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RESEARCH ARTICLE

Response of some sugar beet (*Beta vulgaris* L.) varieties to different harvesting dates under Middle Egypt conditions.

Nareyman N. Kenawy [1] and S.R. Nagib [2]*

[1] *Sugar Crops Research Institute, Agricultural Research Center, 12619 Giza, Egypt*
[2] *Agronomy Department, Faculty of Agriculture, Minia University, 61519 Minia, Egypt.*

Abstract

Two field experiments were conducted at a private farm located at Ehnasya, Beni-suif , Governorate, Egypt (Middle Egypt) during 2021/2022 and 2022/2023 seasons to investigate the influence of three harvesting dates (D_1=195 , D_2=215 and D_3=235 days after sowing) on yield, its attributes and quality traits for six sugar beet varieties (V_1= Goran, V_2= Nazarn, V_3= Faraida, V_4=Bts 3880 , V_5 =Halawa and V_6=Hosam). Each experiment was conducted as a randomized complete blocks design (RCBD) in a split-plot arrangement with three replications. Harvesting dates were allocated in the main plots and sugar beet varieties were assigned to the sub-plots in both seasons. Results showed that: harvest date had a significant effect on root and sugar yields, Pol**.** **%**, RSY, LS, RS %, P % and Q_Z % in both seasons, delaying harvest date from 195 day to 215 or 235 days increased root, sugar yields (ton/fed.), yield attributes and most of studied quality traits in both seasons, while earlier harvest date improved LS (ton/fed.) and α N %. Sugar beet variety Hossam (v_6) followed by Halawa variety (v_5) surpassed all others tested varieties for root, sugar yields and generality of quality parameters. In addition, the interaction between the studied factors had a highly significant influence on most studied traits in both seasons. Thus, the highest root and recoverable sugar yields were obtained from cultivation Hossam variety and harvested it after 215 day in the first season and after 235 day in the second. Finally, we can be recommended that sowing sugar beet variety Hossam or Halawa and harvested after 215 or 235 days from planting to improve the yield and quality of sugar beet under Middle Egypt conditions.

Keywords: sugar beet; varieties; harvest date; yield and quality.

1. Introduction

In the world sugar beet (*Beta vulgaris* L.) ranks the second important sugar crops after sugar cane, it represents 12.5% from total world sugar crops area producing about 38% of total world sugar production, recently in Egypt sugar beet ranks the first important and strategic industrial crops, the total sugar beet cultivated area in Egypt reached 597923 fed. producing about 61.20 % of total sugar production, a local gap between sugar consumption and production is 17.00% imports from foreign countries (CCSC.,2022). Increasing the cultivated area and yield of beets currently is an urgent necessity to reduce this gap.

Harvest date is one of the generality important factors that plays a vital and critical role in yielded and quality of sugar beet, a many of authors indicated the effect of harvest date in yield and quality of sugar beet, Abo- El Magd *et al*. (2003) stated that delay harvest beets significantly increase root and sugar yields/fed, sucrose% and decreased Na, K and α N% in both seasons.; Aly (2006) indicated that there were positively increased by delaying harvest dates from 170, 190 to 210 days from planting in root

***Corresponding author: Samy Ramsis Nagib**
Email: sami.nagib@mu.edu.eg
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and sugar yields/fed were, meanwhile early harvest date at 170 day gave the highest value of Na and K%. Per contra Abd El-Razek and Ghonema (2016) indicated that delaying harvest age from 170, 190 and to 210 days increased root, sugar yields as well as sucrose%, purity% and impurities values. Azzazy *et al.* (2007), Mahmoud *et al.* (2008), El-Sheikh *et al.* (2009) and Shalaby *et al*. (2011) illustrated that root weight, sucrose%, impurities, *i.e.* Na% and K%, root and sugar yields/fed differed significantly when delaying harvest date from 180 to 210 days in both seasons. Nagib *et al.* (2018) observed that harvest age had a significant effect on all studied traits in both seasons. Beets harvested at older age (210 days after sowing) surpassed those harvested earlier (180 days after sowing) in all traits in both seasons, except loss in sugar yield/fed., purity % and α-amino-N%. Lamiae *et al.* (2021) cleared that the suitable harvest date is one of the most important factors for a good sugar yield and quality of sugar beet.

Sugar beet seeds sown in Egypt were imported from foreign countries and had large differences in gene make- up expression in its root yield and quality characteristics, therefor it well be tested annually under Egypt conditions to obtained the best varieties in yield and quality. Ramadan and Nassar (2004), Azzazy, *et al.* (2007), Enan, *et al*. (2009), Abd El-Aal, *et al*. (2010) and Enan, *et al*. (2011) found great variation among sugar beet varieties in yield, quality and its components. Aly, *et al.* (2011) and Aly, *et al.* (2012) indicated that sugar beet varieties differed significantly in all studies traits, Kawemira variety surpassed all tested varieties in root and sugar yields/fed, while, LP12 and Demapoly had the highest value for sucrose, extraction sugar and extractability percentages. Ahmed *et al.* (2017) and Aly (2012) cleared that sugar beet varieties differed significantly in root and sugar yields/fed. as well as sucrose, purity, impurities percentages. Nagib *et al.* (2018) demonstrated that all tested sugar beet varieties varied significantly in all studied traits in both seasons. Beta 398variety recorded the best values of TSS%, root and sugar yields/ fed. Drena variety recorded the best values of sucrose %, loss in sugar/fed. and sugar recovery percentage (SR %), meanwhile Lammia variety had the best values of purity% and α-amino- N%, while the good value of alkalinity coefficient was obtained by Kosmas variety in both seasons. Halvorson *et al.*, (1978) and Halvorson and Hartman, (1980) illustrated that some of the studied sugar beet genotypes considered promoted as high sugar content genotypes adaptable for early harvest and large genotype differences in root tissue production.

Therefore, this research was designed to define the impact of some sugar beet varieties under different harvest ages on yield and quality under Middle Egypt conditions.

2. Materials and Methods

Two field trials were carried out at a private farm located at Ehnasya, Beni-suif , Egypt(Middle Egypt). Latitude of 29º 00' 49" N and longitude of 30º 57' 00" E and altitude of 26 m above sea level, during 2021/2022 and 2022/20123 seasons to investigate the impact of three harvest dates (195, 215 and 235 days after sowing) on yield, its attributes and quality of six sugar beet varieties (Goran, Nazarn, Faraida, Bts 3880, Halawa and Hossam). Each experiment was conducted as a randomized complete blocks design (RCBD) in a split-plot arrangement with three replications. Harvesting dates were allocated in the main plots and sugar beet varieties were assigned to the sub plots in both seasons. Each sub- plot consisted of 5 ridges, 3.5 m in length and 0.6 cm in width. The area of each sub-plot was 10.5 m^2. Sugar beet seeds were planted on 15th and 20th of October in the 1st and 2nd seasons, respectively in hills 20 cm apart, plants were thinned to one plant per hill after 30 days from sowing. In both seasons, preceding summer crop was maize (*Zea mays* L.). Nitrogen fertilizer was applied as ammonium nitrate (33.5 % N) at the rate of 80 kg N/fed, in two equal doses; one after thinning and before the

irrigation at 4 leaf stage (30 days from sowing), the other one month later, plants were thinned to one plant per hill. Potassium was added with the second nitrogen dose at the rate of 50 kg K_2O/fed as potassium sulfate (48% K_2O), Phosphorus fertilizer was added at seed bed preparation at the rate of 30 kg P_2O_5/fed as calcium super-phosphate 15.5% P_2O_5. The other agricultural practices for growing sugar beet were done as recommended by Ministry of Agriculture.

2.1. The recorded data

2.1.1. Root yield/fed. (ton):

Two guarded rows of each sub plot were harvested, topped, cleaned and weighted in kg, and then it was converted to tons to estimate:

1-1- Root yield/ fed. (ton) (RY).

2.1.2. Sugar quality characters:

2-1- Sucrose percentage (Pol. %) was polarimetrically determined by using saccharometer according to the methods of Le-Docte, (1927).

2-2- Purity percentage (P %) was calculated using the following formula according to Devillers (1988): Purity % = 99.36 – [14.27 (Na + K + α-amino N)/sucrose %].

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

2-3- Impurities content, i.e. α-N %, Na % and K % as milliequivalent/100 g beet were estimated according to A.O.A.C. (2005).

2-4- Alkalinity coefficient (A C) was calculated according to the following equation: A C= K% +Na % / α- amino-N %.

2-5- Recoverable sugar % (RS %) (crystal sugar) was calculated according to the following formula:

RS%= pol. % - [0.343 (Na% +K %) + 0.094 ×α-amino-N % + 0.29] according to Reinefeld *et al.* (1974)

2-6- Quality index (Q_z): Q_z= RS% x 100/ pol.%.

2.1.3. Sugar yield characters:

3-1-Sugar yield/fed (ton) (SY) = root yield/fed (ton) × Pol. %.

3-2-Recoverable sugar yield/fed (ton) (RSY) = root yield/fed (ton) × Recoverable sugar %.

3-3-Sugars lost to molasses percentage (LS %) was calculated as described by Devillers (1988) using the following equation: SLM% = [0.14 (Na + K) + 0.25 (α-amino-N) + 0.5]

Loss in sugar % (LS %) = Sucrose % - Recoverable sugar %.

3-4- Loss sugar yield/fed (ton) (LS) = root yield (ton/fed) × loss sugar %.

2.2. Statistical analysis

The recorded data were statistically analyzed according to technique of analysis of variance (ANOVA) by means of "MSTAT-C" software computer package according to the method described by Gomez and Gomez (1984) and least significant differences (LSD) test at 5% level of probability was used to compare treatment means.

3. Results and discussion

3.1. Influence of harvesting dates on yield and quality

3.1.1. Influence of harvesting dates on root and sugar yields (ton/fed)

Harvest date exhibited highly significant effect on root and sugar yields (ton/fed.) in both seasons as showed in Table 1. The third harvest date D_3 increased root yield (RY) by (24.16, 16.50, 13.57 and 7.15%) and sugar yield (SY) by (19.43, 18.37, 2.84 and 4.76 %) as compared with 1st and 2nd (D_1 and D_2) harvest date in the first and second seasons, respectively. such effect may be due to delaying beet harvest allow to increase growth period and photosynthesis of sugar beet plants which led to an increase in root and sugar yields (ton/fed.). These results are harmony with those obtained by Abd El-Razek and Ghonema (2016), Nagib *et al.* (2018) and Lamiae *et al.* (2021).

Table 1. Means of sugar beet yield and quality at harvest as affected by harvesting dates in 2021/2022 and 2022/2023 seasons.

Characters / Treatments		RY	Pol.%	SY	RSY	LS	RS%	LS%	impurities %			P%	AC	Q_Z%
									K%	Na%	α N%			
2021/ 2022														
A:Harvestage	D_1	24.26	17.46	4.26	3.55	0.71	14.54	2.92	3.02	4.28	1.31	92.30	5.75	83.23
	D_2	27.65	18.46	5.13	4.33	0.81	15.53	2.93	3.02	4.30	1.44	92.59	5.08	84.10
	D_3	31.99	16.58	5.28	4.32	0.95	13.62	2.96	3.10	4.29	1.44	91.75	5.15	82.13
F-test		**	**	**	**	**	**	N.S	N.S	N.S	*	*	N.S	*
$LSD_{0.05}$		1.53	0.25	0.22	0.18	0.10	0.39	-	-	-	0.09	0.65	-	1.56
2022/ 2023														
A:Harvestage	D_1	28.38	16.81	4.80	3.99	0.79	14.03	2.78	2.97	3.91	1.35	92.36	5.11	83.47
	D_2	31.56	18.21	5.60	4.89	0.85	15.49	2.72	2.88	3.83	1.30	93.07	5.22	85.07
	D_3	33.99	17.02	5.88	4.83	0.95	14.21	2.81	3.16	3.78	1.45	92.32	4.84	83.48
F-test		**	**	**	**	**	**	N.S	N.S	N.S	N.S	*	N.S	*
$LSD_{0.05}$		1.02	0.55	0.46	0.29	0.07	0.56	-	-	-	-	0.41	-	0.95
D=		D_1=195 days ago ,D_2= 215 days ago and D_3=235 days ago												

RY=root yield ton/fed.; Pol%= Sucrose %;SY= sugar yield ton/fed.; RSY= recoverable sugar yield ton/fed.; LS= Loss sugar yield ton/fed.; RS%= recoverable sugar %; LS%= Loss in sugar %; P%= purity %; AC= Alkalinity coefficient; Q_Z%= quality index

3.1.2. Influence of harvesting dates on quality characters

Concerning to the effect of harvest date on quality parameters it was evident that harvest date had a highly significant effect on sucrose% (Pol. %), recoverable sugar yield ton/fed. (RSY), Loss sugar yield ton/fed. (LS) and recoverable sugar % (RS %), significant effect on purity % (P %) and quality index (Q_Z %) in both seasons, meanwhile α N % differed significantly in the first season only. The second harvest date D_2 cleared the highest Pol. % (18.46 and 18.21 %), RS % (15.53 and 15.49 %) in the first and second seasons, respectively and α N % equally with D_3 of 1.44 % in the first season, as well as improved without significant different with D_3 P % of 92.59 and 93.07 %, Q_Z % of 84.10 and 85.07 % and RSY of 4.33 and 4.89 (ton/fed.) in the 1st and 2nd seasons, respectively. on contrary the first harvest date D_1 recorded favorable values for LS of 0.71 and 0.79 (ton/fed.) in the 1st and 2nd seasons, respectively. and α N % of 1.31 % in the 1st season and lowest values for RSY of 3.55 and 3.99 and 3.99 (ton/fed.) in the 1st and 2nd seasons, respectively, Pol**. %** of 16.81%, RS % of 14.03 % and Q_Z % of 83.47% in the second season. However, the third harvest date (D_3) obtained unfavorable values for Pol. % of 16.58 % and RS % of 13.62 % in the first season and LS of 0.95 and 0.95 ton/ fed. and P% of 91.75 and 92.32 in the 1st and 2nd seasons, respectively. Our results were coincided by those cleared by Azzazy *et al.* (2007), Mahmoud *et al.* (2008, El-Sheikh *et al.* (2009) and Lamiae *et al.* (2021).

3.2. Influence of varieties on yield and quality:

3.2.1. Influence of varieties on root and sugar yields (ton/fed)

Data presented in Table 2 illustrated that, all of root and sugar yields (ton/fed) differed high significantly in both seasons as affected by the tested varieties. Sugar beet variety Hossam (v_6) showed the highest mean values for root yield of 34.66 and 36.82 (ton/fed.) and sugar yield of 6.34 and 6.53(ton/fed.) in the first and second seasons, respectively, followed by Halawa sugar beet variety (v_5)in both seasons. While the lowest mean values of root yield (20.47 and 24.21 ton/fed.) and sugar yield (3.60 and 4.26 ton/fed.) detected by Nazarn sugar beet variety (v_2) in the first and second seasons, respectively, followed by Goran sugar beet variety (v_1) in both seasons. The variance between studied sugar beet varieties may be due to variance genetic structure between

varieties and their response to prevailing environment condition in this country. Similar results were cleared by Hartman, (19800, Enan, *et al*. (2009), Abd El-Aal, *et al*. (2010) and Nagib *et al.* (2018).

Table 2. Means of sugar beet yield and quality at harvest as affected by different varieties in 2021/2022 and 2022/2023 seasons.

Characters / Treatments		RY	Pol.%	SY	RSY	LS	RS%	LS%	impurities %			P%	AC	Q_Z%
									K%	Na%	α N%			
		2021/ 2022												
B:Varieties	V_1	23.36	16.99	3.97	3.32	0.65	14.21	2.77	2.89	3.95	1.46	92.38	4.70	83.65
	V_2	20.47	17.56	3.60	3.00	0.59	14.66	2.90	2.93	4.32	1.28	92.42	5.88	83.48
	V_3	25.65	17.31	4.46	3.68	0.78	14.28	3.04	3.12	4.50	1.39	91.91	5.51	82.42
	V_4	31.30	17.17	5.35	4.41	0.94	14.18	2.99	3.07	4.41	1.38	91.96	5.48	82.53
	V_5	32.36	17.52	5.64	4.68	0.96	14.55	2.97	3.12	4.29	1.46	92.10	5.10	82.97
	V_6	34.66	18.45	6.34	5.31	1.03	15.49	2.96	3.12	4.27	1.40	92.50	530	83.84
F-test		**	**	**	**	**	**	**	N.S	**	**	**	**	**
LSD $_{0.05}$		1.26	0.43	0.28	0.24	0.05	0.42	0.10	-	0.19	0.08	0.27	0.39	0.62
		2022/ 2023												
B:Varieties	V_1	26.69	16.67	4.58	3.75	0.70	14.05	2.62	2.72	3.68	1.43	92.64	4.51	84.26
	V_2	24.21	17.60	4.26	3.54	0.72	14.62	2.97	3.48	3.96	1.36	92.21	5.48	83.08
	V_3	30.96	17.61	5.27	4.57	0.89	14.73	2.87	3.09	4.04	1.43	92.37	5.03	83.58
	V_4	34.09	17.21	5.88	4.94	0.92	14.52	2.69	2.74	3.89	1.31	92.76	5.22	84.35
	V_5	35.07	17.32	6.03	5.11	0.97	14.55	2.77	3.09	3.77	1.33	92.62	5.19	84.03
	V_6	36.82	17.67	6.53	5.52	0.99	14.98	2.69	2.93	3.70	1.35	92.90	4.90	84.75
F-test		**	**	**	**	**	**	**	**	**	N.S	**	**	**
LSD $_{0.05}$		0.87	0.42	0.37	0.15	0.03	0.37	0.08	0.18	0.16	-	0.19	0.41	0.45
V:		V_1= Goran, V_2= Nazarn, V_3= Faraida, V_4=Bts 3880 , V_5 =Halawa and V_6=Hossam												

RY=root yield ton/fed.; Pol%= Sucrose %;SY= sugar yield ton/fed.; RSY= recoverable sugar yield ton/fed.; LS= Loss sugar yield ton/fed.; RS%= recoverable sugar %; LS%= Loss in sugar %; P%= purity %; AC= Alkalinity coefficient; Q_Z%= quality index.

3.2.2. Influence of varieties on quality characters

Regarding the impact of varieties on quality characters, it was concluded that sugar beet varieties had a highly significant effect on all studied quality traits except K % in the first season and α N% in the second one. The variety Hossam (V_6) cleared the highest mean values of pol. % (18.45 and 17.76 %), RSY (5.31 and 5.52 ton/fed.), RS % (15.49 and 14.98 %), P % (92.50 and 92.90 %) and Q_Z % (83.84 and 84.75) in the first and second seasons, respectively and unfavorable values for LS (1.03 and 0.99 ton/fed.) followed by Halawa variety (V_5) (0.96 and 0.97 ton/fed.) in the first and second seasons, respectively, meanwhile variety Goran (V_1) recorded the lowest average values of pol. % (16.99 and 16.67 %) , LS % (2.77 and 2.62 %) , Na % (3.95 and 3.68 %) and AC (4.70 and 4.51) in both seasons, respectively as well as RS % (14.05 %) in the 2nd one . While the lowest mean values for RSY in both seasons of 3.00 and 3.54 (ton/fed.), α N % in the 1st one of 1.28 %, P % (92.21 %) and Q_Z % (83.08 %) in the second one as well as unfavorable AC of 5.88 and 5.48 in both seasons respectively and LS% (2.97%) in the second season detected by Nazarn variety (V_2). Faraida sugar beet variety (V_3) obtained the highest Na % (4.50 and 4.045 in the two respective seasons) and LS % (3.04 % in the first season), otherwise it had the lowest average values for P % (91.91 %) and Q_Z % (82.42 %) in the first season. Moreover, the lowest RS% (14.18%) in the first season achieved by sugar beet variety Bts 3880 (V_4) followed by Goran (V_1). The differences among the tested sugar beet varieties for studied quality characters may be due to the differences in genetic makeup and the

interaction between these genetic makeup with prevailing environmental conditions such as relative humidity, temperature and light The results of Aly *et al.* (2011), Aly *et al.* (2012) and Nagib *et al.* (2018) supported our findings.

3.3. Influence of the interaction between harvesting dates and sugar beet varieties on yield and quality

3.3.1. Influence of the interaction between harvesting dates and sugar beet varieties on root and sugar yields (ton/fed)

The results in Tables 3 and 4 showed that, there were significant and highly significant effect for the interaction between harvest date and sugar beet varieties on all studied traits except, K % in the first season and SY (ton/ fed.) in the second season. Regarding to the interaction effect, it was be noticed that the later harvest date (D_3) 235 days with Hossam sugar beet variety (V_6) increased RY of 40.86 and 39.84 (ton/fed.) and SY of 6.78(ton/fed.) in both and first season, respectively followed by $D_3 \times V_5$ (235 days with Halawa variety) for the two previous traits in both seasons. While, early harvest date D_1 (195 days) with Nazarn variety (V_2) recorded the lowest RY of 19.56 and 22.97(ton/fed.) followed by $D_2 \times V_2$ (215 days with Nazarn variety) of 19.56 and 24.20(ton/fed.). Furthermore, harvested sugar beet variety Goran early at 195 days ($D_1 \times V_1$) decreased SY of 3.43 (ton/fed.) followed by $D_1 \times V_2$ (195 days with Nazarn variety) of 3.44 (ton/fed.) in the first season.

Table 3. Sugar beet yield and quality at harvest as affected by the interaction between harvest date and sugar beet varieties in 2021/2022 season.

C:Interaction A×B	Characters / Treatments	2021/ 2022												
		RY	Pol.%	SY	RSY	LS	RS%	LS%	impurities%			P%	AC	Q_Z%
									K%	Na%	αN%			
	$D_1 \times V_1$	20.91	16.40	3.43	2.86	0.57	13.66	2.74	2.95	3.76	1.55	92.16	4.36	83.27
	$D_1 \times V_2$	19.56	17.57	3.44	2.87	0.57	14.67	2.90	2.89	4.45	0.97	92.61	7.60	83.50
	$D_1 \times V_3$	22.24	17.03	3.79	3.12	0.67	14.00	3.03	3.10	4.53	1.30	91.86	5.86	82.18
	$D_1 \times V_4$	26.65	16.80	4.48	3.71	0.78	13.89	2.91	3.01	4.27	1.27	92.09	5.86	82.69
	$D_1 \times V_5$	26.81	17.71	4.75	3.91	0.84	14.58	3.13	3.18	4.70	1.43	91.85	5.52	82.33
	$D_1 \times V_6$	29.39	19.23	5.65	4.83	0.82	16.42	2.81	2.99	3.99	1.31	93.20	5.33	85.38
	$D_2 \times V_1$	21.63	17.53	3.79	3.18	0.61	14.71	2.83	2.81	4.19	1.46	92.47	4.80	83.86
	$D_2 \times V_2$	20.49	18.05	3.70	3.09	0.61	15.08	2.97	3.08	4.33	1.50	92.32	4.94	83.55
	$D_2 \times V_3$	29.35	18.40	5.40	4.51	0.89	15.36	3.04	3.10	4.53	1.39	92.36	5.48	83.48
	$D_2 \times V_4$	29.28	18.73	5.49	4.60	0.89	15.70	3.03	3.07	4.53	1.41	92.49	5.40	83.82
	$D_2 \times V_5$	31.43	18.53	5.83	4.97	0.86	15.80	2.73	2.88	3.85	1.42	93.09	4.75	85.27
	$D_2 \times V_6$	33.74	19.53	6.59	5.57	1.01	16.53	3.00	3.15	4.36	1.47	92.80	5.13	84.62
	$D_3 \times V_1$	27.54	17.03	4.69	3.93	0.76	14.27	2.76	2.92	3.89	1.38	92.50	4.93	83.82
	$D_3 \times V_2$	21.37	17.06	3.65	3.04	0.61	14.23	2.83	2.83	4.20	1.38	92.32	5.09	83.40
	$D_3 \times V_3$	25.38	16.50	4.19	3.42	0.77	13.47	3.03	3.16	4.44	1.46	91.52	5.21	81.61
	$D_3 \times V_4$	37.95	15.98	6.07	4.92	1.15	12.96	3.02	3.12	4.44	1.46	91.30	5.20	81.09
	$D_3 \times V_5$	38.83	16.32	6.34	5.15	1.18	13.27	3.05	3.31	4.32	1.52	91.36	5.03	81.32
	$D_3 \times V_6$	40.86	16.60	6.78	5.53	1.25	13.53	3.07	3.23	4.47	1.42	91.51	5.44	81.53
	F-test	**	**	**	**	**	**	**	N.S	**	**	**	**	**
	$LSD_{0.05}$	2.29	0.70	0.47	0.40	0.11	0.71	0.27	-	0.45	0.14	0.68	0.82	1.63

RY=root yield ton/fed.; Pol%= Sucrose %;SY= sugar yield ton/fed.; RSY= recoverable sugar yield ton/fed.; LS= Loss sugar yield ton/fed.; RS%= recoverable sugar %; LS%= Loss in sugar %; P%= purity %; AC= Alkalinity coefficient; Q_Z%= quality index.

3.3.2. Influence of the interaction between harvesting dates and sugar beet varieties on quality characters

Regarding, the presented data in Tables 3 and 4 demonstrated that the highest pol. % of 19.53 and 19.03 % achieved by harvested sugar beet varieties Hossam (V_6) and Faraida (V_3) after 215 days (D_2) in the 1st and 2nd seasons, respectively, meanwhile $D_3 \times V_4$ in the first season and $D_1 \times V_1$ in the second season recoded the lowest pol. % of 15.98 and 15.67 % respectively. The later harvest date (D_3) with Hossam variety (V_6)

recorded the high values for RSY of 5.53 and 5.93 (t/ f) and LS of 1.25 and 1.08 (t/ f) in the two seasons, respectively, on the other side $D_1 \times V_1$ cleared the lowest RSY of 2.86 (t/f) in the first season and LS in both seasons of 0.57 and 0.64 (equally with $D_1 \times V_2$ in the 1st one). The favorable RS % 16.53 and 16.32% detected by second harvest date (D_2) with Hossam variety (V_6) in the first season and with Faraida variety (V_3) in the second one, while harvest Bts variety (V_4) later (D_3) decreased RS % of 12.96 % , P % of 91.30 % and Q_Z % of 81.09 % in the 1st season as well as $D_3 \times V_3$ showed the lowest RS% of 13.64% , P% of 91.62% , Q_Z% of 81.85% and highest Na % of 4.07 % in the 2nd season. On contrary early harvest date (D_1) and Hossam variety (V_6) obtained the favorite values for P % of 93.20 % and Q_Z% of 85.38 % in the 1st season, and recorded with second harvest date (D_2) in the second season highest P % of 93.60 %, Q_Z % of 86.37 %, lowest LS % of 2.48 % and K % of 2.58 %, meanwhile $D_2 \times V_5$ recorded the lowest LS % of 2.73 % in the first season. On the other hand $D_3 \times V_2$ yielded unfavorable LS % of 3.03 % and K % of 3.67 % in the 2nd one as well as $D_1 \times V_5$ showed unfavorable LS% of 3.13 % and Na % of 4.70 % in the 1st season. Harvested sugar beet variety Goran after 195 days from planting ($D_1 \times V_1$) obtained the best values for Na % of 3.76.70 %, AC of 4.36 and highest α N % of 1.55 % in the 1st season. Moreover, later harvest date (D_3) with Goran variety ($D_3 \times V_1$) achieved highest α N % of 1.52 % and lowest AC of 4.31 in the second season. The lowest α N % of 0.97 % and highest AC of 7.60 in the 1st season cleared by early harvest date with Nazarn sugar beet variety ($D_1 \times V_2$). The lowest values for Na % of 3.40 %, α N % of 1.07 % and highest AC of 5.68 in the second season were obtained by $D_3 \times V_5$, $D_2 \times V_4$ and $D_2 \times V_5$ in the second season, respectively.

Table 4. Means of sugar beet yield and quality at harvest as affected by the interaction between harvest date and sugar beet varieties in 2022/2023 season.

Treatments \ Characters		2022/ 2023												
		RY	Pol.%	SY	RSY	LS	RS%	LS%	impurities %			P%	AC	Q_Z%
									K%	Na%	αN%			
C:Interaction A×B	$D_1 \times V_1$	24.72	15.76	3.89	3.25	0.64	13.17	2.59	2.62	3.69	1.41	92.36	4.48	83.57
	$D_1 \times V_2$	22.97	16.79	3.86	3.19	0.67	13.88	2.91	3.35	3.94	1.29	92.06	5.65	82.64
	$D_1 \times V_3$	25.65	17.12	4.39	3.65	0.74	14.24	2.88	3.13	4.05	1.37	92.24	5.29	83.17
	$D_1 \times V_4$	31.22	17.28	5.39	4.54	0.85	14.56	2.72	2.79	3.93	1.35	92.69	4.99	84.25
	$D_1 \times V_5$	32.02	16.71	5.35	4.49	0.86	14.01	2.70	2.78	3.88	1.33	92.54	5.05	83.84
	$D_1 \times V_6$	33.70	17.21	5.91	4.84	0.97	14.34	2.87	3.16	3.98	1.37	92.30	5.21	83.33
	$D_2 \times V_1$	26.00	17.72	4.44	3.93	0.67	15.13	2.59	2.78	3.55	1.35	93.18	4.73	85.40
	$D_2 \times V_2$	24.20	18.50	4.48	3.76	0.72	15.53	2.97	3.42	4.02	1.36	92.57	5.50	83.95
	$D_2 \times V_3$	33.07	19.03	5.73	5.40	0.90	16.32	2.71	2.65	4.01	1.45	93.26	4.58	85.73
	$D_2 \times V_4$	33.50	17.88	6.07	5.09	0.89	15.21	2.66	2.68	3.95	1.07	93.22	6.29	85.10
	$D_2 \times V_5$	35.63	17.93	6.22	5.36	1.03	15.04	2.89	3.20	4.02	1.28	92.60	5.68	83.90
	$D_2 \times V_6$	36.93	18.20	6.65	5.80	0.92	15.72	2.48	2.58	3.44	1.33	93.60	4.55	86.37
	$D_3 \times V_1$	29.36	16.54	5.42	4.07	0.79	13.86	2.68	2.75	3.80	1.52	92.39	4.31	83.79
	$D_3 \times V_2$	25.46	17.50	4.46	3.68	0.77	14.47	3.03	3.67	3.94	1.44	91.99	5.30	82.66
	$D_3 \times V_3$	34.17	16.66	5.70	4.66	1.03	13.64	3.02	3.50	4.07	1.46	91.62	5.23	81.85
	$D_3 \times V_4$	37.53	16.48	6.18	5.17	1.01	13.80	2.68	2.75	3.80	1.50	92.37	4.39	83.70
	$D_3 \times V_5$	37.55	17.31	6.50	5.48	1.02	14.60	2.71	3.28	3.40	1.38	92.71	4.84	84.34
	$D_3 \times V_6$	39.84	17.60	7.01	5.93	1.08	14.88	2.72	3.04	3.67	1.37	92.81	4.95	84.55
F-test		**	*	N.S	**	**	**	**	**	*	*	**	**	**
$LSD_{0.05}$		1.56	0.78	-	0.33	0.07	0.74	0.18	0.39	0.28	0.22	0.45	0.95	1.04
D:		D1=195 days ago ,D2= 215 days ago and D3=235 days ago												

RY=root yield ton/fed.; Pol%= Sucrose %;SY= sugar yield ton/fed.; RSY= recoverable sugar yield ton/fed.; LS= Loss sugar yield ton/fed.; RS%= recoverable sugar %; LS%= Loss in sugar %; P%= purity %; AC= Alkalinity coefficient; Q_Z%= quality index.

Such effect may be due to large differences between sugar beet varieties in gene makeup and its responsible to prevailing environmental conditions. The differences among sugar beet varieties in growth and development rate caused

differences on quality characters, so require different harvest strategies.

4. Conclusion

It can be recommended that sowing sugar beet variety Hossam or Halawa and harvested after 215 or 235 days from planting to improve the yield and quality of sugar beet under Middle Egypt conditions.

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