YIELD AND TECHNOLOGICAL CHARACTERISTICS OF SOME SUGAR BEET CULTIVARS AS AFFECTED BY SOWING AND HARVESTING DATES

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Abstract

Two field experiments were conducted at Mallawi Agricultural Research Station, Minia Governorate in 2002/2003 and 2003/2004 seasons to investigate the effect of sowing and harvesting dates on yield and technological characteristics of some sugar beet cultivars. Planting dates were15 September, 15 October and 15 November. The tested sugar beet cultivars were Gloira, Oscar poly, Allexa and Sofie and the harvesting dates were after 180, 195 and 210 days from sowing. Split-split plot design with three replicates was used in both seasons, where sowing dates were arranged in the main plots, harvesting dates occupied the subplots while the sub-sub plots were assigned for the tested sugar beet cultivars.

The obtained results indicated significant differences in root, recoverable sugar and top yields as well as technological quality characteristics (pol. %, rendement, sugar loss %, quality index, and fiber %) as affected by the studied sugar beet cultivars, sowing and harvesting dates.

The highest root and recoverable sugar yields as well as pol. %, rendement and quality index of sugar beet were achieved by sowing sugar beet on 15th October followed by 15th September and 15th November. Harvesting beets at age of 195 days recorded the highest values of the above mentioned traits followed by 210 and 180 days. Gloria cultivar gave the best values of the same traits followed by Oscar poly, Allexa and Sofie cultivar, respectively.

Sowing Gloria and/or Oscar poly cultivars early on the 15th of October/or September combined with harvesting sugar beet plants at age of 195 days is preferable and recommended for increasing sugar production and grower income under Middle Egypt conditions, Minia Governorate.

Keywords: Sugar beet, planting date, harvesting date, cultivar, pol %, rendement and quality index.

INTRODUCTION

After introducing sugar beet (*Beta vulgaris*, L.) to Egypt and its high adaptability for sowing under various environmental factors in many regions expanded from Northern to Middle Egypt, it became the second source for sugar production.

Abou-Qurkas sugar factory in Minia Governorate is the only one in Egypt which process both sugar cane and sugar beet. Sugar beet has been cultivated commercially in Egypt since 1981 after the establishment of El-Hamoul beet sugar factory in Kafr El-Sheikh Governorate. Sugar recovered from sugar beet represented 28.5 % of the total sugar production in Egypt (1.4 million tons) in 2003.

Sugar beet plants can be grown well during the period from 1st September till 15th December under conditions of Minia Governorate and occupy the field about 7 months. Starting sugar beet sowing from med September till med November will ensure continuous delivery of beets to the mill as long as possible during the crushing season and will reduce large post-harvesting losses in yield and quality of sugar beet under Middle Egypt conditions.

Many investigators showed the effect of sowing and harvesting dates on yields and quality characteristics of sugar beet varieties. Nour *et al.* 1978 recorded higher accumulation rates of assimilates in beet roots as plant age increased. Abou-Shady (1994) obtained an increase in pol % with the progress in plant age with a large difference among the studied sugar beet cultivars in pol and fiber percentages in roots. El-Sayed (1997) revealed that delaying harvesting up to 210 days of age reduced sugar yield. Abou-Salama and El-Syiad (2000) found that early planting of sugar beet on 1st October increased root and sugar yields and gave the best quality parameters. They found that the best sugar recovery percentage was obtained from the combination of early planting and mid-harvesting date. Moreover, they showed that harvesting dates did not significantly affect root yield despite its highly significant effect on theoretical sugar, quality index and sugar yield/fed. They added that quality index was at its maximum in late harvesting at age of 210 days and that that the best rendement of sugar beet was recorded at 195 days of age due to low values of impurities associated with that date. Gobarh (2001) revealed that root and sugar yields, percentages of sugar recovery, pol and impurities (α–amino N, K and Na contents) of sugar beet showed significant response to harvesting dates. He reported that root and sugar yields, sugar recovery % and pol. % of sugar beet increased as harvesting date delayed while the impurities of sugar beet significantly decreased with delaying harvesting from 180 to 210 days after sowing. Fadel (2002) reported that sowing date markedly affected root and sugar yields and that the highest sugar yield was recorded by sowing sugar beet on 15th October. He revealed that delaying sowing date gradually and significantly decreased top yield of sugar beet. Moreover, he

explained that the relative advantage of early sowing on 15th October could be due to the rapid growth and better maturity, consequently higher sugar content. Mohamed (2002) clarified that the decrease in root yield might be due to the increase in consumption of sucrose throughout or during respiration process. He declared that the loss in the weight of leaves at later stages of growth might be mainly attributed to the death of leaves. Moreover, he stated that recoverable sugar yield of sugar beet was affected by root yield, sucrose percentage and impurities content. Also, he obtained an increase in pol %, quality index and fiber % with the progress in plant age. In addition, he revealed that superior values of sugar loss % due to high K, Na or α-amino N contents of beet roots. Abou-El-Magd, *et. al* (2003) disclosed that early planting of sugar beet on 1st October increased root and sugar yields and gave the best quality parameters.

The objective of the present work was to evaluate the effect of sowing and harvesting dates on yield, and chemical composition of some sugar beet cultivars to find out the optimal sowing and harvesting dates of the tested sugar beet cultivars to increase productivity and quality of sugar beet especially under Middle Egypt conditions.

MATERIALS AND METHODS

This work was carried out at Mallawi Agricultural Research Station, Minia Governorate in 2002/2003 and 2003/2004 seasons to investigate the effect of sowing and harvesting dates on yield, technological characteristics of some sugar beet cultivars to obtain the highest yield and quality traits. Sowing dates were 15 September, 15 October and 15 November. The tested sugar beet cultivars were Gloira, Oscar poly, Allexa and Sofie and the harvesting dates were 180, 195 and 210 days from sowing. Treatments were laid out in a split-split plot design with three replicates in both seasons. Sowing dates were arranged in the main plots. Harvesting dates occupied the subplots. The sub-sub plots were assigned for the tested sugar beet cultivars. Sub-sub plot area was 10.5 m^2 including five rows of 60-cm width and 3.5 m long. Nitrogen fertilizer was applied in the form of urea (46.5%) at the recommended rate (70 kg N/fed) in two equal doses, after thinning and 30 days later. Potassium fertilizer (in form of potassium sulfate, 48 % K_2O) at a rate of 24 kg K_2O/fed was added after thinning, while phosphorus fertilizer was added during land preparation at a rate of 30 kg P_2O_5/fed. Soil analyses showed that it was silt clay loam containing

(0.11 and 0.10 % of total N), (11.8 and 11.0 ppm available P), and (0.44 and 0.40 meq/100g soil K) with (pH of 8.10 and 8.0), in the 1st and 2nd season, respectively. Other agricultural practices required for growing sugar beet were carried out as usually practiced in the region.

Recorded data:

Sugar beet plants of the three guarded rows were up-rooted, topped, and weighed to determine:

1. Root yield (ton/fed).
2. Top yield (ton/fed).
3. Recoverable sugar yield (ton/fed) was calculated as described by Mohamed (2002), using the following equation:

Recoverable sugar yield (ton/fed) = roots yield (ton/fed) x rendement

4. Pol % was estimated in fresh samples of sugar beet roots, using saccharemeter according to the method described in A.O.A.C. (1995).
5. Rendement (recoverable sugar percent) was calculated using the following equation according to Abou-Shady (1994):

Rendement = Pol % - [0.29 + 0.343 (K + Na) + α-N (0.094)],

Where: K, Na and α-amin-N were determined as meq/100 g beet, Pol %.

6. Quality index was calculated as shown by Abou- Salama and El-Syaid, (2000) using the following formula:

Quality index % = Rendement % x 100/ Pol, %.

7. Sugar loss % was calculated as mentioned by Mohamed (2002) using the following formula: Sugar loss percent = Pol % - Rendement %.
8. Fiber % of sugar beet roots was determined using the method described in A.O.A.C. (1995).

Data collected were statistically analyzed according to procedure outlined by Snedecor and Cochran, (1980).

RESULTS AND DISCUSSION

1. Root yield:

Data given in Table (1) showed significant differences in root yield/fed at different sowing dates. Root yield increased by 0.82 and 16.33 % by sowing sugar beet on 15th October compared with sowing it on the 15th of September and 15th November, respectively. This might be due to the warm weather conditions prevail in

case of early sowing on September 15th which encountered within the early growth stage of seedlings that could boost their growth, and/or the relatively cooler weather in the late sowing on 15th November. This result is in line with those reported by Abou-Salama and El-Syiad (2000) and Fadel (2002). Root yield of sugar beet was relatively higher in case of sowing it on 15th October than sowing it on 15th September. This may be due to the higher infection by insects and diseases in the early sowing on 15th September than sowing 15th October.

Data in Table (1) showed that root yield of sugar beet was statistically influenced by the studied harvesting dates. Root yield increased by 19.48 and 15.32 % when beet roots were harvested at 195 and 210 days from sowing, respectively, compared with beets harvested at age of 180 days. This may be mainly due to higher accumulation rates of assimilates in beet roots as plant age increased (Nour *et al.* 1978). In addition, it was noticed that root yield of sugar beet harvested at 210 days age was lower than that obtained at 195 days age. Such result could be attributed to the hot weather prevailing at the end of growing season causes senescence of leaves leading to a decrease in root yield at the latest harvesting date at 210 days (Abou-Salama and El-Syiad, 2000). Besides, Mohamed (2002) indicated that the decrease in root yield might be due to the increase in consumption of sucrose throughout or during respiration process.

The results in Table (1) showed a significant difference among the tested sugar beet cultivars in root yield. Gloria variety showed superiority in root yield and recorded 1.57, 4.06 and 5.08 tons/fed higher than Oscar, Allexa and Sofie varieties, respectively. The difference in root yield among beet varieties might be principally due to their genetic variation. Similar finding was also given by Abou-Salama and El-Syiad (2001) who obtained varietal differences in this trait.

The collected data pointed out that root yield was significantly affected by the interactions between the studied factors (Table 1). As for the interaction between sowing and harvesting dates, the results showed insignificant difference in root yield when sugar beet plants were harvested at age of 195 or 210 days for sugar beet sown on 15 November while the differences between harvesting dates in root yield/fed were significant under the other two sowing dates.

Regarding the interaction among sowing dates and sugar beet varieties, the results showed no significant differences in root yields of any of the tested sugar beet varieties in case of sowing it on the 15th of September or 15th October. However, the

differences in root yield/fed produced by beet varieties were significant among theses two sowing dates and 15 November.

Table 1. Effect of sowing and harvesting dates on root yield (ton/fed) of some sugar beet cultivars (combined of 2002/2003 and 2003/2004 seasons).

Sowing date (A)	Harvesting date (days from sowing (B)	Sugar beet cultivars (C)				Mean
		Gloria	Oscar	Allexa	Sofie	
15 September	180	27.26	25.83	24.62	24.19	25.48
	195	33.52	31.22	27.71	25.98	29.61
	210	32.79	29.66	26.47	25.64	28.64
Mean		31.19	28.90	26.27	25.27	27.91
15 October	180	24.72	22.84	22.17	21.44	22.79
	195	35.94	31.77	29.89	28.24	31.46
	210	35.00	31.41	28.13	27.14	30.17
Mean		31.89	28.34	26.73	25.61	28.14
15 November	180	23.11	22.58	20.93	19.81	21.61
	195	28.56	26.35	24.63	23.87	25.85
	210	27.76	25.08	24.25	23.30	25.10
Mean		26.48	24.67	23.27	22.33	24.19
Average of harvesting date	180	26.11	25.58	22.57	21.81	24.02
	195	31.56	29.78	27.41	26.03	28.70
	210	30.76	28.38	26.28	25.36	27.70
Overall mean of varieties		29.48	27.91	25.42	24.40	26.81

L.S.D. at 5% level for: A = 0.90, B = 0.49, C = 0.48, AB = 0.85, AC = 0.84, BC = 0.84, ABC = 1.45

Root yield/fed was significantly influenced by the interaction among harvesting dates and sugar beet varieties. No statistical variance was detected in root yield/fed of Gloria and Sofie varieties in case of harvesting them at age of 195 and/or 210 days, with a significant difference in their root yield when they were harvested at these two harvesting dates and 180 days age. Also, insignificant differences in root yield of Sofie variety (harvested at age of 195 or 210 days) with Oscar and Gloria varieties (harvested at 180 days). Moreover, no marked difference in root yield was found between Allexa and Sofie varieties when they were harvested at age of 180 days.

The 2nd order interaction among the three studied factors had a significant effect on root yield/fed. The results pointed out that sowing any of Gloria, Allexa and Sofie varieties on the 15th of September, October or November and harvesting any of them at age of 195 or 210 days, root yield/fed of each of them did not differ

significantly, with significant difference in root yield of the three varieties sown at the three studied dates with their root yield when they were harvested after 180 days from sowing. Moreover, the results showed no significant difference in root yield of Oscar variety in two cases, the 1st: when it was sown on the 15 of October or November and harvesting it at age of 180 days and the 2nd: when it was sown on the 15 of September or October and harvesting it at age of 195 days, with significant differences in root yields obtained under other sowing and/or harvesting dates. This result prove an evidence of the importance and the need to find out the appropriate sowing and harvesting dates as well as selecting the best sugar beet variety which benefit well from the conditions prevailing under a given region as Mina Governorate.

2. Top yield:

Data collected in Table 2 revealed that top yield of sugar beet significantly decreased as sowing date was delayed from 15th September up to 15th November. This result is in agreement with the findings of Fadel (2002). The difference in top yield was insignificant in case of sowing sugar beet in Mid-October and/or November.

Data in Table (2) show that top yield of sugar beet was gradually and significantly decreased with delaying harvesting date from 180 to 210 days age. Sugar beet plants harvested at 210 days age recorded 6.39 and 2.02 tons of tops/fed lower than those harvested after 180 or 195 days from sowing. Such result could be due to the exposure of plant tops to hot weather and high temperature degrees by the end of the growing season, as harvesting date was delayed, leading to increasing transpiration rate and dehydration of leaves and in turn decreasing their weight. Similar results were obtained by Mohamed (2002).

Data in given in Table (2) showed that the studied four sugar beet cultivars differed significantly in top yield. The highest top yield was obtained from Gloria cultivar while the lowest top yield was recorded by Sofie variety. The differences among the tested sugar beet varieties might be principally due to the genetic variation.

Top yield/fed was significantly affected by the interaction between sowing and harvesting dates. Sowing sugar beet plants on the 15th of October or November resulted in insignificant difference in top yield/fed when beets were harvested at age of 195 days while the differences were significant with those harvested at the same age but sown on 15 September.

Top yield/fed was statistically affected by the interaction of sowing date x sugar beet variety. There were no significant differences in top yield given by all the four varieties whether they were sown on 15 October or 15 November, with significant differences in top yield with 15 September. Moreover, each of Allexa and Sofie varieties produced almost the same top yield when they were sown either in September or November with a marked difference with their top yield given in October.

Table 2. Effect of sowing and harvesting dates on top yield (ton/fed) of some sugar beet cultivars (combined of 2002/2003 and 2003/2004 seasons).

Sowing date (A)	Harvesting date (days from sowing (B)	Sugar beet cultivars (C)				Mean
		Gloria	Oscar	Allexa	Sofie	
15 September	180	26.17	24.79	23.94	24.15	24.76
	195	22.04	20.85	18.93	19.62	19.86
	210	19.42	17.36	16.95	15.39	17.28
Mean		22.54	21.00	19.94	19.05	20.63
15 October	180	24.11	22.91	21.45	20.95	22.35
	195	19.35	19.23	18.62	18.01	18.80
	210	17.79	17.51	16.98	16.98	17.32
Mean		20.42	19.88	19.02	18.64	19.49
15 November	180	24.61	24.41	22.77	21.40	23.30
	195	18.77	18.80	18.90	18.09	18.64
	210	17.44	16.59	15.84	16.67	16.63
Mean		20.27	19.93	19.17	18.72	19.52
Average of harvesting date	180	24.96	24.04	22.72	22.16	23.47
	195	20.05	19.63	18.82	17.90	19.10
	210	18.22	17.15	16.59	16.35	17.08
Overall mean		21.08	20.27	19.37	18.81	19.88

L.S.D. at 5% level for: A = 0.41, B = 0.48, C = 0.48, AB = 0.84, AC = 0.84, BC = 0.84, ABC = 1.45

The results Showed a significant effect of the interactions among harvesting dates and sugar beet varieties on top yield. There was insignificant difference in top yield between Allexa and Sofie varieties when they were harvested at age of 180 days with significant differences with other two varieties at the same harvesting date. At 195 days, the difference in top yield between Oscar variety from one side and each of Gloria and Allexa varieties were insignificant with significant difference with the fourth variety. Similarly, insignificant difference in top yield were detected between (Oscar

and Allexa) and (Allexa and Sofie) with a marked difference with Gloria at harvesting date of 210 days.

Top yield was markedly influenced by the interaction among the three studied factors. Each of Gloria and Sofie varieties produced almost the same top yield when they were harvest at age of 180 days when they were sown on 15 October or November with significant difference in their top yields at the same harvesting date in case of sowing them on 15 September. On the other hand, no significant difference in top yield of Oscar variety when it was sown either on the 15 of September or November and harvested at age of 180 days with a significant difference with that obtained at the same harvesting date and sown on 15 October. Other significant interaction effects of the three studied factors on top yield could be obtained from Table 2.

3. Recoverable sugar yield:

Data in Table (3) elucidate that sowing date of sugar beet had a significant effect on recoverable sugar yield/fed. Sowing sugar beet on 15th October increased sugar yield by 0.15 ton/fed (3.76 %) and 0.93 ton/fed (28.97 %) compared with those produced by sowing on 15th September and November, respectively. This result could be attributed to higher root yield recorded by sowing sugar beet on 15 October in comparison to those produced in September or November (Table 1). This result is in agreement with that reported by Fadel (2002).

Sugar yield was significantly influenced by harvesting date with no significant difference in sugar yield in case of harvesting sugar beet at age of 195 or 210 days. Harvesting beets at age of 195 days increased sugar yield by 33.12 % and 0.24 % compared with those harvested at 180 and 210 days from sowing, respectively. The increase in the recoverable sugar yield sugar beets harvested at 195 days age may be attributed to the increase in dry matter accumulated in the roots, while, the slight reduction in this trait when beets were harvested at age of 210 days might be due to increasing sugar consumption in respiration and formation of new leaves. These findings are in the same line with that illustrated by El-Sayed (1997).

Data in Table (3) demonstrated a significant difference in sugar yield among the tested cultivars. Gloria variety surpassed Oscar, Allexa and Sofie varieties in sugar yield by 0.22 ton/fed (5.53 %), 0.63 ton/fed (17.65 %) and 0.83 ton/fed (24.63 %), successively. This result could be probably referred to the superiority of Gloria variety in root yield over the other varieties (Table 1). These results are in agreement with

that found by Mohamed (2002). It could be pointed out that Gloria cultivar followed by Oscar poly is recommended under conditions of El-Minia Governorate.

Table 3. Effect of sowing and harvesting dates on recoverable sugar yield (ton/fed) of some sugar beet cultivars (combined of 2002/2003 and 2003/2004 seasons).

Sowing date (A)	Harvesting date (days from sowing (B)	Sugar beet cultivars (C)				Mean
		Gloria	Oscar	Allexa	Sofie	
15 September	180	3.44	3.48	3.20	3.12	3.31
	195	5.09	4.52	4.06	3.72	4.34
	210	5.10	4.57	4.00	3.80	4.36
Mean		4.51	4.17	3.75	3.54	3.99
15 October	180	3.28	3.19	2.98	2.84	3.07
	195	5.76	4.65	4.52	4.18	4.76
	210	5.58	4.76	4.32	4.10	4.68
Mean		4.81	4.18	3.91	3.68	4.14
15 November	180	2.75	2.91	2.58	2.44	2.67
	195	3.82	3.62	3.37	3.17	3.49
	210	3.95	3.53	3.34	3.19	3.50
Mean		3.48	3.35	3.09	2.92	3.21
Average of harvesting date	180	3.29	3.44	2.92	2.79	3.11
	195	4.69	4.25	3.97	3.94	4.14
	210	4.69	4.27	3.88	3.69	4.13
Overall mean		4.20	3.98	3.57	3.37	3.78

L.S.D. at 5% level for: A = 0.14, B = 0.07, C = 0.08, AB = 0.13, AC = 0.13, BC = 0.13, ABC = 0.23

Sugar yield was markedly affected by all interactions among the studied factors (Table 3). Delaying harvesting date from 180 to 195 days led to a significant increase in sugar yield, however, further delay of 15 days in harvesting date gave an insignificant increase in this trait, under the three studied sowing dates.

As for the interaction of sowing date x sugar beet variety, no significant difference was found between Gloria and Allexa varieties in sugar yield when they were sown on the 15th of October. However these two varieties were significantly different in sugar yield when they were sown at the 15th of September or November.

Significant interaction effects among harvesting dates and sugar beet varieties on sugar yield were detected. Harvesting Gloria, Oscar or Allexa varieties at age of 195 and/or 210 days resulted in insignificant variation in sugar yield, with significant differences when they were harvested earlier after 180 days after sowing.

Sugar yield was significantly affected by the interaction among the three studied factors. No significant difference in sugar yield between Gloria and Oscar varieties when they were harvested at age of 180 days under the three sowing dates, while the difference between the two varieties was significant in case of harvesting them at 195 and 210 days and sown on the 15th of September and/or October. Also, insignificant difference in sugar yield produced by both Allexa and Sofie varieties when they were harvested at 180 and/or 210 days under the three sowing dates but the difference between them reach the level of significance when they were harvested at 195 days age and sown in September and/or October.

4. Pol percentage:

Results in Table (4) that pol % (sucrose content) of sugar beet roots was significantly affected by sowing date. Sowing sugar beet on 15th October resulted in increasing pol % by 0.35 (2.00 %) and 1.33 (8.09 %) compared with that recorded by sowing it in mid September or November, respectively. This result is in general accordance with that reported by Fadel (2002).

Table 4. Effect of sowing and harvesting dates on pol % (on wet weight basis) for some of sugar beet cultivars (combined of 2002/2003 and 2003/2004 seasons).

Sowing date (A)	Harvesting date (days from sowing (B)	Sugar beet cultivars (C)				Mean
		Gloria	Oscar	Allexa	Sofie	
15 September	180	15.70	16.55	16.04	15.87	16.04
	195	18.34	17.61	17.83	17.42	17.80
	210	18.77	18.59	18.27	18.01	18.41
Mean		17.60	17.58	17.38	17.10	17.42
15 October	180	15.77	17.02	16.46	16.23	16.37
	195	19.12	17.74	18.25	17.87	18.25
	210	19.13	18.81	18.52	18.28	18.68
Mean		18.01	17.86	17.74	17.46	17.77
15 November	180	15.00	16.02	15.41	15.33	15.44
	195	16.60	16.89	16.86	16.44	16.70
	210	17.45	17.31	17.01	16.92	17.17
Mean		16.35	16.74	16.43	16.23	16.44
Average of harvesting date	180	15.49	16.53	15.97	15.81	15.95
	195	18.02	17.41	17.65	17.24	17.58
	210	18.45	18.24	17.93	17.74	18.09
Overall mean		17.32	17.39	17.18	16.93	17.21

L.S.D. 5% A = 0.18, B = 0.17, C = 0.14; AB = 0.29, AC = N.S., BC = 0.25; ABC = 0.43

Ascendant and significant increase in pol % amounted to 1.63 (10.21 %) and 2.14 (13.41%) was recorded when sugar beet harvesting was delayed to 195 and 210 days ages compared with that obtained at the early harvesting date (at age of 180 days), respectively (Table 4). This result might be due to increasing the duration of sugar accumulation which reflected in higher pol % with increasing plant age at harvesting. Such finding is in agreement with those of Abou-Shady (1994) and Mohamed (2002).

Gloria cultivar exhibited a significant superiority over the studied sugar beet cultivars in pol % with no significant difference with Oscar poly cultivar (Table 4). This result is in agreement with that stated by Abou-Shady (1994).

Pol. % was markedly influenced by the interactions among sowing and harvesting dates. Increasing beet plant age at harvesting from 180 to 210 days led to an increase of 1.73 % in pol percentage in case of late sowing on 15 November and a pronounced increase of 2.37 % when sugar beet was sown earlier on 15 September.

No significant effect of the interaction between beet varieties and sowing dates on pol % was detected.

The interaction among beet cultivars and harvesting dates had a significant effect on pol %. There was no significant difference in pol % between Gloria and Oscar varieties when they were harvested at 210 days. Meanwhile, the differences were appreciable when they were harvested at 180 and/or 195 days. Moreover, the difference between Allexa and Sofie cultivars in this trait was insignificant when they were harvested after 180 or 210 days from sowing. However, the difference reached the level of significance at harvesting date of 195 days age.

Pol % was significantly affected by the 2nd or order interaction among the studied factors. Data in Table 4 clarified insignificant differences in pol.% recorded by each of Allexa and/or Sofi varieties sown in mid-September or October and harvested at 180, 195 or 210 days. However, the differences in pol.% of these two varieties were significant when they were harvested at any of the three dates but sown in mid-November. Similarly, Oscar variety recorded almost the same values of pol.% when it was sown on the 15th of September or October and harvested at 195 and 210 days with significant differences with the corresponding values obtained at November sowing date.

5. Rendement:

Rendement is the theoretical sugar yield per cent. Data illustrated in Table (5) clarify that sowing sugar beet on the 15th of October significantly increased rendement by 2.94 and 10.85 % than its values recorded by plants sown on Mid-September or November. The increase in rendement might be mainly due to the increase in sucrose content by sowing sugar beet on 15th October compared with the other studied sowing dates (Table 4). These findings are in the same trend with those obtained by Abou-Salama and El-Syiad (2000).

Table 5. Effect of sowing and harvesting dates on rendement of some sugar beet cultivars (combined of 2002/2003 and 2003/2004 seasons).

Sowing date (A)	Harvesting date (days from sowing (B)	Sugar beet cultivars (C)				Mean
		Gloria	Oscar	Allexa	Sofie	
15 September	180	12.62	13.46	13.01	12.90	13.00
	195	15.19	14.47	14.66	14.32	14.66
	210	15.56	15.40	15.12	14.80	15.22
Mean		14.46	14.44	14.27	14.01	14.29
15 October	180	13.27	13.97	13.46	13.24	13.48
	195	16.03	14.46	15.12	14.79	15.14
	210	15.95	15.64	15.35	15.12	15.52
Mean		15.08	14.75	14.64	14.38	14.71
15 November	180	11.88	12.89	12.34	12.30	12.35
	195	13.37	13.72	13.68	13.27	13.51
	210	14.21	14.08	13.77	13.69	13.94
Mean		13.15	13.56	13.26	13.08	13.27
Average of harvesting date	180	12.59	13.44	12.94	12.81	12.96
	195	14.86	14.27	14.48	15.13	14.44
	210	15.24	15.04	14.75	14.54	14.89
Overall mean		14.23	14.25	14.06	13.82	14.09

L.S.D. at 5% level for: A = 0.15, B = 0.15, C = 0.12; AB = 0.26, AC = 0.22, BC = 0.22; ABC = 0.37

Rendement of sugar beet was significantly influenced by thee interaction between beet cultivars and harvesting dates. Insignificant difference in rendement was detected between Gloria and Oscar harvested at age of 210 days but when they were harvested at 180 and/or 195 days the different reached the level of significance. Moreover, at age of 195 and 210 days compared with those harvested at 180 days

from sowing. Such result is in agreement with that of Abou-Shady (1994) and Abou-Salama and El-Syiad (2000).

Data in Table (5) indicated significant differences in rendement % among the studied sugar beet cultivars. In respect to this trait, Oscar poly variety recorded 0.14, 1.35 and 3.11% higher than Gloria, Allexa and Sofie, respectively.

Rendement percentage was markedly affected by the interaction between the studied sowing and harvesting dates. Increasing beet plant age at harvesting from 180 to 210 days resulted in a progressive and distinguished increase in rendement percentage of 1.59, 2.04 and 2.22 % accompanied the earliness of sowing date from 15 November to October and to September, respectively.

The interaction between sowing dates and sugar beet cultivars had a significant effect on rendement %. The variance between Gloria and Sofie varieties in this trait was insignificant when they were sown earlier on October 15th while the difference was significant between these two varieties under the other two sowing dates. In addition, insignificant variation in rendement % was found between Allexa and Sofie sown on the 15 of November. However, these varieties were significantly different in this trait in case of sowing them in September and October.

Rendement % was markedly affected by the interaction between sugar beet cultivars and harvesting dates. Insignificant difference was found between Gloria and Oscar harvested at 210 days age while they were significantly different in this trait when they were harvested at age of 180 and/or 195 days. Moreover, Allexa and Sofie did not differ significantly at harvesting date of 180 and/or 210 days but the difference between them reached the level of significance at 195 days.

The 2nd order interaction among the three studied factors had a significant effect on rendement %. There was no significant difference in rendement % between Gloria and Sofie varieties harvested at 180 days and sown either on September or October 15th while the difference was significant in November. At harvesting date of 195 days, Oscar and Sofie varieties sown in September or October were insignificantly different in this trait while they were markedly differed in rendement % under November sowing date. The same result was shown by Oscar and Alexa cultivars harvested at age of 210 days (Table 5).

6. Quality index:

Quality index trait represents the proportion of rendement to sucrose % (on wet weight basis) found in the raw material (sugar beet roots). Data in Table (6) show a significant difference in quality index of sugar beet as affected by sowing dates. Quality index increased by 0.77 and 2.41% by sowing sugar beet on 15th October compared with that recorded by sowing it on 15th September and November, respectively. This finding might be due to that rendement was higher with sowing sugar beet on 15th October compared with the other sowing dates (Table 5).

Quality index of sugar beet was significantly affected by harvesting date with insignificant difference in quality index of sugar beet in case of harvesting beets at 195 and/or 210 days of age. Quality index of sugar beet harvested at age of 180 days was 1.42 and 1.63 % lesser than its values recorded when beet roots were harvested at 195 and 210 days of ages. Similar results were recorded by Mohamed (2002). Harvesting of beet roots at 195 and 210 days of age is recommended because high quality index indicates to a reduction in the loss in sugar produced at harvesting compared with the early harvesting date at 180 days of age.

The results in Table (6) showed a significant difference in quality index among the studied sugar beet cultivars. However, differences in this trait were insignificant between Goloria and both Oscar poly and Allexa varieties. The slight increase in this trait obtained from Gloria and Oscar poly compared to Allexa and Sofie cultivars make them recommended.

Quality index was significantly affected by the interaction between sowing and harvesting dates. Insignificant variation in quality index was observed for sugar beet sown on October 15 and harvested at age of 195 and/or 210 days. However, the difference reached the level of significance under September and November 15th sowing dates.

Table 6. Effect of sowing and harvesting dates on quality index for some of sugar beet cultivars (combined of 2002/2003 and 2003/2004 seasons).

Sowing date (A)	Harvesting date (days from sowing (B)	Sugar beet cultivars (C)				Mean
		Gloria	Oscar	Allexa	Sofie	
15 September	180	80.43	81.30	81.14	81.27	81.03
	195	82.86	82.18	82.24	81.91	82.30
	210	82.92	82.83	82.51	82.16	82.60
Mean		82.07	82.10	81.96	81.78	81.98
15 October	180	81.53	82.11	81.78	81.55	81.74
	195	83.81	82.76	82.89	82.69	83.04
	210	83.51	83.14	82.88	82.71	83.06
Mean		82.95	82.67	82.52	82.31	82.61
15 November	180	79.24	80.48	80.15	80.22	80.02
	195	80.59	81.20	81.11	80.74	80.91
	210	81.42	81.36	80.69	80.89	81.09
Mean		80.42	81.01	80.65	80.62	80.67
Average of harvesting date	180	80.40	81.30	81.02	81.01	80.93
	195	82.42	82.05	82.08	81.78	82.08
	210	82.62	82.44	82.03	81.92	82.25
Overall mean		81.81	81.93	81.71	81.57	81.75

L.S.D. at 5% level for: A = 0.20, B = 0.17, C = 0.16, AB = 0.29, AC = 0.28, BC = 0.28, ABC = N.S.

As for the significant interaction between sowing date and sugar beet variety, the results showed insignificant difference in quality index recorded by Gloria, Oscar and Allexa cultivars sown on 15 September with significant differences among them under October and November sowing dates in this trait.

No statistical difference between Allexa and Sofie varieties harvested at age of 180 or 210 days in quality index with a marked difference between them when they were harvested at 195 days. Similarly, harvesting Gloria and Oscar varieties at age of 210 days resulted in insignificant variation between them in quality index with

significant differences at the other two harvesting dates. Quality index was not markedly influenced by the 2nd order interaction among the studied factors.

7. Sugar loss percentage:

Data in Table (7) point out to a significant difference in sugar loss % of sugar beet due to the different sowing dates studied. Sugar loss % decreased by 2.23 and 5.26 % in case of sowing sugar beet on 15th October compared with beets sown on 15th September and November, respectively. This result might be attributed to an increase in impurities especially, alpha amino nitrogen, potassium and sodium contents. These results agree with those obtained by Abou-Salama and El-Syiad (2000) and Mohamed (2002).

The results in Table (7) revealed that harvesting dates had a significant effect on sugar loss% which increased by 5.02 and 7.02 % when beet roots were harvested at age of 195 and 210 days compared to those harvested at 180 days of age. This increase might be attributed to the increase in concentration of imparities such as α-amino N, Na and K with the progress in plant age at harvesting. Such result is in line with that reported by Mohamed (2002).

A significant difference in sugar loss % among the used sugar beet cultivars was detected. Gloria cultivars recorded 1.62, 0.97 and 0.65 % less in the values of sugar loss % compared with Oscar poly, Allexa and Sofie cultivars, respectively.

Sugar loss % was significantly influenced by the interaction between sowing and harvesting dates. The results showed that sugar loss % was not significantly different in case of harvesting sugar beet at age of 195 and 210 days under November sowing date. Meanwhile, the differences in this trait were significant under the other two sowing dates.

There was no significant difference in sugar loss % between Gloria Oscar varieties sown on 15 September or November with a significant difference between them when they were sown on 15 October.

Insignificant variance in sugar loss % between Gloria and Oscar cultivars was detected when they were harvested at ages of 195 and 210 days with a significant difference between them at age of 180 days. In addition, Allexa and Sofie varieties differed markedly in case of harvesting them at age of 195 days. However, when they were harvested at 180 and/or 210 days, no significant difference between these two varieties in this trait was found.

Table 7. Effect of sowing and harvesting dates on sugar loss percentage of some sugar beet cultivars (combined of 2002/2003 and 2003/2004 seasons).

Sowing date (A)	Harvesting date (days from sowing (B)	Sugar beet cultivars (C)				Mean
		Gloria	Oscar	Allexa	Sofie	
15 September	180	3.08	3.09	3.03	2.97	3.04
	195	3.15	3.14	3.17	3.10	3.14
	210	3.21	3.19	3.15	3.21	3.19
Mean		3.14	3.14	3.11	3.09	3.13
15 October	180	2.50	3.05	3.00	2.99	2.89
	195	3.09	3.10	3.13	3.08	3.11
	210	3.18	3.17	3.17	3.16	3.16
Mean		2.93	3.11	3.10	3.08	3.06
15 November	180	3.12	3.13	3.07	3.03	3.09
	195	3.23	3.17	3.18	3.17	3.19
	210	3.24	3.23	3.24	3.23	3.23
Mean		3.20	3.18	3.17	3.15	3.17
Average of harvesting date	180	2.90	3.09	3.03	3.00	2.99
	195	3.16	3.14	3.17	2.11	3.14
	210	3.21	3.20	3.18	3.20	3.20
Overall mean		3.09	3.14	3.12	3.11	3.12

L.S.D. at 5% level for: A = 0.08, B = 0.03, C = 0.03, AB = 0.05, AC = 0.04, BC = 0.04, ABC = 0.20

Concerning the 2nd order interaction, data in Table 7 showed a significant difference in sugar loss % between Gloria and Oscar cultivars harvested at 180 days age and sown on 15 October, without any significant differences between the two cultivars at the same harvesting date under the other two sowing dates. Moreover, sowing Allexa and Sofie varieties on 15 September and/or October and harvesting them at age of 180 days led to significant differences between them in sugar loss % with insignificant variance between the two cultivars harvested at the same age but sown later in November.

8. Fiber percentage:

Fiber content of sugar beet roots represents the insoluble cell wall material, hemicellulose and pectin substances. Data in Table (8) showed that sowing sugar beet on the 15th of October caused a significant reduction in fiber % of beet roots by 0.07 (2.23 %) and 0.17 (5.26 %) compared with those recorded by sowing on 15th September and November, respectively. This result might be due to the increasing in the dry matter.

The results in Table (8) showed that fiber content of beet roots increased significantly by (0.86) 19.20 and (1.30) 29.02 % with delaying harvesting to 195 and 210 days compared with that recorded by harvesting beets at 180 days, respectively. Such finding is in accordance with that of Mohamed (2002).

Table 8. Effect of sowing and harvesting dates on fiber % for some of sugar beet cultivars (combined of 2002/2003 and 2003/2004 seasons).

Sowing date (A)	Harvesting date (days from sowing (B)	Sugar beet cultivars (C)				Mean
		Gloria	Oscar	Allexa	Sofie	
15 September	180	4.23	4.28	5.35	4.51	4.34
	195	5.08	5.14	5.31	5.36	5.22
	210	5.61	5.57	5.70	5.76	5.66
Mean		4.97	5.00	5.12	5.21	5.08
15 October	180	4.14	4.20	4.24	4.48	4.26
	195	5.01	5.03	5.15	5.30	5.12
	210	5.58	5.53	5.29	5.70	5.60
Mean		4.91	4.92	4.99	5.15	4.99
15 November	180	4.78	4.76	4.86	4.97	4.84
	195	5.53	5.68	5.64	5.93	5.67
	210	6.14	6.11	6.05	6.05	6.09
Mean		5.48	5.52	5.52	5.61	5.53
Average of harvesting date	180	4.38	4.41	4.48	4.66	4.48
	195	5.21	5.28	5.37	5.50	5.34
	210	5.77	4.74	5.78	5.83	5.78
Overall mean		5.12	5.14	5.21	5.33	5.20

L.S.D. at 5% level for: A = 0.01, B = 0.03, C = 0.05; AB = N.S., AC = N.S., BC = 0.09; ABC = N.S.

Data in Table (8) illustrated a significant difference among the tested sugar beet in fiber % of beet roots. Gloria cultivar recorded the lowest value in this trait while Sofie cultivar had the highest record of fiber %. Similar observation was found by Abou-Shady (1994) and Mohamed (2002) who obtained a significant difference among the studied sugar beet cultivars in fiber % of beet roots.

Concerning the interaction effects, data in Table 8 cleared that fiber % was significantly influenced by the interaction between sugar beet cultivars and harvesting dates only. It was found that Oscar and Allexa cultivars were significantly different in fiber % when they were harvested at age of 180 or 210 days with a significant variation in this trait in case of harvesting them at age of 195 days.

CONCLUSION

Sowing Gloria and/or Oscar poly cultivar early on the 15th of October/or September combined with harvesting sugar beet plants at age of 195 days is preferable and recommended for increasing sugar production and grower income under conditions of Middle Egypt, Minia Governorate.

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الحاصل والصفات التكنولوجية لبعض أصناف بنجر السكر وتأثرها بمواعيد الزراعة والحصاد

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أقيمت تجربتان حقليتان بمحطة البحوث الزراعية بملوى بمحافظة المنيا خلال موسمى الزراعة ٢٠٠٢ /٢٠٠٣، ٢٠٠٣/٢٠٠٤ لدراسة تأثير ثلاثة مواعيد زراعة هى ١٥ سبتمبر ، ١٥ أكتوبر و ١٥ نوفمبر ، ثلاثة مواعيد حصاد هى ١٨٠ ، ١٩٥ و ٢١٠ يوما من الزراعة لأربعة أصناف من بنجر السكر هى جلوريا ، أوسكار بولى ، أليكسا و صوفى. استخدم تصميم قطع منشقة مرتين حيث شغلت مواعيد الزراعة القطع الرئيسية ، ووضعت مواعيد الحصاد فى القطع الشقية الأولى ووزعت أصناف بنجر السكر عشوائيا فى القطع الشقية الثانية. تتلخص أهم النتائج المتحصل عليها فيما يلى:

* أوضحت النتائج وجود فروق معنوية فى الصفات المحصولية (حاصل الجذور ، حاصل الأوراق وحاصل السكر القابل للاستخراج طن/فدان) وصفات الجودة التكنولوجية (النسبة المئوية للمواد الصلبة الذائبة الكلية ، نسبة ناتج السكر ، معامل الجودة ونسبة السكروز في جذور بنجر السكر) متأثرة بالأصناف ، ومواعيد الزراعة والحصاد المدروسة فى كلا الموسمين.
* دلت النتائج على أن أعلى حاصل من الجذور ، حاصل الأوراق و حاصل السكر القابل للاستخراج طن/فدان وكذلك أعلى قيم للنسبة المئوية للمواد الصلبة الذائبة الكلية ، نسبة ناتج السكر ، معامل الجودة ونسبة السكروز في جذور أصناف بنجر السكر تحت الدراسة قد تحققت بزراعة بنجر السكر فى ١٥ أكتوبر يليه ١٥ سبتمبر ثم ١٥ نوفمبر وحصاد بنجر السكر على عمر ١٩٥ يوما يليه ٢١٠ ثم ١٨٠ يوما على التوالى بأصناف جلوريا يليه أوسكار بولى ، أليكسا ثم صوفى على التوالى .
* من النتائج المتحصل عليها يمكن التوصية بزراعة الصنف جلوريا و/أو أوسكار بولى مبكرا فى ١٥ اكتوبر أو ١٥سبتمبر والحصاد على عمر ١٩٥ يوما لزيادة ناتج السكر ودخل المزراع تحت ظروف محافظة المنيا.