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EFFECT OF IRRIGATION WITH MAGNETIC WATER ON VEGETATIVE GROWTH, CHEMICAL CONTENTS AND ESSENTIAL OIL IN ROSEMARY GROWN IN DIFFERENT LEVELS OF SALINITY

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ABSTRACT: Magnetic water has widely used in agriculture irrigation as a promising technology to improve water use efficiency and crop productivity. Pot experiment was conducted at the Experimental Farm of the Faculty of Agriculture, Menoufia University at Shibin El-Kom, Egypt during the two successive seasons of 2015 and 2016. The study was conducting aiming to study the effect of magnetic irrigation water, salinity stress and their interaction on the growth parameters, some chemical constituents and essential oil (percentage and components) of *Rosmarinus officinalis* L. plants grown in different levels of salinity.

The experiments layout was a factorial in a split randomized design. Main plots were irrigation water (normal or magnetic) and the sub plots were different levels of salinity (0.0, 0.1, 0.2, and 0.3%). All growth parameters (i.e. plant height, number of branches, fresh and dry weights of herb/ plant), N, P and K percentage, photosynthetic pigments content and essential oil percentage were decreased significantly with increasing salinity level. On the other hand, magnetic water can overcome (to some extent) the hazards effects caused by salinity. At the high level of salinity (0.3%), the increases in essential oil percentage in herb of rosemary plants irrigated with magnetic water were 139.8% and 147.4% in first and second season respectively (in relation to owing control). Also, the major component of essential oil (Limonene) reached the highest value (20.47%) in the plants irrigated with magnetic water and exposed to salinity level 0.2%.

Key words: *Rosmarinus officinalis* L, Rosemary, magnetic water, salinity

INTRODUCTION

Medicinal and aromatic plants give considerably higher income than the many other crops in Egypt. They provide the raw materials for the local and foreign drug industry. Lamiaceae (Labiatae) family includes large numbers of medicinal and aromatic plants. *Rosmarinus officinalis* L. is one of the most important medicinal and aromatic plants which belong to the Lamiaceae family (Mostafa, Horia 2019). It is used externally as parasiticide, cicatrisant, for muscular pains and rheumatism, dermatitis, dandruff and eczema. Internally it is used for asthma, bronchitis whooping cough, to stimulate poor circulation, it is also used for palpitation, debility, headache, neuralgia, rental fatigue, nervous exhaustion, and stress-related disorders, dyspepsia, flatulence, hepatic disorders, hyper cholesterolaemia, and jaundice (Valnet, 1973 and Lawless, 1992). The influence of magnetic field on the structure of water and aqueous solutions can alter the physical and chemical properties of water-dispersed systems. With the

application of magnetic water, hydration of salt ions and other impurities slides down and improve the possible technological characteristics of the water. Magnetic field can enhance the characteristic of water i.e. better salt solubility, kinetic changes in salt crystallization, accelerated coagulation; therefore water shortage is being increasingly accepted as a major limitation for increased agricultural production and food security. These results suggest that even low magnetic field can decrease the electrical conductivity and total dissolved solids which are good for the removal of salinity from the irrigated land by using magnetic water for irrigation (Ashraf, 2014). Studies concerning the effect of magnetic technology on the growth, chemical constituents and oil yield of rosemary plants under stress conditions are limited. Therefore, this work was aimed to study the changes induced in the growth and biochemical aspects as well as essential oil of salt stressed rosemary plants and irrigated with magnetic water as a new ecological technique.

MATERIALS AND METHODS

The seedlings of rosemary (*Rosmarinus officinalis* L.) were obtained from Experimental Farm of Medicinal and Aromatic Plants Research Department in El Qanater El Khayreya, Egypt. These seedlings were planted in pots (at summer season (15th march) during the two growing seasons 2015 and 2016) and treated with different levels of salinity which were prepared by mixing sodium chloride (NaCl with purity 95%) and calcium chloride ($CaCl_2$ with purity 95%) at ratio of 2:1w/w and then were mixed with the experimental soil at four levels of 0, 0.1, 0.2, 0.3%. After planting, the seedlings were irrigated either with tap water or with magnetic water, which passed through magnetron tube of 2 inches diameter and 4000Gaus strength. Each treatment was represented with three replicates; each of them contained 12 pots (30 cm diameter). The experiment layout was a factorial in a split randomized design. Main plots were irrigation water (tap or magnetic) and the sub plots were different levels of salinity.

Data recorded for vegetative measurements, photosynthetic pigments, minerals (NPK), essential oil % and essential oil components were measured.

Vegetative measurements: Plant height (cm); branches number per plant; fresh and dry weights (g/plant).

Photosynthetic pigments: Chlorophyll "a", chlorophyll "b" and carotenoids contents in fresh leaves determined as recommended by Wettstein (1957).

Minerals concentrations were determined in dry plant herb. Total nitrogen determined using Nessler reagent according to Koch and Mc-Meekin (1924), phosphorus was estimated calorimetrically as recommended by King (1951). Potassium was determined by using flame-photometrically Saric *et al.* (1976)

The essential oil % was determined according to British pharmacopeia (1963) and the chemical composition of essential oil were determined by gas liquid chromatography (GLC) analysis, as recommended by Hoftman (1967) and Bunzen *et al*. (1969).

Statistical analysis

Data recorded on growth parameters and volatile oil percentage were statistically analyzed as split plot design, and separation of means was performed using the least significant difference (L.S.D.) test at the 5% level, as described by Snedecor and Cochran (1980) in the two growing seasons.

RESULTS AND DISCUSSION

1. Vegetative growth parameters

1.1. Effect of magnetic water

The obtained results as shown in Table (1) cleared that, application of magnetic water significantly increased the vegetative growth parameters, i.e., plant height, number of branches/plant, fresh and dry weights/plant, as compared with normal water. The values of number of branches, fresh and dry weights of herb in the second season were higher than those of the first season. It is worthy that the magnetic water caused increases over the plants irrigated with normal water in the above mentioned parameters by about 18.4, 12.5, 14.8 and 16.6%, respectively, in the 1st season and 17.7, 14.8, 11.5 and 17.6% respectively, in the 2nd one.

The obtained result are in harmony with those reported by Boix *et al*. (2018) who demonstrated that using water with static magnetic field can stimulate the plant growth of *Rosmarinus officinalis* L. Khater, Rania (2019) on rosemary stated that using magnetic irrigation water led to a significant increase in plant height and fresh and dry weights, where the increase was estimated at 20%, compared with plants that were irrigated with normal water.

This increase in rosemary growth as a result of magnetic treatment can be explained as follows. Magnetic field may be caused breaking down of hydrogen bonds of the molecule of magnetized water that led to smaller-sized water molecules, which affected the physical changes of water, viscosity and density. This facilitated the entry of the water through plant cellular membranes and increased the absorption of water and may affect the production of the hormone (IAA), which leads to improve activity and division of plant cells. This reflects in the increase in plant height and number of branches (Rao, 2002).

1.2. Effect of salinity

Data recorded in Table (1) showed that salinity had a negative effect on growth parameters. All growth characters studied were reduced with increasing the rates of salinity in the two seasons. The high rate of salt 0.3% decreased the plant height, number of branches, fresh weight and dry weight by about 38.6, 55.4, 27.0 and 34.3% respectively, in the 1st growing season; 38.0, 55.0, 26.6 and 37.7% respectively, in the 2nd one. Our results agreed with Kotagiri and Kolluru (2017) on Coleus plant and this may be attributed to the balanced flow of sodium chloride and other ions like potassium and calcium transport will be disrupted.

The reduction in growth was attributed to lower osmotic potential in the soil, which leads to decreased water uptake, reduced transpiration and stomata closure (Ben-Asher *et al.*, 2006). The mechanisms of salinity on plant growth are highly related to the following points: (a) salinity affects root and stomatal resistance to water flow, (b) the balance between root and shoot hormones shifts greatly under saline conditions, (c) salinity changes the structure of the chloroplasts and mitochondria and such changes may interfere with normal metabolism and growth, (d) salinity increases respiration and decreases photosynthetic products (Said-Al Ahl and Mahmoud, 2010).

1.3. Effect of interaction between magnetic water and salinity

The obtained data illustrated in the same Table (1) indicated that, magnetic water minimized the damage effect of salinity on the vegetative growth of the rosemary plants when compared with owing controls with normal tap water in the two growing seasons. The

interactions between magnetic water and all levels of salinity gave an increase in these parameters and this increase was significantly compared to each treatment and control (tap water). The increases in plant height, number of branches, fresh and dry weights caused by magnetic treatment at the highest salinity level (0.3%) were 27.5, 33.3, 34.4 and 46.1% respectively, in the 1st season, 27.5, 27.3, 21.7 and 45.9% respectively, in the 2nd one, when compared with owing salinity treatments plus nonmagnetic field. The obtained results are in accordance with those revealed by El-Gindy *et al.* (2018) who showed that the growth parameters of pear seedlings were improved significantly by using magnetic technology with a low salinity of irrigation water in both seasons. In addition, Selim, Dalia (2013) and Al-Mashhadani *et al.* (2016) on wheat plants came to similar results.

Table (1): Effect of irrigation with magnetic water (Mag.), salinity and their interaction on vegetative growth of rosemary during summer seasons of 2015 and 2016.

Character / Water type / Salinity		Plant height (cm)	Number of branches /plant	F Wt. (g/plant)	D Wt. (g/plant)	Plant height (cm)	Number of branches /plant	F Wt. (g/plant)	D Wt. (g/plant)
		Season 1				Season 2			
A. Effect of magnetic treatments									
Normal		17.31	9.06	29.87	22.89	17.31	9.31	31.58	24.35
Mag.		20.50	10.19	34.29	26.69	20.38	10.69	35.22	28.64
LSD 5%		0.38	0.40	0.30	0.25	0.38	0.69	0.64	0.27
B. Effect of salinity									
	S0	23.63	13.75	36.64	29.69	23.38	13.88	38.51	32.57
	S1	20.63	10.25	33.91	26.37	20.63	11.00	34.66	28.63
	S2	16.88	8.38	31.01	23.57	16.88	8.88	32.19	24.48
	S3	14.50	6.13	26.76	19.52	14.50	6.25	28.25	20.30
LSD 5%		0.65	0.68	0.44	0.19	0.64	0.53	0.51	0.43
A X B. Effect of the interaction between magnetic water and salinity									
Normal	S0	22.75	12.50	35.38	28.36	22.75	12.50	37.01	30.05
	S1	19.50	10.25	32.12	25.11	19.50	10.75	33.31	27.68
	S2	14.25	8.25	29.14	22.22	14.25	8. 50	30.51	23.14
	S3	12.75	5.25	22.83	15.86	12.75	5. 50	25.48	16.51
Mag.	S0	24.50	15.00	37.90	31.02	24.00	15.25	40.00	35.08
	S1	21.75	10.25	35.69	27.63	21.75	11.25	36.01	29.58
	S2	19.50	8.50	32.87	24.91	19.50	9.25	33.87	25.82
	S3	16.25	7.00	30.68	23.18	16.25	7.00	31.01	24.09
LSD 5%		0.86	0.91	0.59	0.28	0.86	0.77	0.73	0.57

salinity levels: S0= Control, S1=0.1%, S2=0.2% and S3=0.3%

The increase of growth in rosemary may be due to that magnetic water increases plant growth by facilitating the absorption of water by root cells, as water becomes a good carrier for foodstuffs. The increase in the fresh and dry weights of herb per plant may be due to that magnetic irrigation water increases plant growth by crash hydrogen bonds, which facilitates the absorption of water by the root cells, as water becomes a good carrier of nutrients (Khater, Rania 2019). Hence, biological processes within the plant increases, such as an increase in photosynthesis and the plants process an increase in the production of plant hormones.

2. Photosynthetic pigments

2.1. Effect of magnetic treatment

Data recorded in Table (2) showed significant increases in the photosynthetic pigments by irrigation with magnetic water in the two growing seasons when compared with the tap water. The increases in chlorophyll "a", chlorophyll "b", total chlorophylls and carotenoids in rosemary leaves induced by the magnetic treatment reached about 93.3, 41.7, 61.6 and 46.9%, respectively in the 1st season; 87.5, 39.3, 54.9 and 47.5% in the 2nd one. That means that chlorophyll "a" was more affected by magnetic water than other pigments. The recorded results are in harmony with those mentioned by Tayyab *et al.* (2016) on pigeon pea and Hassan *et al.* (2017) on rosemary, who found that irrigation with magnetic water, enhanced the concentrations chlorophyll (a, b, total chlorophylls and carotenoids) in the plants when compared with the control plants irrigated with tap water.

These positive effects on photosynthetic pigments induced by magnetic water may be due to the effect of magnetic field on alteration the key of cellular processes such as gene transcription which play an important role in altering cellular processes.

2.2. Effect of salinity

Data recorded in Table (2) showed that the effect of salinity caused a reduction in the photosynthetic pigments content. All salinity treatments significantly reduced chlorophyll "a", chlorophyll "b", total chlorophylls and carotenoids content in rosemary leaves compared with the control and this reduction was gradually with increasing salinity level. The decrease percentages in these parameters at the higher salinity level (0.3%) were about 50.0, 48.6, 49.3 and 43.9% in the 1st season; 50.5, 46.4, 48.4 and 43.0% in the 2nd one respectively. The obtained results agreed with Hassan *et al*. (2017) on rosemary, who indicted that a significant reduction in the photosynthetic pigments concentrations, were occurred with increasing salinity levels. The reduction could be also related to degradation of chloroplast structure and photosynthetic apparatus, chlorophyll photo-oxidation, destruction of chlorophyll substrate, inhibition of chlorophyll biosynthesis, and the increase of chlorophyllase activity (Kabiri *et al.*, 2014).

2.3. Effect of interaction between magnetic water and salinity

Data presented in same Table (2) showed that irrigation with magnetic water induced positive significant effect on chlorophyll pigments content in rosemary leaves treated with salinity. The interaction between magnetic water and the highest salinity level 0.3% gave an increase in the same characters reached about 79.1, 10.9, 35.8 and 29.6% over

owing control, respectively in 1st season. Similar trend (more or less) was observed in the 2nd one. Similar results were found by Selim, Dalia (2013) on wheat plants, who found that using magnetic treatments enhanced all photosynthetic pigments parameters in leaves at all salinity levels and magnetized seeds treatment was more effective.

Table (2): Effect of irrigation with magnetic water (Mag.), salinity and their interaction on photosynthetic pigments content of rosemary during summer seasons of 2015 and 2016.

Character		Chl a	Chl b	Total Chl	Carotenoids	Chl a	Chl b	Total Chl	Carotenoids
Treatment		mg/g F.W.				mg/g F.W.			
Water Salinity		Season 1				Season 2			
Effect of magnetic treatments									
Normal		0.15	0.24	0.39	0.98	0.16	0.26	0.428	0.998
Mag		0.29	0.34	0.63	1.44	0.30	0.362	0.663	1.472
LSD 5%		0.0095	0.0038	0.0127	0.0073	0.0038	0.0075	0.0113	0.0088
B. Effect of salinity									
	S0	0.30	0.37	0.67	1.55	0.317	0.394	0.711	1.574
	S1	0.25	0.34	0.59	1.44	0.267	0.35	0.617	1.474
	S2	0.18	0.27	0.45	0.97	0.19	0.298	0.488	0.995
	S3	0.15	0.19	0.34	0.87	0.157	0.211	0.367	0.897
LSD 5%		0.0059	0.0056	0.0083	0.0068	0.0048	0.0057	0.0074	0.0063
A X B. Effect of the interaction between magnetic water and salinity									
Normal	S0	0.193	0.325	0.518	1.188	0.218	0.345	0.563	1.195
	S1	0.155	0.268	0.423	1.083	0.175	0.285	0.460	1.115
	S2	0.135	0.203	0.338	0.875	0.145	0.225	0.370	0.905
	S3	0.105	0.183	0.288	0.760	0.115	0.203	0.318	0.775
Mag	S0	0.403	0.423	0.825	1.915	0.415	0.443	0.858	1.953
	S1	0.348	0.403	0.750	1.803	0.358	0.415	0.773	1.833
	S2	0.215	0.343	0.558	1.063	0.235	0.370	0.605	1.085
	S3	0.188	0.203	0.391	0.985	0.198	0.218	0.415	1.018
LSD 5%		0.0089	0.0075	0.0125	0.0095	0.0065	0.0083	0.0111	0.0093

Salinity levels: S0= Control, S1=0.1%, S2=0.2% and S3=0.3%

3. Minerals content (NPK)

3.1. Effect of magnetic water

The obtained results illustrated in Figure (1) indicated that magnetic water increased the minerals content in the herb of rosemary plant during the two growing seasons compared with non-magnetic water, and the concentrations of N, P and K were 4.27, 0.51 and 1.82% respectively (1st season), 4.32, 0.51 and 1.84% respectively, in the 2nd one. The increases in N, P, K percent induced by magnetic treatment were about 36.6, 50.0 and 42.0% (1st season), 37.0, 43.1 and 38.4% (2nd season) respectively, over the untreated plants. The recorded results also indicated the possibility of obtaining the highest values of chemical constituents such as nitrogen, phosphorus and potassium percentages when rosemary plants were irrigated with magnetized water as reported by Khater (2019). These enhanced contents of N, P, K in rosemary plant irrigated with magnetic water may be due to the easy absorption of magnetized water by roots that has led to an increase in the absorption of the nutrients and thus increases the photosynthesis process, leading to an increase in the material tending starchy and sugary and thus an increase in carbohydrate percentage (Pietruszewski, 1999).

3.2. Effect of salinity

Data obtained (Figure 1) indicated that salinity decreased the N, P and K % by increasing the levels of salinity. Salinity stress reduced nutrient amount in the plants herb; the control plants without salinity gave higher minerals contents when compared with the low rates of salinity. The maximum reduction in the contents of N, P and K was recorded at the salinity level 0.3% and reached about 46.1, 63.3 and 40.1% (1st season); 46.1, 63.9 and 39.9% (2nd season) respectively. The main reason for this reduction may be attributed to suppression of growth under salinity stress during the early developmental stages (shooting stage) of the plants. Olfa *et al.* (2010) on (*Origanum majorana*) showed that salt stress caused nutrient disturbances under salinity which reduce plant growth by affecting the availability, transport, and partitioning of nutrients. Salinity may cause nutrient deficiencies or imbalances, due to the competition of Na^+ and Cl^- with nutrients such as K^+, Ca^{2+}, and NO_3^-. Under saline conditions, a reduced plant growth due to specific ion toxicities (e.g. Na^+ and Cl^-) and ionic imbalances acting on biophysical and/or metabolic components of plant growth occurs (Said-Al Ahl and Omar, 2011).

3.3. Effect of interaction between magnetic water and salinity

By using magnetic water to reduce the hazard effect of salinity; the data in Figure (1) indicated that irrigation with magnetic water increased minerals percentage obtained from herb compared to irrigation with tap water.

These results hold the same direction in the two seasons. At the salinity level 0.3%, magnetic treatment not only minimized the adverse effects of salinity, but also increased the N, P and K percent by 28.4, 38.9 and 4.4 % (1st season), 26.1, 26.3 and 3.3 % (2nd season) respectively, when compared with owing control. The remediating effect of magnetic technologies in this respect may be due to the easy absorption of magnetized water by roots that has led to an increase in the absorption of nutrients (Pietruszewski, 1999). These results are in agreement with those obtained by Khater, Rania (2019) on rosemary.

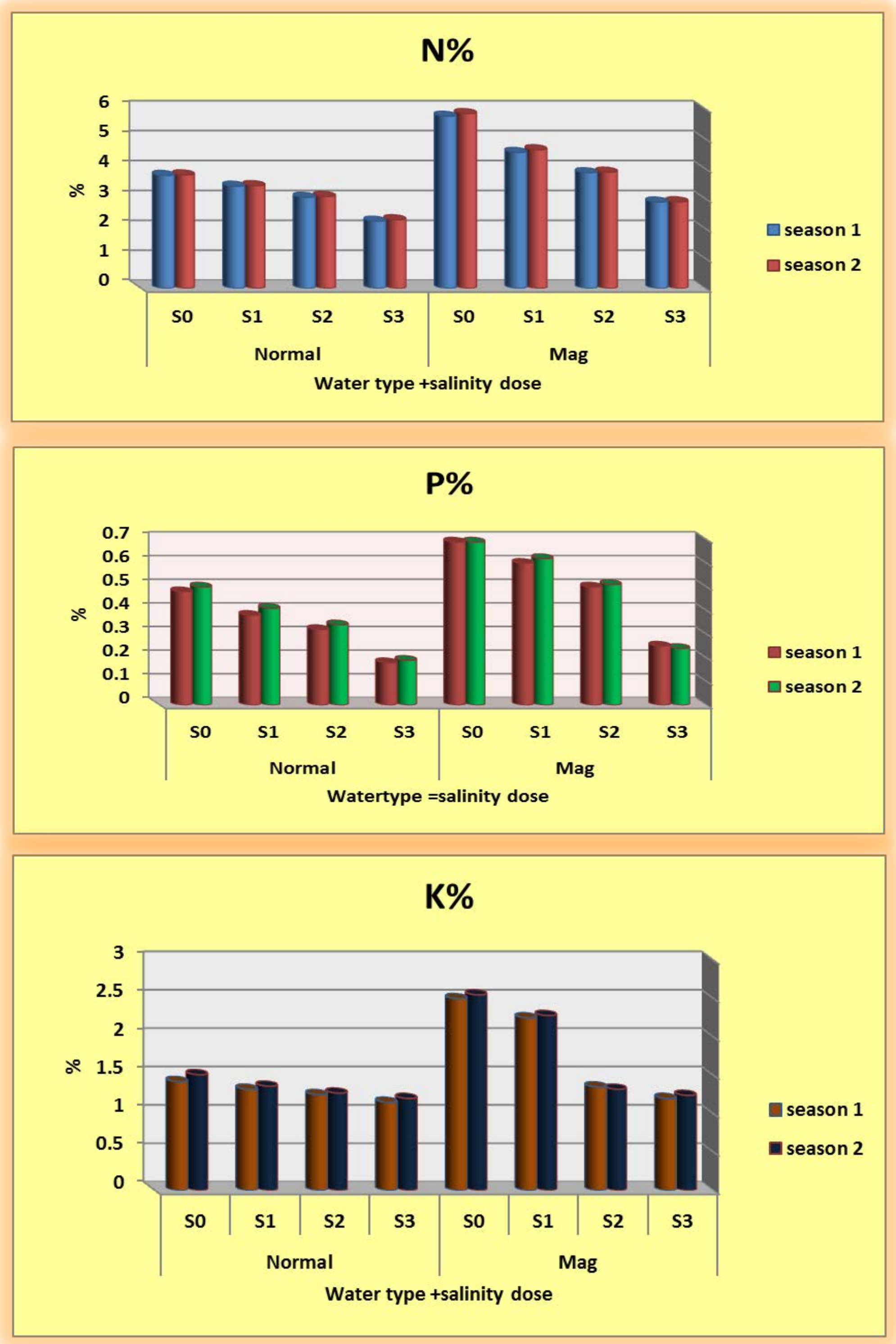

Figure (1): Effect of interaction between type of irrigation water [normal and magnetic (Mag.)] and different salinity rates on rosemary mineral content percentage (NPK %) during summer seasons of 2015 and 2016. (Salinity levels: S0= Control, S1=0.1%, S2=0.2% and S3=0.3%)

4. Essential oil percentage

4.1. Effect of magnetic water

Data illustrated in Figure (2) showed a significant increase in the oil percentage determined in the two growing seasons 0.69%, 0.70% respectively compared with these irrigated with tap water and their values were 0.36% in the two seasons with percentage increase by about 92.5% and 92.9% over the control plants. Our results are agreed with Khater, Rania (2019) on rosemary. This increment in these parameters may be due to that the magnetized water increased the vegetative growth and was reflected in essential oil yield. These results are in agreement with those obtained by Alsafar and Al-Hassan (2009) on *Mentha longifolia* plant.

4.2. Effect of salinity

Data in Figure (2) showed that oil percentage was reduced by increasing salinity rates in the two seasons. The high rate of salt (0.3%) gave the least oil percentage with % reduction reached about 82.5% (1st season) and 83.2% (2nd season) if compared with the control plants. These results symmetrized with Hassan *et al.* (2017) on rosemary and Chrysargyris *et al.* (2018) on Lavender. They stated that salt stress may be affect the essential oil accumulation indirectly through its effects on either net assimilation or the partitioning of assimilates among growth and differentiation processes (Charles *et al.*, 1990). It might be claimed that the formation and accumulation of essential oil was directly dependent on perfect growth and development of the plants producing oils (Penka, 1978). The decrease in oil production might be due to the decrease in plant anabolism. In fact, the effect of salinity on essential oil and its constituents may be due to its effects on enzyme activity and metabolism (Burboot and Loomis, 1969).

4.3. Effect of interaction between magnetic water and salinity

Essential oil percentage produced under the effect of magnetic water gave results twice these produced by non-magnetic water (Figure2). At the highest level of salinity (0.3%), the increases induced by magnetic water were 139.8 % in the 1st season, 147.4% in the 2nd one in relation to owing control. That means that magnetic technology not only alleviated the bad effects of salinity on oil content of rosemary, but also led to a marked increase reached 2-3 times under these conditions.

Similar results were obtained by Abd El-Hamied and Ghieth (2017) on peach cultivar and Cheikh *et al*. (2018) on cucumber. These results may be attributed to the fact that, the magnetized water increased the vegetative growth and was reflected in essential oil percentage. Hilal *et al.* (2003) reported that magnetic water was shown to have 3 main effects: 1) increasing the leaching of excess soluble salts, 2) lowering soil alkalinity and 3) dissolving slightly soluble salts such carbonates, phosphates and sulfates. However, the degree of effectiveness of magnetic water on soil salinity and ionic balance in soil solution depended greatly on the traveling distance of magnetic water along the drip irrigation lines.

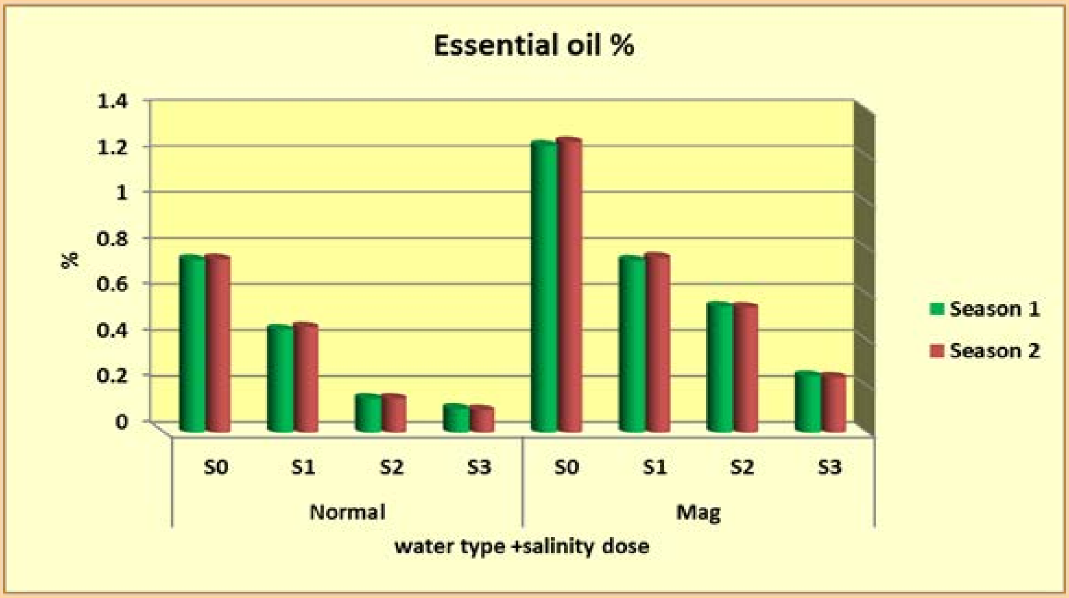

Figure (2): Effect of interaction between type of irrigation [normal and magnetic (Mag.)] water and different salinity rates on rosemary essential oil percentage (%) during summer seasons of 2015 and 2016. (Salinity levels: S0= Control, S1=0.1%, S2=0.2% and S3=0.3%).

5. Essential oil components

The GLC analysis were carried out on the essential oil extracted from rosemary herb as affected by different levels of salinity and irrigated by two types of water (tap water and magnetic water) as well as their interactions in the first season, and the data were recorded in Table (3). The tabulated data indicated that, the identified compounds were 11 for essential oil of *Rosmarinus officinalis*. They are α- Pinene, Camphene, β-Pinene, Lemonene, Camphor, α-Terpineol, Linalool, Borneol, Bornyl acetate, Eugenol and β- caryophyllene. Limonene and Camphor were found to be the major components in the essential oil of rosemary. Limonene maximum content was observed in rosemary herb essential oil that was irrigated with magnetized water in addition to 0.2% salt (20.47 %), while the minimum content (14.90%) was recorded with plants that irrigated with magnetized water without salt. Camphor reached the highest value with plants irrigated with tap water with 0.1% salt. The following essential oil components were Bornyl acetate (9.30 -11.55%), α- Pinene (3.32 -11.48%), Borneol (7.59- 9.85%) and α-Terpineol (4.92 -11.39%). The other essential oil components were Camphene (1.51-4.74%), Eugenol (2.52-5.74%), β-caryophyllene (4.20-6.58%) and β-Pinene (1.75-3.81%). This result agreed with Roodbari *et al*. (2013) on peppermint (*Mentha piperita* L.) who indicated that salinity reduces the production of essential oils in the mint plants and this is probably due to the limited supply of cytokinin from the roots to the branches and the leaves are changing ratio between Abscisic acid and cytokinin. It was conducted that peppermint was moderately tolerant to salinity, because salinity inhibited various growth parameters of this plant to various degrees. Peppermint can be grown successfully on most agricultural soils, as long as NaCl does not exceed the critical values.

Table (3). Effect of irrigation with tap water or magnetized water (Mag.), salinity and their interaction on essential oil components of rosemary during summer seasons of 2015 and 2016.

Treatments \ Components	α-Pinene	Camphene	β-Pinene	Limonene	Linalool	Camphor	α-Terpineol	Borneol	Bornyl acetate	Eugenol	β-caryophyllene
Tap water + 0% salt	8.81	4.17	3.69	17.92	1.65	16.58	6.22	8.03	9.70	2.76	5.82
Tap water +0. 1% salt	11.48	4.74	2.85	14.90	0.64	19.93	4.92	8.43	9.91	2.52	5.51
Tap water +0. 2% salt	9.19	4.09	1.75	18.68	1.12	18.95	10.24	8.70	9.90	2.56	4.20
Tap water +0. 3% salt	3.32	1.51	2.70	16.71	2.08	18.53	8.90	8.80	11.55	3.13	6.58
Mag. + 0% salt	9.58	4.39	2.63	14.95	2.27	17.16	11.39	7.72	9.30	5.74	5.81
Mag. +0. 1% salt	9.65	4.27	3.81	20.12	1.78	17.63	6.26	7.59	9.86	2.62	5.57
Mag. +0. 2% salt	8.52	4.02	3.51	20.47	1.56	16.66	10.31	9.85	9.73	2.76	5.62
Mag. + 0.3% salt	8.81	4.17	3.69	17.92	1.65	16.58	6.22	8.03	9.70	2.76	5.82

These results were symmetry with Bseleh *et al.* (2016) who conducted that using magnetic water technology in irrigation of medicine herbs that suffer from rising of groundwater salinity could be a temporary solution to overcome salinity. Results showed improvement in number of seedling, height, major branches and chlorophyll content of Oregano irrigated with magnetized water comparing with controlled Oregano.

CONCLUSION

Magnetic water treatment could be a promising technique and resulted in significant improvement in all growth parameters of rosemary plant grown under salinity stress. So this mechanism can be used in the field rich with excess of salt to reduce the harmful effect in the growth and increase production (vegetative, chemical components and essential oil percentage) of most medicinal and aromatic plants.

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تأثير الرى بالماء الممغنط على النمو الخضري، والمكونات الكيماوية والزيت الطيار في نباتات الروزماري النامية في مستويات مختلفة من الملوحة

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الملخص العربى

تستخدم المياه الممغنطة على نطاق واسع في الري والزراعة كتكنولوجيا واعدة لتحسين كفاءة استخدام المياه وإنتاجية المحاصيل. أجريت تجارب أصص في المزرعة التجريبية بكلية الزراعة ، جامعة المنوفية بشبين الكوم ، مصر خلال موسمي صيف متتاليين ٢٠١٥ و ٢٠١٦ وكانت التجربة بهدف دراسة تأثير الري بالمياه الممغنطة وإجهاد الملوحة وتاثيرهما معا على قياسات النمو وبعض المكونات الكيميائية والزيوت العطرية (النسبة المئوية والمكونات) لنباتات حصالبان *Rosmarinus officinalis* L. صممت التجربة بنظام القطع المنشقة وتم تحليل النتائج أحصائيا وكانت المعاملات الرئيسية هي (الماء العادي و الماء الممغنط) والمعاملات تحت الرئيسية هي مستويات الملوحة (0.0، 0.1%، 0.2% و0.3%). وتوصلت الدراسة الي أن جميع قياسات النمو (ارتفاع النبات ، عدد الفروع ، الوزن الطازج والجاف للأعشاب / النبات) و محتوي العناصر المعدنية (N، P و K) ، محتوى صبغات التمثيل الضوئي ونسبة الزيت العطري في النبات قد انخفضت بشكل ملحوظ مع زيادة مستوى الملوحة. من ناحية أخرى ، أمكن التغلب باستخدام المياه الممغنطة (إلى حد ما) على التأثيرات الضارة التي سببتها الملوحة. عند مستوى الملوحة العالي (0.3%) ، ازدادت نسبة الزيت العطري في عشب نباتات حصالبان المروية بالماء الممغنط ١٣٩.٨٪ و١٤٧.٤٪ في الموسمين الأول والثاني على التوالي. كما أعطي المكون الرئيسي للزيت الأساسي (ليمونين) أعلى قيمة (٢٠.٤٧٪) عندما رويت النباتات بالمياه الممغنطة وكانت معرضة لمستوى ملوحة 0.2%.

التوصية : يمكن إستنتاج أن تقنية الماء الممغنط تعتبر تقنية واعدة و يمكن إستخدامها لتحسين النمو و المكونات الكيميائية وإنتاجية الزيت الطيار لنباتات حصالبان تحت ظروف ملوحة التربة. ولذا فإن إمكانات ري الأراضي التى بها نسبة ملوحة متوسطة بماء ممغنط يكون له أكبر الأثر المفيد في التوسع الزراعي وزياة انتاجية النباتات الطبية والعطرية.

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