ALLEVIATION OF SALINITY EFFECT IN IRRIGATION WATER AND SOIL ON MANFALOUTY POMEGRANATE TREES USING MAGNETIC WATER, BIO-FERTILIZER AND SOME SOIL AMENDMENTS

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Abstract

An experiment was carried out in a private orchard located at Wadi El-Natroon district, El-Beheira Governorate, Egypt, during two successive seasons of 2014 and 2015. The aim was to test the influence of magnetizing irrigation water, bio-fertilizer inoculation [Effective Microorganisms (EM) – Plant Growth Promoting Rhizobacteria (PGPR) – Phosphorine (*Bacillus megaterium*)] and some soil amendments (agriculture sulphur – gypsum-magnetic iron oxide) on yield and fruit nutrients content of Manfalouty pomegranate. Generally, the analysis of variance proved that, average of fruit weight (gm) and total yield (Kg/tree) were positively affected by magnetic water treatments than all other non-magnetic ones and the control. It can be seen that, in the 1st season magnetic water + PGPR gave the highest average of fruit weight (341.68 gm.) whereas, in the 2nd season the same previously mentioned treatment and magnetic water + gypsum recorded the highest values (325.00 and 326.00 gm). Magnetic water produced the maximum fruit yield (10.60 and 20.78 kg/tree) when supplemented with PGPR. All magnetic water treatments (especially when inoculated with PGPR or EM) caused more effective increasing of fruit yield compared with non-magnetic treatments and the control. As for fruit nutrients content (N, P, K, Mg, Ca, Fe, Cu, Zn and Mn), all magnetic treatments surpassed the other non-magnetic treatments\ and the control. However, fruit sodium content took the other way around whereas; the control and non-magnetic treatments led to marked increases in both parameters.

INTRODUCTION

The pomegranate (*punica granatum L.)* is a popular fruit of tropical and sub tropical regions. It belongs to the family (*Punicaceae*) and it is one of the oldest cultivated fruit plants (Khattab *et al.,* 2011). Egypt is among the countries of the temperate region of the northern hemisphere and relatively close to equator which has arid or semi-arid conditions that suitable for pomegranate production. The total cultivated area of pomegranate in Egypt reached 58319 fed. and total production is 219663 tons (According to the statistics of the Ministry of Agriculture, 2015). Manfalouty pomegranate is considered one of the most important commercial cultivar grown successfully in Egypt. It grows in most soils, with the exception of saline or very calcareous, alkaline soils. Light to sandy soils are also used in pomegranate cultivation as long as orchards are well-irrigated (Kitren and Louise, 2011). While pomegranates tolerate mildly alkaline soils (up to pH 7.5), they prefer slightly acid soil (pH 5.5-6.5). Pomegranates have a higher salt tolerance than some other fruit crops. The water quality should be less than 1000 ppm total soluble salts for best crop quantity and quality, but plants can tolerate more than 2000 ppm total soluble salts (Burt, 2007).

The pomegranate is classified as moderately sensitive to salinity. The effect of magnetic field on water bears a complex and multifactorial character that in the final result affects the structure of water and hydrated ions as well as the physico-chemical properties and behavior of dissolved inorganic salts (Ochkov, 2006). It has been claimed that preliminary water treatment with magnetic or electromagnetic (EM) fields can help descale metal surfaces, improve cement hydration, change potential of colloids, make plants irrigated with such water grow faster and enhance efflux of calcium. Salinity also has a negative impact on the sustainability of beneficial microorganisms associated with the plant rhizosphere. The beneficial attributes of these organisms such as antagonism against bacterial and fungal pathogens of agricultural crops, nutrient recycling in the rhizosphere microcosm and root colonization are some of the challenges under stress (Paul, 2008). PGPR strains use several mechanisms such as synthesis of plant growth hormones i.e. indole-3-acetic acid (IAA), gibberellic acid, cytokines, ACC deaminase, suppression of deleterious organisms, activation of phosphate solubilization to enhance the growth and alleviate salt stress in plants (Miransari, 2011).

Magnetite may be playing an important role in cation uptake capacity and has a positive effect on immobile plant nutrient uptake (Esitken and Turan, 2003) and magnetic field could be substitution of chemical additives, which can reduce toxins in raw materials and these raise the food safety. Amendments, including those that improve soil physical properties, may work by chemical, biological, and physical modes of action. Lime and elemental sulfur used to modify soil pH are considered to be amendments but do not affect soil physical properties. For example, gypsum acts chemically by supplying calcium (a "good salt"), which helps counteract the harm that excessive sodium (a "bad salt") can cause to soil physical structure (Cooperative and

Yolo, 2010). The form of soil sulphur available for uptake by plants is adsorbed and soluble sulphate which comprised about 10 % or less of total soil sulphur. Sulphur is naturally present as elemental sulphur and needs to be oxidised before it is available to plants (Williams, 1975). Therefore, the aim of the present study was to test the influence of magnetic water, some bio–fertilizers and natural minerals to alleviate salinity stress on yield and fruit nutrients contents of Manfalouty pomegranate cultivar grown in newly reclaimed soil.

MATERIALS AND METHODS

The present investigation was conducted during 2014 and 2015 successive seasons in a private orchard, located in Wadi El-Natroon district, El-Beheira Governorate, Egypt. The pomegranate trees were of the same age (4 years), with approximately the same vigor as possible and planted at 3×3 meters apart under drip irrigation system (2400m^3/fed.), 2 drippers/tree and discharge 4 liters /hour. The experimental soil and water analysis are presented in Tables (1-4).

Table 1. Chemical analysis of the experimental soil before and after experiment

	2014			**2015**		
	December (N.M.)	**April (M.)**	**August (M.)**	**April (N.M.)**	**April (M.)**	**August (M.)**
pH	7.76	7.54	7.43	7.92	7.41	7.28
EC (ds/m)	9.04	8.20	7.75	9.81	7.68	6.99
Ca^{+2} (meq/l)	16.60	14.20	15.00	15.80	14.08	14.00
K^+ (meq/l)	1.64	1.30	1.02	1.54	1.22	1.23
Na^+ (meq/l)	51.60	47.50	46.50	60.50	46.49	42.56
Mg^{+2}(meq/l)	10.60	9.64	13.00	11.28	12.28	13.00
CO_3 (meq/l)	-	-	-	-	-	-
HCO_3^- (meq/l)	2.40	2.20	1.30	2.50	2.25	1.96
CL^- (meq/l)	78.00	62.40	68.00	79.10	66.00	53.60
SO_4^{-2} (meq/l)	10.00	8.04	6.20	7.52	5.82	5.79
$CaCO_3^-$ (%)	9.38	9.18	8.45	10.56	9.00	9.44

N.M.: Non-magnetic water irrigation M.: magnetic water irrigation

Table 2. Available and total phosphorous in the experimental soil

Soil depth	**Total Phosphorous (mg/kg)**	**Available Phosphorous (mg/kg)**
(0-60) cm	50	5

Table 3. Physical analysis of the experimental soil

Soil depth	Texture	Sand (%)	Clay (%)	Silt (%)
(0-30) cm	Sandy	90.32	7.68	2.00
(30-60) cm	Sandy	87.45	10.11	2.44
(60-90) cm	Sandy	85.00	12.34	2.66

Table 4. Chemical analysis of the orchard irrigation water

Date	Type	First Season									
		pH	EC (ds/m)	Ca (meq/l)	K (meq/l)	Na (meq/l)	Mg (meq/l)	CO3 (meq/l)	HCO3 (meq/l)	Cl (meq/l)	SO4 (meq/l)
December	Non-magnetic	6.81	5.76	8	0.44	42.2	7	-	3.8	51	2.8
April	Magnetic	6.22	5.32	-	-	-	-	-	-	-	-
August	Magnetic	6.8	5.22	-	-	-	-	-	-	-	-
Second Season											
April	Non-magnetic	6.96	6	-	-	-	-	-	-	-	-
	Magnetic	6.12	5.41	-	-	-	-	-	-	-	-
August	Magnetic	6.13	5.23	-	-	-	-	-	-	-	-

All trees were annually fertilized with the recommended regular organic fertilization (farm compost) at a rate of 15 m^3/fed, plus 200kg/fed. calcium super phosphate (15.5% P_2O_5) in December in two ditches (15 cm soil depth 1m. from the tree trunk) at two different directions and changed into the other two directions in the next year. Besides, 250kg/fed. ammonium sulphate (20.6% N) and potassium sulphate (48% K_2O) as 170 kg/fed. were added in three equal doses on December May and August by mixing with the soil surface (15cm.depth) under the drip emitters.

The experiment was set in a complete randomized block design with thirteen treatments; each treatment was represented by three replicates. The treatments were as follow:

1- **Non-magnetic irrigation water (control).**
2- **Non-magnetic irrigation water + Effective Microorganisms (EM).** (March-May and August).
3- **Non-magnetic irrigation water + Plant Growth Promoting Rhizobacteria (PGPR).** (December- March- May and August).
4- **Non-magnetic irrigation water + Phosphorine (Phosphate solubilizing bacteria).** (mid-February).
5- **Non-magnetic irrigation water + agriculture sulphur.** (December).

6- **Non-magnetic irrigation water + gypsum.** (December).

7- **Non- magnetic irrigation water + magnetic iron oxide.** (December)**.**

8- **Magnetic irrigation water + Effective Microorganisms (EM).** (March- May and August).

9- **Magnetic irrigation water + Plant Growth Promoting Rhizobacteria (PGPR).** (December- March- May and August).

10- **Magnetic irrigation water + Phosphorine (Phosphate solubilizing bacteria). (mid-February).**

11- **Magnetic irrigation water + agriculture sulphur. (December).**

12- **Magnetic irrigation water + gypsum. (December).**

13- **Magnetic irrigation water + magnetic iron oxide. (December).**

Magnetic iron oxide, agriculture sulphur and gypsum were applied to the soil in December at the time of winter fertilization. The Effective micro-organisms (EM) was used which consists of a mixed culture of beneficial micro-organisms primarily photosynthetic and lactic acid bacteria, yeast and Streptomyces. EM was applied as three soil applications on March, May and August as 60 cm/ tree after diluting with water as 1:2.

Table 5. Components of EM

Total bacteria	**Lactic acid bacteria**	**Yeasts**	**Streptomycetes**
2.5 - 9.6 x 10^4 cfu/ml	6.6-9.9 x $1C^4$ cfu/ml	10^5 – 10^6/ml	8.5 – 10^3 cfu /ml

Plant Growth Promoting Rhizobacteria (PGPR) consists of (*Bacillus polymyxa, Serratia marcescens and Pseudomonas fluorescens*) bacteria. It was applied as four soil applications (December, March, May and August) as 120 cm / tree after diluting with water as 1: 5. Phosphorine was mixed with sand and applied at mid-February then covered with the soil. All the experimental trees were irrigated immediately after the transactions addition.

The following parameters were measured to evaluate the tested treatments:

1. Yield (Kg/tree): pomegranate fruits were harvested on mid-September. Total fruit number/tree and average of fruit weight (gm.) were recorded. Average total yield/tree was calculated as kg/tree as follow:

Total yield (Kg / tree) = No. of fruits × average of fruit weight (gm)

2. Fruit weight (gm): it was determined by weighting sample of fruits (5 fruits/tree) and average of fruit weight was calculated.

3. Fruit aril nutrients composition:

Twenty fruits/replicated tree were taken during August. Then, fruit samples were washed, air dried at 70ºC till constant weight and grounded. The dried fruits samples were digested by sulphoric acid and hydrogen peroxide according to **Evenhuis and Dewaard (1980)**. In this digested solution nitrogen, phosphorus, potassium, calcium, magnesium, sodium, iron, manganese, copper and zinc were determined.

- Nitrogen and phosphorous: were determined cholorimetrically according to **Evenhuis (1976**).

- Calcium and magnesium: were determined by Versenate (EDTA) method according to **Cheng and Bray (1951)**.

- **Potassium and sodium:** were measured against a standard using flame photometer.

- **Iron, manganese, copper and zinc**: were Spectrophoto-meterically determined using Atomic Absorption (Model, Spectronic 21D) as described by **Jackson (1973).**

Statistical analysis:

The Complete Randomized Block Design was followed in this study. The obtained data in both seasons was subjected to Analysis of Variance according to **(Snedecor and Cochran, 1980)**. Differences between treatments were compared using LSD at level 5 %.

RESULTS AND DISCUSSION

Fruit yield (kg/tree)

Results in Table (6) showed that, magnetic water gave the maximum value of fruit yield (10.60 and 20.78 kg/tree) when supplemented with PGPR in both seasons, respectively. On the other hand, the minimum fruit yield (2.69 and 4.64 kg/tree) in both seasons, respectively were recorded with control. Moreover, all magnetic treatments were more effective in increasing fruit yield than non-magnetic ones. Passing the water through a magnetic field increases the number of water molecules in the volume unit and increases the ability of water molecules to absorb nutrients. Magnetic water treatment has found to have a pronounced effect on plants productivity (Basant and Harsharn, 2009). Our results are in harmony with Aly *et al.* (2015) on Valencia orange, reported that, magnetic water treatments in both seasons increased fruit yield compared to non-magnetic irrigation water in both seasons. Abou-Taleb *et al.* (2011) proved that, all tested treatments of EM on Manfalouty pomegranate had stimulant effect on total yield as compared with the control.

Fruit weight (gm)

It is apparent from Table (6) that, in the 1st season magnetic + PGPR gave the highest average of fruit weight (341.68 gm) compared with the other all treatments. Whereas, in the 2nd season the same previously mentioned treatment and magnetic water + gypsum gave the highest average of fruit weight (325.00 and 326.00 gm) compared with all other treatment and controls. On the other hand, the lowest averages of fruit weight were coupled with the control (271.11 and 224.00 gm) in both seasons, respectively. . El-Khawaga *et al.* (2013) on pomegranate reported that, the bigger fruit weights were found in Wonderful cultivar (197.63 and 205.22 gm) under the lowest salinity. According to Aly *et al.* (2015) on Valencia orange, magnetic water treatments in both seasons increased fruit weight compared to non-magnetic irrigation water in both seasons.

Table 6. Effect of magnetic water, non-magnetic water, bio-fertilizer and some soil amendments on fruit weight (gm) and fruit yield (Kg/tree) of Manfalouty pomegranate trees in 2014 and 2015 seasons.

Treatments	Fruit Weight (gm.)		Fruit Yield (Kg/tree)	
	2014	2015	2014	2015
Control	271.11	224.00	2.69	4.64
N. M. + EM	284..25	291.00	3.60	7.30
N. M. + PGPR	285.14	306.00	4.47	9.83
N. M. + phosphorine	278.13	314.00	4.17	9.64
N. M. + agric. Sulphur	274.03	292.00	3.74	9.45
N. M. +gypsum	272.89	320.00	3.00	10.07
N.M. + M. iron oxide	279.01	295.00	3.79	11.65
M. +EM	309.59	300.00	10.84	18.53
M. + PGPR	341.68	325.00	10.60	20.78
M. + phosphorine	303.74	321.00	8.80	16.93
M. + agric. Sulphur	320.13	314.67	10.35	17.06
M. + gypsum	311.97	326.00	8.50	16.46
M. + M. iron oxide	307.01	305.67	9.01	15.67
$LSD_{0.05}$	10.06	27.76	1.26	3.04

*N.M: Non-Magnetic Water * M.: Magnetic Water * PGPR: Plant Growth Promoting Rhizobacteria
* EM: Effective Microorganisms * M. iron oxide: Magnetic iron oxide * agric. Sulphur: agriculture sulphur.

Fruit nutrients composition

Data presented in Table (7) revealed that, all magnetic treatments caused more effective increasing in fruit nitrogen content than other all non-magnetic treatments and the control. In this concern, the differences between the control and non-magnetic treatments were not too big enough to reach the significant (irrespective non-magnetic + EM and non-magnetic + PGPR in 1st season and non-magnetic + PGPR and non-magnetic + M. iron oxide in 2nd season). In addition, all treatments caused a non-significant increase in fruit rind phosphorous content in the first season compared with the control (except for, non-magnetic + PGPR, magnetic + EM and magnetic + PGPR). Moreover, in the second season, all treatments caused a significant increase in this character compared with the control treatment (except for, non-magnetic + agric. sulphur, non-magnetic + gypsum, non-magnetic + m. iron oxide, magnetic + phosphorine and magnetic + m. iron oxide) where, the differences were not big enough to be significant. The highest significant fruit rind phosphorous percentage took place with magnetic water+ EM and magnetic water + PGPR, while the control was the lowest in both seasons. The highest values of fruit rind potassium content were recorded by non-magnetic + EM (0.94 %) and decreased to (0.61 %) by control in the 1st season compared with other all treatment. In addition, in the 2nd season, the highest values were associated with magnetic + PGPR (0.79 %) and the lowest values of this character were recorded by control treatment (0.69 %). Also, all treatments caused a significant increase in fruit rind magnesium content compared with the control (except for, non-magnetic + EM, non-magnetic + agric. sulphur, non-magnetic + gypsum, non-magnetic + m. iron oxide and magnetic + m. iron oxide) where, the differences were not big enough to be significant in the first season. Moreover, in the second season, all treatments caused a significant increase in fruit rind magnesium compared with the control. In addition, all magnetic treatments gave more effective increasing than other all non-magnetic treatments. Magnetic fields are known to induce biochemical changes and could be used as a stimulator for growth related reactions. According to Ahmed (2011) reported that, the magnetic water has significant effect on concentration and uptake of nutrients by plant parts, higher and significant N concentration. Al-Khazan *et al.* (2011) noticed that, the essential elements except sodium were increased significantly ($P \leq 0.01$) in plants irrigated with magnetic treatment water compared to their control. Ali *et al.* (2013) found that, magnetic iron treatments increased nitrogen in leaves of grapevines compared with control. Han and Lee (2005) proved that, inoculation with two PGPR strains, *Serratia sp*. and *Rhizobium sp*. into saline soils alleviated the salinity effects on the mineral content.

Concerning results in Table (8) explained that, all treatments caused a significant increase in fruit rind magnesium content compared with the control (except for, non-magnetic + EM, non-magnetic + agric. sulphur, non-magnetic + gypsum, non-magnetic + m. iron oxide and magnetic + m. iron oxide) where, the differences were not big enough to be significant in the first season. Moreover, in the second season, all treatments caused a significant increase in fruit rind magnesium compared with the control. In addition, all magnetic treatments gave more effective increasing than other all non-magnetic treatments. When, fruit rind calcium content was significantly positively affected by different treatments in both seasons compared with the control. Moreover, magnetic + PGPR recorded the highest values of this character (1.79 %) in both seasons. Conversely, the lowest values of fruit rind calcium content were recorded by control treatment (1.49 and 1.47 %) in both seasons, respectively. Moreover, all magnetic treatments caused more effective increasing in fruit rind calcium content than all other non-magnetic treatments (irrespective non-magnetic + PGPR).

Table 7. Effect of magnetic water, non-magnetic water, bio-fertilizer and some soil amendments on fruit rind nitrogen, phosphorous and potassium elements percent (dry weight basis) of Manfalouty pomegranate trees in 2014 and 2015 seasons.

Treatments	**N (%)**		**P (%)**		**K (%)**	
	2014	**2015**	**2014**	**2015**	**2014**	**2015**
Control	0.13	0.13	0.02	0.03	0.61	0.69
N. M. + EM	0.18	0.17	0.06	0.06	0.94	0.74
N. M. + PGPR	0.22	0.18	0.08	0.07	0.89	0.77
N. M. + Phosphorine	0.16	0.16	0.04	0.06	0.63	0.75
N. M. + agric. Sulphur	0.16	0.15	0.05	0.05	0.64	0.73
N. M. + gypsum	0.17	0.17	0.04	0.05	0.69	0.73
N.M. + M. iron oxide	0.16	0.19	0.06	0.05	0.73	0.72
M. +EM	0.29	0.31	0.09	0.09	0.86	0.75
M. + PGPR	0.24	0.29	0.11	0.07	0.82	0.79
M. + phosphorine	0.24	0.26	0.06	0.05	0.80	0.75
M. + agric. Sulphur	0.21	0.26	0.05	0.06	0.84	0.77
M. + gypsum	0.23	0.24	0.06	0.06	0.82	0.73
M. + M. iron oxide	0.23	0.24	0.05	0.04	0.77	0.73
$LSD_{0.05}$	0.04	0.04	0.04	0.02	0.11	0.05

*N.M: Non-Magnetic Water * M.: Magnetic Water * PGPR: Plant Growth Promoting Rhizobacteria
* EM: Effective Microorganisms * M. iron oxide: Magnetic iron oxide * agric. Sulphur: agriculture sulphur.

On the other hand, it is worthy to mention that, all treatments caused a significant decrease in fruit rind sodium content **(%)** compared with the control in both seasons. The untreated trees had the richest fruits in sodium content as they recorded (0.08 & 0.08 %). The opposite was resulted from trees which irrigated with magnetic water and supplemented with PGPR (0.03 & 0.03 %) in both studied seasons.

Osman *et al.* (2014) reported that, Mg of pear seedlings increased for those grown under magnetic water. Tai *et al.* (2008) tested the effects of magnetic field on the crystallization of CaCO3 using permanent magnets. They observed that, on subjecting water to magnetic field, it leads to modification of its properties, as it becomes more energetic and more able to flow which can be considered as a birth of new science called Magneto biology. Sodium chloride is the most soluble and abundant salt released; apart from natural salinity, a significant proportion of recently cultivated agricultural land has become saline owing to human activities such as unsuitable agricultural functions. Repeated use of external inputs destroys the soil biota and reduces the nutritive value of soil, resulting in salinization which causes various stresses in agricultural plants. Soil salinity prevents plant growth and development with adverse effects such as osmotic stress, Na+ and Cl– toxicity (Abolfazl *et al.*, 2009). Various PGPRs including *Rhizobium, Pseudomonas, Acetobacter, Bacillus,* and *Flavobacterium* and *several Azospirillum* can maintain their PGP ability even at high saline conditions. Han and Lee (2005) reported that, inoculation with two PGPR strains, *Serratia sp*. and *Rhizobium sp*. into saline soils alleviated the salinity effects on the mineral content of lettuce.

Data presented in Table (9) cleared that magnetic water treatments tended to promote fruit rind iron content than non-magnetic water treatments as an averages (67.61 and 70.60 mg/kg) with magnetic + PGPR in two seasons, respectively when, control treatments recorded the lowest fruit rind iron content (38.73 and 44.52 mg/kg) in both seasons, respectively. The elements uptake i.e. Fe was significantly increased by magnetic irrigation water as compared with plants irrigated with non-magnetic water. It can be observed that, irrigation with magnetic water can be considered as one of the valuable modern technologies that can assist in saving irrigation water, enhance nutrient uptake of pepper under greenhouse conditions. It was noticed that, irrigation with magnetically treated water lead to an increase in all elements content. This is because the elements are diamagnetic which are repelled by a magnetic field (Nave, 2008) and Abou-Amer (2014) found that, using magnetized irrigation water as a technology, which may be one of the factors contributing to the increase in the nutrients availability for Florida peach trees grown in newly reclaimed soils conditions.

The lowest values of fruit rind cupper content took place in the control (1.25 and 1.26 mg/kg) however, it increased to reach (2.55 and 2.14 mg/kg) when the trees were irrigated with magnetic water and received PGPR followed by (2.45 and 1.96 mg/kg) with magnetic + PGPR in two seasons, respectively and magnetic + PGPR gave the highest fruit rind zinc content (4.07 and 4.97 mg/kg) compared to control which produced the lowest fruit rind zinc content (1.68 and 1.94 mg/kg).

This was true in both seasons of the present study. Generally, all magnetic treatments caused a pronouncing increase in fruit rind zinc content than all other non-magnetic treatments. In addition, all tested treatments caused a significant increase in fruit manganese content compared with the control. Besides, all magnetic treatments were more pronounced in increasing fruit manganese content than all other non-magnetic ones. In this concern, fruits of the untreated trees scored the least records (2.24 and 2.79 mg/kg) to increase to the level (5.26 and 5.33 mg/kg) in the treated trees with magnetic water + PGPR.

Table 8. Effect of magnetic water, non-magnetic water, bio-fertilizer and some soil amendments on fruit rind magnesium, calcium and sodium elements percent (dry weight basis) of Manfalouty pomegranate trees in 2014 and 2015 seasons.

Treatments	**Mg (%)**		**Ca (%)**		**Na (%)**	
	2014	**2015**	**2014**	**2015**	**2014**	**2015**
Control	0.69	0.66	1.49	1.47	0.08	0.08
N. M. + EM	0.70	0.71	1.60	1.57	0.05	0.06
N. M. +PGPR	0.78	0.75	1.71	1.78	0.04	0.04
N. M. + Phosphorine	0.76	0.74	1.64	1.62	0.06	0.06
N. M. + agric. Sulphur	0.73	0.71	1.61	1.64	0.06	0.05
N. M. + gypsum	0.71	0.71	1.68	1.66	0.06	0.06
N.M. + M. iron oxide	0.72	0.73	1.67	1.71	0.05	0.06
M. +EM	0.82	0.80	1.77	1.77	0.04	0.04
M. + PGPR	0.83	0.86	1.79	1.79	0.03	0.03
M. + phosphorine	0.77	0.78	1.73	1.72	0.04	0.04
M. + agric. Sulphur	0.76	0.80	1.75	1.74	0.05	0.04
M. + gypsum	0.75	0.80	1.76	1.72	0.04	0.05
M. + M. iron oxide	0.73	0.77	1.69	1.71	0.03	0.04
$LSD_{0.05}$	0.04	0.03	0.05	0.05	0.02	0.02

*N.M: Non-Magnetic Water * M.: Magnetic Water * PGPR: Plant Growth Promoting Rhizobacteria
* EM: Effective Microorganisms * M. iron oxide: Magnetic iron oxide * agric. Sulphur: agriculture sulphur.

Ahmet and Metin (2004) reported that, increasing magnetic field strength from control to 0.384 T increased contents of N, K, Ca, Mg, Cu, Fe, Mn, Na and Zn, but reduced P and S. Tai *et al.* (2008) reported that, magnetic field increases the percentage of nutrient elements like zinc. Osman *et al.* (2014) reported that, Fe and Zn of pear seedlings increased than those grown under non- magnetic water. Abou-Taleb *et al.,* 2011 confirmed that, the use of bio-fertilizers enhanced the rhizosphere microbial activity and concentration of various nutrients in pomegranate.

Table 9. Effect of magnetic water, non-magnetic water, bio-fertilizer and some soil amendments fruit rind micro elements content of Manfalouty pomegranate trees in 2014 and 2015 seasons.

Treatments	Fe (mg/kg)		Cu (mg/kg)		Zn (mg/kg)		Mn (mg/kg)	
	2014	2015	2014	2015	2014	2015	2014	2015
Control	38.73	44.52	1.25	1.26	1.68	1.94	2.24	2.79
N. M. + EM	46.78	50.49	1.70	1.49	2.76	2.49	3.28	3.63
N. M. + PGPR	55.81	60.35	1.88	1.86	3.15	3.08	4.11	4.19
N. M. + Phosphorine	48.48	55.48	1.48	1.69	2.73	2.61	4.04	3.77
N. M. + agric. Sulphur	47.16	50.82	1.53	1.65	2.80	2.77	3.99	3.69
N. M. + gypsum	43.15	50.71	1.53	1.61	2.97	2.93	3.93	3.86
N.M. + M. iron oxide	43.15	48.52	1.44	1.66	2.86	2.79	4.04	3.96
M. +EM	58.10	66.27	2.45	1.96	3.79	4.04	4.85	4.49
M. + PGPR	67.61	70.60	2.55	2.14	4.07	4.97	5.26	5.33
M. + phosphorine	57.31	63.11	2.09	1.92	3.77	4.15	4.48	4.87
M. + agric. Sulphur	57.59	65.45	2.17	1.85	3.63	4.23	4.66	4.72
M. + gypsum	57.72	65.55	2.11	1.84	3.44	4.24	4.19	4.59
M. + M. iron oxide	57.31	65.91	2.09	1.84	3.35	4.05	4.57	4.71
$LSD_{0.05}$	3.65	3.59	0.14	0.08	0.23	0.29	0.27	0.23

*N.M: Non-Magnetic Water * M.: Magnetic Water * PGPR: Plant Growth Promoting Rhizobacteria

* EM: Effective Microorganisms * M. iron oxide: Magnetic iron oxide * agric. Sulphur: agriculture sulphur.

CONCLUSION

It can be concluded that, under the same conditions of the present study we may recommend that irrigation under magnetized water with the application of bio-fertilizers (PGPR or EM) to alleviate salinity effect in irrigation water and soil increased yield, fruit weight and improved fruit nutrients of Manfalouty pomegranate.

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التقليل من التأثير الضار للملوحة فى التربه ومياه الرى على أشجار الرمان المنفلوطى باستخدام الماء الممغنط والأسمدة الحيوية وإضافة بعض محسنات التربة

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أجريت هذه التجربة خلال موسمى الزراعه (٢٠١٤ ، ٢٠١٥) بمزرعه خاصة فى منطقة وادى النطرون– محافظة البحيرة، مصر لدراسة مدى تأثير الري بالماء الممغنط والماء الغير ممغنط وبعض الملقحات الحيوية (EM- PGPR- Phosphorine) وبعض محسنات التربة (الجبس الزراعى – الكبريت الزراعى– أكسيد الحديد المغنطيسي) على المحصول ومحتوى الثمار من العناصر المعدنية لأشجار الرمان صنف المنفلوطى.

وقد أوضحت النتائج أن الماء الممغنط أدى لزيادة المحصول ومتوسط وزن الثمره مقارنة بالاشجار التى تروى بماء غير ممغنط والكنترول وكانت معاملة الماء الممغنط + PGPR قد أعطت أعلى متوسط فى وزن الثمار (341.68 gm) فى الموسم الاول بينما أعطت معاملة الماءالممغنط + PGPR والماء الممغنط + الجبس أعلى متوسط وزن ثمار (326.00 & 325.00 gm) مقارنة بباقى المعاملات والكنترول. وعلى النقيض من ذلك فإن أقل متوسط وزن الثمره سجلت فى معاملة الكنترول (271.11 and 224.00 gm) فى كلا موسمى التجربه على التوالى. الماء الممغنط أعطى أعلى قيمة للمحصول (10.60 and 20.78 kg/tree) مقارنة بالكنترول. كما أن محتوى الثمار من النيتروجين والفوسفور والبوتاسيوم والماغنسيوم والكالسيوم والحديد والنحاس والمنجنيز والزنك زادت عن طريق معاملة الماء الممغنط ماعدا محتوى الثمار من الصوديوم فأن معاملة الكنترول أعطت أعلى تقدير فى كلا الموسمين.

يتضح مما سبق أن زراعة أشجار الرمان تحت نفس ظروف التجربة مع استخدام الأسمدة الحيوية PGPR والــ EM لمقاومة تأثير الملوحة تزيد المحصول وتحسن محتوى للثمار من العناصر المعدنية لأشجار الرمان صنف المنفلوطى.