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Effect of Magnetic Water, Number of Irrigation, Foliar Application with Salicylic Acid and Potassium on Productivity and Quality of Sugar Beet

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ABSTRACT

This study was carried out at Tag Al-Ezz Agricultural Research Station, in 2018/2019 and 2019/2020 seasons to find out the impact of two kinds of water (magnetic and field canal water); number of irrigation (5, 4 and 3 irrigations) and foliar transactions (without, spraying with water, salicylic acid at 300 mg/l and potassium sulphate at 4%) on sugar beet yield and quality characteristic. Each kind of irrigation water was achieved in a separate experiment. In each experiment, a strip-plot design was used with three repeats. Maximum growth, quality traits and yields/fed were recorded by irrigating beets with magnetized water. Supplying plants with 5 irrigations produced the highest values of root and foliage fresh weight, root length and diameter, as well as root and top yields/fed. Irrigating beets four times/season attained highest gross sucrose, extracted sucrose and quality index percentages, as well as corrected sugar yield/fed. Spraying plants with K_2SO_4 at 4% resulted in the highest values of growth, quality characteristics and yields/fed. Under condition of this study, irrigate sugar beets four times with magnetized water and spraying it with K_2SO_4 at 4% can be recommended to raise its production and quality traits.

Keywords: Sugar beet, magnetic water, irrigation, salicylic acid, potassium sulphate.

INTRODUCTION

Sugar beet (*Beta vulgaris* var. *saccharifera* L.) is cultivated for sugar manufacture and is believed the truly critical sugar crop in Egypt and in numerous nations across the world. Since 2012, sugar beet has become the main source for sugar production in Egypt, while sugarcane ranks the second. It is an essential winter crop, which can be grown in variable kinds of soils.

To improve the productivity of sugar beet simultaneously with the rationalization of irrigation water, some agricultural factors including magnetic water, number of irrigation and foliar application of salicylic acid and potassium were studied in the present work.

Magnetized water is attained by throwing of water across the eternal electromagnets. Magnetized water was exposed to have foremost properties for instance increasing the leakage of additional soluble salts, lessening soil alkalinity, softening somewhat soluble salts *e.g.*, carbonates, phosphates and sulfates. These effects have been described to adjust some of the physical and chemical properties of water. These adjustments in water state may result in enhancing plant growth (Ali *et al*., 2014). Hozayn *et al.* (2013) demonstrated that application of magnetized water be able to improve yield and characteristics of sugar beet. Faiyad and Hozayn (2020) concluded that irrigation with magnetic water had a positive influence on characteristics of sugar beet as compared with irrigation with nonmagnetic water. Hozayn *et al.* (2020) demonstrated that irrigation through magnetically treated brackish water exceeded significantly irrigation with brackish water in a number of vegetative growth constraints. Root contents of impurities and sugars lost to molasses ratio were significantly inspired by magnetically treated water. Aleman *et al.* (2022) mentioned that raise in mineral absorption of elements and the behavior of physiological activity in sugar beet were obtained.

Saving some irrigation water is necessary to face the shortage of water in the future. One way to save water can be done by reducing the number of irrigations by skipping some irrigation during growing season. In this respect, Ibrahim (2017) reported that irrigation intervals had a significant effect on all studied characteristics except purity%. The greatest values of studied traits were recorded when irrigation was given every 35-day intervals, while the greatest values of sucrose and purity percentages were recorded by irrigation every 25-day interval. Abd El-Rehem (2018) showed that raising water stress up to 50 % of irrigation water requirements considerably diminished top, root and sugar yields/fed. Meanwhile, it increased extractable sugar percentage. Osman *et al*. (2019) studied the effect of five regulated deficit irrigation transactions *i.e*., no stress at all physiological stages, skip irrigation at the beginning of the development stage (I2), skip irrigation through the development stage (I3), skip irrigation at mid season (I4) and skip irrigation at late season (I5) on sugar beet yield and quality. They showed that irrigation levels considerably influenced root, shoot and sugar yields. Their results pointed out that the reductions in root yield were 9.55, 6.43, 5.58 and 0.84 ton/fed, while sugar yield decreased by 1.89, 1.34, 1.22 and 0.10 ton/fed for I2, I3, I4 and I5, respectively compared to unstressed check. Fitters *et al.* (2020) showed that sugar beet yield is diminished due to water restriction. Yassin *et al.* (2021) indicated that reducing water supply reduced roots, sugar and biomass yields.

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Salicylic acid (SA) plays a crucial role in the regulation of several physiological activities in plants *e.g.*, photosynthesis, growth and stress tolerance (Ashraf *et al*., 2010). Abido *et al.* (2015) and Merwad (2015) observed that spraying plants with salicylic acid enhanced plant growing characteristics and heightened the capacity of plants to underneath abiotic tension, which finally increased sugar beet root and top yields. Cheraghabadi *et al.* (2016) stated that foliar application with salicylic acid caused a significant increase in leaf area and chlorophyll content of sugar beet plants as well as decrease membrane permeability compared to control. Abdelaal *et al.* (2020) revealed that the spraying beets with 100 ppm salicylic acid significantly influenced sugar beet top and root fresh weight. El-Gamal *et al.* (2021) pointed out that foliar supply with 2000 ppm salicylic acid significantly influenced sugar beet top and root biomass. However, increasing SA concentration led to significant variations in sugar yield, sucrose and purity %.

Potassium (K) is contribute in numerous imperative roles in plants *i.e.* photosynthesis, photosynthates translocation, synthesis of protein, ionic balance control, management of plant stomata and water use, stimulation of enzymes and osmoregulation (Mengel, 2007). Enan *et al*., (2016) revealed that foliar sprinkling with 2 L potassien (30% K2O and 8% P2O5/L)/fed increased root diameter, root and top fresh weights/plant, gross sugar%, corrected sugar%, characteristic index, root and sugar yields/fed in addition to diminished Na and alpha amino-N contents. Hamada (2019) concluded that foliar sprinkling twice with K-silicate at 12.0 ml/ Liter and applying 48 kg K2O/fed improved sugar beet growth, yielding and its apparatuses. El-Kalawy (2021) indicated that sprinkling with potassium silicate at 200 ppm gave the uppermost quantities of roots and total plant weights, root diameter, yielding of top and roots/fad.

So, this study aimed to study the consequence of magnetic water the number of irrigations and foliar sprinkling transactions on yielding and its constituents as well as the characteristic of sugar beet.

MATERIALS AND METHODS

The present investigation was conducted at Tag Al-Ezz Agricultural Research Station Farm (latitude of 31°31' 47.64'' N and longitude of 30°56' 12.88'' E), Dakahlia Governorate, Egypt, through 2018/2019 and 2019/2020 seasons to examine the impact of magnetic water, number of irrigations and foliar sprinkling transactions on yield and quality characteristic of sugar beet (Hossam multigerm cultivar).

Sugar beet was irrigated with magnetic water compared with field canal water as a check. In both kinds of water, plants were irrigated superficially as usual in the farmers' fields. Magnetized irrigation water was applied after raising the water to the field by a pump and installing the magnetization device of the irrigation water on the disposal hole.

Each experiment of magnetic water transactions was accomplished in a strip-plot design in three replicates in both seasons. Vertical plots were assigned to skipping irrigations which expressed as number of irrigations after sowing irrigation *i.e.* 5 irrigations (normal irrigation as a control), 4 irrigations (skipping the third one) and 3 irrigations (skipping the third and fifth irrigations) as shown in Table 1. Horizontal plots were committed at random along with four foliar sprinkling transactions *i.e.* with no foliar application (control), sprinkling with tap water, sprinkling with salicylic acid at 300 mg/liter of water and sprinkling with potassium sulphate (K2SO4) 4%. Foliar treatments were added twice at the above-mentioned rates after 50 and 70 days from planting. Each experimental unit contained 5-ridgesn of 60 cm width and 3.5 m long (10.5 m2). Mechanical and chemical assessments at 30 cm depth from soil surface of the experimental site is described in Table 2. Chemical analysis of irrigation water before and after magnetizing (Table 3).

Table 1. Schedule of irrigations during 2018/2019 and 2019/2020 seasons.

Number of irrigations	First irrigation	Second irrigation	Third irrigation	Fourth irrigation	Fifth irrigation
5 irrigations	√	√	√	√	√
4 irrigations	√	√	×	√	√
3 irrigations	√	√	×	√	×

Table 2. Physical and chemical of the soil at 30 com depth in 2018/2019 and 2019/2020 seasons.

Physical characteristics							
Properties Season	**Coarse sand (%)**	**Fine sand (%)**	**Silt (%)**	**Clay (%)**	**Soil texture**	**$CaCO_3$ (%)**	**Field capacity (%)**
2018/2019	6.2	32.6	25.7	35.5	Clay loam	2.45	34.3
2019/2020	5.8	33.2	25.3	35.7	Clay loam	2.54	35.2

Chemical characteristics						
Properties Seasons	pH soil paste	EC dSm^{-1}	Organic matter (%)	Available nutrients (ppm)		
				N	P	K
2018/2019	7.6	2.2	1.72	32.3	7.1	232
2019/2020	7.8	2.4	1.83	36.4	7.3	240

Table 3. Chemical analysis of irrigation water before and after magnetizing according to standard methods.

Parameter	**Non magnetizing water**	**Magnetizing water**
pH	7.42	7.48
EC ($dS\ m^{-1}$)	0.76	0.69
SAR*	2.32	1.62
Soluble Cations (meq L^{-1})		
Ca^{+2}	2.50	2.53
Mg^{+2}	1.44	1.71
Na^{+}	3.26	2.36
K^{+}	0.40	0.30
Soluble Anions (meq L^{-1})		
CO_3^{-2}	-	-
HCO_3^{-}	4.25	4.50
CL^{-}	1.73	1.62
SO_4^{-2}	1.62	0.78

*** SAR=Na/SQRT(Ca^{+2} +Mg^{+2})/2**

The experimental field was well prepared. Through soil preparation, calcium super phosphate (15 % P_2O_5) was applied at 200 kg/fed.

Sugar beet seeds were sown on one side of the ridge in hills of 20 cm apart in the first week of October in both seasons. Plants were thinned to one plant/hill (35000 plants/fed) at the age of 35 days from planting.

Other agricultural practices for growing sugar beet were performed as recommended by Sugar Crops Research Institute.

The studied characters:

At harvest, five plants were collected at random from each plot to determine fresh weight of root and foliage (g/plant), as well as root length and diameter (cm).

The following root quality characteristics were determined in Dakahlia Sugar Company, Bilkas Sugar Factory Laboratories, Dakahlia Governorate:

1. Sodium percentage.
2. Potassium percentage.
3. α-amino nitrogen percentage.
4. Gross sucrose percentage, which was determined polarimetrically according to the method of Carruthers and OldField (1960).
5. Extracted sucrose percentage *i.e.*, extractable white sucrose (correct sugar content) of beet roots was calculated by joining the beet non-sugar, K, Na and α-amino nitrogen (converted as a meq/100 g beet) as shown by Harvey and Dutton (1993) using the following equation:

Extractable white sugar (%) = Gross sugar (%) - [0.343 (K + Na) + 0.094 α-amino N + 0.29]

6. Quality index (%) of sugar beet root juice was determined according to a reported method of Carruthers and Old Field (1960).

At harvesting, root and top yields/plot were determined in kg and converted to ton/fed. Moreover, Sugar yield/fed (ton) was calculated as follows:

Sugar yield/fed (ton) = root yield/fed (ton) x extracted sucrose %

The collected data were statistically analyzed as published by Gomez and Gomez (1984) intended for strip-plot design of each trial (magnetic water treatments), next the collective analysis was passed after doing homogeneity test error mean squares between magnetic water transaction. Least significant difference (LSD) technique as expressed by Snedecor and Cochran (1980) was used to estimate the variations among transaction means at 5% level of possibility.

RESULTS AND DISCUSSION

1. Effect of irrigation water kind (field canal and magnetic water):

The results showed that magnetic water transactions (untreated water "control transaction" and magnetized water) had significant effects on yield constituents (fresh weight of root and foliage per each plant, root tall and thickness as shown in Table 4), quality parameters (sodium "Na", potassium "K", α-amino-nitrogen, gross sucrose, extracted sucrose and quality index percentages in beet root juice as revealed in Table 5) and beet yielding (root, top and corrected sugar yields/fed as given away in Table 6) in the two growing seasons.

The obtained results in Table 4 showed that irrigating sugar beets with magnetic water substantially increased the mean values of fresh weight of both root and foliage per each plant, root length and thickness by (139.7 and 129.0 g), (44.3 and 41.0 g), (4.41 and 4.07 cm) and (1.92 and 1.77 cm), in the 1st and 2nd season, respectively, compared with using water from field canals. Meanwhile, data in Table 5 cleared that using field canal water for sugar beet irrigation resulted in higher contents of impurities (Na, K and α-amino-nitrogen) in roots, while irrigating beets with magnetic water attained higher values of gross sucrose, extracted sucrose and quality index percentages. Moreover, the results in Table 6 indicated that using the magnetic water caused significant increases in root, top and corrected sugar yields/fed amounted to (4.147 and 3.734), (1.872 and 1.727) and (1.419 and 1.281) tons/fed, in the 1st and 2nd season, successively, in comparison with field canal water.

These results may be due to higher quality of magnetic water in respect reducing the amounts of salts in different depths of the soil (from 1 to 1.5 m) and leaching away of various anions from the soil, which guaranteed favorable uptake of nutrients by plants and hence better growth. These results are in agreement with those reported by Hozayn *et al*. (2013), Ali *et al.* (2014), Faiyad and Hozayn (2020), Hozayn *et al*., (2020) and Aleman *et al*., (2022).

2. Number of irrigations effect:

From obtained results in this investigation, it could be noticed that yield constituents (fresh weight of root and foliage for each plant, root tall and thickness as exposed in Table 4), quality parameters (sodium "Na", potassium "K", α-amino-nitrogen, gross sucrose, extracted sucrose and quality index percentages in beet root juice as showing in Table 5) and beet yielding (root, top and corrected sugar yields/fed as publicized in Table 4) were significantly affected by studied number of irrigations *i.e.* 6 irrigations (normal irrigation "control transaction"), 4 irrigations (skipping third irrigation) and 3 irrigations (skipping third and fifth irrigations) in the two seasons.

There were considerable distinctions in all studied yield components, characteristic parameters and beet yielding among various irrigation transactions *i.e.* giving sugar beet plants 5 irrigations (normal irrigation "control transaction "), 4 irrigations (skipping third irrigation) and 3 irrigations (skipping third and fifth irrigations) in every agricultural season. The acquired results in Table 4 showed that control transaction (giving sugar beet plants 5 irrigations) substantially increased the mean values of fresh weight of both root and foliage per each plant, root length and thickness by (3.20 and 75.80 g), (1.80 and 12.20 g), (0.22 and 0.66 cm) and (0.14 and 0.29 cm), compared with giving sugar beet plants 4 irrigations by skipping third irrigation only and by (66.50 and 101.60 g), (32.30 and 37.00 g), (3.80 and 3.94 cm) and (1.81 and 1.86 cm), compared with giving plants 3 irrigations only by skipping the third and fifth irrigations in the 1st and 2nd season, respectively. Meanwhile, data in Table 5 cleared that giving plants 3 irrigations only by skipping the third and fifth irrigations resulted in higher contents of impurities (Na, K and α-amino-nitrogen) in roots, while giving sugar beet plants 4 irrigations by skipping third irrigation only attained higher values of gross sucrose, extracted sucrose and quality index percentages. Moreover, the results in Table 6 indicated that control transaction (giving sugar beet plants 5 irrigations) caused significant increases in root and top yields/fed amounted to (0.201 and 0.721) and (0.091 and 0.314) and reductions in corrected sugar amounted to (0.200 and 0.032) tons/fed in comparison giving sugar beet plants 4 irrigations by skipping third irrigation only and increases in root, top and corrected sugar yields/fed reached about (2.042 and 2.264), (0.689 and 0.788) and (0.165 and 0.576) tons/fed compared with giving plants 3 irrigations only by skipping the third and fifth irrigations in the 1st and 2nd season, successively.

These increases in root and top yielding and their constituents due to decreasing irrigation tension by giving sugar beet plant 5 irritations may be due to providing moisture for sugar beet plants continuously which allows better growth and enhancement photosynthesis process, consequently improving root and tops yielding and its constituents. These outcomes are in excellent consistency with those registered by Osman *et al*., (2019) and Yassin *et al*., (2021). Also, Abd El-Rehem (2018) who showed that increasing water stress significantly decreased top, root and sugar yielding (t/fed), while it increased extractable sugar percentage.

3. Foliar sprinkling transactions effect:

The studied foliar fertilization transactions *i.e.* with no foliar sprinkling (control transaction), sprinkling sugar beet plants with tap water, salicylic acid at the rate of 300 mg/liter and potassium sulphate (K_2SO_4) at 4% significantly precious yield constituents (fresh weight for root and foliage per capita plant, root tall and thickness as shown in Table 4), quality parameters (sodium "Na", potassium "K", α-amino-nitrogen, gross sucrose, extracted sucrose and quality index percentages in beet root juice as revealed in Table 5) and beet yielding (root, top and corrected sugar yielding per capita fed as given away in Table 6) in every agricultural seasons.

Sprinkling two times as soon as 50 and 70 days from planting with tap water, salicylic acid and potassium sulphate caused continuing boosts in all studied characteristics contrasted with no sprinkling (control transaction) in the two-growth time of year. The attained results in Table 4 showed that foliar spraying beet plants with potassium sulphate (K_2SO_4) at 4% substantially increased the mean values of fresh weight of both root and foliage per each plant, root length and thickness by (349.60 and 342.90 g), (93.90 and 92.10 g), (1.85 and 1.82 cm) and (4.52 and 4.44 cm), compared with control transaction (no foliar sprinkling) and by (332.50 and 326.20 g), (88.40 and 86.70 g), (1.23 and 1.21 cm) and (4.27 and 4.20 cm), compared with foliar spraying beet plants with tap water and by (134.10 and 131.70 g), (42.00 and 41.10 g), (0.92 and 0.91 cm) and (3.00 and 2.95 cm), compared with foliar spraying beet plants with salicylic acid at the rate of 300 mg/liter in the 1st and 2nd season, respectively. Meanwhile, data in Table 5 cleared that with control transaction (no foliar sprinkling) resulted in higher contents of impurities (Na, K and α-amino-nitrogen) in roots, while foliar spraying beet plants with potassium sulphate (K_2SO_4) at 4% attained higher values of gross sucrose, extracted sucrose and quality index percentages. Moreover, the results in Table 6 indicated that the increases in root, top and corrected sugar yielding per /fed as a result of sprinkling twice with potassium sulphate (K_2SO_4) at rate of 4% reached about 8.98, 6.15 and 11.60% as compared with sprinkling with salicylic acid at the rate of 300 mg/liter and about 20.94, 13.43 and 28.90% as compared with sprinkling sugar beet plants with tap water and about 22.55, 14.44 and 33.67% as compared with control transaction (without foliar application) over every studied growing season.

Table 4. Root and foliage fresh weight/plant, root tall and diameter of sugar beet as affected by magnetic water transactions, number of irrigations and foliar sprinkling treatments as well as their interactions through 2018/2019 and 2019/2020 seasons.

Character	Root fresh weight/ plant (g)		Foliage fresh weight/ plant (g)		Root length (cm)		Root diameter (cm)	
Season	**2018/2019**	**2019/2020**	**2018/2019**	**2019/2020**	**2018/2019**	**2019/2020**	**2018/2019**	**2019/2020**
A. Water treatment								
Field canal water	922.3	908.4	292.9	288.4	29.13	28.69	12.66	12.47
Magnetized water	1062.0	1037.4	337.2	329.4	33.54	32.76	14.58	14.24
F. test	*	*	*	*	*	*	*	*
B. Number of irrigations								
5 irrigations	1015.4	1032.0	326.4	325.3	32.67	32.26	14.27	14.07
4 irrigations	1012.2	956.2	324.6	313.1	32.45	31.60	14.13	13.78
3 irrigations	948.9	930.4	294.1	288.3	28.87	28.32	12.46	12.21
LSD at 5%	14.9	15.6	14.5	15.3	1.88	1.85	0.05	0.06
C. Foliar application treatments								
Without	846.6	830.2	277.2	271.8	30.48	29.89	12.05	11.81
Tap water	863.7	846.9	282.7	277.2	31.10	30.50	12.30	12.05
Salicylic acid (300 mg/l)	1062.1	1041.4	329.1	322.8	31.41	30.80	13.57	13.30
Potassium sulphate (4%)	1196.2	1173.1	371.1	363.9	32.33	31.71	16.57	16.25
LSD at 5%	26.7	27.5	12.8	13.1	0.77	0.76	0.04	0.05
Interactions (F. test)								
A × B	*	*	NS	NS	*	*	*	*
A × C	NS	NS	NS	NS	NS	NS	*	*
B × C	*	*	*	*	*	*	*	*
A × B × C	*	*	*	*	NS	NS	*	*

Table 5. Sodium (Na), potassium (K), α-amino-nitrogen, gross sucrose, extracted sucrose and quality index percentages in sugar beet root juice as affected by magnetic water treatments, number of irrigations and foliar sprinkling transactions as well as their interactions through 2018/2019 and 2019/2020 seasons.

Character Season	Na (%)		K (%)		α-amino-nitrogen (%)		Gross sucrose (%)		Extracted sucrose (%)		Quality index (%)	
	2018/2019	2019/2020	2018/2019	2019/2020	2018/2019	2019/2020	2017/2018	2018/2019	2018/2019	2019/2020	2018/2019	2019/2020
A. Water treatment												
Field canal water	1.94	1.89	6.01	5.87	4.12	4.03	17.47	17.18	14.47	14.22	75.81	74.69
Magnetized water	1.68	1.66	5.23	5.15	3.58	3.53	20.47	19.94	17.06	16.60	86.86	85.26
F. test	*	*	*	*	*	*	*	*	*	*	*	*
B. Number of irrigations												
5 irrigations	1.81	1.59	5.88	4.99	4.09	3.65	18.56	18.84	15.25	15.95	77.65	83.10
4 irrigations	1.78	1.76	5.05	4.95	3.37	3.31	20.07	19.64	17.11	16.74	90.41	89.31
3 irrigations	1.84	1.97	5.94	6.60	4.10	4.38	18.27	17.19	14.93	13.55	75.93	67.52
LSD at 5%	0.03	0.05	0.26	0.27	0.03	0.04	0.33	0.34	0.42	0.44	2.81	2.70
C. Foliar application treatments												
Without	1.94	1.90	6.50	6.37	3.97	3.89	18.54	18.14	15.04	14.70	80.72	79.19
Tap water	1.90	1.86	6.37	6.24	3.89	3.81	18.96	18.55	15.40	15.05	80.75	79.44
Salicylic acid (300 mg/l)	1.80	1.76	5.27	5.17	3.84	3.77	19.13	18.71	16.05	15.69	81.35	80.04
Potassium sulphate (4%)	1.60	1.57	4.35	4.26	3.72	3.65	19.25	18.83	16.56	16.20	82.50	81.23
LSD at 5%	0.02	0.02	0.23	0.22	0.02	0.02	0.23	0.22	0.27	0.26	1.59	1.70
Interactions (F. test)												
A × B	*	*	*	*	*	*	*	*	*	*	*	*
A × C	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
B × C	*	*	NS	*	NS	*	NS	*	NS	*	NS	NS
A × B × C	*	NS	NS	NS	*	NS	*	*	*	*	NS	NS

Table 6. Root, top and corrected sugar yields/fed of sugar beet as affected by magnetic water transactions, number of irrigations and foliar sprinkling treatments as well as their interactions through 2018/2019 and 2019/2020 seasons.

Character	Root yield (t/fed)		Top yield (t/fed)		Corrected sugar yield (t/fed)	
Season	2018/2019	2019/2020	2018/2019	2019/2020	2018/2019	2019/2020
A. Water treatment						
Field canal water	27.347	26.937	12.343	12.158	3.957	3.830
Magnetized water	31.494	30.761	14.215	13.885	5.376	5.111
F. test	*	*	*	*	*	*
B. Number of irrigations						
5 irrigations	30.168	29.844	13.539	13.389	4.655	4.652
4 irrigations	29.967	29.123	13.448	13.075	4.855	4.684
3 irrigations	28.126	27.580	12.850	12.601	4.490	4.076
LSD at 5%	0.955	0.945	0.161	0.150	0.237	0.244
C. Foliar application treatments						
Without	26.972	26.447	12.553	12.309	4.084	3.911
Tap water	27.330	26.798	12.665	12.419	4.235	4.056
Salicylic acid (300 mg/l)	30.328	29.740	13.533	13.271	4.890	4.686
Potassium sulphate (4%)	33.052	32.411	14.365	14.087	5.458	5.229
LSD at 5%	0.818	0.805	0.235	0.231	0.173	0.167
Interactions (F. test)						
A × B	*	*	NS	NS	*	*
A × C	NS	NS	NS	NS	NS	NS
B × C	*	*	*	*	*	*
A × B × C	*	*	*	*	*	*

The attractive impact of sprinkling with K-sulphate (K_2SO_4) at the rate of 4 % may be imputed to the role of K in in numerous imperative roles in plants. Furthermore, the attractive effect of sprinkling with salicylic acid at 300 mg/liter may be ascribed to its title role in controlling several physiological activities in plants. Abido *et al.* (2015), Merwad (2015), Cheraghabadi *et al*. (2016) and Abdelaal *et al*. (2020) pointed out that foliar sprinkling with salicylic acid led to improve plant growth characteristics. Also, Enan *et al*. (2016), Hamada (2019) and El-Kalawy (2021) revealed that foliar sprinkling with potassium improved sugar beet growth, yielding and its components.

4. Effect of the interactions:

Concerning the impact of interactions, several considerable consequences of the interactions amongst examined factors (magnetic water transactions, number of irrigations and foliar sprinkling transactions) were found on examined characteristics as demonstrated in Tables 4, 5 and 6. We described adequate of the triple significant interaction on root, top and corrected sugar yields/fed.

The three-way interaction amongst magnetic water transactions, number of irrigations and foliar sprinkling transactions significantly impacted root, top and corrected sugar yielding per fed through the initial and following agricultural seasons of this study (Table 7). The uppermost incomes of root yield (34.558 and 33.638 t/fed) and top yield (15.618 and 15.232 t/fed) were produced by giving sugar beet plants 5 irrigations with magnetized water and sprinkling plants twice with potassium sulphate (K_2SO_4) at rate of 4 % and the second best quantities with insignificant differences of root yield (34.413 and 33.616 t/fed) and top yield (15.089 and 14.739 t/fed) were produced from giving sugar beet plants 4 irrigations with magnetized water by skipping third irrigation only and sprinkling plants twice with potassium sulphate (K_2SO_4) at 4 % in the primary and additional seasons, respectively. While, the maximum quantities of corrected sugar yield (6.234 and 6.014 t/fed) were produced from giving sugar beet plants 4 irrigations with magnetized water by skipping third irrigation and sprinkling plants twice with K-sulphate (K_2SO_4) at rate of 4% in the primary and another seasons, respectively. On the further knowing, the lowest possible quantities of root, top and corrected sugar yielding per fed were obtained by giving plants 3 irrigations with untreated water (normal irrigation water) by skipping the third and fifth irrigations and without foliar sprinkling in every agricultural season.

Table 7. Root, top and corrected sugar yields/fed of sugar beet as affected by the interaction among magnetic water transactions, number of irrigations and foliar sprinkling treatments through 2018/2019 and 2019/2020 seasons.

Characters			Root yield (t/fed)		Top yield (t/fed)		Corrected sugar yield (t/fed)	
Water treatment	Number of irrigations	Foliar application treatments	2018/ 2019	2019/ 2020	2018/ 2019	2019/ 2020	2018/ 2019	2019/ 2020
Field canal water	5 irrigations	Without	25.700	25.315	11.800	11.624	3.601	3.485
		Tap water	26.047	25.658	11.907	11.730	3.736	3.616
		Salicylic acid	28.833	28.299	12.800	12.610	3.743	4.140
		Potassium sulphate	34.833	34.317	14.633	14.416	4.490	4.464
	4 irrigations	Without	25.000	24.620	11.800	11.623	3.674	3.557
		Tap water	25.328	24.943	11.906	11.728	3.810	3.689
		Salicylic acid	28.733	28.406	12.733	12.542	4.419	4.277
		Potassium sulphate	29.800	29.350	13.067	12.871	4.801	4.648
	3 irrigations	Without	24.500	24.136	11.400	11.231	3.104	3.001
		Tap water	24.823	24.454	11.499	11.328	3.220	3.114
		Salicylic acid	27.000	26.591	12.200	12.016	4.279	3.623
		Potassium sulphate	27.567	27.149	12.367	12.181	4.610	4.345
Magneti-zed water	5 irrigations	Without	29.678	28.974	13.626	13.305	4.915	4.668
		Tap water	30.079	29.365	13.750	13.426	5.097	4.840
		Salicylic acid	33.181	32.409	14.704	14.362	5.944	5.654
		Potassium sulphate	34.558	33.638	15.618	15.232	6.133	5.833
	4 irrigations	Without	28.562	27.899	13.401	13.092	5.111	4.861
		Tap water	28.938	28.265	13.521	13.210	5.297	5.038
		Salicylic acid	32.744	31.986	14.536	14.199	6.020	5.724
		Potassium sulphate	34.413	33.616	15.089	14.739	6.234	6.014
	3 irrigations	Without	28.391	27.738	13.290	12.981	4.098	3.895
		Tap water	28.764	28.102	13.406	13.093	4.249	4.039
		Salicylic acid	31.477	30.749	14.223	13.894	4.937	4.696
		Potassium sulphate	32.138	31.394	14.417	14.083	6.078	5.774
LSD at 5%			1.604	1.546	0.577	0.565	0.322	0.332

CONCLUSION

Under conditions of the present work, supplying sugar beets with four irrigations of magnetized water, skipping the third irrigation and spraying beets with twice (after 50 and 70 days from sowing) with potassium sulphate at 4 % can be recommended to get the highest root and sugar yields/fed.

REFERENCES

Abd El-Reheem, M.K. (2018). Effect of some soil amendments on physiological traits and productivity of sugar beet under water stress in sandy soil in Egypt and Morocco. M.D. Thesis, Inst. African Res. Studies, Cairo Univ., Egypt.

Abdelaal, K.A.A.; S.H. Rashed; A. Ragab; A. Hossain and A. El-Sabagh (2020). Yield and characteristic of two sugar beet (*Beta vulgaris* L. ssp. *vulgaris* var. *altissima* Döll) cultivars are influenced by foliar sprinkling of salicylic acid, irrigation timing, and planting density. Acta Agric. Slovenica, 115(2): 273-282, doi:10.14720/aas.2020. 115.2.1159.

Abido, W.A.E.; M.E.M. Ibrahim, and M.M. El-Zeny (2015). Growth, productivity and characteristic of sugar beet as affected by antioxidants foliar sprinkling and potassium fertilizer top dressing. Asian J. Crop Sci., 7(2): 113-127, doi. Org /10. 3923 /ajcs .2015 .113.127.

Aleman, E.I.; V.R.F. Hernández; A.E.F. Dubois; Y.F. Boix; A. Cuypers; G.A. Kindelán; J.G. Aguilera; A.M. Zuffo; R.F. Ratke and R.J. Goes (2022). Magnetically treated water influences soil properties, water absorption and nutrients in *Beta vulgaris* L. Res., Soc. and Dev., 11(7), e45111730203, DOI: 10.33448/rsd-v11i7.30203.

Ali, Y.; R. Samaneh and F. Kavakebian (2014). Applications of magnetic water technology in farming and agriculture development: A review of recent advances. Curr. World Environ., 9(3): 695-703.

Ashraf, M.; N.A. Akram; R.N. Arteca and M.R. Foolad (2010). The physiological, biochemical and molecular roles of brassinosteroids and salicylic acid in plant processes and salt tolerance. Critical Rev. Plant Sci., 29(3): 162-190.

Carruthers, A. and J.F.T. OldField (1960). Methods for the assessment of beet quality. Int. Sugar J., 63: 72-74.

Cheraghabadi, M.M.; H. Roshanfekr; P. Hasibi and M. Mousa (2016). Effect of foliar sprinkling of salicylic acid on some physiological traits of sugar beet in salt stress conditions. Iranian J. Filed Crop Sci., 46(4): 1-16.

El-Gamal, I.S.H.; Nadia, K. El-Safy and E.A. Abo-Marzoka (2021). Growth of some sugar beet varieties under different locations as affected by foliar sprinkling with salicylic acid on yield and quality. Egypt. Acad. J. Bio. Sci., 12(1): 161-173.

El-Kalawy, Samia, M.S. (2021). Effect of potassium levels as soil application and foliar spray with silicon and boron on yield and root characteristic of sugar beet under clay soil. Middle East J. of Agric. Res., 10(1): 207-226, DOI: 10.36632/mejar/2021.10.1.12.

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

Faiyad, Riham, M. and M. Hozayn (2020). Effect of magnetic water and urea fertilizer on sugar beet yield and quality. Plant Arch., 20 (2): 8622-8634.

Fitters, T.; S.J. Mooney and D.L. Sparkes (2020). Impact of water availability on root growth of sugar beet varieties. Soil Use Man., 38: 1033-1043.

Gomez, K.N. and A.A. Gomez (1984). Statistical procedures for agricultural research. John Wiley and Sons, New York, 2nd Ed., 68 P.

Hamada, Maha, M.A. (2019). Effect of sources and rates of potassium fertilizer on growth, productivity and characteristic of sugar beet. East African Sch. J. of Agric. and Life Sci., 2(6): 295-305.

Harvey, C.W. and J.V. Dutton (1993). Root Characteristic and Processing pp: 571-617. In D. A. Cooke and R. K. Scott (eds.). The Sugar Beet Crop. Chapman and Hall, London, 675 p.

Hayat, S.; B. Ali and A. Ahmed (2007). Salicylic acid Biosynthesis, Metabolism and Physiological Role in Plants. In : Salicylic Acid, a Plant Hormone, Hayat, S and Ahmed A. (Eds). Springer, Drodrecht, pp: 1-14.

Hozayn, M.; A.A. Abd El Monem; R.E. Abdelraouf and M.M. Abdalla (2013). Do magnetic water affect water use efficiency, characteristic and yield of sugar beet (*Beta vulgaris* L.) plant under arid regions conditions?. J. Agron., 12: 1-10, DOI: 10.3923/ja.2013.1.10.

Hozayn, M.; M.F. El-Dahshouri; Azza, M. Salama; R.E. Abdelraouf and A.Z. Ahmed (2020). Influence of magnetic brackish-water transactions on growth, anatomical structure, yield and characteristic of sugar beet (*Beta vulgaris* L.). Plant Arch., 20 (2): 8271-8278.

Ibrahim, M.E.M. (2017). Plant distribution patterns and irrigation intervals effects on yield and characteristic of sugar beet in North Delta. J. Plant Prod., Mansoura Univ., 8(6): 679 -684.

Mengel, K. (2007). Potassium. In "Handbook of Plant Nutrition" (Eds. Barker AV, Pilbeam DJ) 1st Ed., pp: 91-120.

Merwad, A.M.A. (2015). Effect of potassium fertilization and salicylic acid on yield, characteristic and nutrient uptake of sugar beet (*Beta vulgaris* L.) grown in saline soil. Malaysian J. Soil Sci., 19: 95-105.

Osman, A.M.; K.M. Agami; H.M. El-Sharnoby and A.K. Abdelhalim (2019). Effect of regulated deficit irrigation and boron rates on sugar beet productivity in newly reclaimed soils. Menoufia J. Soil Sci., 4(8): 155-169.

Snedecor, G.W. and W.G. Cochran (1980). Statistical Methods. 7th ed. Iowa State Univ. Press, Iowa, USA.

Yassin, O.; S.M. Ismail; M.A. Ali; F.A. Khalil and E.M. Ahmed (2021). Optimizing roots and sugar yielding and water use efficiency of different sugar beet varieties grown under upper Egypt conditions using deficit irrigation and harvesting dates. Egypt. J. Soil Sci., 61(3): 367-372, DOI: 10. 21608 /ejss. 2021 .105612.1476.

تأثير الماء المُمغنَط وعدد الريات والرش الورقى بحمض السلسيليك والبوتاسيوم على إنتاجية وجودة بنجر السكر

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الملخص

أجريت هذه الدراسة في مزرعة محطة البحوث الزراعية بمنطقة تاج العز، محافظة الدقهلية، مركز البحوث الزراعية، مصر، خلال موسمي 2019/2018 و 2020/2019 لدراسة تأثير الماء الممغنط مقارنة بمياه الرى العادية من قناة الحقل، عدد الريات (5 ، 4 و 3 ريات أى رى عادي، إسقاط الرية الثالثة وإسقاط لريتين الثالثة والخامسة) ومعاملات الرش الورقي (بدون، الرش الورقى بالماء والرش الورقى بحمض الساليسيليك بمعدل 300 ملجم/لتر والرش الورقى بكبريتات البوتاسيوم بمعدل 4٪) على محصول وصفات جودة جذور بنجر السكر. تم إجراء تجربة منفصلة لكلٍ من الرى بالمياه العادية والمياه الممغنطة ، وتم توزيع عدد الريات ومعاملات الرش الورقى في تصميم الشرائح المتعامدة فى ثلاث مكررات. تم الحصول على أعلى القيم لمكونات المحصول وصفات الجودة وحاصل الجذور والعروش والسكر المعدل بري البنجر بالمياه الممغنطة. أدى رى نباتات بنجر السكر 5 ريات للحصول على أعلى القيم لصفات الوزن الطازج للجذور والعروش، وطول وقطر الجذور وحاصل الجذور والعروش والسكر المعدل - بينما أدى رى نباتات بنجر السكر 4 ريات بإسقاط الرية الثالثة فقط للحصول على أعلى نسبة مئوية للسكروز والسكروز المُستخلَص ودليل الجودة وكذلك حاصل السكر المعدل للفدان. تم الحصول على أعلى قيم لمكونات المحصول وصفات الجودة وحاصل الجذور والعروش والسكر المعدل بالرش الورقى بكبريتات البوتاسيوم K_2SO_4 بمعدل 4٪. تحت ظروف هذا البحث، يمكن التوصية برى نباتات بنجر السكر 4 ريات (بإسقاط الرية الثالثة فقط) بمياه الرى الممغنطة مع الرش الورقى بكبريتات البوتاسيوم K_2SO_4 بمعدل 4٪ وذلك لتعظيم الإنتاجية وجودة الجذور.