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Evaluation of chemical composition of roots of three sugar beets varieties growing under different water deficit and harvesting dates in Upper Egypt

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A B S T R A C T

Field experiments were carried out at Shandaweel Agricultural Research Station, Sohag, Egypt to study the effects of deficit irrigation and harvesting date chemical composition of three sugar beet varieties. A split block design with three replications was used. Main blokes were assigned to three irrigation water regimes (100%, 85%, and 70% of water requirement). The sub blot was occupied by three harvesting dates (180, 195 and 210 days). Sub- sub plots comprised three sugar beet varieties namely (RAVEL, SV1841and SA1686). Results indicated that reducing water supply reduced alpha - amino N present in the second season, Na present in the second season, and K present and sugar lost to molasses, but increased sucrose present, extractable present, QZ present, purity present, extractability present. Increasing harvesting date increased K present, sucrose present, extractable present, QZ present, purity present, extractability present but reduced alpha - amino N present, Na present and sugar lost to molasses in the second season. Sucrose present, extractable present, QZ present purity present and extractability present of RAVEL and SA1686 varieties were almost comparable but higher than those of SV1841 variety.

1. Introduction

The uses of functionalized organic and inorganic compounds has been extensively developed, which is presented in a lot of scientific papers.[1-17] The optimum water use in agricultural production is considered as one of the most important environmental factors affecting plant growth and development, particularly in arid and semi-arid regions.[18] Egypt is a country with limited water resources and large population growth rate. Therefore, the Egyptian Government imports about 1.10 million ton of sugar every year to face the rapid increase of population consumption. Sugar beet plays a prominent role in sugar production and accounts for the second largest production for sugar after sugarcane with about 37.3% of the local sugar production (1.61 million ton). Sugar beet is one of the highest water consuming crops due to its long growth period, with an annual consumption of 350 to 1150 mm in different regions of the world. Although, it is a drought resistant plant that could produce economic yield even with declined irrigation. [19] The harvesting age is one of the main factors which directly affect maturity and consequently root yield and juice quality of sugar beet. Sugar beet varieties differ inherently in their maturity ages, which extend from 150 to 240 days, through which changes in quality, yield and its components occur until they reach their maximum values. [20-22] Sugar beet variety is considered one of the essential wings of sugar production, in terms of its root yield and quality characteristics. In this context[23-25] they found differences among beet varieties.

The main objectives of this study were to evaluate chemical composition of roots of three sugar beets varieties growing under different water deficiencies and harvesting dates in Upper Egypt.

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2. Results and Discussion

2.1 Technological characteristics of sugar beet juice

During the processing of sugar beet, one of the most important raw substance technological parameter are nitrogen, sodium and potassium, which cannot be removed via purification of juice, may be lead to increment the thickness of juice and reduce the recovery rate of sugar as well as causing an increment in losses sugar rate.

2.2.1 Effect of irrigation water regimes on Alpha- amino N percentages, Na percentages and K percentages.

The data in Table 1 showed the insignificant effect of water stress treatments on impurities percentages (α- amino nitrogen percentages, sodium percentages and Potassium percentages) in the two seasons. From results it could be seen that level of 70% WR recorded the best value of α- amino N% in the first season but the best value of α- amino N% in the second season was with 100% WR, while the highest value of sodium % was recorded 4.388% compared with irrigation 70%WR in the first season only and 3.713% and compared with irrigation 85% WR in the second season only and the highest values of K % was recorded 5.104% compared with irrigation 70 WR in the first season only and 4.958% and compared with irrigation 100 WR in the second season only .These data are in partial agreement with those obtained by this is probably due to the various counteracting effects of deficit irrigation on ion uptake.[26-28]

2.2.2 Effect of harvesting dates Alpha - amino N percentages, Na percentages and K percentages.

Data listed in Table 1 clear that the tested harvesting ages led to insignificant effects in the values of α- amino N and potassium content, meanwhile the difference between harvesting ages did reach the level of significance on sodium contents in the second seasons. The highest values of sodium % was recorded 3.826% from 195 days, the amount of harvest age from 210 days gave the lowest values in both seasons this superiority may be due to the decreased temperature at this time of harvest.[29-32]

2.2.3 Effect of sugar beet varieties on Alpha - amino N percentages, Na percentages and K percentages.

Results collected in the same Tables 1 showed that impurities percentages characteristics (α- amino N%, Na% and K %) among tested sugar beet varieties, were insignificantly affected in both seasons.[33,30,18]

Table 1. Means of Alpha amino – N %, Sodium %and Potassium (K) %of sugar beet crop as effected by irrigation water regimes, harvesting dates and varieties for two growing seasons of 2018/2019 and 2019/2020.

Treatments	Alpha amino – N %		Sodium %(Na)		Potassium (K) %	
	2018/2019	2019/2020	2018/2019	2019/2020	2018/2019	2019/2020
Irrigation treatments (I)						
100% WR	2.30	2.36	4.312	3.697	5.104	4.906
85% WR	2.55	2.52	4.388	3.567	4.693	4.930
70% WR	2.80	2.91	4.197	3.713	4.691	4.958
L.S.D. (0.05)	*NS*	*NS*	*NS*	*NS*	*NS*	*NS*
Harvesting dates (H)						
180 days	2.66	2.44	4.309	3.820	4.670	4.840
195 days	2.54	2.59	4.304	3.826	4.905	4.846
210 days	2.46	2.76	4.285	3.331	4.913	5.107
L.S.D. (0.05)	*NS*	*NS*	*NS*	*0.313*	*NS*	*NS*
Varieties (V)						
RAVEL	3.15	3.01	4.383	3.894	4.752	5.044
SV1841	2.01	2.14	4.040	3.577	5.023	4.878
SA1686	2.49	2.65	4.474	3.577	4.713	4.871
L.S.D. (0.05)	*NS*	*NS*	*NS*	*NS*	*NS*	*NS*
Interactions						
IH	*NS*	*NS*	*NS*	*NS*	*NS*	*NS*
IV	*NS*	*NS*	*NS*	*NS*	*NS*	*NS*
HV	*NS*	*	*NS*	*NS*	*NS*	*NS*
IHV	*NS*	*NS*	*NS*	*NS*	*NS*	*

* = significant at $F_{.05}$ and N.S = not significant.

2.2.4 Effects of the interactions on Alpha amino – N %, Sodium %and Potassium (K) %.

Moreover, Tables 2 and 3 view the interaction effects between the different combinations for the three studied factors. It could be noted that the effects of the all possible interaction between the studied on impurities percentages (α- amino N%, Na% and K %) were insignificant in the two seasons, except the interaction between harvesting ages and sugar beet varieties on α- amino N percentages recorded the best value (2.329) by harvesting age 180 days with SV1841 variety in second season only. Tested sugar beet varieties did not behave the same at the different harvesting age, α- amino N% was significantly increased by harvesting age 180 days with SV1841 variety but this was not the case with the other two

varieties. and the interaction between irrigation treatments, harvesting age and sugar beet varieties on K % in the second season only was significantly increased, with a recorded value at 6.147% by70% of WR , harvesting age 210 days and RAVEL variety the highest . insignificantly affected in both seasons.[33,30,18]

Table 2. Alpha amino – N percentages as affected by the interaction between harvesting dates and varieties in two consecutive seasons of 2018/19 and 2019/20.

Harvesting dates	Variety	Alpha amino – N %	
		2018/19	2019/20
180 days	RAVEL	2.008	2.248
	SV1841	2.266	2.329
	SA1686	2.109	2.045
195 days	RAVEL	2.031	2.289
	SV1841	2.161	2.322
	SA1686	1.690	1.792
210 days	RAVEL	1.811	1.915
	SV1841	2.376	1.990
	SA1686	1.959	2.319
L.S.D.$_{0.05}$		*0.65*	*0.44*

Table 3. Potassium (K) percentages as affected by the interaction between irrigation water regimes, harvesting dates and varieties for two growing seasons of 2018/2019 and 2019/2020.

		2018/19			2019/20		
Irrigation treatments	**Harvesting dates**	**RAVEL**	**SV1841**	**SA1686**	**RAVEL**	**SV1841**	**SA1686**
100% WR	180 days	4.790	5.250	4.370	4.943	4.813	4.643
	195 days	4.883	5.483	5.273	5.157	5.313	4.433
	210 days	4.840	5.367	5.683	4.543	5.160	5.147
85% WR	180 days	4.793	5.127	4.463	5.180	4.210	5.257
	195 days	4.007	4.840	4.703	5.180	4.377	4.670
	210 days	4.843	4.890	4.573	5.013	6.017	4.463
70% WR	180 days	4.900	4.800	3.540	4.080	4.720	5.717
	195 days	5.030	4.830	5.097	5.157	4.877	4.447
	210 days	4.683	4.620	4.717	6.147	4.417	5.060
L.S.D.$_{(0.05)}$		**1.41**			**1.30**		

2.3.1 Effect of irrigation water regimes on sucrose %, sugar lost to molasses %and extractable sugar %

The results presented in Table 4 clearly indicated that irrigation water regimes on sucrose % and extractable sugar % was significant in both growing seasons except the effect of irrigation water regimes on sugar lost to molasses %was insignificant. Irrigation at 70% WR and 85% WR treatments increased sucrose %by about 10.9% and 5.2% in 2018/19 season and by 8.5% and 4.1 % in the 2019/20 season as compared to 100% WR treatment. Also, the same treatments increased sugar loss to molasses % by 2.6% and 0.04% in 2018/19 season and 2.4% and 0.9% in 2019/20 season as compared by 70% WR treatment, respectively. Similarly, extractable sugar % of 85% WR and 70% WR irrigation treatments increased by 1.4% and 0.9 % in 2018/19 season and by 1.1 % and 0.7 % in the 2019/20 season as compared by 100% WR, respectively.[34,35,28]

2.3.2 Effect of irrigation water regimes on sucrose %, sugar lost to molasses %and extractable sugar %

The result of harvesting dates for sucrose % and extractable sugar % are presented in Table 4 was significant but sugar lost to molasses % was not significant. The results clearly indicated that the longest harvesting date gradually creased sucrose % and extractable sugar % in both growing seasons. However, the highest sucrose percentage and extractable sugar % (18.68 and 18.87%) and (16.92 and 17.27%) followed by harvesting date of 195 days (18.32 and 18.59%) and (16.59 and 16.96%) while the lowest mean of sucrose percentage and extractable sugar % by harvesting date of 180 days in the first and second seasons. The highest sugar lost to molasses % was obtained from the harvesting date of 210 days in the first season and harvesting date of 180 in the second season.[36]

2.3.3 Effect of sugar beet varieties on sucrose %, sugar lost to molasses %and extractable sugar %.

Table 4 shows that the results of sugar beet types for sucrose % and extractable sugar % were significant, while sugar lost to molasses % was not. However, in the first and second seasons, the RAVEL variety (20.97 and 20.57 %) and (19.28 and 17.27 %) had the highest sucrose percentage and extractable sugar %, followed by SA1686 (17.97 and 18.38 %) and (16.27 and 16.78 %), and SV1841 had the lowest sucrose percentage and extractable sugar %. In both seasons, the SA1686 cultivar had the lowest mean percentage of sugar lost to molasses.[37, 22, 38]

Table 4. Means of sucrose %, sugar lost to molasses % %and extractable sugar %of sugar beet crop as effected by irrigation water regimes, harvesting dates and varieties for two growing seasons of 2018/2019 and 2019/2020

Treatments	Sucrose %		Sugar lost to molasses %		Extractable sugar %	
	2018/2019	2019/2020	2018/2019	2019/2020	2018/2019	2019/2020
Irrigation treatments (I)						
100% WR	17.40	17.81	2.328	2.268	15.62	16.14
85% WR	18.31	18.55	2.269	2.233	16.60	16.91
70% WR	19.30	19.34	2.268	2.213	17.60	17.75
L.S.D.$_{(0.05)}$	*0.05*	*0.08*	*NS*	*NS*	*0.11*	*0.11*
Harvesting dates (H)						
180 days	18.02	18.25	2.288	2.266	16.31	16.58
195 days	18.32	18.59	2.279	2.248	16.59	16.96
210 days	18.68	18.87	2.299	2.199	16.92	17.27
L.S.D.$_{(0.05)}$	*0.03*	*0.03*	*NS*	*NS*	*0.13*	*0.13*
Varieties (V)						
RAVEL	20.97	20.57	2.266	2.289	19.28	18.88
SV1841	16.07	16.77	2.334	2.227	14.28	15.14
SA1686	17.97	18.35	2.266	2.197	16.27	16.78
L.S.D.$_{(0.05)}$	*0.03*	*0.05*	*0.12*	*0.10*	*0.13*	*0.10*
Interactions						
IH	*NS*	*NS*	*NS*	*NS*	*NS*	*NS*
IV	*	*	*NS*	*NS*	*	*
HV	*	*	*NS*	*NS*	*	*
IHV	*	*	*NS*	*NS*	*NS*	*

* = significant at F.05 and N.S = not significant

2.3.4 Effects of the interactions on sucrose %, sugar lost to molasses %and extractable sugar %

All levels of the interaction's effects presented in Table 4 indicated that only irrigation (I) x harvesting date (H) showed no significant effects on sucrose % and extractable sugar % in the growing season and indicated that irrigation treatments (I) x harvesting date (H) x Varieties (V) showed no significant effects on sucrose % during the in first season. However, there was no significant effect of the interaction at all levels for sugar loss to molasses %. The results of the effect of the interaction between irrigation treatments and varieties presented in Table 5 indicates that the highest significant sucrose % and extractable sugar %was obtained from 70% WR (22.26and 20.73% in the first season and 21.72 and 20.06% in the second season) with RAVEL variety. In addition, the interaction between harvesting date (H) x Varieties (V) effects on sucrose % and extractable sugar % in the growing season presented in Table (6)indicates that harvesting age (21.54 and 21.00 % in the first season and 19.80 and 19.45 %in the second season) with the RAVEL variety produced the highest significant sucrose % and extractable sugar %.but regarding interaction between irrigation treatments (I) × harvesting date (H) × Varieties (V) presented in Tables 7 and 8 effects on sucrose % was significantly in the both season was recorded value at 22.98 and 22.45% by70% of WR , harvesting age 210 days and RAVEL variety the highest and extractable sugar % in the second season Values of 21.31 and 20.74 percent by 70% of WR, harvesting age 210 days, and RAVEL variety the highest were recorded.

Table 5. Sucrose % and extractable sugar % as affected by the interaction between irrigation treatments and varieties in two consecutive seasons of 2018/19 and 2019/20

irrigation treatments	Variety	Sucrose %		Extractable sugar %	
		2018/19	2019/20	2018/19	2019/20
100% WR	RAVEL	19.57	19.62	17.80	17.99
	SV1841	15.58	15.94	13.33	14.20
	SA1686	17.42	17.86	15.73	16.23
85% WR	RAVEL	20.93	20.38	19.30	18.60
	SV1841	16.17	16.95	14.37	15.44
	SA1686	17.83	18.31	16.13	16.70
70% WR	RAVEL	22.26	21.72	20.73	20.06
	SV1841	16.82	17.42	15.13	15.80
	SA1686	18.65	18.95	16.93	17.40
L.S.D.$_{0.05}$		*0.06*	*0.09*	*0.23*	*0.18*

Table 6. Sucrose % and extractable sugar % as affected by the interaction between Harvesting dates and varieties in first season

Harvesting dates	Variety	Sucrose %		Extractable sugar %	
		2018/19	2019/20	2018/19	2019/20
180 days	RAVEL	20.46	20.12	18.80	18.41
	SV1841	15.78	16.44	13.97	14.79
	SA1686	17.81	18.18	16.17	16.55
195 days	RAVEL	20.92	20.60	19.23	18.79
	SV1841	16.06	16.83	14.27	15.21
	SA1686	17.97	18.33	16.27	16.87
210 days	RAVEL	21.54	21.00	19.80	19.45
	SV1841	16.35	17.05	14.60	15.44
	SA1686	18.13	18.56	16.37	16.91
L.S.D.$_{0.05}$		*0.06*	*0.09*	*0.23*	*0.18*

Table 7. Sucrose %percentages as affected by the interaction between irrigation water regimes, harvesting dates and varieties for two growing seasons of 2018/2019 and 2019/2020

Irrigation treatments	Harvesting dates	2018/19			2019/20		
		RAVEL	SV1841	SA1686	RAVEL	SV1841	SA1686
100% WR	180 days	19.17	14.76	17.33	19.25	15.40	17.70
	195 days	19.41	15.27	17.43	19.73	16.00	17.88
	210 days	20.13	15.58	17.51	19.88	16.43	18.00
85% WR	180 days	20.43	15.95	17.60	20.01	16.65	18.08
	195 days	20.83	16.14	17.85	20.46	17.04	18.31
	210 days	21.52	16.42	18.05	20.66	17.16	18.55
70% WR	180 days	21.77	16.63	18.50	21.11	17.26	18.75
	195 days	22.52	16.78	18.62	21.60	17.46	18.79
	210 days	22.98	17.06	18.84	22.45	17.55	19.13
L.S.D. *(0.05)*		**0.11**			**0.16**		

Table 8. Extractable sugar percentages as affected by the interaction between irrigation water regimes, harvesting dates and varieties for two growing seasons of 2018/2019 and 2019/2020

Irrigation treatments	Harvesting dates	2018/19			2019/20		
		RAVEL	SV1841	SA1686	RAVEL	SV1841	SA1686
100% WR	180 days	17.40	12.90	15.70	17.53	13.66	16.12
	195 days	17.60	13.40	15.80	17.96	14.20	16.34
	210 days	18.40	13.70	15.70	18.48	14.74	16.22
85% WR	180 days	18.90	14.00	15.90	18.18	15.09	16.30
	195 days	19.30	14.40	16.30	18.49	15.67	16.84
	210 days	19.70	14.70	16.20	19.14	15.55	16.97
70% WR	180 days	20.10	15.00	16.90	19.51	15.61	17.22
	195 days	20.80	15.00	16.70	19.93	15.75	17.43
	210 days	21.30	15.40	17.20	20.74	16.03	17.54
L.S.D. *(0.05)*		**0.40**			**0.32**		

2.4.1 Effect of irrigation water regimes on QZ %, Purity %and extractability sugar%

Data presented in Table 9 show the significant effect of irrigation water on QZ %, extraction sugar % and sugar lost to molasses % in the two seasons. Irrigation at 70% WR treatments increased QZ % by about 3.8 % and 2.4 % in 2018/19 season and by 2.0% and 1.3 % in the 2019/20 season as compared to 100% WR treatment, respectively. Similarly, Purity % of 70% WR irrigation treatments increased by 1.4% and 0.8 % in 2018/19 season and by 0.9 % and 0.6 % in the 2019/20 season as compared to 100% WR. Also, the same treatments increased extractability sugar%.1.4 and 0.9% in 2018/19 season and 1.1% and 0.7% in 2019/20 season compared to 100% WR treatment, respectively. [28]

2.4.2 Effect of harvesting dates QZ %, Purity %and extractability sugar%.

Delaying harvest date resulted in Table 9 a no significant increase in Purity %and extractability sugar% except the QZ % was significantly in the second season only, the highest QZ % was from harvest 210 days (80.43 and 81.89 %) in both seasons. [21,40]

2.4.3 Effect of sugar beet varieties on QZ %, Purity %and extractability sugar%

Table 9. Means of QZ %, Purity % and extractability sugar% of sugar beet crop as effected by irrigation water regimes, harvesting dates and varieties for two growing seasons of 2018/2019 and 2019/2020

Treatments	QZ %		Purity %		Extractability sugar%	
	2018/2019	2019/2020	2018/2019	2019/2020	2018/2019	2019/2020
Irrigation treatments (I)						
100% WR	78.55	80.38	89.80	90.57	89.88	90.54
85% WR	80.47	81.46	90.58	91.14	90.70	91.19
70% WR	81.56	82.05	91.09	91.45	91.19	91.61
L.S.D. *(0.05)*	*1.58*	*1.03*	*0.43*	*0.37*	*0.60*	*0.52*
Harvesting dates (H)						
180 days	80.10	80.84	90.39	90.79	90.43	90.81
195 days	80.06	81.17	90.47	91.03	90.64	91.10
210 days	80.43	81.88	90.61	91.33	90.69	91.44
L.S.D. *(0.05)*	*NS*	*0.84*	*NS*	*NS*	*NS*	*NS*
Varieties (V)						
RAVEL	82.83	80.84	91.77	91.65	91.99	91.77
SV1841	77.58	81.17	89.21	90.31	89.09	90.26
SA1686	80.17	81.88	90.49	91.19	90.69	91.30
L.S.D. *(0.05)*	*1.32*	*1.19*	*0.66*	*0.52*	*0.77*	*0.57*
Interactions						
IH	*NS*	*NS*	*NS*	*NS*	*NS*	*
IV	*NS*	*NS*	*NS*	*	*NS*	*NS*
HV	*	*NS*	*NS*	*NS*	*NS*	*NS*
IHV	*NS*	*NS*	*NS*	*NS*	*NS*	*NS*

* = significant at $F_{.05}$ and N.S = not significant.

The results in Table 9 clearly showed the best results in QZ %, Purity %and extractability sugar% was significantly in the two seasons obtained from RAVEL variety(82.48, 91.77 and 91.99 %)in the first season and (82.66, 91.65 and 91.77 %) in the second season followed by SA1686 variety (80.17, 90.49 and 90.69 %)in the first season and (81.57, 91.19 and 91.30 %) in the second season, and SV1841(77.59, 89.21 and 89.09 %)in the first season and (79.69, 90.31and 90.26 %) in the second season. [41,42,43,25]

2.4.4 Effects of the interactions on QZ %, Purity %and extractability sugar%

Regarding the interaction effects between the three studied factors on QZ %, Purity %and extractability sugar%, it is clear that there are insignificant effect by all possible interaction in the two seasons except interaction between harvesting date (H) × Varieties (V) presented in Table 10 Showed significantly effects on QZ % during the in first season indicates that harvesting age195days (83.27) with the RAVEL variety produced the highest significant QZ %. But regarding the effect of the interaction between irrigation treatments and varieties presented in Table 11 indicates that the highest significant Purity %and in extractability sugar % the second season only was obtained from 70% WR (92.9 and 92.35 in the second season) with RAVEL variety, respectively.

Table 10. Means of QZ %as affected by the interaction between irrigation and varieties in two consecutive seasons of 2018/19 and 2019/20

Harvesting dates	Variety	QZ %	
		2018/19	2019/20
180 days	RAVEL	82.66	82.16
	SV1841	76.26	79.43
	SA1686	81.36	80.93
195 days	RAVEL	83.27	81.66
	SV1841	77.13	79.96
	SA1686	79.77	81.90
210 days	RAVEL	82.56	84.13
	SV1841	79.36	79.66
	SA1686	79.36	81.86
L.S.D.$_{0.05}$		*2.29*	*2.06*

Table 11. Means of Purity %and extractability sugar% as affected by the interaction between irrigation and varieties in two consecutive seasons of 2018/19 and 2019/20

irrigation treatments	Variety	Purity %		Extractability sugar%	
		2018/19	2019/20	2018/19	2019/20
100% WR	RAVEL	91.00	91.63	91.23	91.68
	SV1841	88.17	89.27	87.90	89.05
	SA1686	90.23	90.81	90.50	90.88
85% WR	RAVEL	92.03	91.24	92.30	91.28
	SV1841	89.33	90.94	89.20	91.08
	SA1686	90.37	91.24	90.60	91.22
70% WR	RAVEL	92.27	92.09	92.43	92.35
	SV1841	90.13	90.73	90.17	90.66
	SA1686	90.87	91.53	90.97	91.82
L.S.D.$_{0.05}$		*1.14*	*0.91*	*1.34*	*0.99*

3. Conclusion

Results clarified that cultivating either RAVEL or SA1686 varieties with 70% of water requirement and for 210 growing days under Upper Egypt conditions optimize chemical composition of roots, sucrose present and extractable sugar present.

4. Experimental

4.1 Materials and methods

A field experiment was carried out at Shandaweel Agricultural Research Station at Sohage, Egypt (latitude of 26˚ 26' N, longitude of 31º 68' E and altitude of 70 m) in two consecutive seasons of 2018/2019, 2019/2020 to study the effects of three irrigation water regimes and three harvest dates on biomass, roots and sugar yield as well as water use efficiency of three sugar beet varieties grown under upper Egypt conditions. The design of the experiment was split – split block with three replicates. The plot area was 10.5 m^2 (3 x 3.5 m). The main blocks were subjected to irrigation water regimes where I_1, I_2, and I_3 represented100%, as full irrigation requirement treatment and 85 % and 70% of crop water requirement as deficit irrigation treatments. The sub plots were assigned to the three harvesting dates; H_1 = 180, H_2 = 195 and H_3 =210 days from sowing. The sub sub plots comprised three sugar beet varieties namely: V_1 = RAVEL (mono variety), V_2 =

SV1841 (mono variety) and V_3 = SA1686 (multi-germ). Sugar beet seeds of the three varieties were sown on 8 and 7 November in the 1st and 2nd seasons, respectively. From 3 to 4 seeds were used in each hill 20 cm apart between two consecutive hills. All treatments were fertilized with P-fertilizer in the form of mono-calcium (MCP) phosphate (15.5% P_2O_5) at the rate 67.5 kg P_2O_5/ha added to the soil during land preparation. Nitrogen fertilizer was applied in the form of ammonium nitrate (33.5% N) at the rate of 225 kg N/ha divided into two equal doses (before the first and second irrigation). Potassium fertilizer in the form of potassium sulfate 48% K_2O was applied at the rate of 54 K_2O/ha and added during the second irrigation. The other farming practices required for sugar beet growth were carried out according to the common practices followed at Shandaweel station. Traditional furrow irrigation method for irrigation was used during both growing seasons.

Recorded data:
Plant samples were then sent to the laboratory of quality analyses at laboratory of Abu Kurgas to determine the following quality characteristics:
At each of the studied harvest ages, a random sample of five guarded roots of each plot was taken to determine the following traits:
1. Root impurities in terms of α-amino N, Na and K percentages (meq/100 g beet) according to .[44]
2. Sucrose percentage which was estimated in fresh samples of sugar beet root using "Saccharometer" according to the method described by [44]
3. Sugars lost to molasses percentage (SLM %) was calculated as described by [45] using the following equation: SLM% = [0.14 (Na + K) + 0.25 (α-amino N) + 0.5]
4. Extractable sugar percentage (ES%)was calculated using the equation of [46] as follows: ES% = [sucrose % – (sugar lost to molasses % + 0.6)].
5– (QZ) was calculated as following QZ= ZB/ Pol x100 .Impurities percentage %calculated as the formula ZB = Pol - {(K + Na) x0.0343)+(alpha-amino N x 0.094) + 0.29} as described by.[47]
Where: ZB = corrected sugar content (% beet)
6. Purity percentage was calculated according to the following equation, described by Devillers (1988): Purity % = 99.36 – [14.27 (Na + K + α-amino N)/sucrose %].
7. Extractability = [(extractable sugar % / sucrose %) x 100].

Table 12. Average values of meteorological data recorded at Shandaweel Agricultural Research Station in 2018/2019 and 2019/2020 growing seasons

Months	2018/2019					2019/2021				
	Temperature (ºC) Max.	Min.	RH (%)	WS m/sec	SR (%)	Temperature (ºC) Max.	Min.	RH (%)	WS m/sec	SR (%)
Nov.	26.6	13.0	54	2.3	13	28.8	14.5	59	2.3	17
Dec.	20.3	7.1	65	2.5	15	21.7	7.9	58	2.4	15
Jan.	18.8	5.0	60	2.1	15	18.3	4.3	58	2.5	15
Feb.	21.5	7.1	48	2.6	18	21.4	6.6	52	2.6	19
Mar.	25.1	9.1	35	2.9	23	27.2	10.6	45	3.1	22
Apr.	30.1	13.8	34	3.2	24	30.1	14.0	37	3.4	25
May	38.4	20.8	30	3.0	27	36.0	19.8	36	3.4	27

WS= wind speed m/sec ; SR = solar radiation, MJ/m^2/day, RH =relative humidity in % ETo= evapotranspiration, mm

Statistical analysis

The obtained data were subjected to statistical analysis of variance using MSTAT_C computer program. The means were compered for significant differences using the L.S.D. at p=0.05.[48]

This work confirms the importance of scientific research in different fields.[49-53]

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