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INFLUENCE OF WATER STRESS ON QUALITY, YIELD AND PHYSIOLOGICAL TRAITS OF SOME SUGAR BEET VARIETIES

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Key Words: Antioxidant activity, Growth, Yield, Sugar beet *(Beta vulgaris* L.*)*, Water stress.

ABSTRACT

Water stress is considered as one of the major factors responsible for reducing sugar beet crop productivity. A field trial was conducted at Sidi Salem district private farm (31° 07' N latitude, 30° 05'E longitude), Kafr El-Sheikh governorate, north Nile Delta, Egypt, for two successive seasons at 2018-2019 and 2019-2020, to find out the effects of water stress treatments (2, 3 and 4 weeks of irrigation intervals) on the vegetative growth, and juice quality of five sugar beet varieties, which were three multigerm (Marwa-KWS, Farida, and Nabila), and two monogram (Amaldi and Xanada). Treatments were conducted in a split-plot design with three replicates. The most important results obtained showed that delayed irrigation intervals (4 weeks) led to a marked decrease in, root diameter, root weight, root yield in both seasons. Meanwhile, increase root length, sucrose%, extractable sugar%, and sugar yield in both seasons. The drought-tolerant variety (Marwa-KWS) showed significant differences compared to the control. However, drought-sensitive variety (Nabila) was markedly affected even at the water stress (4 weeks). Results indicated that varieties (Marwa KWS, Farida, and Amaldi) appeared the best performance under the longest irrigation intervals (4 weeks) for root and sugar yields and their components. chlorophyll a and b, carotenoids, significantly decreased with delay irrigating days, meantime increase antioxidant enzymes under stress conditions.

INTRODUCTION

Sugar beet (*Beta vulgaris* L.) is considered the most important sugar crop for sugar production in Egypt. Sugar beet plays a prominent role in sugar production, about 57.7% of the local sugar production, which amounted to 1.25 million tons, is produced from sugar beet, which is considered the first sugar crop in Egypt (Sugar Crops Council Report, 2020). It is an important crop that helps in establishing integrated agricultural-industrial societies, especially in the newly reclaimed areas, and contributes to many industries such as the sugar industry, and highly-value animal feed **(Moliszewska *et al.,* 2016).** Sugar beet is deemed to be an important sugar crop, and improving its productivity is an urgent demand to meet the consumption of the ever-growing population.

Water is scarce in Egypt which has to depend on River Nile as well as water stress effect is highly influenced by the period, continuity, and period of lack of time. Egypt is one of the most vulnerable countries to the potential impacts and risks of drought stress that constringe the production of crops and altered Food Security. Water stress in Egypt is expected to further increase in the future as a result of rapid population growth, rising temperatures, and increasing water consumption in Egypt and other Nile basin countries, especially the Ethiopian dam on the Blue Nile. If not properly dealt with, growing water scarcity will put severe strains on Egypt's economy and make the country more vulnerable to renewed food scarcity. Drought is one of the most important growth restricting environmental factors for crop species in arid and semi-arid regions of the world as well as crop losses resulting from abiotic stresses such as drought or salinity can reduce crop yield by as much as 50% **(Chaves and Oliveira 2004).** Climate changes largely exacerbate this situation due to the increasing incidence of more extreme climate events. Lack of water can inhibit the growth and development of plants, mainly by decreasing photosynthesis, leaf turgor, and transpiration rates **(Tahi *et al.*, 2007)**. Plants have evolved a series of adaptive mechanisms to maintain cellular optimal environment for ensuring the normal growth of plants under drought stress **(Ludlow and Muchow 1990).** The increasing threat of drought stress is already having a substantial impact on agricultural production worldwide as water stress causes significant yield losses with great risks for future global food security. The susceptibility to water stress in sugar beet varieties varies with the stages of plant development, water stress affecting to a certain extent all growth and productivity traits **(Abu-Ellail and El- Mansoub, 2020).** Drought tolerance depends on varieties and genotype variances, with abundant inter-and intra-specific variations **(Barnabas *et al.*, 2008).** The aims of this research were to study the effect of water stress on some physiological traits, yield, and quality of five sugar beet varieties, and their responses to water stress.

MATERIALS AND METHODS

A field trial was conducted at Sidi Salem district private farm (31° 07' N latitude, 30° 05'E longitude), Kafr El-Sheikh governorate, North Nile Delta, Egypt in two successive seasons of 2018-2019 and 2019-2020. The treatments included two types of sugar beet varieties (Marwa-KWS, Farida, and Nabila) as a multigerm, and (Amaldi and Xanada) as a monogram and three irrigation intervals (control unstressed 2 weeks, 3 weeks, and 4 weeks) to study the effects of water stress on growth, physiological traits, yield and quality of sugar beet varieties under clay soil conditions. The experiment design was a split plot design with three replications. The irrigation intervals were assigned in the main plot while sugar beet varieties distributed randomly in the sub plots. Each experimental basic unit included 6 rows, 60 cm apart, and 3.5 m long, (21 m^2). Sowing date was on August 28th and 31th in the first and the second seasons, respectively. After 40 days from sowing seedlings were thinned to one plant/hill. Nitrogen fertilizer level at the rate of 100 kg N/fed in the form of ammonium nitrate (33.5%) was applied in two equal portions, the first was applied after thinning and the other was applied a month after the first application. The fertilizers, surface irrigation and all other agronomic practices were applied as recommended. Phosphorus fertilizer level at the rate of 45 kg P_2O_5/fed in the form of Calcium superphosphate (15.5% P_2O_5) was added during land preparation. Potassium fertilizer rate of 36 kg K_2O/fed in the form of potassium sulfate (48% K_2O) was applied with the second dos of nitrogen fertilizer. Other cultural practices were carried out as recommend by Sugar Crop Research Institute, Agricultural Research Centre. The physical and chemical analysis of the experimental soil, are given in Table (1), according to the method of **Richards (1954).**

Table (1): Physical and chemical analysis of the experimental sites of the two seasons.

Physical analysis	2018/2019	2019/2020
Sand%	21.68	20.32
Silt%	25.74	23.99
Clay%	52.58	55.69
Texture class	Clay	Clay
Chemical analysis		
pH (1:2.5)	7.30	7.00
EC(m.mhos/cm)	2.18	2.00
Organic matter %	1.30	2.10
Available N ppm	17.00	16.00
Available P ppm	9.30	9.20
Available K ppm	275.74	252.54
Soluble anions (meq/L)		
SO4 -	5.06	6.87
CO3-	2.00	2.14
HCO3 -	3.43	3.19
Cl -	11.31	8.60
Soluble cations (meq/L)		
Ca++	2.17	3.65
Mg++	8.74	7.12
Na+	10.34	9.29
K+	0.56	0.64

At harvest time (200 days from sowing) ten plants from each sub plot were randomly taken for different measurements for each treatment. The following characters were determined:

1. Root length. **2**. Root diameter. **3**. Root fresh weight (g).

4. Sucrose percentage was determined according to **Le-Docte (1927).**

5. Extractable white sugar percentage was determined according to **Reinefeld *et al.*, (1974).**

6. Sugar loss to molasses percentage (SLM%), was determined as described by **Carruthers *et al.*, (1962).**

7. Root yield (ton/fed): was calculated based on weight experimental plot.

8. Sugar yield (ton/fed.): was determined according to the method described by **McGinnus (1971)**, sugar yield = root yield (ton/fed) x extractable sugar %.

9. Drought susceptibility index (DSI) of root and sugar yields:

It was calculated for each sugar beet variety at harvest time according to the method of **Fischer and Maurer (1978)** as follows:

SSI= $\left(1-\left(\frac{Yd}{Yw}\right)\right)/D$.

Where: Yd (mean yield for a variety in stress environment), Yw (mean yield for a variety in normal environment), D (environmental stress intensity) Sugar beet varieties with "DSI" value of 1.0 or more than one are susceptible to drought, while those with values less than 1.0 are less susceptible (tolerant).

10. Decrease percentage of root and sugar yields (ton/fed):

It was calculated for each sugar beet variety at harvest time according to the method of **Abu-Ellail *et al.*, (2019)** as follows:

1. D1-D2/D1%, 2. D1-D3/D1%

Where: D1 (mean yield for a variety in normal irrigation intervals), D2 (mean yield for a variety in stress environment 3 weeks), D3 (stress environment 4 weeks' intervals).

11. Photosynthetic pigments:

Chlorophyll a, b, and carotenoids were calorimetrically determined in the leaves of sugar beet plants at 120 days after thinning according to methods described by **Wettstein (1957)** and calculated as mg/g fresh weight.

12. Antioxidant Enzyme Activities:

Chemical analyses were carried out on the samples of leaves and roots during the two successive seasons.

1. Activity of catalase (CAT) was determined, according to **Aebi, 1984.**
2. Peroxidase (POX) activity was directly determined according to a typical procedure proposed by Hammer **Schmidt *et al.*, 1982.**

Statistical analysis

Data collected was statistically analyzed according to **Gomez and Gomez (1984)** by using (SAS) computer software package. Revised L.S.D at 5% level was used to compare the means.

RESULTS AND DISCUSSION

Root yield and it is components

Results in Table (2) showed that water stress from 2 to 4 weeks was accompanied by substantial significantly decreased in root diameter, root weight and root yield in first season a counted by (3.51cm, 0.33kg and 10.71 ton/fed) corresponding by (2.95 cm, 0.35kg and 12.13 ton/fed) second season compared to the control. While root length increased under water stress (4 weeks' intervals) in first season by (10.28 cm) and (10.05cm) in the 2nd season compared with control (2 week). This finding could be explained by under the long irrigation intervals of 4 weeks; more water was depleted from the lower depths due to the lack of the available water in the upper layer. So roots tracing behind soil water within the sub soil layer. These results are in general agreement with those obtained by **Ibrahim *et al*., (2002)** who found that root grow longer under moisture stress. Also, **Emara (1990)** mentioned that the highest root length was obtained by irrigation every 28 days, while the lowest root length was every 14 days.

Results in Table 2 showed significant differences between sugar beet varieties. The highest mean values of root diameter, root weight and root yield recorded by variety (Marwa-KWS) followed by variety (Farida) in first and second season compared by the mean values of the previous mention characters for Nabila, Xanada and Amaldi varieties. This results may be due to the differences between the studied varieties in gene expressions, these results are in agreement with that founded by **Abu-Ellail and El- Mansoub (2020)** who reported that delay irrigation days caused significant decreases in sugar beet plant growth criteria (root diameter, root weight, and root yield). Meanwhile, increased root length compared to control plants.

Table (2): The effect of different irrigation intervals on root length, diameter, weight and root yield of five sugar beet varieties during two successive 2018/2019 and 2019/2020 seasons.

Varieties	1st Season 2018/2019															
	Root length (cm)				Root diameter (cm)				Root weight (kg)				Root yield (ton/fed)			
	Irrigation intervals (weeks)				Irrigation intervals (weeks)				Irrigation intervals (weeks)				Irrigation intervals (weeks)			
	2	3	4	Mean	2	3	4	Mean	2	3	4	Mean	2	3	4	Mean
Marwa KWS	41.62	42.48	45.61	43.24	15.72	13.95	11.86	13.84	1.24	1.00	0.78	1.01	28.98	23.86	21.14	24.66
Nabila	24.72	31.00	42.71	32.81	13.36	11.68	10.02	11.69	0.84	0.71	0.53	0.69	27.42	18.82	15.63	20.62
Farida	31.79	36.29	36.91	35.00	15.16	13.48	11.20	13.28	1.09	0.92	0.72	0.91	29.13	22.59	18.59	23.44
Xanada	31.55	36.58	43.75	37.29	14.15	13.64	11.25	13.01	0.98	0.88	0.75	0.87	27.07	20.28	15.92	21.09
Amaldi	31.47	39.13	43.57	38.06	14.33	13.35	10.88	12.85	0.84	0.75	0.55	0.71	28.92	18.47	16.67	21.35
Mean	32.23	37.10	42.51	37.28	14.54	13.22	11.04	12.94	1.00	0.85	0.67	0.84	28.30	20.80	17.59	22.23
	2nd Season 2019/2020															
Marwa KWS	33.95	36.74	45.49	38.73	15.52	14.03	12.58	14.04	1.28	1.08	0.93	1.10	30.49	24.28	19.98	24.92
Nabila	22.53	27.46	33.84	27.94	14.08	13.01	12.06	13.05	0.85	0.78	0.62	0.75	27.57	18.86	15.77	20.73
Farida	23.48	28.84	36.73	29.68	15.34	13.51	11.89	13.58	1.23	0.98	0.86	1.02	29.98	20.53	16.47	22.33
Xanada	28.85	30.28	31.28	30.14	15.22	14.92	12.17	14.10	1.06	0.91	0.77	0.91	28.36	21.55	16.19	22.03
Amaldi	29.12	34.31	46.05	36.49	14.85	13.88	11.57	13.43	1.18	0.84	0.66	0.89	29.38	19.79	16.76	21.98
Mean	28.63	30.49	38.68	32.60	15.00	13.87	12.05	13.64	1.12	0.92	0.77	0.94	29.16	21.00	17.03	22.40
L.S.D 5%	1st	2nd				1st	2nd			1st	2nd				1st	2nd
Stress (S)	0.72*	0.51*				0.59*	0.14*			0.18**	0.11*				0.28**	0.30*
Variety (V)	0.31*	0.28*				0.25*	0.13*			0.10**	0.08*				0.27**	0.18*
S_XV	0.18*	0.43*				0.21*	0.46*			0.19**	0.09*				0.53**	0.61*

Sugar yield and it is components

Sucrose%, extractable sugar% and sugar yield ton/fed as affected by irrigation intervals are given in Table (3). The obtained results show that increasing the irrigation intervals, sucrose and extractable sugar percentages significantly increased, however, MLS% decreased. The longest irrigation intervals had the highest mean values of sucrose and extractable sugar percentage of sugar beet in first season (16.16 and 13.44 %) corresponding (16.68 and 12.68 %) in the second season, meanwhile, the smallest MLS%, was recoded (1.22 and 1.66%) and the smallest mean values of sugar yield ton/fed (2.31 and 2.24 ton/fed) in the first and second season, respectively. This means that extending irrigation intervals from 2 to 4 weeks, increased juice quality values. Concerning water stress and its effect on sugar yield, it is observed show from the illustrated data in Table (2) there is a significant reduction in the values of sugar yield (ton/fed) with the increased irrigation intervals period. This funding was completely true in both seasons. the observed decrease in sugar yield may be due to suffering in the balance of water stress on a physiological process in the plant which affected plant metabolism consequently affected root yield Table 1, in turn, sugar yield Table 2. Water stress inhibits the photosynthesis of plants, and thus reduces growth and development **(Gong *et al.*, 2005).**

Water stress significantly decrease in sodium (Na+) and potassium (K+) concentrations was observed in the sugar beet varieties whereas a reduced MLS%, it led to increase in juice quality **(Wu *et al.*, 2014).**

Data in table 3 indicated a significant difference in juice quality traits and the highest mean values of sucrose and extractable sugar percentages recorded by variety Amaldi, while the highest mean values of sugar yield in first and second season registered by Marwa-KWS (3.00 and 3.06 ton/fed, respectively). With respect to the interaction effect between water stress and the examined varieties, it could be noticed that the juice quality and sugar yield statistically affected by this interaction. The highest sucrose% and extractable sugar % was recorded with Marwa-kws variety with water stress of 4 weeks. However, the irrigation intervals, i.e every 2 weeks produced the highest sugar yield with variety Marwa-kws. These results were highly true in both seasons.it could be noted that root yield was the most effective one on sugar yield. **Gizem and Hamit, (2020) and Abu-Ellail and ElMansoub (2020)** reported a significant difference between the tested sugar beet varieties under water stress. White sugar content increased in drought condition about 58.86% in compare to normal condition **(Habibi, 2011).** Moderate moisture stress just before harvest tends to increase sugar percentage without limited sugar yield per acre **(Kirda, 2002 and Abu-Ellail *et al.*,2019).**

Table (3): The Effect of different irrigation intervals on sucrose, sugar extractable, sugar loss to molasses (MLS) percentages and sugar yield of five sugar beet varieties during two successive seasons 2018/2019 and 2019/2020.

Varieties	1st Season 2018/2019															
	Sucrose%				Extractable sugar%				SLM%				Sugar yield (ton/fed)			
	Irrigation intervals (weeks)				Irrigation intervals (weeks)				Irrigation intervals (weeks)				Irrigation intervals (weeks)			
	2	3	4	Mean	2	3	4	Mean	2	3	4	Mean	2	3	4	Mean
Marwa KWS	14.41	15.22	16.38	15.34	10.82	12.83	13.21	12.29	2.17	1.69	1.12	1.66	3.14	3.06	2.79	3.00
Nabila	14.52	14.71	15.75	14.99	10.38	11.59	12.82	11.60	1.66	1.54	1.22	1.47	3.02	2.62	2.38	2.68
Farida	14.89	14.94	15.86	15.23	11.35	12.02	13.31	12.23	1.72	1.57	1.27	1.52	3.11	2.26	2.08	2.48
Xanada	14.49	15.31	16.07	15.29	10.54	12.37	13.34	12.08	1.81	1.49	1.23	1.51	2.85	2.51	2.12	2.50
Amaldi	15.34	15.63	16.73	15.90	10.61	13.28	13.14	12.34	1.77	1.53	1.27	1.52	3.07	2.45	2.19	2.57
Mean	14.73	15.16	16.16	15.35	10.74	12.42	13.16	12.11	1.83	1.56	1.22	1.54	3.04	2.58	2.31	2.64
	2nd Season 2019/2020															
Marwa KWS	15.53	15.92	17.23	16.23	11.01	13.56	12.73	12.43	2.34	2.07	1.92	2.11	3.36	3.29	2.54	3.06
Nabila	14.45	14.68	15.65	14.93	10.84	11.34	13.21	11.80	1.93	1.75	1.67	1.78	3.07	2.44	2.14	2.55
Farida	14.87	15.94	16.57	15.79	10.24	12.23	13.25	11.91	1.86	1.79	1.44	1.70	2.82	2.31	2.09	2.41
Xanada	14.94	15.11	16.64	15.56	10.98	13.59	13.44	12.67	1.91	1.75	1.65	1.77	3.29	2.79	2.21	2.77
Amaldi	15.62	16.54	17.32	16.49	11.16	12.66	13.07	12.30	1.84	1.69	1.64	1.72	3.28	2.51	2.19	2.66
Mean	15.08	15.64	16.68	15.80	10.85	12.68	13.14	12.22	1.98	1.81	1.66	1.82	3.16	2.67	2.24	2.69
L.S.D 5%																
Stress (S)		0.41**	0.19*			0.34*	0.51*			0.02*	0.10*				0.21*	0.18**
Variety (V)		0.06*	0.05*			0.03*	0.05*			0.07*	0.03*				0.03*	0.02*
$S_X V$		0.14*	0.11*			0.09	0.10*			NS	NS				0.23*	0.19*

Photosynthetic pigments

The contents of photosynthetically active pigments (chlorophyll a, chlorophyll b and carotenoids), which estimated in leaves of sugar beet plant at vegetative stages are presented in (Fig. 1). Results showed the effect of delay irrigation intervals to 4-weeks (water stress) significantly decreased chlorophyll A (2.42 and 2.91 mg/g.f.w), chlorophyll B (1.09 and 1.47 mg/g.f.w) and carotenoids content (14.95 and 25.20 mg/g.f.w) in first and second season respectively. Chlorophyll breakdown under stress is a typical response for limiting photo-inhibition, which decreases leaf chlorophyll accumulation under stress **(Niazi *et al.*, 2004).** The percentages of decreases in chlorphell A, chlorphell B and carotenoids in both seasons, as compared with unstressed control condations.

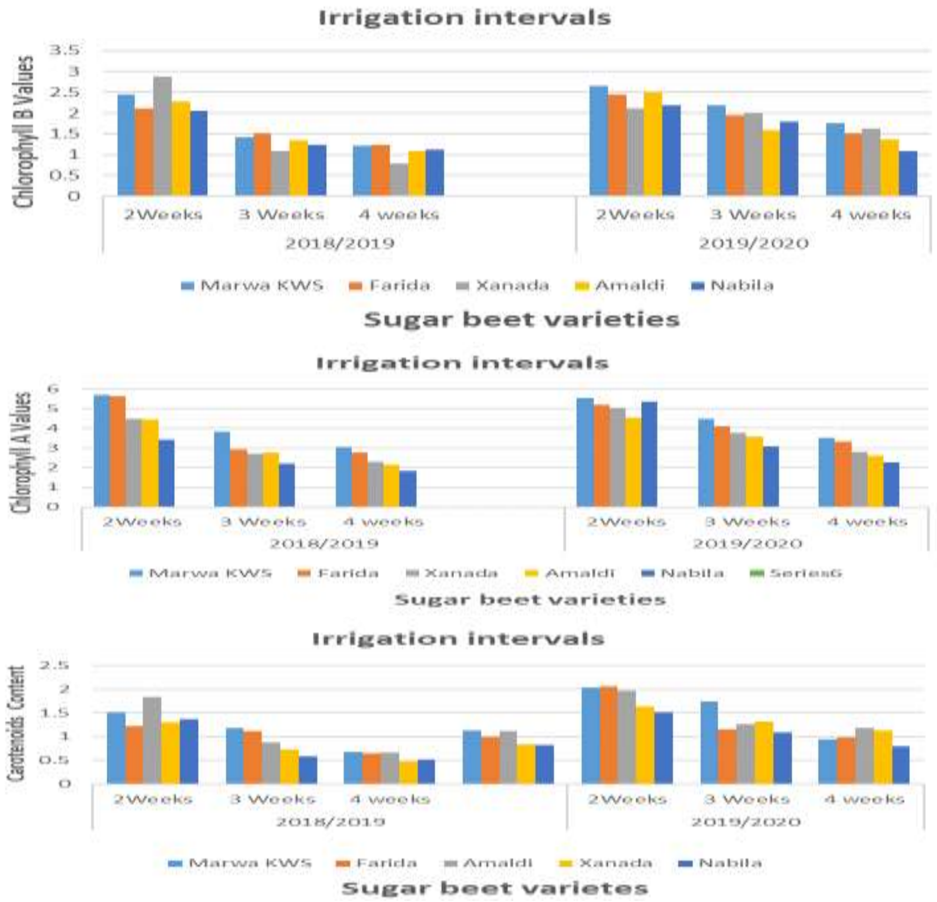

Fig 1. Photosynthetic pigments of five sugar beet varieties as grown under water stress.

Sugar beet variety (Marwa-KWS) recorded the highest values of chlorophyll A (3.04 and 3.52 mg/g.f.w), chlorophy ll b (1.22 and 1.76 mg/g.f.w) and carotenoids (1.13 and 0.94 mg/g.f.w) in first and second season, respectively. while variety (Nabila) registered the lowest values under water stress (4 weeks' intervals). These reductions in chlorphell A and B and carotenoids are mainly due to the reduction in photosynthetic pigments, that led to decrease in growth parameters of sugar beet varieties. **Xiang *et al*., (2013)** mentioned that the drought stress led to a significant decrease and degradation in chlorophyll a and b as well as total chlorophyll content. The sugar yield is the product of the total amount of dry matter accumulated in the plant during growth, the percentage allocated to the storage root, and the proportion of accumulated dry matter **(Bell *et al*., 1996).**

Antioxidant Enzyme Activities

Results showed significant differences ($P \leq 0.05$) for Catalase (CAT) and Peroxidase (POD) activities under irrigation intervals (Fig. 2). The POD and CAT activity increased sharply (2.24 and 0.44, respectively) and (5.31 and 0.69) in first and second season respectively in the leaves with delay irrigation intervals. These increases may help in turgor up keeping and cellular membrane stabilization **(Hosseini *et al.*, 2014).** Many studies have shown that water stress, significantly increased the peroxidase (POD), and catalase (CAT), that was the major antioxidant enzymes **(Bowler *et al.*, 1992 and Wei *et al.*, 2015).**

The stress-induced activity of the POD and CAT in the leaves was obviously different for the sugar beet varieties. Sugar beet variety (Marwa KWS) recorded the highest percentage of CAT and POD (2.42 and 0.52%) and (5.62 and 0.69%) in first and second season, respectively. while variety (Xanada) registered the lowest values under water stress. Overall, activities of all the antioxidant enzymes increased under water stress in all the varieties. Significant differences ($P \leq 0.01$) observed for activity levels of CAT and POD in irrigation × varieties interactions in both years. These results are in agreement with findings of **Habibi *et al.*, (2011) and Tohidi-Moghaddam *et al.*, (2009)** who, showed the activities of antioxidant enzymes significantly changed after water treatment.

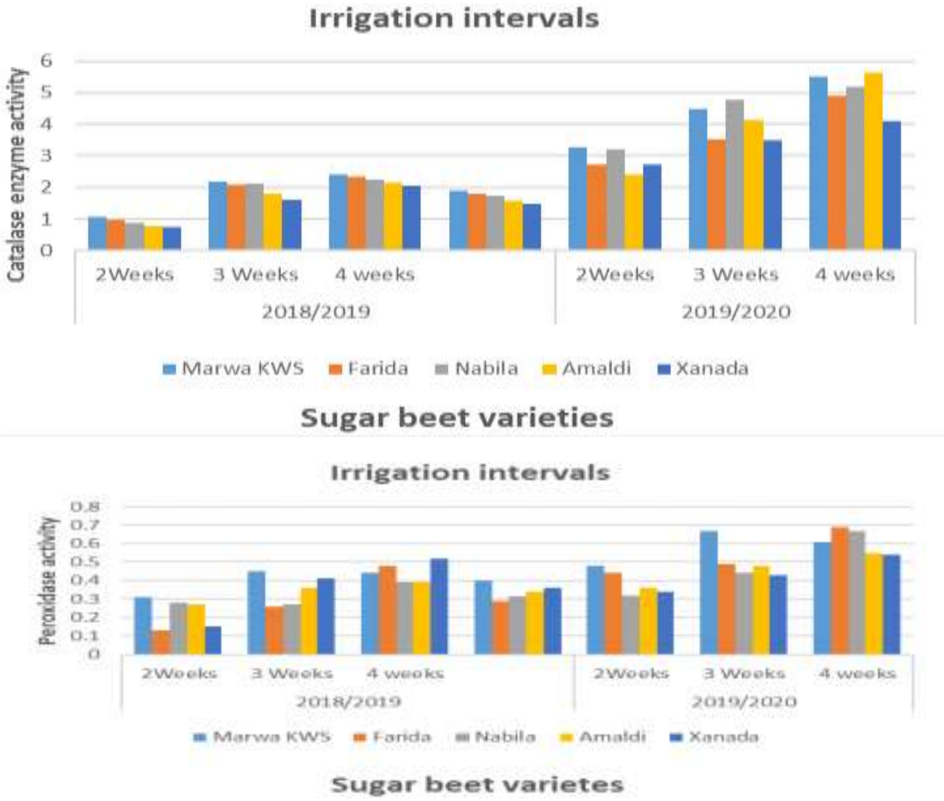

Fig 2. Antioxidant enzyme activities of five sugar beet varieties as grown under water stress.

Drought susceptibility of sugar beet varieties

Yield components are the most important agronomic traits in selecting for varieties tolerant to water stress, in addition, water stress (4 weeks' intervals) reduced root and sugar yields by reducing the root weight/plant, root diameter, sucrose% and extractable sugar% compare results with performance under normal irrigation intervals (2 weeks). Data in Table 4 showed that two varieties had a drought susceptibility index (DSI) based on root and sugar yields less than one and were relatively tolerant to drought stress in both season. DSI of root and sugar yields (ton/fed) indicated that the varieties Marwa-KWS, and Farida were tolerant to water stress, which had DSI values less than one. The most sensitive varieties Amaldi and Nabila were had drought susceptibility index (DSI) more than unity. Root yield was the most affected than sugar yield, and the decrease percentage of root and sugar yields ranged from 27.05 and 11.15 % for variety (Marwa-KWS) to the highest values 43.00 and 33.12% for variety (Nabila and Farida, respectively) in first season. While in the second season it ranged from 34.47 and 24.40 % for variety (Marwa-KWS) to the highest values 42.95 and 33.23% for variety (Amaldi). Root and sugar yields confirmed that it is important to use these traits as useful selection criteria for screening the drought tolerance, most importantly, both traits can be considered for screening sugar beet varieties at high water stress. **Abu El-lail *et al.*, (2019)** found that the selection of more tolerant varieties with the least DSI values may be a suitable method under stress. **Sadeghian *et al.*, (2000)** found that under severe drought stress, root yield, sugar yield, and white sugar yield decreased to 59%, 59%, and 60%, respectively, of the values obtained with adequate water; whereas, sugar content increased 6%.

Table (4): The decrease percentage and drought susceptibility index (SSI) of root and sugar yields (ton/fed) of five sugar beet as affected by water stress levels during two seasons 2018/2019 and 2019/2020.

Varieties	Root yield (ton/fed)			Sugar yield (ton/fed)		
	DSI	Decrease percentage		DSI	Decrease percentage	
		D^1-D^2/D^1%	D^1-D^3/D^1%		D1-D2/D1%	D1-D3/D1%
Season 2018/2019						
Marwa KWS	0.73	17.67	27.05	0.48	2.55	11.15
Nabila	1.13	31.36	43.00	1.38	13.25	21.19
Farida	0.95	22.45	36.18	0.88	27.33	33.12
Xanada	1.08	25.08	41.19	1.07	11.93	25.61
Amaldi	1.11	36.13	42.36	1.19	20.20	28.66
Mean	1.00±0.02	26.50±0.33	37.84±0.55	1.00±0.04	15.13±0.64	24.01±0.71
Season 2019/2020						
Marwa KWS	0.74	20.37	34.47	0.79	2.08	24.40
Nabila	1.13	31.59	42.80	1.16	20.52	30.29
Farida	0.89	31.52	45.06	0.81	18.09	25.89
Xanada	1.11	24.01	42.91	1.16	15.20	32.83
Amaldi	1.13	32.64	42.95	1.08	23.48	33.23
Mean	1.00±0.04	27.98±0.75	41.60±0.88	1.00±0.03	15.51±0.74	29.11±0.68

CONCLUSION

The results concluded that water stress significantly influenced the root yield and sugar yield. The studied varieties, as well, showed different reactions to water stress. There are acceptable varieties to be introduced to the farmers for cultivation under deficit water conditions. But, further research in this regard can provide more comprehensive results. The varieties Marwa and Farida had DSI less than unity and performed the best in relation to root yield and sugar yield. Hence, these varieties can be cultivated as commercial varieties in districts of deficit water stress.

REFERENCE

Abu-Ellail, F.F.B. ; K.A. Sadek and H.M.Y. El-Bakary (2019). Broad-sense heritability and performance of ten sugar beet varieties for growth, yield and juice quality under different soil salinity levels. Bull. Fac. Agric., Cairo Univ., 70:327-339.

Abu-Ellail, F. F.B. and M. M. A. El-Mansoub (2020). Impact of water stress on growth, productivity and powdery Mildew disease of ten sugar beet varieties. Alexandria Science Exchange J., 41:(2)165-179.

Aebi, H. (1984). Catalase in vitro. Methods Enzymol. 105:121-126.

Barnabas, B. ; K. Jager and A. Feher (2008). The effect of drought and heat stress on reproductive processes in cereals. Plant Cell Environ, 31(1): 11-38.

Bell, C.I. ; G.F.J. Milford and R.A. Leigh (1996). Sugar beet. In: Zamski E., Schaffer A.A. (eds.): Photoassimilate distribution in plants and crops. Source-sink relationships. Marcel Dekker Inc., USA, New York, Pp: 691–707.

Bowler, C. ; M.V. Montagu and D. Inze (1992). Superoxide dismutase and stress tolerance. Annu. Rev. Plant Physiol. Plant Mol. Biol., 43:83-116.

Carruthers, A. ; J. F. T. Oldifield and H. J. Teague (1962). Assessment of beet quality. Paper presented to the 15th Annual Technical Conference, Brtish Sugar Corporation Ltd. 28 PP.

Chaves, M.M. and M.M. Oliveira (2004). Mechanisms underlying plant resilience to water deficits: Prospects for water-saving agriculture. Journal of Experimental Botany, 55: 2365–2384.

El-Hassanin, A.S. ; S.M.R Moustafa ; N. Shafika ; A.M. Khalifa and M. Ibrahim (2016). Effect of foliar application with humic acid substances under nitrogen fertilization levels on quality and yields of sugar beet plant. Journal of Current Microbiology and Applied Sciences, 5(11): 668-680.

Emara, S.M. (1990). Effect of irrigation intervals, growth regulars and NK fertilizer on yield and quality of sugar beet. M.Sc. Thesis, Fac. Agric, Mansoura Univ., Egypt .

Enan, S.A.A.M.; E.F.A Aly and A.I. Badr (2016). Effect of humic acid and potassium on yield and quality of some sugar beet varieties in sandy soil. Journal of Plant Production Mansoura University, 7(2): 289- 297.

Fischer, R. and R. Maurer (1978). Drought Resistance in Spring Wheat Cultivars. I. Grain Yield Responses. Australian Journal of Agricultural Research, 29: 897-912.

Gizem, A.K.S.U. and A.L.T.A.Y. Hamit (2020). The effects of potassium application on drought stress in sugar beet: PART I. Sugar beet quality components. Journal of Scientific Perspectives, 4(2): 157-168.

Gomez, K.A. and A.A. Gomez (1984). Statistical Procedures for Agriculture Research. John Wiley and Sons. Inc. New York, USA.

Gong, H.J. ; X.Y. Zhu ; K.M. Chen ; S.M. Wang and C.L. Zhang (2005). Silicon alleviates oxidative damage of wheat plants in pots under drought. Plant Sci., 169:313–321.

Habibi, D. (2011). Evaluation of antioxidant enzymes activity in sugar beet genotypes under drought stress, Magnt Research Report, 2 (3): 225-238.

Hammer Schmidt, R.; E.M. Nuckles and J. Kuć (1982). Association of enhanced peroxidase activity with induced systemic resistance of cucumber to *Colletotrichum lagenarium*. *Physiological Plant Pathology*,20(1): 73-76, IN9-IN10, 77-82

Hosseini, S.M. ; T. Hasanloo and S. Mohammadi (2014). Physiological characteristics, antioxidant enzyme activities, and gene expression in 2 spring canola (*Brassica napus* L.) cultivars under drought stress conditions. Turkish Journal Agricultural. Forestry, 38:1–8.

Ibrahim, M.M. ; M.R. Khalifa ; M.A. Korim ; F.I. Zein and E.H. Omer (2002). Yield and quality of sugar beet crop as affected by mid to late season drought and potassium fertilization at north Nile Delta. Egypt. Journal of Soil Science, 42(1): 87-102.

Kirda, C. (2002). Deficit irrigation scheduling based on plant Growth stages showing water stress tolerance. Deficit irrigation practices. Water Report, 22. p.8.

Le-Docte (1927). Commercial determination of sugar beet in the beet root using the sacks. Le-Docte process. Int. Sugar. J., 29: 488-492.

Ludlow, M.M. and R.C. Muchow (1990). A critical evaluation of traits for improving crop yields in water-limited environments. Advance in Agronomy, 43: 107–153.

McGinnus, R.A. (1971). Sugar Beet Technology 2nd ed. Sugar Beet Development Foundation, fort collins, coloimbia, USA.

Moliszewska, E. ; M. Nabrdalik and P.J. Tubercle (2016). Disease (*Xanthomonas beticola*) and other gall-malformed diseases of sugar beet roots: a review. Journal of Plant Diseases and Protection, 123 (5): 197-203.

Niazi, B.H. ; M. Athar and J. Rozema (2004). Salt Tolerance in Fodder Beet and Sea Beet: Analysis of Biochemical Relation. Bulgarian Journal of Plant Physiology 30: 78-88.

Reinefeld, E.; A. Emmerich; Winner and U. Beiss (1974). For the prediction of molasses sugar extraction analgesics. Zucke., 27:2-12.

Sadeghian, S.Y. ; H. Fazli ; R. Mohammadian ; D. F. Taleghani and M. Mesbah (2000). Genetic Variation for Drought Stress in Sugarbeet. Journal of Sugar Beet Research, 37 (3):55-77.

Tahi, H. ; S. Wahbi ; R. Wakrim ; B. Aganchich ; R. Serraj and M. Centritto (2007). Water relations, photosynthesis, growth and water-use efficiency in tomato plants subjected to partial root zone drying and regulated deficit irrigation. Plant Bio systems – An International Journal Dealing with all Aspects of Plant Biology: Official Journal of the Societa Botanica Italiana, 141: 265–274.

Tohidi-Moghadam, H.R. ; A.H. Shirani-Rad ; G. Nour-Mohammadi ; D. Habibi and M. Mashhadi-Akbar-Boojar (2009). Effect of Super Absorbent Application on Antioxidant Enzyme Activities in Canola (*Brassica napus* L.) Cultivars under Water Stress Conditions. American Journal of Agricultural and Biological Sciences, 4 (3): 215-223,

Wei, P. ; Y. Yang ; F. Wang and H. Chen (2015). Effects of Drought Stress on the Antioxidant Systems in Three Species of Diospyros L. Hortic. Environ. Biotechnol., 56(5):597-605.

Wettstein, D. (1957). Chlorophyll-lethal and the submicroscopic change in form of the plastids. Exptl. Cell Res., 12: 427-433.

Wu, G.Q. ; C.M. Wang ; Y.Y. Su ; J. J. Zhang ; R.J. Feng and N. Liang (2014). Assessment of drought tolerance in seedlings of sugar beet (*Beta vulgaris* L.) cultivars using inorganic and organic solutes accumulation criteria. Soil Science and Plant Nutrition, 60: 565–576 .

Xiang, D.B. ; L.X. Peng ; J.L. Zhao ; L. Zou ; G. Zhao and C. Song (2013). Effect of drought stress on yield, chlorophyll contents and photosynthesis in tartary buckwheat (*Fagopyrum tataricum*). Food, Agriculture and Environment (JFAE), 11(3-4):1358–1363.

تأثير الإجهاد المائي على الجودة والإنتاجية والصفات الفسيولوجية لبعض أصناف بنجر السكر

فراج فرغل برعى أبو الليل ، ابراهيم سليمان هلال الجمل ، سعيد مصطفى ابراهيم بقوش و نادية كامل الصافي

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يعتبر الإجهاد المائي أحد العوامل الرئيسية المسؤولة عن تقليل إنتاجية محصول بنجر السكر. أجريت تجربة ميدانية بمزرعة خاصة بمديرية سيدي سالم (خط عرض 31 ° 07 'شمالاً وخط طول 30 ° 05' شرقاً) بمحافظة كفر الشيخ شمال دلتا النيل بمصر لموسمين متتاليين في 2018–2019 و 2019– 2020 ، لمعرفة تأثير معاملات الإجهاد المائي (2 ، 3 ، 4 أسابيع من فترات الري) على النمو الخضري ، وجودة العصير لخمسة أصناف من بنجر السكر ، ثلاثة أنواع متعددة الجنين (مروة ، وفريدة ، ونبيلة) ، واثنان أحادية الجنين (إكساندا و أملدي).أجريت المعاملات في تصميم القطعة المنشقة مرة واحدة بثلاث مكررات. أظهرت أهم النتائج التي تم الحصول عليها أن فترات الري المتأخرة (4 أسابيع) أدت إلى انخفاض ملحوظ في قطر الجذر ووزن الجذر ومحصول الجذر في كلا الموسمين. زيادة طول الجذر ونسبة السكروز ونسبة السكر القابل للاستخلاص ومحصول السكر في الموسمين. أظهر الصنف (مروة) تحمل للجفاف وفروق معنوية. أما الصنف الحساس للجفاف (نبيلة) فقد تأثر بشكل ملحوظ حتى مع الإجهاد المائي (4 أسابيع). أشارت النتائج إلى أن أصناف (مروة ، وفريدة ، وأملدي) ظهرت أفضل أداء تحت فترات الري الأطول (4 أسابيع) لمحصول الجذور والسكر ومكوناتهما. الكلوروفيل أ ، ب ، الكاروتينات ، انخفض بشكل ملحوظ مع تأخير أيام الري ، في هذه الأثناء يزيد من إنزيمات مضادات الأكسدة تحت ظروف الإجهاد.