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SALINITY STRESS MITIGATION OF SOME CANOLA CULTIVARS GROWN UNDER SOUTH SINAI CONDITIONS USING MAGNETIC WATER TECHNOLOGY

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ABSTRACT

Salinity stresses either in irrigation water and/or soil is one of the most serious agricultural problems facing farmers in arid and semi-arid regions included Egypt. Many areas in the Sinai region depend mainly on the underground water of various degrees of salinity that prevent cultivated crops from reach to the full yield. Under these conditions, a split-plot field experiment using three canola cultivars; Pactol, Serw-4 and Serw-6 under three irrigation water treatments: i) Brackish-water (BW), ii) Magnetic-BW_1; brackish water after magnetization through passing a three inch static-magnetic unit,3.75 mT, produced by Delta Water Company, Egypt and iii) Magnetic-BW_2; brackish water after magnetization through passing a three inch static magnetic unit, 0.75 mT, produced by Magnetic-Technologies Company, UAE, was carried out at Agricultural Experimental Station of Desert Research Centre, Ras Sidr region, South Sinai Governorate, Egypt during the 2017/18 winter season. The results showed that irrigation with M-BW_1 or M-BW_2 surpassed irrigation with BW in all tested growth parameters (plant height, branches and leaf number/plant, leaf area, dry matter of leaves, stem and total plant, and total chlorophyll); leaf anatomy (instance, midvein and lamina thickness, length and width of leaf vascular bundle and lower and upper epidermis thickness); stem anatomy (stem diameter and thickness of cortex, xylem and phloem in addition pith diameter) and chemical analysis for mineral content (N, P, K, Mg, Fe, Cu, Zn) at 85 days after sowing (DAS). As an average of both magnetically brackish-water treatments over tested three canola varieties, the percent of improvement compared to irrigation with brackish-water ranged between 10.78-16.02% for growth parameters, 28.33-31.76% for dry matter of plant; 15.58 -80.81% for leaf ; 10.71-63.88% for stems and 2.42-54.48% for mineral content of leaves at 85 DAS. Reverse trends were observed in the best indicators for alleviation salinity stress (Na, and proline), where these decreased under both magnetic brackish water treatments by 66.08 and 43.75%, respectively (average of both magnetically brackish-water treatments compared to BW water treatment). Generally, the three tested canola varieties showed a positive response under magnetic brackish water treatments. The positive results in above-mentioned parameters of vegetative growth reflected improvement in canola yield and its components. The percent of improvement ranged between 9.35 and 35.98 for yield components and reached1.29,19.66 and21.30% in seed oil percentage, seeds and oil yield (kg fed^{-1}; fed=4200 m^2), respectively compared to brackish water**.**

Key words: Canola productivity, Magnetic brackish-water, Salinity stress, Anatomy, Proline

INTRODUCTION

In Egypt, oil gap (which reaches to 85- 90%), could be removed by either increasing the cultivated area of oil crops and/or by improving crop productivity. Canola as widely edible oil in many countries considered as an important oil crop that can contribute to reduce the oil gap where its seeds contain 35-45% oil. Moreover, its main use is for cooking. It is also commonly used in margarine [1]. Canola meal is produced as a by-product during the extraction of oil from canola seed and is widely used as a high protein feed source in animal nutrition. Full fat canola seed may also be used directly as animal feed [2]. The canola plant is characterized as salt and drought tolerant, so, it can give an economical yield under conditions of newly reclaimed land, but its exposure to environmental stresses such as irrigation water and/or soil salinity stresses under this area including Sinai region, prevents crops from realizing their full yield potential

Salinity reduces the growth of plants by osmotic stress [3]. High soil salinity is an important issue that greatly reduces plant productivity [4]. The ratio of salt-affected soil is constantly increasing all over the world with estimates reaching up to 6% [5] and that may result in 50% arable land loss by 2050 [6]. Salinity is one of the major issues responsible for reduction in agricultural yields [7]. Salt affects the growth of crop plants by reducing the uptake of water by roots [8, 9]. In this regard, many common (sowing of moderate or tolerant-salt crops) and un-common strategies (magnetic water technology) are using for alleviation of salinity stress on crops productivity.

As an uncommon tool, magnetic fields can enhance the characteristics of water, such as better salt solubility, kinetic changes in salt crystallization, and accelerated coagulation. From the literature and reports, it is evident that all structural changes of water-dispersed systems treated by magnetic field are due to the ionic substances present in the water and colloidal particles of considerable magnetic susceptibility. Apart from magnetic treatment, electrolysis of saline water can also play an important role to reduce the salinity. Use of magnetic water (MW) is a modern trend to reduce the effect of salinity and to increase soil ventilation. In addition, magnetic treatment of saline irrigation water is an effective method for soil partial desalinization throughout, decreasing the hydration of salt ions and colloids that increase accelerated coagulation, salt solubility, and salt crystallization [10, 11]. The magnetic water increased leaching of excess soluble salts, slightly dissolved soluble salts, and lowered soil alkalinity. Magnetic water removes the excess of the soluble salts; reduces pH values, due to magnetic water have solving for soil salts, and leaches the salts away from roots zone [12,13,14].

Moreover, many recent studies have shown positive effects on seed germination, plant growth, maturity and productivity of different tested crops [11,15,16,17,18]. They reported this opinion through influence of magnetic technology, whether water and/or seeds, of physiological, biochemical and molecular processes changes in plants (protein biosynthesis, cell reproduction, photochemical activity, respiration rate, enzyme activities, nucleic acid content). Under Egyptian conditions, irrigation with magnetic water has improved productivity of many crops including wheat, barley quinoa, and maize, faba bean, lentil, chickpea, ground nut, mung bean, sunflower, sugar beet, canola, flax, and potatoes either under salinity stress or normal conditions [13,14,19,20,21]. This

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study investigates the effects of magnetically treated brackish water to explore the role of magnetic brackish-water treatments for alleviation of salinity stress on growth, anatomical, chemical and productivity of canola under South Sinai conditions.

MATERIALS AND METHODS

A field trial was conducted using three canola cultivars (*Brassica napus* L.: cultivars ; Pactol, Serw-4 and Serw-6) under three irrigation water treatments: i) Brackish-water (BW), ii) Magnetic-BW_1; brackish water after magnetization through passing a three inch static-magnetic unit,3.75 mT, produced by Delta Water Company, Egypt and iii) Magnetic-BW_2; brackish water after magnetization through passing a three inch static magnetic unit, 0.75 mT, produced by Magnetic-Technologies Company, UAE. The trial took place at Agricultural Experimental Station of Desert Research Centre, Ras Sidr Province, South Sinai Governorate, Egypt during the winter season of 2017/2018. The three irrigation water treatments and the three canola cultivars were laid out in a split-plot design with three replicates and allocated in the main and sub-plots, respectively under gated pipe irrigations system. The experimental area is located on the Gulf of Suez and the Red Sea coast (29°60'28" N latitude and 32°68'96" E longitude). The soil of the experimental site and irrigation water were analyzed according to Chapman and Pratt [22] and the results obtained are shown in Table 1. The soil of the experimental site was sandy loam, saline and poor in available N, P, K and organic matter content. Also, irrigation water is classified as saline [23].

Cultivation methods and layout of experiment

The soil was ploughed twice, ridged at 0.60 meters apart and divided into main and sub-plots with area 18 m^2 and 6 m^2, respectively. During seed bed preparation, 100 kg fed^{-1} calcium superphosphate (15.5% P_2O_5) was applied. Recommended seed rates of canola (5 Kg fed^{-1}) cultivars, Pactol, Serw-4 and Serw-6, were sown in hills 20 cm apart at the second week of November, 2017. A gated pipe irrigation system was implemented immediately after sowing and as plants needed during the period of experiment. Thinning was carried out after 21 days from sowing to secure two plants per hill on one side of the ridge. Nitrogen fertilizer as ammonium sulfate (20.60 N%) at the rate (45 kg N fed^{-1}) was added in four equal doses starting from 15 days after sowing till flowering, while, potassium fertilizer at the rate of 50 kg fed^{-1} as potassium sulfate (48% K_2O) was added after one month from sowing. Experimental layout is shown in (Figure 1).

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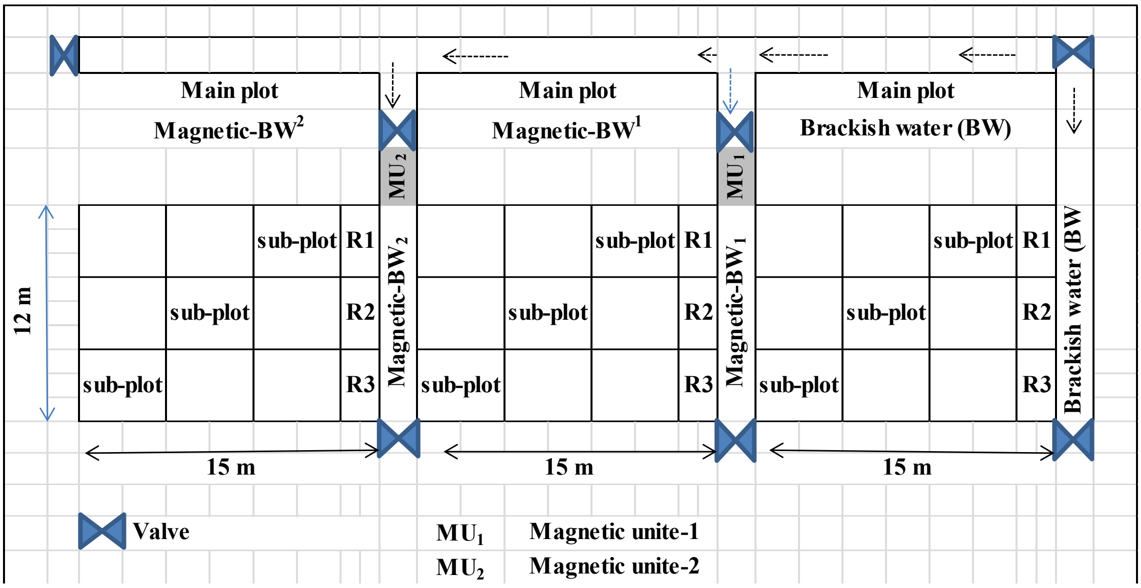

Figure 1: Layout and design of the field experiment

Data recorded

Morphological studies: After 85 days from sowing (DAS), ten plants were randomly taken from each plot to record vegetative growth parameters; plant height (cm), branches and leaves numbers plant^{-1}, accumulated dry matter of leaves, stem and total plant (g plant^{-1}). Leaf area (LA; dm^2 plant^{-1}) was determined according to leaf disc method.

Anatomical studies: Specimens of leaf and stem were taken from the third node and from its corresponding leaf. Plants used for examination were taken throughout the growing season of 2017/18 at the age of 85 days from sowing date. The vegetative specimens were fixed in the formalin-acetic acid-alcohol solution (FAA; 10 ml formalin, 5 ml glacial acetic acid, 50 ml ethyl alcohol 95%, 35 ml distilled water), washed in 50% ethyl alcohol, dehydrated in a normal butyl alcohol series, embedded in paraffin wax with a melting point of 60-63 °C, sectioned to 20 µm in thickness, stained with the double stain method (crystal violet/erythrosine), cleared in xylene and mounted in Canada balsam [24]. The slides were microscopically examined to detected histological manifestations of the chosen treatments and photomicrographed. Examination and photomicrographs were taken using a Reichert Microstar IV microscope and digital camera (Cannon Power Shot G12) at Botany Department, Faculty of Agriculture, Cairo University, Egypt. Average of readings from 3 slides/treatment was calculated.

Chemical studies in leaves at 85 DAS: Macro-minerals such as N, K, Mg, Na, Ca and micro-minerals such as Fe, Mn, Zn, Cu leaf concentrations were determined at 85 DAS according to [16]. Total N was determined using the micro-Kjeldahl method [25]. Potassium, calcium and sodium were determined using a flame photometer (Genway), while, Mg, Fe, Mn, Zn and Cu contents were determined using the Atomic absorption spectrophotometer (Perkin Elemer 100-B). Total chlorophyll in leaves was determined using SPAD Chlorophyll meter [26].

Canola yield and its components: At harvest time, a random sample of ten plants from each plot were taken to determine yield attributes such as plant height (cm), branches and siliquas numbers plant^{-1}, seed yield plant^{-1} (g) and 1000-seed weight (g). Plants of two square meters from the two lines of each plot were harvested, dried under sunshine for one week and seeds were cleaned after they were separated from the pods, then the seed yields (kg/fed; fed=4200 m^2) were calculated. Seed oil percentage was determined using Soxhlet apparatus according to Official Methods of Analysis (AOAC) [27] and oil yield fed^{-1} was calculated by multiplying seed yield by seed oil percentage.

Statistical analysis: Data were statistically analyzed using MSTAT-C computer package [28]. The least significant difference ($LSD_{5\%}$) test was used to compare among the means. The coefficient of variation (CV) is a statistical measure of the dispersion of data points in a data series around the mean.

RESULTS AND DISCUSSION

Vegetative growth

Data in Table 2 show significant variations among the three-canola cultivars, magnetized brackish water and its interaction treatments on all growth parameters at 85 days after sowing, plant height, branches and leaves number plant^{-1}, leaf area, dry matter of leaves, stem and total plant and total chlorophyll in leaves. Regarding the irrigation water treatments, the data revealed that, irrigation with either M-BW_1 or M-BW_2 surpassed BW in all tested growth parameters. As an average of both magnetically brackish-water treatments, the percent of improvement compared to irrigation with BW reached 14.15, 10.78, 12.51, 16.02, 28.33, 31.76, 30.65 and 15.60 for above-mentioned growth characteristics, respectively. Also, significant differences were recorded among the three canola cultivars where Serw-6 came in first for producing more values in the above mentioned growth characters followed by Serw-4 and Pactol, respectively. The same previous table shows significant differences due to the interactions between two studied factors where M-BW_1 or M-BW_2 treatments caused positive effect on growth of the three canola cultivars compared to BW treatment. Similarly, recorded were more values of growth parameters of tomato, pepper, barley, wheat under irrigation with magnetic water than tap water [29]. Recent studies, confirmed the above results where they found that irrigation sunflower and alfalfa with magnetic-brackish water improved tested growth parameters [23]. Generally, alleviation salinity stress using magnetic field on vegetative growth were reported by many studies [11, 30, 31].

Anatomical traits

Leaf structure

The anatomical characteristics of canola leaf grown under salinity stress and treated with magnetic brackish-water treatments at 85 DAS are in Table 3 and illustrated in Figure 2. Results indicate that salinity stress decreased thickness of midvein and lamina as well as length and width of midvein bundle and upper and lower epidermis. This effect of salinity stress could be attributed to the decrease induced in mesophyll tissues thickness, as well as in xylem and phloem thickness. It is realized from Table 4 and Figure 2 that treatment with magnetic-brackish water (M-BW_1) or (M-BW_2) was the most effective in increasing

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leaf thickness of the three cultivars of canola than those of control. Serw-6 recorded the highest values for the most traits followed by Serw-4 then Pactol. Results indicated that midvein and lamina thickness recorded the highest values in canola cv. Serw-6 treated with magnetic-BW by 80.70 and 128.3% more than irrigation with brackish water. The main vascular bundle of the midvein was increased in size as a result of M-BW. The increment was mainly due to the increase in length of bundle by 67.40% noticed in Pactol and in width by 127.6% over the control recorded in Serw-4. On the other hand, upper and lower epidermis recorded the highest increase in Serw-6 treated with magnetic-BW by 25.60 and 3.10% over control, respectively. Similarly, Hasan *et al*. [32] found that epidermis and parenchyma cells of cortex and pith in maize were shrinkage in 2 and 3% NaCl-treated plants. Leaf anatomy observation showed mesophyll and bundle sheath cells slightly suppressed. While plants irrigated with magnetic brackish-water (BW_1 or BW_2) increased anatomical parameters due to the increase thickness of palisade, spongy tissues and the dimension of the main mid vein bundle. These results are in harmony with Matwijczuk *et al.* [14], who reported that potato treated with magnetic-water increased thickness of both midvein and lamina leaflet by 19.3 and 3.8% more than the control, respectively.

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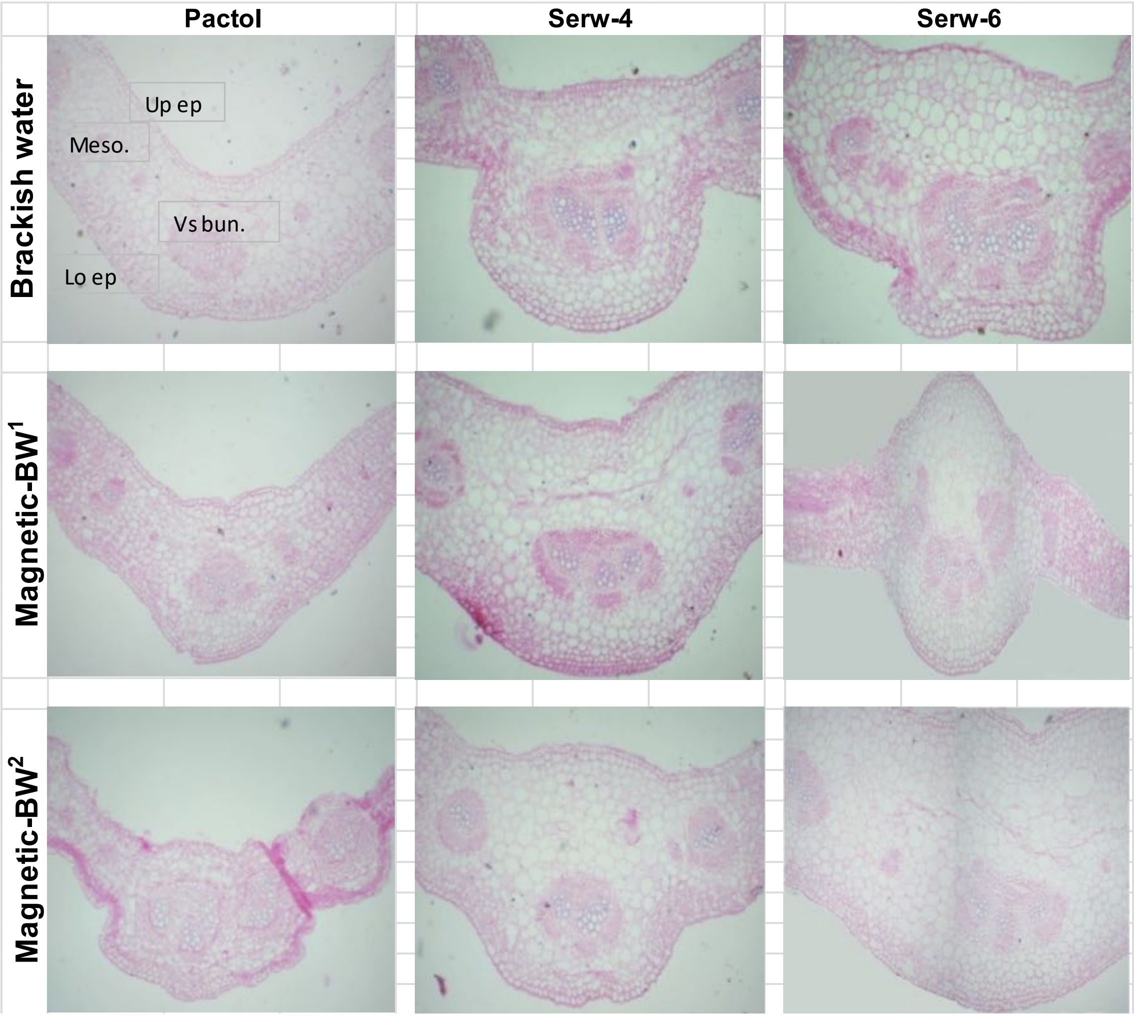

Figure 2: Transverse sections of tested three canola leaf cultivars (Pactol, Serw-4 and Serw-6) under magnetic brackish irrigation water treatments. Details: Up ep.= upper epidermis, Meso= mesophyll tissue, Vs bun.= vascular bundle, Lo ep.= lower epidermis (X40)

Stem structure:

It is clear from Table 3 and Figure 3 that the lowest values of stem diameter and thickness of cortex, xylem and phloem and pith diameter of canola cultivars were recorded in the untreated plants (control), whereas the best values of previous mentioned characters were achieved in the plants irrigated with magnetic water (Magnetic-BW_1 or Magnetic-BW_2). Application of magnetic-BW increased diameter of the main stem in Serw-6 by 34.20% more than BW and this increase could be attributed mainly to the prominent increase induced in all included tissues. Also, the thickness of cortex was increased by 59.10% more than those of the control. On the other hand, the thickness of phloem and xylem tissues was increased with magnetic water (MBW) by 40.00 and 14.40%, respectively over the control plant. A decrease of 7.80% below the control in parenchymatous pith thick was observed with magnetic water. The reduction in anatomical characters under salinity stress may be due to the harmful effect of water deficit on cell division and expansion as well as nutrient uptake. It was reported that salinity plays an important role in growth inhibition of plants [33]. Xylem and phloem areas of stem and cortex were decreased under salt stress condition. Aria *et al*. [34] noticed that plants grown in saline solution showed higher thickness in cuticle, vascular tissues and vessel than unstressed plant while cortex zone thickness was decreased [34]. Potato irrigation with magnetic water increased the thickness of epidermis, cortex, parenchymatous pith and stem diameter by, 2.8, 16.3, 1.6 and 7.7 % more than those of the control, respectively, although a decrement of 2.0 and 42.3% was observed less than that of the control in collenchyma thickness and diameter of hollow pith [14].

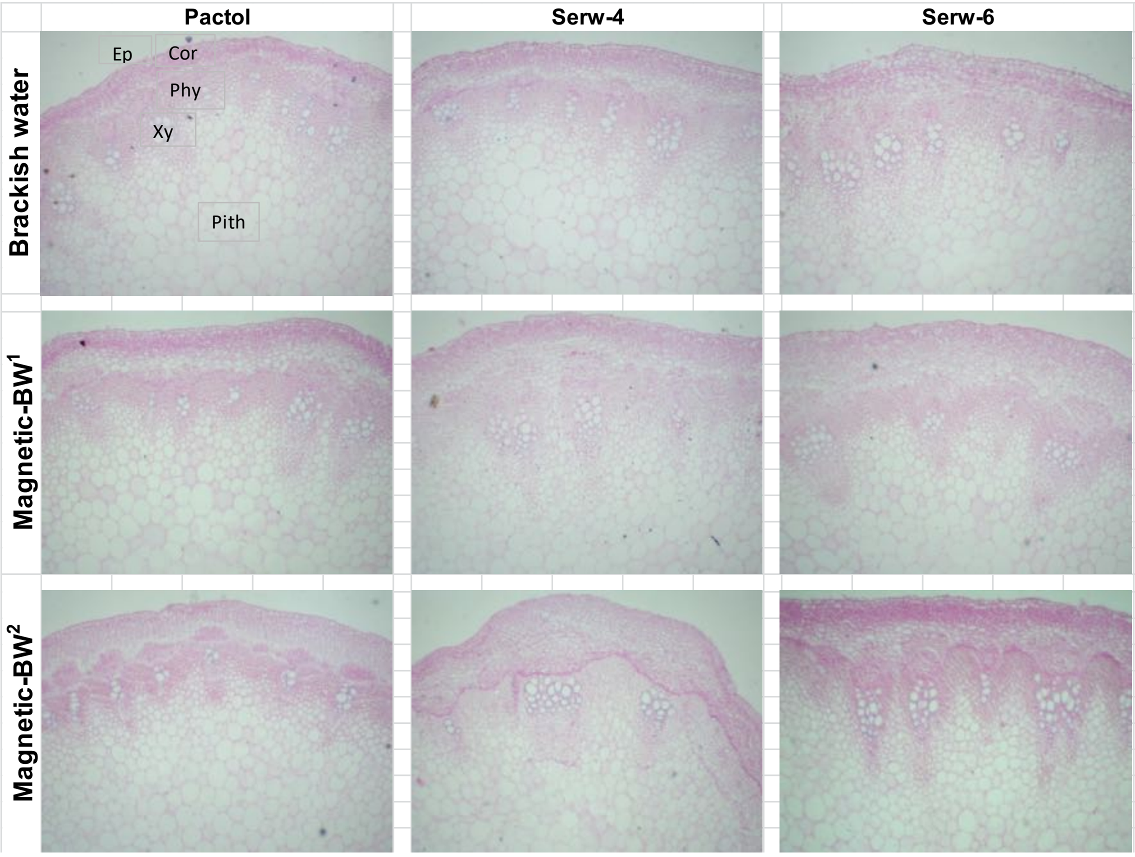

Figure 3: Transverse sections of tested three canola stem cultivars (Pactol, Serw-4 and Serw-6) under magnetic brackish irrigation water treatments. Details: Ep.= epidermis, Cor. = cortex, Phl.= phloem, Xyl.= xylem,(X40)

Chemical composition in leaves at 85 DAS

Macro- and micro-minerals and proline content in leaves

Table 4 shows that the three canola cultivars (Pactol, Serw-4 and Serw-6) gave greater concentrations of macro and micro-minerals (N, K, Mg, Fe and Zn) under irrigation with MBW_1 or MBW_2 than irrigation with BW treatment. Reverse trends were recorded for Na, Ca, Mn, Cu and proline. Serw-6 showed the first order for all recorded nutrient-elements followed by Serw-4 and pactol, respectively. As an average of both magnetically brackish-water treatments and the three canola cultivars, the percent of improvement over control reached 26.39, 12.13, 54.59, 20.85 and 2.41% in leaves content of N, K, Mg, Fe and Zn, respectively compared to BW treatment. Reverse trends were reported in leaf contents of Na, Ca, Mn, Cu and proline where it was reduced by 66.08, 23.48, 13.48, 18.96 and 43.75%, respectively. Similar trends regarding application of magnetic treatments were recorded on sunflower [14], alfalfa and barley [35,36]. The magnetized water application increased the availability of minerals in soil through increased solubility of salts and minerals required for cell division and elongation during the plant growth [37]. irrigation of potato plants using magnetic water significantly increased N %, P%, K%, in leaves [38,39]. An increase of Ca, Mg and K concentration into plants under magnetic treatments compared to control treatment [13, 34]. Magnetic water lead to an increase in all elements content except sodium [25]. This is because Na is a paramagnetic element, i.e., having a small positive susceptibility to magnetic fields, while other elements are diamagnetic which are slightly repelled by a magnetic field.

Canola yield and its components

At harvest date, as shown in Table 5, there was significant variation among the three canola cultivars, magnetized brackish-water and its interaction treatments on canola yield and its components. Regarding irrigation water treatments, data showed that, irrigation with M-BW_1 or M-BW_2 treatments surpassed irrigation with brackish water (BW) in all tested parameters. As an average of both magnetically brackish-water treatments, the percent of improvement reached 9.32% in plant height, 11.89% in branches (no. $plant^{-1}$), 35.98% in siliquas (no. $plant^{-1}$), 29.83% in seed yield (g $plant^{-1}$) and 11.36 in 1000-seed weight (g). A similar trend was observed in seed oil (%), seeds and oil yields (kg fed^{-1}; fed=4200 m^2), where the increases reached 1.29, 19.66 and 21.30% in the above-mentioned parameters, respectively. In addition, significant differences were recorded among three canola varieties where serw-6 came in the first order for producing high values in above characters followed by serw-4 and pactol, respectively. Significant differences due to the interactions between the two studied factors, where irrigation with magnetically treated brackish-water (M-BW_1or M-BW_2) caused positive effect on all yields and yield components of tested three cultivars compared to irrigation with brackish water.

Changes in morphological and physiological of plants and irrigation water and soil properties resulting from the application of different magnetic treatments are ultimately focused on the productivity of the tested crops. In this study, irrigation with magnetic brackish-water improvement clearly and significantly yield components, seed and oil yields (kg fed^{-1}) and seed oil % of the canola varieties compared to irrigation with brackish-water. Recent studies [25,36] clarify that magnetized brackish-water caused a clear improvement for leaching of soluble salts, especially (Na and Cl) far from the plant root zone, improvement soil availability from some macro and micro-elements (P, Ca, Mg and Fe), improvement aggregates soil particles, reducing slightly Ec irrigation and SAR that reflect for reducing the negative effects of irrigation water and soil salinity stresses. This was lead to lower soil profile salt concentrations and better soil conditions for plant development growth and yield productivity of sunflower, barley and alfalfa tested crops [11, 23]. Earlier studies reported that plants irrigated with magnetized water absorbed more water and consequently they uptake more nutrients as a result of water molecules of MTW are minute and small and is reflected on the productivity of tested crops [40,41]. Generally, clear and significantly positive effects regarding magnetic field treatments either under normal or salinity stress conditions were recorded in many studies on different tested crops (cereal, rice, wheat, soybean, broad bean, sunflower, sugar beet, pepper and pea) [42,43,44,45]. They also noticed improvement in quality parameters: oil, protein, carbohydrates and sugar (%) according to tested crops.

CONCLUSION

This study confirmed that salinity stresses in irrigation water (Ec; 9.86 dS m^2) and soil (Ec; 8.65 dSm^2) have harmful effects on the growth and productivity of the canola cultivars that were tested. Irrigation with magnetic-brackish water ameliorated the harmful effects of salinity stress either in soil and/or irrigation water through improvement leaching of soluble salts (Na and Cl) from the plant root zone. Moreover, irrigation with magnetic brackish water caused an increasing in aggregates soil particles, slight reduction in electrical conductivity irrigation and sodium adsorption ratio, which led to, enhanced the macro and micro-vegetative growth parameters and productivity of tested canola cultivars. As an average of both magnetically brackish-water treatments over tested three canola varieties, the percent of improvement compared to irrigation with brackish-water ranged between 11-16% for growth parameters, 28 - 32% for dry matter of plant; 16 - 81% for leaves anatomical; 11 - 64% for stems anatomical and 2 - 54% for nutrition value of macro and micro elements of leaves at 85 DAS. Reverse trends were observed in the best indicators for alleviation salinity stress (Na, and proline), where decrease under both magnetic brackish water treatments by 66 and 44%, respectively (average of both magnetically brackish-water treatments compared to BW water treatment). Amelioration salinity stress led to improving growth parameters, which reflected in improvements canola yield components by 9-36% and by 2, 20, and 21% in seed oil contents percentage, seeds and oil yields (ton fed^{-1}), respectively compared to brackish water**.**

Application of magnetic technology for alleviation of salinity stresses (either in irrigation water and/or in soil) and improving growth and productivity of canola crop under south Sinai region is, therefore, recommended.

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Table 1: The main chemical and physical properties of the experimental soil site and chemical composition of irrigation water

Parameter	Soil depth (cm) 0-30	Soil depth (cm) 30-60	Irrigation water
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 class	Sandy loam	Sandy loam	..
Soil chemical properties:			
Soluble cations (meq/L)			
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	00.08	00.14
*SAR	10.18	12.80	8.17
Soluble anions (meq/L)			
$CO^{-2}{}_3$	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

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

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Table 2: Plant height, branches and leaves number, leaf area, dry matter of plant organs and total chlorophyll of some canola cultivars under magnetic brackish water treatments at 85 days after sowing

Treatment		Plant height (cm)	Branches (no. plant^{-1})	Leaves (no. plant^{-1})	LA (dm^2 plant^{-1})	Dry matter (g plant^{-1})			Total chlorophyll (SPAD)
Water	Cultivar					Leaves	Stem	Plant	
Brackish water (BW)	Pactol	70.20	7.83	9.27	50.53	33.00	73.00	106.00	49.67
	Serw-4	78.60	8.40	10.40	53.73	35.00	77.67	112.67	50.90
	Serw-6	94.40	10.40	10.60	60.75	42.00	89.67	131.67	51.02
Magnetic-BW^1 (MBW^1)	Pactol	79.00	8.75	10.50	58.15	38.00	82.00	120.00	55.22
	Serw-4	88.40	9.00	11.50	61.49	46.00	113.00	159.00	58.63
	Serw-6	105.26	11.67	11.77	69.76	54.00	116.67	170.67	59.27
Magnetic-BW^2 (MBW^2)	Pactol	82.25	8.25	10.80	58.28	38.00	88.00	126.00	57.60
	Serw-4	93.00	9.33	11.17	61.89	48.00	114.67	162.67	58.84
	Serw-6	107.31	12.00	12.62	73.34	58.33	119.00	177.33	60.90
F test		**	**	**	**	**	**	**	**
LSD$_{5\%}$		**6.82**	**1.18**	**1.13**	**4.08**	**2.24**	**5.52**	**6.11**	**2.04**
Water treatment	BW	81.07	8.88	10.09	55.00	36.67	80.11	116.78	50.53
	MBW^1	90.89	9.81	11.26	63.13	46.00	103.89	149.89	57.71
	MBW^2	94.19	9.86	11.53	64.50	48.11	107.22	155.33	59.11
F test		**	**	**	**	**	**	**	**
LSD$_{5\%}$		**4.01**	**1.21**	**0.43**	**4.57**	**0.80**	**4.77**	**4.20**	**1.27**
Cultivar	Pactol	77.15	8.28	10.19	55.66	36.33	81.00	117.33	54.16
	Serw-4	86.67	8.91	11.02	59.03	43.00	101.78	144.78	56.13
	Serw-6	102.32	11.36	11.66	67.95	51.44	108.44	159.89	57.06
F test		**	**	**	**	**	**	**	**
LSD$_{5\%}$		**3.94**	**0.68**	**0.65**	**2.36**	**1.30**	**3.18**	**3.53**	**1.18**
CV$_{\%}$		**4.32**	**7.01**	**5.76**	**3.77**	**2.89**	**3.19**	**2.44**	**2.06**

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Table 3: Anatomical characteristics of canola leaf and stem of some canola cultivars under magnetic brackish water treatments at 85 days after sowing

Treatment		Leaf histology (µm)						Stem histology (µm)				
Water	**Cultivars**	**Midvein thick.**	**Lamina thick.**	**Vascular bundle length**	**Vascular bundle width**	**Upper epidermis**	**Lower epidermis**	**Stem diameter**	**Cortex thick.**	**Phloem tissue thick.**	**Xylem tissue thick.**	**Pith diameter**
Brackish water (BW)	**Pactol**	720.0	667.5	330.0	397.5	33.5	42.5	2925.0	232.5	170.0	532.5	1750.0
	Serw-4	772.5	565.0	338.5	460.0	35.0	46.0	3000.0	340.0	190.0	615.0	1800.0
	Serw-6	850.0	405.0	352.5	517.5	39.0	47.5	3025.0	355.0	200.0	650.0	2312.5
Magnetic-BW$_1$ (MBW^1)	**Pactol**	1297.5	682.5	535.0	705.0	36.0	37.5	3400.0	430.0	220.0	635.0	1850.0
	Serw-4	1332.5	636.0	442.5	865.0	37.5	46.5	3512.5	490.0	230.0	660.5	2150.0
	Serw-6	1340.0	881.0	460.0	556.5	45.0	47.5	3600.0	510.0	245.0	670.0	2212.5
Magnetic-BW$_2$ (MBW$_2$)	**Pactol**	1470.0	503.5	552.5	837.5	38.5	45.0	3750.0	515.0	255.0	710.0	2250.0
	Serw-4	1495.0	772.5	402.5	1047.5	42.5	48.5	3887.5	530.0	265.0	714.0	2387.5
	Serw-6	1536.0	925.0	415.0	747.5	49.0	49.0	4062.5	565.0	280.0	744.0	2130.6
Water treatment	**BW**	780.8	545.8	340.3	458.3	35.8	45.3	2983.33	309.17	186.67	599.17	1954.17
	MBW$_1$	1323.3	733.2	479.2	708.8	39.5	43.8	3504.17	476.67	231.67	655.17	2070.83
	MBW$_2$	1500.3	733.7	456.7	877.5	43.3	47.5	3900.00	536.67	266.67	722.67	2256.03
Variety	**Pactol**	1162.5	617.8	472.5	646.7	36.0	41.7	3358.33	392.50	215.00	625.83	1950.00
	Serw-4	1200.0	657.8	394.5	790.8	38.3	47.0	3466.67	453.33	228.33	663.17	2112.50
	Serw-6	1242.0	737.0	409.2	607.2	44.3	48.0	3562.50	476.67	241.67	688.00	2218.53

Thick. = thickness

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Table 4: Macro and micro-nutrients in leaves of some canola cultivars under magnetic brackish water treatments at 85 days after sowing

Treatment		Macro-minerals (%)					Micro-minerals (ppm)				proline (ppm)
Water	**cultivars**	**N**	**K**	**Mg**	**Na**	**Ca**	**Fe**	**Mn**	**Zn**	**Cu**	
Brackish water (BW)	**Pactol**	1.10	2.55	0.12	1.48	1.90	89.0	166.0	144.0	3.0	560.00
	Serw-4	1.30	2.45	0.24	1.50	1.80	121.0	275.0	126.0	3.0	620.00
	Serw-6	1.50	2.20	0.42	1.53	2.05	97.0	233.0	144.0	6.0	420.00
Magnetic-BW1 (MBW1)	**Pactol**	1.20	2.85	0.25	0.54	1.25	95.0	185.0	167.0	1.5	290.00
	Serw-4	1.60	2.52	0.33	0.55	1.60	122.0	210.0	145.0	3.0	370.00
	Serw-6	1.67	2.50	0.47	0.56	1.40	102.0	245.0	103.0	4.5	350.00
Magnetic-BW2 (MBW2)	**Pactol**	1.60	2.73	0.25	0.48	1.75	97.0	230.0	102.0	4.5	260.00
	Serw-4	2.10	2.95	0.45	0.43	1.50	178.0	161.3	156.0	3.0	250.00
	Serw-6	1.70	2.60	0.66	0.50	1.30	148.0	135.0	175.0	3.0	280.00
F test		***	***	***	*	***	***	***	***	***	***
LSD5%		**0.15**	**0.05**	**0.03**	**0.04**	**0.06**	**1.78**	**1.43**	**2.13**	**0.17**	**9.73**
Water treatment	**BW**	1.30	2.40	0.26	1.50	1.92	102.33	224.67	138.00	4.00	533.33
	MBW1	1.49	2.62	0.35	0.55	1.42	106.33	213.33	138.33	2.99	336.67
	MBW2	1.80	2.76	0.45	0.47	1.52	141.00	175.44	144.33	3.49	263.33
F test		***	***	***	***	***	***	***	***	***	***
LSD5%		**0.08**	**0.07**	**0.02**	**0.04**	**0.01**	**2.31**	**0.40**	**1.15**	**0.03**	**7.44**
Cultivars	**Pactol**	1.30	2.71	0.21	0.83	1.63	93.67	193.67	137.67	3.00	370.00
	Serw-4	1.67	2.64	0.34	0.83	1.63	140.33	215.44	142.33	2.99	413.33
	Serw-6	1.62	2.43	0.52	0.86	1.58	115.67	204.33	140.67	4.49	350.00
F test		***	***	***	*	*	***	***	***	***	***
LSD5%		**0.09**	**0.03**	**0.02**	**0.03**	**0.03**	**1.03**	**0.83**	**1.23**	**0.10**	**5.61**
CV%		**5.34**	**1.21**	**4.79**	**2.93**	**2.05**	**0.25**	**0.40**	**0.85**	**2.74**	**1.44**

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Table 5: Yield and yield components at harvest of some canola cultivars under magnetic brackish water treatments

Treatment: Water	Treatment: Cultivar	Plant height (cm)	Branches (no. plant^{-1})	Weight (g plant^{-1}): Siliquas	Weight (g plant^{-1}): seeds	1000-seed wt. (g)	Seed oil (%)	Yield (kg fed^{-1}): Seeds	Yield (kg fed^{-1}): oil
Brackish water (BW)	Pactol	98.14	14.12	45.45	22.09	4.34	44.01	403.43	177.56
	Serw-4	102.47	15.75	56.13	24.11	4.62	43.35	452.20	196.04
	Serw-6	110.67	16.08	59.60	28.43	4.86	42.12	475.48	200.27
Magnetic-BW_1 (MBW_1)	Pactol	107.20	15.17	55.80	27.60	4.79	44.34	490.47	217.41
	Serw-4	111.93	17.17	79.20	30.00	4.99	43.94	519.63	228.30
	Serw-6	114.93	18.33	81.00	37.60	5.57	42.33	562.10	237.94
Magnetic-BW_2 (MBW_2)	Pactol	108.74	16.33	63.73	30.20	4.60	44.67	497.00	222.02
	Serw-4	115.40	17.25	73.20	32.40	5.16	44.46	546.00	242.73
	Serw-6	122.33	18.58	85.40	36.00	5.68	42.74	570.50	243.79
F test		**	**	**	**		**	**	**
$LSD_{5\%}$		**3.00**	**1.83**	**1.28**	**1.45**	**0.26**	**0.91**	**7.45**	**5.93**
Water treatment	BW	103.76	15.32	53.73	24.88	4.61	43.16	443.70	191.29
	MBW_1	111.35	16.89	72.00	31.73	5.12	43.53	524.07	227.88
	MBW_2	115.49	17.39	74.11	32.87	5.15	43.95	537.83	236.18
F test		**	**	**	**		**	**	**
$LSD_{5\%}$		**1.58**	**0.56**	**0.91**	**1.94**	**0.18**	**0.47**	**2.17**	**2.49**
Cultivar	Pactol	104.69	15.21	54.99	26.63	4.58	44.34	463.63	205.66
	Serw-4	109.93	16.72	69.51	28.84	4.92	43.91	505.94	222.36
	Serw-6	115.98	17.67	75.33	34.01	5.37	42.39	536.03	227.33
F test		**	**	**	**		**	**	**
$LSD_{5\%}$		**1.73**	**1.06**	**0.74**	**0.83**	**0.15**	**0.52**	**4.30**	**3.43**
$CV_{\%}$		**1.53**	**3.57**	**1.08**	**2.73**	**2.96**	**1.18**	**0.83**	**1.53**

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REFERENCES

1. **Pritchard R, Jone D, Okeeffe K and D McCaffery** Challenges for irrigated canola in. Report, 2007; No. 175.

2. **Roth-Maier DA** Investigation on feeding full-fat canola seed and canola meal to poultry. In"New horizons for an old crop" Proceedings of the 10th International Rapeseed Congress, Canberra, Australia. 1999.

3. **Mittal D, Sharma N, Sharma V, Sopory SK and NS Mishra** Role of micro RNAs in rice plant under salt stress. Annalls Applied Biology. 2015;168.

4. **Nounjan N, Nghia PT and P Theerakulpisut** Exogenous proline and trehalose promote recovery of rice seedlings from salt-stress and differentially modulate antioxidant enzymes and expression of related genes. *J. of Plant Physiology*, 2012;**169**: 596-604.

5. **Rabhi M, Giuntini D, Castagna A, Remorini D, Baldan B, Smaoui A, Abdelly C and A Ranieri** Sesuvium portulacastrum maintains adequate gas exchange, pigment composition, and thylakoid proteins under moderate and high salinity. *J. of Plant Physiology*, 2010; **167**: 1336-1341.

6. **Latef AAH and H Chaoxing** Effect of arbuscular mycorrhizal fungi on growth, mineral nutrition, antioxidant enzymes activity and fruit yield of tomato grown under salinity stress. Science Horticulture. 2011;**127**: 228–233.

7. **Flowers TJ and A Muscolo** Introduction to the special issue: halophytes in a changing world. AoB Plants. 2015:7- 20.

8. **Sakina I, Ahmed A, Shahzad M, Iqbal M and Asif** Genetic variation for salinity tolerance in Pakistani rice (*Oryza sativa* L.) germplasm. *J. Agronomy Crop Science*, 2016; **202 (1)** : 25-36.

9. **Mohamed MF, Maha MSA, Khalifa RKM, Ahmed AG and M Hozayn** Effect of arginine and GA_3 on growth, yield, mineral nutrient content and chemical constituents of faba bean plants grown in sandy soil conditions. *Interna. J. of ChemTech Research,* 2015; **8 (12)**: 187-195.

10. **Hilal MH and MM Hilal** Application of magnetic technologies in desert agriculture II – Effect of magnetic treatments of irrigation water on salt distribution in olive and citrus fields and induced changes of ionic balance in soil and plant. *Egyptian J. Soil Science*, 2000; **40(3)**: 423 - 435.

11. **Hozayn M and AA Ahmed** Effect of tryptophan and ascorbic acid as magneto-priming on germination attributes of barley (*Hordeum vulgare*, L.) under salinity stress. *Eurasian J. of Biosciences.* 2019; **13 (1)**: 245-251.

12. **Hozayn M, Abdallha MM, Abd El-Monem AA, El-Saady AA and MA Darwish** Applications of magnetic technology in Agriculture, a novel tool for improving crop productivity (1): Canola. *Afric. J. of Agric. Research,* 2016a; **11(5)**: 441-449.

13. **Hozayn M, Salama MA, Abd El-Monem AA and HF Alharby** The impact of magnetized water on the anatomical structure, yield and quality of potato (*Solanum tuberosum* L.) grown under newly reclaimed sandy soil. *Research J. of Pharmaceutical, Bio. and Chem. Science*, 2016 b; **7(3)**:1059-1072.

14. **Hilal M, El-Fakhrani Y, Mabrouk V, Mohamed A and B Ebead** Effect of magnetic treated irrigation water on salt removal from a sandy soil on the availability of certain nutrients. *Intern. J. of Engineer. and A. Science*, 2013; **2**:36-44.

15. **Matwijczuk A, Kornarzyñski K and S Pietruszewski** Effect of magnetic field on seed germination and seedling growth of sunflower. International Agro physics., 2012; **26**: 271-278.

16. **Zia-Ul-Haq M, Shahid Iqbal, Shakeel Ahmad, Muhammad Imran, Abdul Niaz and MI Bhanger** Nutritional and compositional study of Desi chickpea (*Cicer arietinum* L.) cultivars grown in Punjab, Pakistan. Food Chemistry, 2007;**105**: 1357-1363.

17. **Zlotopolski V** The Impact of magnetic water treatment on salt distribution in a large unsaturated soil column. International Soil and Water Conservation Research / International Soil and Water Conservation Research, 2017; **5**: 253–258.

18. **Ben Hassen H, Hozayn M, Elaoud A and AA Abdel-Monem** Inference of Magnetized Water Impact on Salt-Stressed Wheat. *Arabian J. Science Engineer*., 2020 https://doi.org/10.1007/s13369-020-04506-6

19. **Hozayn M, Abdallah MMS and AA Abd El-Mone** Effect of proline on growth, yield, nutrient and amino acid contents of barley (*Hordeum vulgare* L.) irrigated with moderate saline water. *Inter. J. of ChemTech Research,* **2015** a**; 8 (12**): 772-783.

20. **Hozayn M, El-Bassiouny HMS, Abd El-Monem AA and MM Abdallah** Applications of magnetic technology in agriculture, a novel tool for improving water use efficiency and crop productivity: 2. Wheat. *Inter. J. of ChemTech Research,* 2015b; **8 (12):** 759-771.

21. **Hozayn M, Abd El-Wahed MSA, Abd El-Monem AA, Abdelraouf RE and EM Abd Elhamid** Applications of magnetic technology in agriculture, a novel tool for improving water and crop productivity: 3. Faba bean. *Research J. of Pharmaceutical, Bio. and Chem. Sciences*, 2016 c; **7 (6)**: 1288-1296.

22. **Chapman HO and PE Pratt** Methods of Analysis for Soils, Plants and Water. Univ. of California Agric. Sci. Priced Publication, 1978; **40**: 34-50.

23. **Hozayn M, Abd El-Monem AA and A Amal Elmahdy** Application of magnetic technology for salinity stress mitigation and improving sunflower productivity under South Sinai conditions. *Middle East J. of Agric. Research*, 2017; **6(4)**: 1490-1500.

24. **Nassar MA and KF El-Sahhar** Botanical Preparations and Microscopy (Microtechnique). Academic Bookshop, Dokki, Giza, Egypt. 1998: 219 pp. (In Arabic).

25. **Hozayn M, Abeer A A, El-Saady AA and AA Abd El-Monem** Enhancement in germination, seedling attributes and yields of alfalfa (*Medica gosativa* L.) under salinity stress using static magnetic field treatment. *Eurasian J. of Biosciences*. 2019a; **13 (1)**: 369-378.

26. **Konica MO** Chlorophyll Meter SPAD-502 Plus - A lightweight handheld meter for measuring the chlorophyll content of leaves without causing damage to plants. 2012.

27. **AOAC.** Official Methods of Analysis. 17th Edition, The Association of Official Analytical Chemists, Gaithersburg, MD, USA. Methods 2000; **925, 10,** 65.17, 974.24, 992.16.

28. **Freed RSP, Einensmith S, Gutez S, Reicosky D, Smail VW and P Wolberg** MSTAT-C analysis of agronomic research experiments. Michigan Univ. East Lansing, USA. 1989.

29. **Kataria S and lL Baghe** Guruprasad KN Pre-treatment of seeds with static magnetic field improves germination and early growth characteristics under salt stress in maize and soybean. Biocatalysis and Agriculture Biotechnology, 2017; **10**: 83-90.

30. **Midan SA and MF Tantawy** Effect of magnetized irrigation water on mineral nitrogen fertilization efficiency, nutrients availability and snap bean plants productivity. *Minufiya J. Agric. Research*, 2013; **38 (1):** 423 – 443.

31. **Fatahallah MA, Ali FA, Gawish RA and DM Hassan** Effect of water regimes and irrigation with magnetic and non-magnetic water on soil salinity and growth of bean plants. *Minufiya J. Agric. Research*, 2014; **39(5):** 1643- 1654.

32. **Hasan R, Kawasaki M, Taniguchi M and H Miyake** The Damage of Root, Leaf and Chloroplast Ultrastructure on Maize Seedlings Caused by Salinity Stress. The 2nd International Conference on Biosciences (ICoBio), 2018.

33. **Adnan Y, Atif R, Iftikhar A, Muhammad Irfan S, Usman T, Mansoor H and N Muhammad** Anatomical Changes Induced by NaCl Stress in Root and Stem of *Gazania harlequin* L. Agricultural communications, 2014; **2(3)**: 8-14.

34. **Aria D, Seyed AM, Modarres S and G Faezeh** Effect of salinity on growth, xylem structure and anatomical characteristics of soy bean. notscibiol, 2011; **3(1):**41-45.

36. **Hozayn M, Sahar M I, Abd El-Monem AA and MM Darwish** Magnetically treated brackish water new approach for mitigation salinity stress on sunflower productivity and soil properties under South Sinai region, Egypt, Alexandria Science Exchange Journal, 2019b; **40 (3)**: 441-461.

37. **Kronenberg KJ** Magneto hydrodynamics: the effect of magnets on fluids GMX international. 2005.

38. **Estken A and M Turan** Alternating magnetic field effects on yield and plant nutrient element composition of strawberry (*Fragaria* x *ananassa* cv. Camarosa). Acta Agriculturae Scandinavica, Section B-Soil & Plant Science, 2004; **54 (3**): 135-139.

39. **Hajer AS, Malibari AA, Al-Zahrani HS and OA Almaghrabi** Responses of three tomato cultivars to sea water salinity 1. Effect of salinity on the seedling growth. *Africa J. of Biotechnology*, 2006; **5**: 855- 861.

40. **Maheshwari BL and HS Grewal** Magnetic treatment of irrigation water: Its effects on vegetable crop yield and water productivity. Agriculture Water Management., 2009; **96:** 1229–1236.

41. **Selim MM** Application of magnetic technologies in correcting under ground brackish water for irrigation in the arid and semi-arid ecosystem. The 3rd International Conference on Water Resources and Environment and the 1st Arab Water Forum, 2008.

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

43. **Surendran U, Sandeep O and EJ Joseph** The impacts of magnetic treatment of irrigation water on plant, water and soil characteristics. Agricultural Water Management, 2016;**178**:21-29.

44. **Vladimir Z** The impact of magnetic water treatment on salt distribution in a large unsaturated soil column. International Soil and Water Conservation Research, 2017; **5**:253-257.

45. **Razmkhaha M, Fatemeh M, Mohammad THM and A Ali** Does electric or magnetic field affect reverse osmosis desalination? Desalination, 2018; **432**:55-62.