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Mitigation salinity stress using magnetically treated water and *Chlorella sp algae* extract on sunflower productivity

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Abstract
In agriculture, the use of magnetic technology in conjunction with Chlorella sp. algae extract is regarded as a novel and unconventional approach that is safe, healthful, ecologically friendly, and has the potential to reduce salt stress and increase crop yield. Laboratory and field experiments using sunflower (Helianthus annuus L.; Var., Sakha-53) were conducted at the Laboratory of Field Crops Research Department, NRC, and Agricultural Experimental Station of Desert Research Centre, Ras-Sidr, South Sinai Governorate; Egypt during the autumn season of 2020/21 and 2021/22. The laboratory experiment included two treatments (un-priming and priming seeds with 1% Chlorella algae extract) while the field Experiment included two factors: I) magnetized brackish water [1) Brackish water (BW), 2) Magnetic-BW1, and 3) Magnetic-BW2; brackish water after magnetization through passing a three-inch permanent static magnetic unit having intensity 0.35 and 0.06T, respectively] and II) Magneto-priming seeds [Un-priming and magneto-priming seeds with 1% Chlorella algae]. The results of the field experiment showed priming sunflower seed with 1% chlorella algae and irrigation with magnetized brackish water (BW1 or BW2) induced positive and significant effects on all studied parameters (plant height (cm), fresh and dry weight (g plant-1), total chlorophyll, leaves contents of N, K, Mg, Ca ins % and Fe, Mn and Zn in ppm at 45 days after sowing, sunflower yield (kg fed-1) and its component at harvest. The results obtained clarify that, the application of magnetically brackish-water technology with a combination of 1% chlorella algae can be applied as an essential way to alleviate salinity stress and improve sunflower productivity

Keywords: *Salinity stress, magnetically brackish-water, Priming seeds, Chlorella algae, Magnetic water*

1. Introduction

Salinity is a major problem affecting crop production all over the world [1]; its lead to loss of productivity of many agricultural crops [2]. Salinity reduces the productivity of many agricultural crops and poor quality [3] and salinity led to delay the germination [4, 5].

Magnetic water (MW) led to good effects on the availability of macro-micronutrients [6]. Improved crop yield could be achieved by using magnetic water [7]. The germination rate of corn seedlings irrigated with saline water treated by electromagnetic treatment is significantly improved [8]. Cowpea irrigated with magnetic saline water showed significant increase in growth parameters such as stem and root length in magnet treated solutions than in control solutions [9]. Harmful and negative effect of salinity on the germination of corn and potatoes, and at the same time increase productivity by about 10%, by using magnetic treatment of salt water [9]. Also, use of magnetic water by recommended method enhances the vegetative growth, yield and its components of potato plants, reduces soil salinity and improves soil fertility [10]. According to [11], tomato plants treated with magnetic water had higher yield than those treated with non-magnetic water; the percentage increase varied from 39.9 to 68.7%.The majority of vegetative growth parameters, chemical constituents (such as photosynthetic pigments, such as chlorophyll a, chlorophyll b, and carotenoids), total phenols, total indole, and number of protein bands, yield components, and yield over the control plants are all increased in irrigation wheat plants with MW [10].The magnetized underground brackish water increased seed germination over control in wheat, barley and triticale [12]. It is reported by [13] that MW significantly increased plant height, fresh and dry weight in lentil plant. On tomato magnetized water gave taller and heavier plants [14]. Likewise, higher germination and growth of sunflower were noticed under magnetized water treatment [15].

Algal extract could be containing high macro-micronutrients, natural enzymes and hormones [16], amino acid, organic acids, phytohormons, enzymes [17].Enhancing seed germination, plant growth and yield, as well as fruit production, in addition to increasing the shelf life after harvest, occurs as a result of using algae extracts [18,19]. Green microalgae water

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extract enhanced uptake, nutrient balance and dry matter accumulation of wheat Plants [20] and the oxidative stress for wheat plants [21]. Fenugreek plants treated with algal extract by foliar application showed significantly increased plant height, number of leaves, number of branches and fresh and dry weights; also, markedly increased nitrogen, phosphorous and potassium contents.

The sunflower (Helianthus annuus L.) is an important oil crop in Egypt [22]. Sunflower has a high ratio of polyunsaturated fatty acids and a low cholesterol level. There have been few reports of sunflower tolerance to salt stress [23].

The study aims to explore the role of combination of some magneto-priming seed materials with magnetically treated brackish-water for alleviation water and soil salinity stress conditions on productivity of sunflower and Water Use Efficiency under drip irrigation system in Ras-Sidr province, South Sinai Governorate, Egypt.

2. Materials & Methods

During the fall season of 2020 and 2021, a field experiment of sunflower (Helianthus annuus L.; Var., Sakha-53) was carried out at the Desert Research Centre's Agricultural Experimental Station in Ras-Sidr, South Sinai Governorate, Egypt. The experimental location is located on the Gulf of Suez and the Red Sea coast (29o60'28" N latitude and 32o68'96" E longitude), at an elevation of 16 meters above sea level. It has a desert climate. Ras-Sidr's average annual temperature and. rainfall are 22.2 °C and 15 mm, respectively. The experimental soil and irrigation water were analyzed according to the method described by Chapman and Pratt 1978. Data in Table (1) reveal that soil of the experimental site was sandy loam, saline and poor in NPK and organic matter and the irrigation water was saline.

2.1. Treatments:

Three different irrigation water treatments were tested: i) Brackish water (BW); ii) Magnetic-BW1, which was brackish water that was magnetized using a 3-inch permanent magnet device made by Delta Water Company, Alexandria Industrial Zone 1, Egypt. and iii) Magnetic-BW2, a brackish water magnetic device made by Magnetic Technologies LLC, P.O. Box 27559, Dubai, United Arab Emirates, which is magnetized by a 3-inch permanent magnet device. and two priming seed treatments (magnetic priming and non-priming, with 1% Chlorella as the control). Using a split-plot design, the two test components were duplicated three times under a drip watering system. The main plot and subplots received three different kinds of irrigation water and seed preparation treatments, respectively.

Table 1. Mechanical, Chemical and physical analysis of soil and irrigation water before sowing

Parameter	Soil depth (cm) 0-30	Soil depth (cm) 30-60	Irrigation water
Soil physical properties			
pH	7.66	7.00	8.60
EC (dSm^2)	8.65	7.90	9.68
Organic matter (%)	1.70	1.23	…
Particle size distribution			…
Sand (%)	81.28	86.08	..
Clay (%)	10.67	6.33	..
Silt (%)	8.05	7.59	..
Texture	Sandy loam		..
Soil chemical properties			
Soluble cations (mq/100g)			
Ca^{+2}	38.22	30.82	23.54
Mg^{+2}	27.44	22.00	24.48
Na^{+}	58.33	65.80	40.05
K^{+}	2.01	0.08	0.14
Soluble anions (mq/100g)			
CO^{-2}_3	0.00	0.00	0.00
HCO^{-}_3	3.44	2.00	4.50
SO^{-2}_4	58.93	65.20	29.23
Cl^{-}	64.14	51.50	48.94

2.2. Magneto-priming seeds procedure:

Pass dry seeds through a magnetic funnel device (350 mT; 0.5 inch; produced by Magnetic- Technologies Company LLC PO Box 27559, Dubai, UAE), then magnetized seeds were soaked in magnetized solutions of *Chlorella algae*1.0%, seeds were left for four hours. After priming, seeds were air dried at room temperature. For equal control, amount seeds from the same lot were kept with priming.

2.3. Cultivation method and layout of Experiment:

The soil was ploughed twice, ridged at 0.60 meter apart and divided into main and sub-plots. During seed preparation, 150 kg/fed calcium superphosphate (15.5% P_2O_5) (fed. = 4200 m^2) was applied. The recommended amount of sunflower seeds (5 kg fed-1; variant, Sakha-53; obtained from Petroleum Research Department, Field Crops Research Institute, Agricultural Research Center, Giza, Egypt) was sown on a hill at a distance of 20 cm in mid-July 2017, after sowing drip irrigation was carried out immediately, and drip irrigation was carried out according to the needs of the plants during the experiment. Thin out 21 days after sowing to ensure one plant per hill on one side of the ridge. From the 15th day after sowing to the flowering period, nitrogen fertilizer (45kg N supply^{-1}) in the form of ammonium sulfate (20.60 N%) is added in four equal portions. One month after sowing, potassium fertilizer is added in the form of potassium sulfate (48% K_2O) at a dosage of 50kg fed-1. Others have recommended agricultural practices for sunflower seeding under provincial conditions based on the Agricultural Research Center manual.

Seeds were obtained from the Oil Research Department, Agricultural Research Center, Giza, Egypt, and were planted in mid-July 2017 and used at a rate of 5 kg per fed. in hills with a distance of 20 cm between them. Drip irrigation was done immediately after planting. The thinning process took place 21 days after planting one plant per hill. Fertilization was done with 20.6% ammonium sulfate at a rate of 45 kg/fed. in four equal doses, starting from 15 days after planting until the flowering stage, while potassium sulfate fertilizer 48% (50 kg/fed.) was used 30 days after planting. The layout of the experiment was shown in (Fig 1).

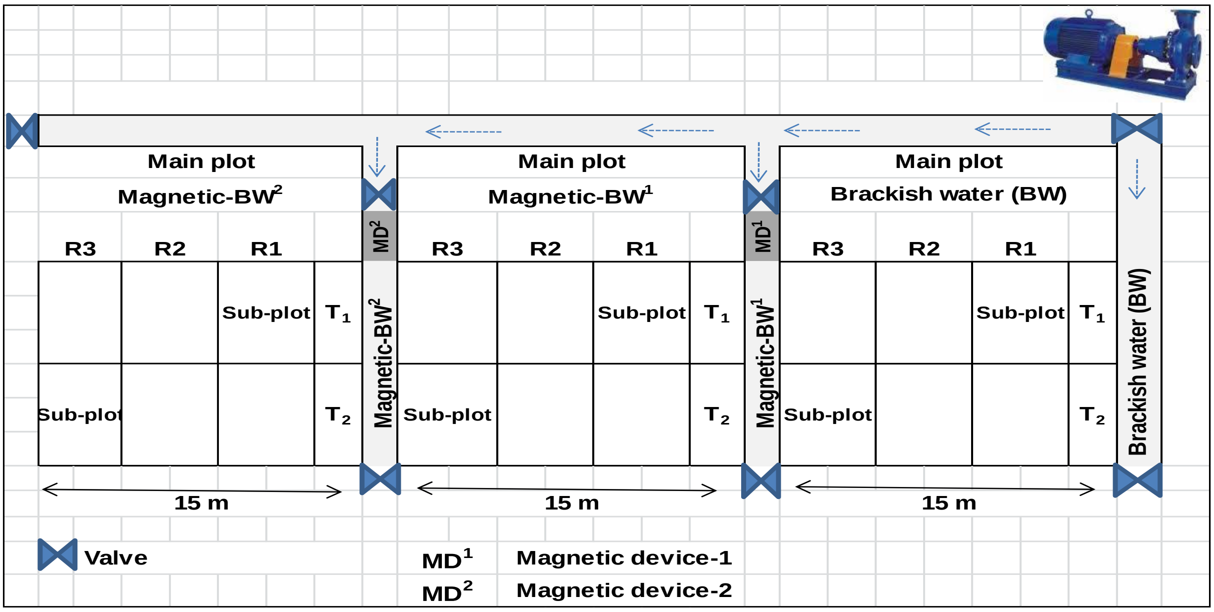

Fig 1. Layout of the experiment design under drip irrigation system.

2.4. Data recorded:

Growth parameters: After 45 days from planting, ten plants were randomly taken from each plot to record Plant height (cm), fresh and dry weight of leaves plant^{-1}, Fresh and dry of total plant.

Total Chlorophyll: Total Chlorophyll in leaves was determined using SPAD Chlorophyll meter, (Konica Minolta Optics, 2012).

Macro-elements content in leaves (45 DAS): Macro-elements contents in dry leaves were determined according to Chapman and Pratt, (1978). Total nitrogen (N) was determined by using micro-Kjeldahl method. Potassium (K), calcium (Ca) and sodium (Na) were determined using flame photometer (Genway). While, estimation of Micronutrients (Fe, Mg and Zn) contents was determined using the Atomic absorption spectrophotometer (Perkin Elemer 100 B).

Yield and yield component: Each experimental unit's ten guarded plants were randomly sampled during harvest in order to measure the plant's height (cm), head diameter (cm), head weight (g), seed head weight (g), and weight (g) of 100 seeds. To determine the seed yield fed-1, the plants in the three inner ridges were harvested, and their heads were air dried and threshed.

Quality of yielded seeds: The Soxthelt device was used according to [24] to determine oil in seeds, and the percentage of oil per fed. was calculated as follows: seed yield multiplied by the percentage of seed oil.

2.5. Statistical analysis:

Data were statistically analyzed using MSTAT-C computer package [25]. The least significant difference ($LSD_{5\%}$) test was used to compare among the means.

3. Results and Discussion

3.1. Vegetative growth parameters and chlorophyll in leaves (45 DAS):

Data in (Table 2) show significant effects of three irrigation water-types, magneto-priming-seeds and its interaction treatments on vegetative growth parameters at 45 days from sowing, i.e., Plant height (cm) and number of leaves plant-1, fresh and dry of total plant (g plant^{-1}) and total chlorophyll (Table 2). According to the results found by using brackish water in irrigation, the previous table showed that irrigation with brackish water treated magnetically 1 or 2 was surpassed irrigation with brackish water not treated magnetically, as the improvement index compared to the control treatment reached 36.05, 20.22, 58.63, 84.51 and 4.84. %, respectively.

The lowest, value were recorded when sunflower plants irrigated with brackish-water. Attributed increased germination percentage of lettuce seeds to a significant increase in the water absorption rate by seeds [26]. Similar encouraging effect of magnetic treatment on germination was reported by [27, 28]. These results are in agreement with those obtained by other researchers; it is reported by [13] that MW significantly increased plant height, fresh and dry weight in lentil plant. On tomato magnetized water gave taller and heavier plants [14]. Higher germination and growth of sunflower were noticed under magnetized water treatment [15].

Also, using priming-seeds with 1% *chlorella* algae, significant increases were obtained when compared to control treatment (un-priming-seeds) in all the studied traits (Table 2). The percent of increasing reached to 7.00, 5.78, 10.73, 1.14 and 4.04% over sowing seeds without any priming at plant height (cm), number of leaves plant-1, fresh and dry weight of total plant and total chlorophyll (Table 2); respectively.

Table 2. Vegetative growth parameters and chlorophyll in leaves 45 days after sowing (45 DAS):

Treatment		Plant height (cm)	Leaves (no. plant^{-1})	Total plant wt. (g)		Total chlorophyll (SPAD)
Water treat.	Seed priming			Fresh	Dry	
Brackish Water (BW)	Control	30.67	11.00	29.50	5.11	38.42
	Algae (1%)	37.33	11.67	37.17	5.38	41.45
Magnetic-BW^1	Control	48.67	13.67	51.50	11.07	41.53
	Algae (1%)	52.17	14.50	57.17	10.22	42.80
Magnetic-BW^2	Control	46.17	12.83	51.00	8.29	41.27
	Algae (1%)	49.17	13.50	51.83	9.15	41.87
F test		**ns**	**ns**	**ns**	**	**ns**
$LSD_{5\%}$		**4.56**	**1.37**	**4.97**	**0.54**	**2.49**
Water treat.	Brackish Water	34.00	11.33	33.33	5.25	39.93
	Magnetic-BW^1	50.42	14.08	54.33	10.64	42.17
	Magnetic-BW^2	47.67	13.17	51.42	8.72	41.57
F test		**	**	**	**	*
$LSD_{5\%}$		**3.07**	**0.66**	**3.96**	**0.30**	**1.56**
Seed priming	Control	41.83	12.50	44.00	8.16	40.41
	Algae (1%)	46.22	13.22	48.72	8.25	42.04
F test		**	**ns**	**	**ns**	*
$CV_{\%}$		**8.22**	**8.5**	**8.51**	**5.23**	**4.81**

Concerning the interaction between irrigation with water types and priming-seed treatments, the results (Table 2) showed significant differences in all tested growth parameters. Sowing magneto-priming seed with Chlorella algae1% and irrigation with magnetically treated brackish-water1 or magnetically treated brackish-water2 gave more values in all tested growth parameters compared to sowing seeds without priming and irrigation with brackish water. Compared to the other treatments, sowing control seeds and irrigating brackish water produced the lowest values for the attributes under study. Utilizing algal extract has an impact on how well plants absorb components, which is directly correlated with the amount of chlorophyll in the plant. By slowing down the breakdown of chlorophyll and postponing leaf senescence, the application of algal extract enhances plant health by balancing the processes of photosynthesis and respiration [29,30]. Algal extract was found to have a similar improving impact on fenugreek plants [21] wheat plants [20].

3.2. Macro- and micronutrient concentration in sunflower leaves at 45 days after sowing (45 DAS):

The results in (Table 3) showed significant effects of three irrigation water-types on macro- and micronutrients concentration (%) in sunflower leaves at 45 days from sowing, i.e., N, K, Mg, Ca, Fe, Mn and Zn. Regarding irrigation brackish-water treatments, previous table revealed that irrigation sunflower with magnetically treated brackish-water[1] or magnetically treated brackish-water[2] treatments surpassed irrigation with brackish-water in all macro- and micronutrients in leaves. The highest values of macro- and micronutrient concentrations in sunflower leaves; i.e., N (2.53 and 2.23%), K (1.32 and 1.42 %), Mg (0.35 and 0.37 %), Ca (3.73 and 3.87 %), Fe (194.25 and 221.5 ppm), Mn (157.5 and 139.75 ppm) and Zn (63.70 and 54.95 ppm) were recorded with magnetically treated brackish-water[1] or magnetically treated brackish-water[2] treatments, respectively (Table 3). The lowest value recorded when sunflower plants irrigated with brackish-water. It indicated by [12] that the effectiveness of magnetized brackish water caused changes in the movement of nutrients in the root zone and also had a positive effect on the solubility of some accumulated soil components such as $CaCO_3$ and gypsum. Magnetic water led to good effects on the availability of macro-micronutrients [6].

With regard to the differences between priming-seed treatments, significant increases were obtained due to sowing priming-seeds with *Chlorella* algae1% compared to control treatment (un-priming-seeds; T1) in all tested macro- and micronutrient concentrations in sunflower leaves plants (Tables 3). The highest values of macro-and micronutrient concentrations in sunflower leaves; i.e., N (2.62 %), K (1.40 %), Mg (0.36 %), Ca (3.94 %), Fe (217.33 ppm), Mn (137.67 ppm) and Zn (60.55 ppm) were recorded with priming-seeds with Chlorella algae1%, respectively (Table 3). The lowest value found when sunflower plants were treated (control) without using chlorella algae. These findings might be explained by the fact that algae extract is regarded as a high-protein source that breaks down into naturally occurring amino acids that are directly involved in metabolism [31]. Additionally, it includes certain macronutrients like N, P, and K that are necessary for the plant's growth and development. Furthermore, algal extract influences how well plant roots absorb nutrients [32].

Table 3. Macro-and microelements in leaves (45 DAS):

Treatment		Macronutrients (%)				Micronutrients (ppm)		
Water treat.	**Seed priming**	**N**	**K**	**Mg**	**Ca**	**Fe**	**Mn**	**Zn**
Brackish Water (BW)	**Control**	**1.70**	**1.09**	**0.30**	**3.20**	**136.50**	**74.00**	**36.50**
	Algae (1%)	**2.40**	**1.23**	**0.33**	**3.65**	**168.50**	**132.00**	**63.25**
Magnetic-BW1	**Control**	**2.15**	**1.24**	**0.32**	**3.50**	**190.00**	**173.50**	**63.95**
	Algae (1%)	**2.90**	**1.59**	**0.38**	**3.95**	**198.50**	**141.50**	**63.45**
Magnetic-BW2	**Control**	**2.03**	**1.27**	**0.38**	**3.53**	**158.00**	**140.00**	**62.40**
	Algae (1%)	**2.55**	**1.37**	**0.37**	**4.21**	**285.00**	**139.50**	**54.95**
	F test	**	*	**	**	*	**	**
	LSD5%							
Water treat.	**Brackish Water**	**2.05**	**1.16**	**0.31**	**3.43**	**152.50**	**103.00**	**49.88**
	Magnetic-BW1	**2.53**	**1.42**	**0.35**	**3.73**	**194.25**	**157.50**	**63.70**
	Magnetic-BW2	**2.29**	**1.32**	**0.37**	**3.87**	**221.50**	**139.75**	**58.68**
	F test	**	**	**	**	**	**	**
	LSD5%							
Seed priming	**Control**	**1.96**	**1.20**	**0.33**	**3.41**	**161.50**	**129.17**	**54.28**
	Algae (1%)	**2.62**	**1.40**	**0.36**	**3.94**	**217.33**	**137.67**	**60.55**
	F test	**	**	**	**	**	**	**
	CV%							

Regarding the interaction between irrigation with water types and priming-seed treatments, results (Table 3) showed significant differences in all tested macro-micronutrient concentration. Sowing magneto-priming seed with Chlorella algae1%

and irrigation with magnetically treated brackish-water1 or magnetically treated brackish-water2 gave more values in all tested macronutrients (N, K, Mg and Ca %) and micronutrients (Fe, Mn and Zn ppm) compared to sowing seeds without priming and irrigation with brackish water. While, sowing control seeds and irrigation with brackish water gave the lowest values in all tested nutrient concentrations in sunflower leaves compared to other treatments. These finding are in agreement with that mentioned by [20] on wheat plants and [21] on Fenugreek plants.

3.3. Yield, yield components and seed oil %:

Data in (Table 4) showed significant results for sunflower yield, plant height, diameter, plants weight, seed weight of 100 seed, seed oil % and yield (seed and oil kg/fed.). Concerning irrigation brackish-water treatments, previous table 4 revealed that the percent of improvement irrigation treatments compared with control treatment reached to 18.70, 14.89, 42.97, 39.75 and12.76 % in the plant height, diameter, head weight/plant seed weight/plant and weight of 100 seed, respectively (Table4), while the percent of improvement compared with control treatment reached to 6.94, 39.31 and 49.07 in the seed oil (%), seed yield (kg/fed.) and oil (kg/fed.), respectively. The lowest, value were recorded when sunflower plants irrigated with brackish-water. These results are in agreement with [9] who mentioned that electromagnetic treatment of saline water can reduce the negative effect of salinity on corn germination and potato crop and increase yield in about 10% in test conditions. It also, recommended to enhance vegetative growth, yield, its component of potato plants, reduce soil salinity and improve soil fertility [10].

In terms of how the priming-seed treatments differed from the control treatment (un-priming-seeds; T1), there were notable gains in plant height (cm), head diameter (cm), head weight (g), 100-seed (g), seed oil percentage, and yield (kg/fed.); the weight of the seeds head, however, decreased when the priming-seed by *chlorella* algae 1% was applied (Table 4). The percent of increasing reached to 9.76, 4.29, 2.40 and 13.69 % over sowing seeds without any priming at plant height (cm), diameter of head, weight of head and weight of 100 seeds (Table 4), respectively. On the other hand, the percent of increasing for seed oil (%) and yield (seed and oil kg/fed.) reached to 4.29 and (7.89 and 12.75 %), respectively. The interaction between irrigation with water types and priming-seed treatments, table 4 showed significant differences in all tested yield and yield components. Sowing magneto-priming seed with Chlorella algae1% and irrigation with magnetically treated brackish-water1 or magnetically treated brackish-water2 gave more values in all tested yield parameters compared to sowing seeds without priming and irrigation with brackish water. While, sowing control seeds and irrigation with brackish water gave the lowest values in all tested parameters compared to other treatments. The rise in growth characteristics (Table 2) may be the cause of the increase in yield and its components, which is represented in the yield and its components based on the source and downstream theory. Algal extract was found to have a similar improving impact on fenugreek plants [21] and wheat plants [20].

Table 4. Sunflower yield and its components:

Treatment		Plant height (m)	Head parameter (s)			100-seed (g)	Seed oil (%)	Yield (Kg fed^{-1})	
Water treat.	Seed priming		Diameter (cm)	Weight (g)	Seed weight (g)			Seed	Oil
Brackish water (BW)	**Control**	1.03	13.9	75.79	54	6.56	40.2	635.7	255.6
	Algae (1%)	1.26	16.45	79.63	54.5	7.55	41.2	683.8	282.3
Magnetic-BW^1	**Control**	1.5	17.65	107.5	80.25	7.33	42.9	861.4	369.3
	Algae (1%)	1.45	17.35	111.96	74.75	8.18	45.1	976.3	439.8
Magnetic-BW^2	**Control**	1.17	17.45	113.06	76	7.58	42.1	905.9	381.7
	Algae (1%)	1.35	17.3	111.9	72.25	8.69	44.2	932.5	412.9
F test		**	**	*	**	**	ns	**	**
LSD$_{5\%}$		**0.08**	**0.88**	**3.15**	**1.35**	**0.23**	**1.0**	**8.0**	**9.7**
Water treat.	**Brackish water**	1.15	15.18	77.71	54.25	7.05	40.7	659.7	268.9
	Magnetic-BW^1	1.47	17.5	109.73	77.5	7.76	44.0	918.8	404.6
	Magnetic-BW^2	1.26	17.38	112.48	74.13	8.14	43.1	919.2	397.3
F test		**	**	**	**	**	**	**	**
LSD$_{5\%}$		**0.03**	**0.51**	**1.75**	**1.75**	**0.23**	**0.9**	**6.5**	**8.8**
Seed priming	**Control**	1.23	16.33	98.78	70.08	7.16	41.7	801.0	335.5
	Algae (1%)	1.35	17.03	101.16	67.17	8.14	43.5	864.2	378.3
F test		**	**	**	**	**	**	**	**
CV$_{\%}$		**4.9**	**4.17**	**2.51**	**1.56**	**2.37**	**1.8**	**0.7**	**2.0**

4. Conclusion:

The study results indicate that applying magnetically combined priming seeds with 1% *Chlorella sp* algae has beneficial effects. Magnetic treatments of brackish water and seed priming-magneto with Chlorella sp algae are essential for the growth parameters of sunflower plants. Sowing magneto-priming seeds with 1% *Chlorella sp* algae and irrigating with magnetically treated brackish water or magnetically treated brackish-water^2 resulted in higher values in all tested growth parameters and yield (seed and oil kg fed^{-1}) of sunflower plants.

5. References

1- Machado, R.M. A. and Serralheiro, R.P.(2017) Review, Soil Salinity: Effect on Vegetable Crop Growth. Management Practices to Prevent and Mitigate Soil Salinization. Horticulturae, 3(30); https://doi.org/10.3390/horticulturae3020030

2- Shrivastava, P.; Kumar, R. (2015) Soil salinity A serious environmental issue and plant growth promoting bacteria as one of the tools for its alleviation. Saudi J. Biol. Sci., 22, 123–131.

3- Botía, P.; Navarro, J.M.; Cerdá, A.; Martínez, V. (2005) Yield and fruit quality of two melon cultivars irrigated with saline water at different stages of development. Eur. J. Agron. 2005, 23, 243–253.

4- Cuartero, J and FernaÂndez-Muñóz R, (1999). Tomato and salinity, Sci. Hortic., 78: 83–125.

5- El-Habbasha, K.M., A.M. Shaheen, and F.A. Rizk. 1996. Germination of some tomato cultivars as affected by salinity stress condition. Egyp. J. Hort. 23, 179-190.

6- Fanous, N.E.; Mohamed, A.A. and Shaban, Kh. A. (2017) Effect of Magnetic Treatment for Irrigation Ground Water on Soil Salinity, Nutrients, Water Productivity and Yield Fruit Trees at Sandy Soil. Egypt. J. Soil Sci. 57(1): 113-123.

7- Duarte Diaz, C. E., Riquenes, J. A., Sotolongo, B. and Perez, E. (1997) Effect of magnetic treatment of irrigation water on Tomato crop . Hortic.Abst. 69,494.

8- Hachicha, M.; Kahlaoui, B.; Khamassi, N.; Misle, E. and Jouzdan, O. (2018) Effect of electromagnetic treatment of saline water on soil and crops.Journal of the Saudi Society of Agricultural Sciences, 17(2): 154-162.

9- Surendran, U.; Sandeep, O.; George Mammen and Joseph, E.J. (2013) A novel technique of magnetic treatment of saline and hard water for irrigation and its impact on cow pea growth and water properties. Inter. J. Agric. Environ. Biotech., 6(1) : 85-92.

10- Ahmed M.E.M. and Abd El-Kader, N. I. (2016) The Influence of Magnetic Water and Water Regimes on Soil Salinity, Growth, Yield and Tubers Quality of Potato Plants. Middle East Journal of Agriculture Research, 5(2): 132-143.

11- Yusuf, K.O. and Ogunlela, A.O. (2105) Impact of Magnetic Treatment of Irrigation Water on the Growth and Yield of Tomato. Notulae Scientia Biologicae, 7(3)

12- Selim MM (2008) Application of magnetic technologies in correcting underground brackish water for irrigation in the arid and semi-arid ecosystem. The 3rd Int.

13- Amira M.S. Abdul Qados and M. Hozayn (2010).Magntic Water Technology, a Novel Tool to Increase Growth, Yield and Chemical Constituents of Lentil (Lens esculenta) under Greenhouse Condition. Eurasian J. of Agric. & Envir. Sci.; 7(4): 457 – 462.

14- Abou El-Yazied, A., A.M. El-Gizawy, S.M. Khalf, A. El-Satar and O.A. Shalaby 2012.Effect of magnetic field treatments for seeds and irrigation water as well as N, P and K levels on productivity of tomato plants. Journal of Applied Sciences Research, 8(4): 2088-2099.

15- Fischer G, Tausz M, Kock M, Grill D (2004) Effects of weak 16(2/3) Hz magnetic fields on growth parameters of young sunflower and wheat seedlings. Bioelectromagnetics, 25: 638-41. https://doi.org/10.1002/bem.20058

16- Shaaban M.M. (2001) Green microalgae water extract as foliar feeding to wheat plants. Pakistan J BiolSci 4: 628-632.

17- Snedecor, G.W. and Cochran, W.G. (1980).Statistical Methods. 7th Edition, Iowa State University Press, Ames.

18- Khan, W.; Rayirath, U. P.; Subramanian, S.; Jithesh, M. N.; Rayorath, P.; Hodges, D. M., et al. (2009) Seaweed extracts as biostimulants of plant growth and development. J. Plant Growth *Reg.* 28, 386–399. https://doi.org/10.1007/s00344-009-9103-x

19- Calvo, P.; Nelson, L. and Kloepper, J.W. (2014).Agricultural uses of plant biostimulants. Plant Soil 383, 3–41. https://doi.org/10.1007/s11104-014-2131-8

20- Shaaban, M.M.; El-Saady, A.M,; El-Sayed, A.B. (2010) Green Microalgae Water Extract and Micronutrients Foliar Application as Promoters to Nutrient Balance and Growth of Wheat Plants. Journal of American Science, 6(9): 631-636.

21- Abd El-Baky, H.H.; Hussein M.M. and Baroty, G.S. (2008) Algal extracts improve antioxidant defense abilities and salt tolerance of wheat plant irrigated with sea water. African Journal of Biochemistry Research, 2 (7): 151-164.

22- Mohamedin, A.A.M., A.S.A. Osman, N.M. Badr and K.I. Kotb, 2004. Productivity of sunflower yield and yield composition under different drainage systems at Egyptian salt affected soils. Egypt J. Appl. Sci., 19: 749–63

23- Liu, X. and W.V. Baird, (2003). Differential expression of genes regulated in response to drought or salinity stress in sunflower. Crop Sci., 43: 678–87

24- AOAC.(2000). “Official Methods of Analysis”, Association of Official Agricultural Chemists.17th Ed, Washington DC. USA; 1970.

25- Freed, R.S.P., S. Einensmith, S. Gutez, D. Reicosky, V.W. Smail and P. Wolberg, (1989).MSTAT-C analysis of agronomic research experiments. Michigan Univ. East Lansing, USA.

26- Reina FG, Pascual LA, Fundora IA. (2001) Influence of a stationary magnetic field on water relations in lettuce seeds. Part II: experimental results. Bioelectro magnetics. Dec; 22(8):596-602. doi: 10.1002/bem.89. PMID: 11748678

27- Iqbal M., Haq Z.U., Jamil Y., Ahmad M.R., 2012. .Effect of presowing magnetic treatment on properties of pea. International Agrophysics, 26, 25-31

28- Vashisth, A. and Nagarajan, S. (2010). Effect on germination and early growth characteristics in sunflower (*Helianthus annuus*) seeds exposed to static magnetic field. J. Plant Physiol., 167(2), 149-156.

29- Raupp, J. and Oltmanns, M. (2006) Farmyard manure, plant based organic fertilizers, inorganic fertilizer-which sustains soil organic matter best. Aspects of Applied Biology, 79, 273-276.

30- Hass, M., Berkovits, D., Hirsh, T. Y., Kumar, V., Lewitowicz, M., de Oliveira, F., & Veintraub, S. (2007). Light radio-isotopes for nuclear astrophysics and neutrino physics. Journal of Physics G: Nuclear and Particle Physics, 35(1), 014042.

31- Marrez, D. A., Naguib, M. M., Sultan, Y. Y., Daw, Z. Y. and Higazy, A. M. (2014).Evaluation of chemical composition for Spirulina platens is in different culture media. Res. J. Pharmaceutical, Biol. and Chem. Sci. 5 (4), 1161-1171.

32- Abd El-Mawgoud, A.M.R., Tantawy, A.S., El-Nemr, M.A. and Sassine, Y.N. (2010) Growth and yield responses of strawberry plants to chitosan application. Europ. J. Scientific Res.39 (1), 161-168.