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Impact of Magnetic Water on Soil Fertility and Faba bean Productivity under Reducing Phosphorus Fertilizer Rates in Salt Affected Soils

Hozayn, M.[1]; Eman M. Rashwan[2*] and Maha M. Othman[2]

[1] Field Crop Research Department, Agricultural and Biological Research Division, National Research Centre, 33 El-Behouth St., (Former El-Tahrir St.) 12622 Dokki, Giza, Egypt.
[2] Soil Fertility and Plant Nutrition Research Department, Soils, Water and Environment Research Institute, Agriculture Research Centre, El-Gama St., Giza, Egypt.

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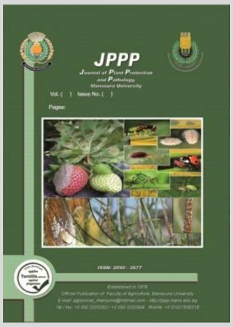

ABSTRACT

This study aims to optimize of P fertilizers unit and alleviation soil salinity stress using irrigation with magnetic water. Two field trials on faba bean (*Vicia faba* L.; Variety Giza 843), were conducted at Tag El-Ezz Agricultural Research Station, Agricultural Research Centre (ARC), Dakahlia Governorate, Egypt during two successive winter seasons of 2015/16 and 2016/17. The experiment treatments were included two factors 1) two irrigation water treatment (tab and magnetized water) and 2) three rates of P fertilizers (50, 75 and 100% from recommended P application). The two factors were layout in split plot design with three replicates, where the water and P fertilizers treatments were located randomly in the main and sub plots, respectively. The obtained results indicated that irrigation faba bean plants with magnetic water treatment surpassed significantly irrigation with tab water under all rates of P fertilizers in all recorded parameters. Regarding irrigation with magnetic water, the increasing reached 21.45, 24.24 and 40.17% in plant height (cm), plant weight (g) and seeds yield (g plant^{-1}) at harvest compared to irrigation with tab water of both seasons. As well as the improvements in concentration of N, P, K, Ca and Mg in seeds reached 19.01, 79.59, 49.43, 22.18, and 10.06 % respectively compared to irrigation with tab water. Finally, irrigation with magnetic water and P fertilizer at a rate of 100% from recommended application was considered as most suitable treatment for obtaining the highest yield of faba bean under these experimental conditions.

Keywords: Magnetic water, Faba bean, Soil fertility, Phosphours, salinity stress.

INTRODUCTION

Faba bean (*Vicia faba* L.) is one of the most important winter legume crops and a major source of protein for both human and animal nutrition. Mature seeds of faba bean are good sources of protein (about 25% in dried seeds), starch, cellulose, vitamin C, and minerals.

Phosphours is an essential element needed in all living organisms. When phosphorus fertilizers are applied, only a small proportion of it is immediately available to plants. The rest is stored in soils in varying degrees of availability. Some imbalances in phosphorus use from farmers due to applying phosphorus in excess to make it more available to plants, although this also increases the risk of most phosphorus being lost via run off, leaching, or soil erosion, finally ending up in lakes, rivers and oceans. This represents financial loss and environmental damage. So, optimizing the use of phosphorus in the ecological farming system will help in using nutrients efficiently and avoiding massive losses of phosphorus into the environment and achieving high yield. Tirado and Allsopp, (2012).

Magnetic water technology has widely studied and adopted in the field of agriculture in many countries, but in Egypt available review on the application of magnetized water in agriculture is very limited. Hozayen and Amira, (2010) reported that irrigation with a magnetized water induced positive significant effect on the presence of an increase in seeds of chickpea, straw and biological yield per plant compared with tap water. Magnetic water treatment could be used to enhance the growth, chemical constituents and productivity of chickpea under greenhouse conditions. Grewal and Maheshwari, (2011) illustrated that magnetic treatment of irrigation water led to a significant increase in shoot dry weight (25% for snow pea and 20% for chickpea) and contents of N, K, Ca, Mg, S, Na, Zn, Fe and Mn in both seedling varieties compared to control seedling. Likewise there were significant increases in shoot dry weight (11% for snow pea and 4% for chickpea). Moussa, (2011) stated that irrigation with magnetic water increased significantly the growth. Mohamed, and Ebead, (2013) showed that plant length, shoot and root fresh dry weights, shoot N, P and K contents and uptake of faba bean were significantly increased by using magnetized irrigated water. El-Sayed, (2014) found that magnetic water increasing plant growth (plant height, leaf area, leaves, stems, roots fresh and dry weights); and yield production. Also, increase the absorption and assimilation of nutrients (K, Na, Ca and P) in all parts of the broad faba bean plant. Abobatta,(2019) reported that magnetizing treated water can improve the growth and development of plants both quantitatively and qualitatively,

[*] Corresponding author.
E-mail address: d.emanrashwan@gmail.com
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also, it can improve seeds germination, increase seedlings surviving and raise mineral content of seeds or fruits, moreover use of magnetic water devices increase water use efficiency, reduced soil pH, also, it could use as an abiotic stress agent, or as a growth-inducing, furthermore, magnetizing treated water induced positive significant effect on mobility and uptake of micronutrient concentration.

The present study, investigated the magnetic water on soil fertility and also faba bean growth, yield components and chemical characteristics.

- Study the role of phosphorus fertilization rates on faba bean growth, yield, yield components and chemical characteristics to produce both high faba bean yield and its quality.
- Increasing efficiency in the use of phosphorus fertilizers and minimize mineral phosphorus use and optimize land use.

MATERIALS AND METHODS

The present work was postulated to study the effects of irrigation with magnetic water under reducing phosphorus fertilization rates on yield and yield components and chemical characteristics of faba bean plants and chemical characters of soil. Two field experiments were conducted at Tag El-Ezz Agricultural Research Station, Agricultural Research Centre (ARC), Dakahlia Governorate, Egypt, on clay loam soil during two consecutive winter growing seasons of 2015/16 and 2016/17 on faba bean plants (*Vicia Faba* L.; variety Giza 843). The physical and chemical characteristics of the studied soil before planting and irrigation water are shown in Table (1). The experiments were included two factors: 1) Irrigation water treatments (i.e. tab and magnetic water) and 2) P fertilizers rate (i.e. 50, 75 and 100% from recommended P application). The treatments were lay out in split-plot design with three replications where the irrigation and mineral phosphorus fertilizers treatments were assigned at random in the main and sub plots, respectively.

Cultivation method and layout of Experiment: Seeds of the faba bean crop were obtained from Legume Research Department, Field Crop Research Institute, Agriculture Research Centre, Giza, Egypt. Recommended rates of faba bean seeds (30-50 Kg Fed^{-1}) were sown on ridges with plant spacing of 25 cm in plots (3.5 m length m x 3 width m) at the first week of November in both seasons. Control treatment was irrigated with tab water, while magnetized water treatment was irrigated after magnetization irrigation water through passing a 1.5 inch Magnetic device [U.T.3, Magnetic Technologies LLC PO Box 27559, Dubai, UAE]. The normal cultural practices for faba bean production were followed according to the instruction laid down by the Ministry of Agriculture and Land Reclamation (MALR). The P fertilizer rate was (100, 75 and 50 kg Fed^{-1}) applied as (100, 75 and 50%) from recommended rate, all treatments added in the form of calcium super phosphate (6.76% P) before cultivation. K fertilizer was applied in a rate of 50 Kg Fed^{-1} potassium sulphate (40% K) at life irrigation. N fertilizer was applied as ammonium nitrates (33.5%N) in a rate of 44.77Kg Fed^{-1} for all treatments as active dose with planting. Flood water irrigation was applied as plants needed. The layout of the experiment was shown in Fig (1).

Table 1. Some physical and chemical properties of experimental soil:

Properties	2015/16	2016/17	Irrigation water
Soil physical properties			
pH (soil: water suspension 1:2.5)	8.65	8.60	7.41
EC (dSm^{-1}, soil: water extract 1:5)	2.97	2.28	5.24
Organic matter (%)	1.16	1.25	…
Particle size distribution			
Sand (%)	24	23.4	
Clay (%)	35	34.6	
Silt (%)	41	42	
Texture	Clay loam		
Soil chemical properties			
Available macro nutrients (mg kg^{-1})			
N	48.5	46.5	2.75 mg l^{-1}
P	8.50	8.00	0.095 mg l^{-1}
K	300	293	5.25 mg l^{-1}
Soluble Cations (meq l^{-1})			
Ca^{+2}	3.11	2.74	
Mg^{+2}	2.05	1.80	
Na^{+}	23.81	17.74	
K^{+}	0.73	.052	
Soluble anions (meq l^{-1})			
HCO^{-}_{3}	1.62	.096	
SO^{-2}_{4}	5.70	5.25	
Cl^{-}	22.38	16.59	

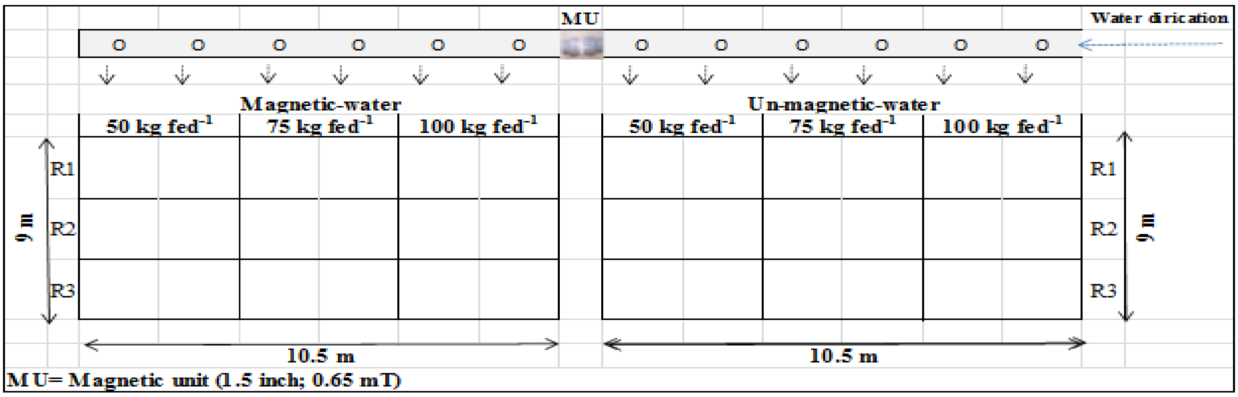

Fig. 1. Layout of the experiment

Data recorded:

Faba bean yield and its components: At harvest date, ten plants were taken randomly to determine: plant height (cm), plant weight (g plant^{-1}), seeds weight (g plant^{-1}). The whole plot was harvested and pods were threshed to determine seeds yield and calculated to (ton fed^{-1})

Chemical analysis in shoot and seeds plant at harvest: Concentration of some macronutrients i.e., N, P, K, Ca, Mg and Na in seeds were determined at harvest according to

Chapman and Pratt (1978) and Cottenie *et al*., (1982). Total N was determined based micro-Kjeldahl method. Potassium, calcium and sodium were determined using flame photometer (Genway). Estimation of Mg content was determined using the Atomic absorption spectrophotometer (Perkin Elemer 100-B). P was determined calorimetrically using spectrophotometer.

Soil chemical analysis: Soil texture, physical and chemical analyses were determined using the methods described by Piper, (1950), Hesse, (1971) and Hillel, (1972).

Plant analysis: The plant analysis was determined as described by Doubios *et al*, (1956) and Cottenie *et al*., (1982).

Statistical analysis: Appropriate analysis of variance was performed using Mstat-C software program (Mstat-C, 1983). The significant differences among the mean of various treatments were established by the Least Significant Differences method (LSD) according to Gomez and Gomez, (1984).

RESULTS AND DISSCUSSION

Faba bean yield and its components at harvesting stage:

The obtained results in Table 2 show that, faba bean plant height at harvesting stage were significantly increased under magnetic water and ranged from 22.59 % in 1st season and 20.31 % in 2nd season over control. Also, magnetic water at harvesting stage gave a significant increase for plant weight of faba bean plants while reached to 25.75 % in 1st season and 22.73 % in 2nd season, respectively over control. Seeds weight of faba bean also affected significantly by magnetic water 37.95 % in1st season and 42.38 % in 2nd season. This increment due to increase ions mobility or improve ions uptake under magnetic field treatment which leads to biochemical changes or altered enzyme activities which might be resulted in better development of photosynthesis stimulation, Dhawi, Faten and Khayri, (2009).This result was confirmed with those obtained by Moussa, (2011) and Mohamed, and Ebead, (2013) who illustrated that magnetic water increased plant height, shoot and root fresh dry weights of faba bean plants. Concerning phosphorus fertilizers, all the parameters increased with increasing phosphorus fertilizers rates. This increase might be attributed to the physiological effect of P nutrition on plant development and root growth. The interactions between water treatments and P fertilizer rates had a high significant effect on plant height, plant weights and seeds weight of faba bean plants in the two seasons. The magnetic water and P fertilizers rates 100 % gave the highest values of all parameters. Whereas, the lowest values was at tab water and P fertilizers rates 50 % in both seasons.

Table 2: Effect of irrigation water, phosphorus fertilizer rates and its interaction treatments on plant height (cm), plant, seeds weight (g plant^{-1}) and seeds yield (ton fed^{-1}) of faba bean plant on 2015/16 and 2016/17 winter seasons.

Treatment		Plant height (cm)		plant wt (g plant^{-1})		Seeds wt (g plant^{-1})		Seeds yield (ton fed^{-1})	
Water treat.	P Fert. rates (%)	1st	2nd	1st	2nd	1st	2nd	1st	2nd
Magnetic-water (MW)	50	69.00	67.33	45.33	44.33	19.00	18.00	0.64	0.63
	75	78.00	77.33	55.67	53.67	26.33	24.67	0.87	0.84
	100	111.67	112.00	66.67	64.00	31.00	29.00	1.06	0.90
Tab-water (TW)	50	59.00	59.33	38.33	39.00	15.33	13.67	0.59	0.53
	75	69.33	70.00	44.67	44.00	17.67	15.67	0.65	0.55
	100	82.67	84.00	50.33	49.00	22.33	21.00	0.82	0.74
F test		***	***	**	***	***	**	***	**
LSD 5%		2.75	4.08	2.99	2.17	1.47	1.66	0.01	0.01
P fertilizer rates	50	64.00	63.33	41.83	41.67	17.17	15.83	0.61	0.58
	75	73.67	73.67	50.17	48.83	22.00	20.17	0.76	0.69
	100	97.17	98.00	58.50	56.50	26.67	25.00	0.94	0.82
F test		***	***	***	***	***	***	***	***
LSD 5%		1.95	2.88	2.12	1.54	1.04	1.18	0.01	0.02
Water treatment	MW	86.22	85.56	55.89	54.00	25.44	23.89	0.86	0.79
	TW	70.33	71.11	44.44	44.00	18.44	16.78	0.69	0.60
F test		**	**	**	*	***	**	**	**
CV%		1.87	2.77	3.17	2.36	3.56	4.34	3.08	4.00

Nitrogen %, phosphorus % and potassium % concentration in faba bean seeds:

Concerning the effect of magnetic water, data at Table 3 show that, magnetic water increased nitrogen, phosphorus and potassium % in faba bean seeds. Nitrogen, phosphorus and potassium % increasing due to magnetic water ranged from (19.40 %, 107.79 % and 43.64 %) at 1st season to (18.62 %, 51.39 % and 55.21 %) at 2nd season over control.

This result was conformity to those reported by Grewal and Maheshwari, (2011), Mohamed, and Ebead, (2013), El-Sayed, (2014) and Abobatta, (2019). This increase due to the effect of magnetic field in increasing ions mobility in the root zone and ions absorption by the plants which were varied seriously from one element to another according to the element magnetic field. Atak, *et.al*, (2007). And also, magnetic field had a positive effect on decreasing the surface tension and increasing of viscosity, water was more stabilized with magnetic treatment with minimal molecular energy while greater in activation energy. Cai, *et.al*, (2009).

It was clearly in same Table that increasing P fertilizers rates led to increasing nitrogen, phosphorus and potassium in seeds content during both seasons. This increase might be attributed to the increase of available nitrogen, phosphorus and potassium in the root zone which led to increase in nitrogen phosphorus and potassium content and uptake by plants. N, P and K content were found to be no significantly affected by the interaction effect between water treatment and P fertilizer rates at 1st season and significantly with N and Pat 2nd season. Magnetic water and P fertilizers rates 100 % gave the highest values of N, P and K% in both seasons. The lowest values of N, P and K% with tab water and P fertilizers rates 50 %.

Table 3. Effect of irrigation water, phosphorus fertilizer rates and its interaction treatments on nitrogen, phosphorus and potassium concentration (%) in faba bean seeds on 2015/16 and 2016/17 winter seasons.

Treatment		N (%)		P (%)		K (%)	
Water treat.	**P Fert. rates (%)**	**1st**	**2nd**	**1st**	**2nd**	**1st**	**2nd**
Magnetic-water (MW)	50	3.93	3.47	0.12	0.06	2.32	2.30
	75	3.97	3.60	0.18	0.13	2.99	2.72
	100	4.00	4.40	0.23	0.17	3.20	3.23
Tab-water (TW)	50	3.27	3.00	0.06	0.06	1.56	1.27
	75	3.33	3.13	0.08	0.08	2.11	1.88
	100	3.37	3.53	0.12	0.10	2.25	2.16
F test		NS	*	NS	**	NS	NS
LSD 5%		0.21	0.23	0.05	0.02	0.43	0.32
P fertilizers	50	3.60	3.23	0.09	0.06	1.94	1.79
	75	3.67	3.37	0.13	0.11	2.55	2.30
	100	3.67	3.97	0.18	0.13	2.73	2.70
F test		NS	***	***	***	***	***
LSD 5%		0.15	0.16	0.03	0.02	0.31	0.23
Water treatment	MW	3.97	3.82	0.18	0.12	2.84	2.75
	TW	3.32	3.22	0.09	0.08	1.98	1.77
F test		*	**	*	NS	*	**
CV%		3.03	3.51	19.02	12.40	9.61	7.51

Calcium %, Magnesium % and Sodium % concentration in faba bean seeds:

Listed data presented in Table 4 show that, Calcium %, Magnesium % increased significantly by using magnetic water but decreased Sodium % concentration in faba bean seeds. Calcium % and magnesium increased ranged from (27.53 % and 12.90 %) in 1st season to (16.66 % and 6.89 %) in 2nd season. The reduction of Sodium % concentration in faba bean seeds ranged from 19.51 % in 1st season to7.69 % in 2nd season.

This result was agree with the result of El-Sayed, (2014). Tisdal *et al*., (1993) reported that water is a key factor in nutrient uptake by root interception, mass flow and diffusion. Roots intercept more nutrients especially Ca and Mg. The concentration of Calcium %, Magnesium % and Sodium % in faba bean seeds affected significantly by increasing p fertilizers rates. With regard to the effect of interactions between the two factors, it had a significant increase on calcium % but had no significant effect on Magnesium % in the two seasons. The highest value of Ca and Mg% was magnetic water and P fertilizers rates 100 % in both seasons and the lowest values was recorded at tab water and P fertilizers rates 50 %. Whereas the magnetic water and P fertilizer rates 50 % gave the lowest values of Sodium % at both season. The reduction was significant at 1st season and no significant at 2nd season.

Table 4. Effect of irrigation water, phosphorus fertilizer rates and its interaction treatments on calcium, magnesium and sodium concentration (%) in faba bean seeds on 2015/16 and 2016/17 winter seasons.

Treatment		Ca (%)		Mg (%)		Na (%)	
Water treat.	**P Fert. rates (%)**	**1st**	**2nd**	**1st**	**2nd**	**1st**	**2nd**
Magnetic-water (MW)	50	0.45	0.35	0.27	0.25	0.88	0.72
	75	0.86	0.80	0.37	0.32	0.89	0.83
	100	1.33	1.15	0.42	0.36	1.20	0.96
Tab-water (TW)	50	0.42	0.38	0.23	0.22	1.11	0.85
	75	0.75	0.72	0.32	0.31	1.25	0.91
	100	0.90	0.87	0.39	0.33	1.34	0.98
F test		*	**	NS	NS	**	NS
LSD 5%		0.19	0.11	0.04	0.06	0.40	0.41
P fertilizers	50	0.43	0.37	0.25	0.23	1.12	0.84
	75	0.80	0.76	0.35	0.32	1.16	0.85
	100	1.12	1.01	0.40	0.35	1.17	0.94
F test		***	***	***	***	NS	NS
LSD 5%		0.13	0.08	0.03	0.04	0.28	0.29
Water treatment	MW	0.88	0.77	0.35	0.31	0.99	0.84
	TW	0.69	0.66	0.31	0.29	1.23	0.91
F test		*	NS	*	*	NS	NS
CV%		13.02	8.24	6.79	11.25	9.58	12.49

Nitrogen, phosphorus and potassium ppm concentration in soil:

It is evident from Table 5 that, Nitrogen, phosphorus and potassium ppm reduced by magnetic water compare to tab water it ranged from 12.63, 15.6 and 39.5 % in 1st season to 9.72, 17.39 and 39.66 % in 2nd season. Soil available nitrogen, phosphorus and potassium increased by increasing p fertilizers rates in both seasons. The interactions between water treatments and P fertilizer rates had no effect on N content in soil, the highest value was at tab water and P fertilizer rates 100 % in both seasons. And a significant effect on K content in soil the highest value was recorded with tab water and P fertilizers rates 100 % in both seasons. Whereas, P content had a significant effect at 1st season and no effect at 2nd season the highest value was at tab water and P fertilizers rates 100 % in both seasons. This reduction was due to magnetic water enhanced faba bean plant growth, consequently increased the absorption of nutrients which reduce the residual of these nutrients in soil. These results were in harmony with Verma, (2011) who stated that magnetic water treatment does not change the chemical properties of the water; it adjusts the structure of liquid water, then more absorption by plants so the residual in soil was low. Magnetically water treatment reduces the bond angle of the hydrogen-oxygen within the water molecule, so, these formatting smaller clusters of water molecule than in ordinary water and then it is leads to enhanced absorption of water into the cell.

Table 5. Effect of irrigation water, phosphorus fertilizer rates and its interaction treatments on nitrogen, phosphorus and potassium concentration (ppm) in soil on 2015/16 and 2016/17 winter seasons.

Treatment		N (ppm)		P (ppm)		K (ppm)	
Water treat.	**P Fert. rates (%)**	**1st**	**2nd**	**1st**	**2nd**	**1st**	**2nd**
Magnetic-water (MW)	50	49.17	45.00	8.17	7.83	171.67	161.67
	75	49.60	45.50	8.33	8.00	190.00	180.00
	100	52.67	47.33	8.83	8.67	225.00	240.00
Tab-water (TW)	50	56.67	49.33	9.17	9.17	163.33	161.67
	75	57.33	50.67	10.33	9.83	240.00	250.00
	100	59.33	52.67	10.50	10.67	366.67	358.33
F test		NS	NS	*	NS	***	***
LSD 5%		1.97	2.84	0.52	0.44	70.54	53.78
P fertilizers	50	52.92	47.42	8.67	8.50	167.50	161.67
	75	53.47	47.83	9.33	8.92	215.00	215.00
	100	56.00	50.00	9.67	9.67	395.83	390.17
F test		**	*	***	***	***	***
LSD 5%		1.40	2.01	0.37	0.31	49.88	38.03
Water treatment	MW	50.48	45.94	10.00	9.89	195.56	193.89
	TW	57.78	50.89	8.44	8.17	323.33	323.33
F test		**	**	*	*	*	*
CV%		1.94	2.94	3.00	2.61	14.43	11.04

Sodium, calcium and magnesium ppm concentration in soil:

Data in Table 6 illustrated that, residual sodium ppm in soil decreased by tab water. On the other hand, calcium and magnesium ppm concentration in soil increased in the two season this increasing ranged from (9.64 % and 25.75 %) in 1st season to (12.98 % and 25.08 %) in 2nd season. In the same table, it can be observed that soil available sodium, calcium and magnesium ppm was increased by increasing p fertilizer rates. The interaction between the two factors had no effect on Ca content whereas had high significant effect on Na and Mg content in soil at both seasons. The highest value of Ca and Mg was recorded with tab water and P fertilizers rates 100 % in both seasons. The lowest value of Ca and Mg ppm was recorded with magnetic water and P fertilizers rates 50 % whereas the lowest value of Na ppm was recorded with tab water and P fertilizers rates 100 %. Magnetize treated water increased dissolving and deeper penetration of fertilizers in soil irrigated compare with untreated water. So, increasing nutrients uptake by plants and reduce the residual in the soil. Na reduced by magnetic water might be due to distribute the salts in the soli depth by leaching these results was confirmed with those of Ben, (2007) who indicated that the benefits of magnetic irrigation water include reduced salts amount in various soil depths owing to leaching away of salts during watering soil with magnetic water and washing of different anions from the soil. Magnetic irrigation water considered as most effective methods in arid regions where water alkalinity is high and there was a tendency for soda salinization of soil. Rokhinson, *et.al.* (1994).

Table 6. Effect of irrigation water, phosphorus fertilizer rates and its interaction treatments on calcium, magnesium and sodium concentration (ppm) in soil on 2015/16 and 2016/17 winter seasons.

Treatment		Na (ppm)		Ca (ppm)		Mg (ppm)	
Water treat.	**P Fert. rates (%)**	**1st**	**2nd**	**1st**	**2nd**	**1st**	**2nd**
Magnetic-water (MW)	50	370.00	360.00	313.33	283.33	130.00	125.00
	75	290.00	290.00	466.67	366.67	131.67	128.33
	100	163.33	150.00	500.00	466.67	146.67	140.00
Tab-water (TW)	50	228.33	240.00	416.67	366.67	133.33	133.33
	75	191.67	180.00	466.67	433.33	183.33	158.33
	100	175.00	166.67	533.33	483.33	233.33	233.33
F test		***	***	NS	NS	***	***
LSD 5%		19.51	30.59	60.69	56.57	20.64	20.64
P fertilizers	50	169.17	158.33	365.00	325.00	132.50	129.17
	75	240.83	235.00	406.67	400.00	156.67	143.33
	100	299.17	300.00	426.67	415.00	190.00	186.67
F test		***	***	***	***	***	***
LSD 5%		13.80	21.63	42.91	40.00	14.59	14.59
Water treatment	MW	274.44	266.67	426.67	372.22	136.11	131.11
	TW	198.33	195.56	472.22	427.78	183.33	175.00
F test		***	**	*	NS	*	*
CV%		4.38	7.02	7.17	7.51	6.86	7.16

CONCLUSION

Magnetic water had an important role in reduce the negative effect of salt stress on faba bean plants. The enhancement effect of magnetic water was previously mentioned. Finally, it could be concluded that, for obtaining a high, good quality and economically faba bean yield, we recommended that faba bean plants should be fertilized with phosphorus fertilizer at the rate of (100Kg fed^{-1}) calcium super phosphate as 100% from recommended rate and magnetic water irrigation under the same conditions of this study.

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تأثير الماء الممغنط على خصوبة التربة وإنتاجية الفول تحت معدلات متناقصة من التسميد الفوسفاتى فى الأراضى المتأثرة بالأملاح

محمود حزين[١]، إيمان محمود رشوان[٢] و مها محمود عثمان [٢]

[١]قسم بحوث المحاصيل الحقلية – شعبة البحوث الزراعية والبيولوجية – المركز القومي للبحوث – الجيزة – مصر.

[٢]قسم بحوث خصوبة الأراضى وتغذية النبات – معهد بحوث الأراضي والمياه والبيئة – مركز البحوث الزراعية – الجيزة – مصر .

تهدف هذه الدراسة إلى الإستفادة المثلى من الأسمدة الفوسفاتية والتخفيف من الإجهاد الملحى للتربة باستخدام الرى بالماء الممغنط. أجريت تجربتان حقليتان على الفول البلدى (صنف جيزة ٨٤٣) في محطة البحوث الزراعية بتاج العز، مركز البحوث الزراعية ، محافظة الدقهلية ، مصر خلال موسمين شتويين متتاليين٢٠١٥ /٢٠١٦ و ٢٠١٦ /٢٠١٧. اشتملت معاملات التجربة على عاملين ١) معاملتين لماء الرى (ماءعادى وماء ممغنط) و٢) ثلاث معدلات من الأسمدة الفوسفاتية (٥٠ و ٧٥ و ١٠٠٪ من التركيز الموصى به للفوسفور). تم وضع هذين العاملين في تصميم القطع المنشقة بثلاث مكررات ، حيث تم وضع معاملات الماء والأسمدة الفوسفاتية بشكل عشوائي في المعاملات الرئيسية والفرعية على التوالي. أوضحت النتائج المتحصل عليها أن رى نباتات الفول تحت معاملة الري بالماء الممغنط تفوقت معنوياً على الري بالماء العادى تحت جميع معدلات الأسمدة الفوسفاتية في جميع الصفات المدروسة. أما بالنسبة للري بالماء الممغنط فقد بلغت الزيادة ٢١.٤٥ و ٢٤.٢٤ و ٤٠,١٧٪ في طول النبات (سم) ووزن النبات الطازج (جرام) ووزن البذور (جرام لكل نبات) عند الحصاد مقارنة بالري بالماء العادى في كلا الموسمين. وكذلك الزيادة في تركيز النيتروجين ، الفوسفور ، البوتاسيوم ، الكالسيوم والماغنسيوم في البذور حيث بلغ ١٩,٠١ و ٧٩.٥٩و ٤٩.٤٣ و٢٢,١٨ و١٠,٠٦٪ على التوالي مقارنة بالري بالماء العادى. أخيرًا ، يعتبر الري بالماء الممغنط والسماد الفوسفاتى بمعدل ١٠٠٪ من المعدل الموصى به أنسب معاملة للحصول على أعلى محصول من الفول تحت ظروف هذه التجربة.