (أول سبتمبر، أول أكتوبر وأول نوفمبر) و ثلاثة أعمار للحصاد (١٨٠، ١٩٥ و ٢١٠ يوماً من الزراعة). إستخدم تصميم القطع المنشقة لكل ميعاد زراعة حيث وضعت أعمار الحصاد في القطع الرئيسية، والأصناف في القطع الشقية وتم عمل التحليل التجميعى لمواعيد الزراعة والسنوات.

* أظهرت النتائج التأثير المعنوى لميعاد الزراعة على كلٍ من النسبة المئوية للسكروز والنقاوة وكذلك محصولي الجذور والسكر للفدان - كما أظهر التحليل التجميعى للموسمين أن الزراعة المبكرة فى أول سبتمبر أو أول أكتوبر أعطت أعلى محصول للجذور والسكر للفدان.
* إختلفت أصناف بنجر السكر معنوياً فى جميع الصفات تحت الدراسة حيث سجل الصنف كليوباترا أعلى قيمة فى النسبة المئوية للسكروز بينما تم الحصول على أعلى قيم لمحصولي الجذور والسكر للفدان عند زراعة الصنفين فلوريما وهيرقل.
* أشارت الدراسة إلي أن أفضل ميعاد لحصاد بنجر السكر هو بعد ٢١٠ يوماً من الزراعة للحصول على أعلى محصول وجودة.
* أثر التفاعل بين الأصناف وميعاد الزراعة معنوياً على محصول الجذور ، وسجل الصنف فلوريما أعلى محصول جذور عند زراعته فى أول سبتمبر، بينما أعطى الصنفين كليوباترا وأفنتاج أعلى محصول جذور عند زراعتهما فى أول أكتوبر.
* وقد تأثرت الصفات تحت الدراسة معنوياً بالتفاعل بين ميعاد الزراعة وعمر المحصول عند الحصاد، وقد أوضحت معادلات الإستجابة التي تم حسابها لمحصول السكر/فدان إمكانية معظمة محصول السكر الي ٤.٥٤ طن/فدان في زراعة أول سبتمبر عند تأخير الحصاد الي ٢٣٩.٢ يوماً (٢٤٠ يوماً)، حيث يمكن تحقيق زيادة قدرها ٠.٣٧ طن سكر/فدان بهذا التأخير وهو ما يحتاج مزيد من البحث في الدراسات المستقبلية للحكم علي العائد الإقتصادي من ذلك.
* وعموماً أوضحت النتائج أنه تحت ظروف هذه الدراسة يمكن زراعة الصنفين فلوريما وهيرقل فى أول سبتمبر أو أول أكتوبرمع حصادهما بعد ٢١٠ يوماً من الزراعة للحصول على أعلى محصول جذور وسكر/فدان.