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Assessing the effect of irrigation with different levels of saline magnetic water on growth parameters and mineral contents of pear seedlings

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ABSTRACT

A pot experiment was conducted during the 2012 and 2013 seasons at Kanater Horticultural Research station, Qalubia Governorate, Egypt, to determine the effects of irrigation with different levels of water salinity i.e. 1000, 2000, 3000, 4000 and 5000 ppm as well as fresh water combined with magnetized water technology (with or without) on growth parameters and some mineral contents of pear seedlings. Obtained results show that the irrigation by magnetic water increased significantly plant height, no. of leaves / plant as well as fresh and dry weight, root fresh weight lowest and highest 2 mm as well as survival rate, N and P% of pear seedlings than those grown non- magnetic water in both seasons. While, the same results were achieved concerning with Na and Mg % of pear seedlings in the 1st season and, Fe, Zn, Ca, Mg and B content in the 2nd one. Prolein increased by irrigation with non magnetic water compared with magnetic one in both seasons.Generally, the plant height, fresh and dry weight, no. of branch and no. of leaves / plant, root fresh weight lowest and highest 2 mm as well as survival rate of pear seedlings were increased significantly by using irrigation water salinity at the concentration of 1000 ppm or fresh water in two seasons. Vice versa, the lowest ones were recorded by increasing water salinity up to the highest levels (5000 ppm and 4000 ppm) in both seasons. Increasing water salinity up to 5000 and /or 4000 ppm increased significantly prolien, N, P and K % as well as Fe, Mn, Zn, Cu, B, Na, Mg and Ca of pear seedlings , while, the lowest ones were recorded by irrigation with fresh water or the lowest salinity level (1000) ppm in both seasons. In most cases, the growth parameters (shoot and root) of pear seedlings were improved significantly by using magnetic technology with lowest salinity of irrigation water 1000 ppm fresh water while, the opposite trend was recorded by raising salinity up to 4000 and 5000 ppm without magnetic technology in both seasons. Conversely, increasing water salinity up to 4000 and 5000 ppm with magnetic technology gave the highest values of macro and micronutrients as well as prolien % of pear seedlings in two seasons.

Keywords: *Assessing, Irrigation, Different levels, Water, Pear seedlings.*

INTRODUCTION

Agriculture is the main user of water. However, because of the increase in demand from other users and the occurrence of drought in many countries, water resource has become scarce and limited. In Egypt, where agriculture uses more than 80% of the available water and where crop production is based mainly on irrigation, high demand from the ever-increasing population and the expansion of irrigated areas put pressure on the resource, has become a global concern (Mohamed, 2013). Under the population pressure in Egypt, the need to provide additional land for farming to increases food production to support the acceleration of population growth compels the country to use all sources of low quality (e.g. water saline).

Salinity is one of the most severe environmental factors limiting the productivity of agricultural crops. Salinity can negatively affect plants through three limited components: osmotic, nutrition's and toxic stresses (Lauchli and Epstein 1990 and Munns 1993). When exposed to salinity, growth and development tend to decline, with consequent reduction in their economic value. The use of saline water for agricultural production in water scarcity regions requires innovative and sustainable research, and an appropriate transfer of technologies. There is a pressing need for a system (technology roll e.g. magnetic field) that can help by saline water. The use of sea water diluted should be considered as complementary sources for the expansion of irrigated agriculture and agricultural development.

The water treated by pass during a magnetic device called magnetized water. The effects of magnetic fields on running water have been observed for years. This technology was used mainly in countries which have very little chemical industry, like Russia, China, Poland and Bulgaria, who all reported the successful use of magnets in treating water for irrigation, industry and home use. Till 1980, a little were known about how the magnetic field can stimulate plant growth or even prevent (Mahmoud and Amira, 2010). Recent years, there has been a rapid increase in the use of technologies employing magnetic water. The magnetized water is made by ordinary water which is allowed to get through the magnetic field of certain intensity with a certain flow rate, along with a direction perpendicular to the magnetic field lines. The physical and chemical properties of magnetized water have a series of changes which lead to special functions (Dandan and Shi, 2013). There has been some researches of salt stress on crop growth (Yang, 2007) and a considerable amount of researches on effects of magnetized water on crops physiological and biochemical (Qiu, 2011; Zhou, 2012) and few researches on magnetized saline solution treatment on crop growth and development (Shimin and Guocheng, 2000). Magnetic water improved the plant growth characteristics and nutrients uptake in tomato and soybean (Carbonell, 2011; Radhakrishnan and Kumari, 2012), root function (Aladjadjiyan, 2010), influenced the chemical composition of plants, activate plant enzymes (Alikamanoglu and Sen, 2011; Shabrangi, 2011), wheat (Hozayn and Abdul Qados, 2010), Maize (Zepeda, 2011).In this sense, Ahmed (2013) reported that improvement in tomato plant growth parameters which reflected in yield per plant was increased until the treatment of 6000 ppm magnetic water. Also he found that significant increase in plant growth, some chemical contents, fresh and dry weights of plant occurred compared to control. Mahmoud, (2011) found that using magnetic treatment on Wheat, lentil, Flax and Chick-pea increased biochemical components such as photosynthetic pigments, also protein content was increased significantly in plants treated with magnetic water. Magnetic fields have been reported to exert a positive effect on barley plant growth and development Martínez, (2000), on tree growth (Ruzic, 1998_a). Mahmoud and Amira (2010) on chick pea plant with magnetized water significantly increased tested for plant height, fresh and dry weight (g/plant) and protein content of Chick-pea. In a few words, irrigation with magnetically treated water or/and magnetic seed treatment are friendly environmental techniques. Therefore, they take an important place in the list of environmental clean methods and harmless technology (Aguilar, 2009; Nimmi and Madhu, 2009 and Abou El-Yazied, 2012),

Pear (Pyrus spp.) belongs to the Rosaceae, subfamily Pomoideae, the pome fruits (Jackson, 2003). Pear trees are generally sensitive salinity (Francois and Maas, 1994), and are damaged by exposure to relatively low salinity for long periods (Okubo, 2000).

Therefore, in this work, an attempt was made to understand the applicability of using of magnetized saline irrigation water in evaluation growth and some macro and micro nutrients contents of pear seedlings.

MATERIAL AND METHODS

A pot experiment was conducted in the green house of El- Qanater Horticultural Research Station, Kalubiya Governorate, Egypt, during two seasons of 2012 and 2013, to study the effect of different diluted seawater concentrations with or without magnetic field on vegetative growth and some chemical constituents of pear betulaefolia rootstock seedlings. The initial electrical conductivity (EC) values of sea water used in the experiment were 43.2 and 42.95 dSm^{-1} in the first and second seasons, respectively.

The design of the experiment was split plot design with Randomized in Complete Block Design with three replicates.

The tested variables were as follows:

A: Main plots (magnetic field):

M_1: Irrigation water passed through magnetic field generated from passed (the device consists of a normal magnetic strips are arranged in a way to get the technological magnetic forces is a 28 Gauss)

M_2: Irrigation water without magnetic field.

B: Sub main plots (Irrigation water salinity levels):

N: Fresh Nile water, 270 ppm.

S_1: diluted Seawater 1000 ppm.

S_2: diluted Seawater 2000 ppm.

S_3: diluted Seawater 3000 ppm.

S_4: diluted Seawater 4000 ppm.

S_5: diluted Seawater 5000 ppm.

Some physical and chemical properties of the soil at the experimental site which were measured and determined before planting according to Ryan (1996) are presented in Tables 1 and 2.

Table 1. Some Physical properties of the soil

Seasons	BD	F.C	W.P	AW	Particle size distribution (%)			
	g cm^{-3}	%			Clay	Silt	Sand	Texture
2012	1.21	35.8	18.8	17.0	16.4	33.5	50.1	SC
2013	1.24	36.0	18.5	17.5	17.6	34.5	47.9	SC

SC: Sandy clay; F.C: Field Capacity; W.P.: Welting point; AW: Available water; OM: Organic matter; BD: Bulk density

Table 2. Chemical properties and available macronutrients of the soil

Seasons	ECe	pH	$CaCO_3$	OM	HCO_3^-	SO_4^{2-}	Cl^-	Na^+	K^+	Ca_2^+	Mg_2^+	N	P	K
	dSm^{-1}	(1:2.5)	%		M mole L-1							ppm		
2012	1.0	7.75	3.75	1.80	3.65	2.56	4.00	4.20	0.31	2.97	2.73	38.50	9.12	193.30
2013	1.10	7.80	3.60	1.65	3.75	2.78	4.20	4.42	0.49	2.94	2.88	37.00	10.15	190.40

At the beginning of each growing season during the first week of February, a one year old seedling betulaefolia rootstock pear was planted in a black polyethylene bags 30 cm diameter. The bags were filled with about 5kg sandy clay soil (1 sand to 2 clay, v: v) and were put under 53% shaded greenhouse equipped. The plants were irrigated with fresh water till the 30th of April, until the beginning of the experimental treatments. Prior to irrigation, seawater was diluted with fresh water to the required concentrations (1000, 2000, 3000, 4000, and 5000) in plastic tank. The diluted seawater was used for irrigation throughout the course of the study that extended to seven months.
All normal cultural practice was practiced on pear seedlings.

Fir the magnetic field treatments, irrigation water passed through a magnetic device before the application to the plants. The device comprised of two magnets, arranged to the north and south poles. The directions of magnetic field generated at the flow rate diameter 2 inch are shown in (Figure 1).

At the end of experiment, vegetative growth parameters (shoot fresh and dray weight (g), plant height (cm), no. of branches / plant, stem diameter (cm), and no. of leaves) were measured. Also, prolien conc., survival rate % as well as root fresh diameters lower and higher than 2mm (g) were measured.

Seedlings samples (Shoots and roots) dried at 70ºC; grounded, digested and assigned for analyzing N, P, K, Ca, Mg, Na, B, Fe, Mn and Zn. Nitrogen was determined using modified Kjeldahl method, phosphorous was determined colourimetrically using ammonium molybdate and ammonium metavanadate according to the procedure outlined by Ryan, (1996). Potassium was determined using the flame spectrophotometry method Black (1982).

The results were statistically analysed using M-Stat computer package to calculate F ratio according to Snedecor and Cochran (1980). Least Significant Differences method (L.S.D) was used to differentiate between means at the 0.05 probability, level according to Waller, and Duncan (1969).

RESULTS AND DISCUSSION

1-Vegetative growth, shoot parameters:

Overall, irrigating with magnetically water significantly increased the vegetative growth (shoot parameters) of pears betulaefolia rootstock seedling. Results in Table (3) show that the plant height and leaves number/ plant as well as fresh and dry weight were significantly increased with magnetic irrigation water than those grown without magnetic in both seasons. Similar trend was observed on branches number and stem diameter in the first and second seasons, respectively. On the contrary, stem diameter and branch number didn't affect significantly by irrigation of magnetic water in the first and second seasons respectively. The beneficial effect of magnetic water may be due to the influence of ions activation and polarization of dipoles in living cell. Magnetic water can alter the plasma membrane structure and function. Such results are in accordance with Mohamed (2013) who found that magnetic water improved fresh and dry weights of tomato plant compared to control. It appears that utilization of magnetized water technology may be considered a promising technique to improve tomato yield productivity. He also, concluded that the use of magnetic techniques with low quality water is very important for irrigation without any expected problems in the soils and plant.

Data in Table (3) reveal the effect of salinity concentration (fresh,1000,2000,3000,4000 and 5000ppm) on the studied parameters, data illustrate that the plant height, fresh and dry weight, branch No. and leave number were improved significantly by using irrigation water salinity of 1000 ppm in two seasons. The same trend was obtained by irrigation with fresh water treatment for branch No., stem diameter and leave number in both ones. Vice versa, the lowest ones of all parameters were recorded by increasing water salinity up to the highest level (5000 ppm) in both seasons. Under salinity stress, leaf photosynthetic capacity is limited by the electron transport capacity of thylakoid proteins, the activity of Rubisco and mesophyll resistance (Searson, 2004). Salinity water stress reduced significantly photosynthetic rates of birch-leaved pear seedlings, and the reduction was proportional to the increase in different water salinity levels. The obtained results agree with (Velikova, 2000), who found that, with Brassica species, photosynthetic rates showed significant decreasing trends with increasing salt concentrations in the rooting medium.

Table 3. Effect of different salinity levels and magnetite treatments on some components of Pear seedlings

Treatments	2012 Fresh weight (g)	Dry weight (g)	Plant height (cm)	Branch No. / plant	Steam diameter (cm)	Leave number	2013 Fresh weight (g)	Dry weight (g)	Plant height (cm)	Branch No. / plant	Stem diameter (cm)	Leave number
Magnetic water												
M_1	17.02	10.99	48.47	5.44	0.80	7.29	22.41	12. 60	48.50	4.78	0.83	7.43
M_2	15.83	8.46	48.36	4.45	0.78	6.91	18.21	9.78	44.72	4.56	0.79	7.01
L.S.D 0.05	*	*	*	*	NS	*	*	*	*	NS	*	*
Salinity												
N	12.95	6.583	55.83	5.17	0.86	9.23	22.28	10.57	48.17	5.00	0.93	9.50
S_1	23.13	13.43	55.67	5.67	0.93	9.07	24.23	14.72	52.83	5.67	0.93	8.98
S_2	18.52	12.32	50.83	5.50	0.80	7.50	20.83	12.87	48.83	4.67	0.83	7.88
S_3	15.55	10.70	47.45	4.83	0.78	5.85	21.67	10.60	45.50	4.50	0.82	5.78
S_4	14.90	8.383	43.67	4.50	0.70	5.63	17.47	9.750	43.17	4.17	0.70	6.13
S_5	13.48	6.900	40.78	4.00	0.68	5.30	15.37	8.617	41.17	4.00	0.67	5.05
L.S.D 0.05	0.9601	1.297	2.212	1.136	0.07	0.69	1.102	1.058	2.67	0.86	0.12	0.81
Interactions												
M_1X N	12.57	5.767I	57.00	5.67	0.85	10.10	20.60	9.803	49.67	5.00	0.97	10.17
M_1X S_1	25.47	15.27	56.00	6.33	0.97	9.17	29.07	18.00	55.33	5.67	0.97	9.10
M_1X S_2	17.70	13.77	51.00	6.00	0.80	7.60	24.07	15.50	50.33	4.67	0.83	7.77
M_1X S_3	16.17	12.10	47.67	5.67	0.77	5.70	23.70	12.00	48.00	4.67	0.80	5.93
M_1X S_4	15.87	10.63	45.00	5.00	0.73	5.67	19.40	10.47	44.67	4.33	0.73	6.50
M_1X S_5	14.33	8.400	41.67	4.00	0.70	5.50	17.60	9.800	43.00	4.33	0.70	5.13
M_2X N	13.33	7.400	54.67	4.67	0.87	8.37	23.97	11.33	46.67	5.00	0.90	8.83
M_2X S_1	20.80	11.60	55.33	5.00	0.90	8.97	19.40	11.43	50.33	5.67	0.90	8.87
M_2X S_2	19.33	10.87	50.67	5.00	0.80	7.40	17.60	10.23	47.33	4.67	0.83	8.00
M_2X S_3	14.93	9.300	47.23	4.00	0.80	6.00	19.63	9.200	43.00	4.33	0.83	5.63
M_2X S_4	13.93	6.133	42.33	4.00	0.67	5.60	15.53	9.033	41.67	4.00	0.67	5.77
M_2X S_5	12.63	5.400	39.90	4.00	0.67	5.10	13.13	7.433	39.33	3.67	0.63	4.97
L.S.D 0.05	1.679	1.443	2.248	0.678	0.097	0.82	2.609	1.623	3.138	1.36	0.079	0.82

M_1= Magnetic water; M_2 = non-magnetic; N = Fresh water and S = Salinity

Regarding the interaction effect between different salinity levels and irrigation magnetite water treatments on abovementioned parameters of pear seedling, results in Table (3) illustrate that the highest significant values of plant height and branches number as well as fresh and dry weight of pear seedlings were recorded by lower level of water salinity (1000 ppm) under magnetic field in both seasons. Oppositely, the lowest ones were observed by the higher salinity water up to 5000 ppm under non magnetic water in both seasons. Beneficial effects of magnetic water of concentration salinity in the current study may be due to some alterations within plant system at biochemical level and their possible effects at cell level. Also, Irrigation magnetic water is considered one of numerous physical factors affects plant growth and its development or may be to the effect on cell division.

Root fresh weight, prolien and survival rate

Presented data in Table (4) reveal that the highest significant values of root fresh weight lower and higher 2 mm as well as survival rate were observed by irrigation with magnetic water compared to non magnetic one in both seasons. In the contrary, the prolien increased by irrigated with non magnetic water compared with magnetic one in two seasons. Magnetic treatment of water may affect phyto-hormone production leading to improved cell activity and plant growth. In this connection, (Belyavskaya, 2001, 2004; Turker, 2007) concluded that the magnetic water can influence the root growth of various plant species. Also, Muraji, (1992) demonstrated an enhancement in root growth of maize by exposing the maize seedling to 5 mT magnetic fields at alternating frequencies of 40–160 Hz. However, there was a reduction in primary root growth of maize plants grown in a magnetic field alternating at 240–320 Hz.

Table 4. Effect of different salinity levels and magnetite treatments on root fresh weight, prolein and survival % of Pear seedlings

Treatments	2012				2013			
	Root fresh (g) >2mm	Root fresh <2mm	Prolein	Survival rate %	Root fresh (g) >2mm	root fresh <2mm	Prolein	Survival rate %
Magnetic water								
With	4.415	9.908	0.152	70.37	4.485	9.654	0.148	72.22
without	3.917	8.978	0.200	54.31	3.665	8.626	0.193	61.11
L.S.D 0.05	*	*	*	*	*	*	*	*
Salinity								
N	4.313	13.40	0.082	100.0	4.232	12.70	0.078	100.0
S_1	5.973	14.95	0.098	94.43	5.453	14.66	0.092	94.43
S_2	4.185	10.98	0.105	66.68	3.967	10.72	0.097	77.78
S_3	3.748	5.163	0.153	50.00	3.763	5.000	0.147	61.13
S_4	3.775	6.652	0.267	35.17	3.915	6.467	0.261	38.87
S_5	3.000	5.515	0.352	27.75	3.120	5.305	0.345	27.75
L.S.D 0.05	0.498	0.967	0.001	12.20	0.611	1.010	0.001	13.94
Interaction								
M_1X N	5.057	13.80	0.070	100.0	5.100	13.06	0.068	100.0
M_1X S_1	6.213	15.40	0.064	100.0	5.633	15.00	0.057	100.0
M_1X S_2	4.637	11.62	0.083	77.80	4.567	11.36	0.077	88.87
M_1X S_3	3.830	5.610	0.104	66.70	4.000	5.600	0.100	66.70
M_1X S_4	3.383	7.037	0.290	44.43	3.833	7.063	0.284	44.43
M_1X S_5	3.367	5.980	0.303	33.30	3.783	5.843	0.300	33.30
M_2X N	3.570	13.00	0.093	100.0	3.363	12.33	0.088	100.0
M_2X S_1	5.733	14.50	0.132	88.87	5.273	14.32	0.127	88.87
M_2X S_2	3.733	10.33	0.127	55.57	3.367	10.07	0.118	66.70
M_2X S_3	3.667	4.717	0.202	33.30	3.527	4.400	0.194	55.57
M_2X S_4	4.167	6.267	0.243	25.90	3.997	5.870	0.238	33.30
M_2X S_5	2.633	5.050	0.401	22.20	2.457	4.767	0.391	22.21
L.S.D 0.05	0.639	0.898	0.001	8.713	0.825	0.907	0.0018	13.98

Tabulated data in Table (4) demonstrate that the root fresh weight lower and higher 2 mm as well as survival rate of pear seedlings were improved significantly by lower water salinity 1000 ppm in both seasons. Similar trend was obtained of survival rate when irrigated with normal water (fresh water) in two seasons. While, the lowest ones were obtained with water salinity was increased up to 5000 ppm in both seasons, similar trend was observed for survival rate % % of seedlings irrigated with 4000 ppm and 3000 ppm as well as root fresh weight higher than 2 mm in two ones. Conversely, increasing water salinity up to 5000 ppm increased significantly prolien in pear seedlings, while, the lowest one was recorded by (control treatment) irrigated with fresh water in both seasons. Salinity stress depresses plant growth and development at different physiological levels. The decrease in plant growth by salinity stress might be related to adverse effects of excess salt on ion homeostasis, water balance, mineral nutrition and photosynthetic carbon metabolism (Munns, 2002).

For the interaction effect between factors under study on the studied parameters, results reveal that the highest significant values of root fresh weight lower and higher 2 mm were obtained when lower water salinity 1000 ppm under magnetic and non magnetic treatment were practiced in both seasons. The same trend was observed by irrigated with fresh water under magnetic technique in the first season only. On the other hand, the lowest ones were recorded when seedlings were irrigated by the highest water salinity under non magnetic water in two seasons. Survival rate was improved significantly when pear seedlings irrigated with fresh water or lower water salinity 1000 ppm with or without magnetic technique in both seasons. Meanwhile, the lowest one was obtained by 4000 and 5000 ppm under non magnetic system in two ones. Oppositely, prolein was increased by increasing water salinity up to 5000 ppm under non magnetic water compared with lower water salinity 1000 ppm under magnetic one in two seasons. The results of this study showed that magnetized water play an important role in salts solubility resulting in increasing their cations and anions concentration. Removal of excess salts or decreasing their activity is necessary for preventing transformation of highly productive soil into non-productive salt affected soils (Hilal and Hillal 2000b).

Macro and micronutrients content of pear seedlings

Results presented in Table (5) show that irrigation with magnetic water improved significantly nitrogen and phosphorus percentage of pear seedlings as compared with non magnetic water in both seasons. Also, the same trend was obtained for iron and zinc in the second season only. On the other hand, other parameters weren’t significantly affected by the two types of irrigation water. Magnetic water may influence desorption of P and N from soil adsorbed P and N on colloidal complex, and thus increasing its availability to plants resulting in an improved plant growth and productivity. Noran, (1996) observed (under drip irrigation system) differences in the concentrations of K, N, P, Na and Ca + Mg in soils irrigated with magnetic water when compared with normal water. They argued that magnetic water more available for plants to absorb from soil solution, probably due to the effect of acceleration of the crystallizations and precipitation processes of the solute minerals.

Results indicate also that, nitrogen and potassium % as well as Fe, Mn, Zn and Cu ppm increased significantly by increasing water salinity up to 5000 ppm as compared with irrigation by fresh water in both seasons. While, irrigation with 4000 ppm gave the highest significant value of phosphorus percentage as compared to control treatment in both seasons. Such findings coincide with those reported by Mesut et al., (2010), who suggested that the growing plants in saline media come across generally with major drawbacks; the first is the increase in the osmotic stress due to high salt concentration of soil solution that decreases water potential of soil; the second is the increase in concentration of Na and Cl, exhibiting tissue accumulation of Na and Cl, and inhibition of mineral nutrients uptake.

As for the interaction effect, results reveal that the highest significant values of N, P, K, Fe, Mn and Zn were obtained from the highest water salinity level under magnetic water (M_1S_5) treatment. These values were 2.20, 0.179 and 0.113 % as well as 1308, 70.35 and 180.4ppm), respectively in the first season. While, the same values were 2.21, 0.206 and 0.114 % as well as 1312, 70.66 and 181.0 ppm, respectively in the second one. Similar trend was recorded at the same water salinity level under non- magnetic water for Fe, Mn, Zn and Cu ppm of pear seedlings in the two seasons. In most cases, the lowest significant values of macro and micronutrients content were observed with irrigation by fresh water and lowest water salinity level 1000 ppm with or without magnetic water. Grewal and Maheshwari (2011) reported that there are some changes occurred in the physical and chemical properties of water according to magnetic water, mainly hydrogen bonding, polarity, surface tension, conductivity, pH and solubility of salts, and these changes in water properties may be capable of affecting the growth of plants. They assumed that the reduction in water pH and increase in EC in magnetic water may be due to changes in hydrogen bonding and increased mobility of ions.

Table 5. Effect of different salinity levels and magnetite treatments on nutrients content of pear seedlings

	2012							2013						
Treatments	N %	P	K	Fe ppm	Mn	Zn	Cu	N %	P	K	Fe ppm	Mn	Zn	Cu
Magnetic water														
M_1	1.631	0.163	0.091	793.722	60.590	113.36	18.917	1.661	0.190	0.093	792.33	60.11	95.97	18.61
M_2	1.478	0.142	0.083	679.611	55.573	85.198	20.080	1.489	0.168	0.087	671.22	55.00	84.86	19.41
L.S.D 0.05	*	*	NS					*	*	NS	*	NS	*	NS
Salinity levels														
N	1.175	0.135	0.066	497.0	45.87	38.33	11.68	1.186	0.160	0.079	476.3	44.89	37.87	10.70
S_1	1.267	0.147	0.087	577.2	48.37	80.92	14.03	1.336	0.175	0.084	572.7	47.38	80.13	13.35
S_2	1.550	0.152	0.087	555.0	62.58	89.82	16.08	1.561	0.183	0.086	551.5	61.86	89.42	15.35
S_3	1.717	0.152	0.091	685.2	56.47	61.11	18.52	1.728	0.180	0.091	684.8	55.82	59.29	17.74
S_4	1.533	0.175	0.094	745.3	67.34	150.7	22.20	1.545	0.198	0.095	745.2	67.44	100.9	22.30
S_5	2.083	0.155	0.103	1360.0	67.85	174.8	34.50	2.095	0.179	0.105	1360.0	67.98	174.9	34.63
L.S.D 0.05	0.108	0.0012	0.001	81.26	3.940	NS	3.494	0.1008	0.001	0.001	88.99	4.843	4.595	5.935
Interactions														
M_1X N	1.200	0.1393	0.079	565.3	47.85	49.95	12.65	1.211	0.161	0.081	561.7	47.13	49.52	11.93
M_1X S_1	1.333	0.1627	0.084	671.3	52.85	83.63	14.10	1.461	0.187	0.057	667.0	51.23	82.88	13.61
M_1X S_2	1.650	0.1667	0.088	570.0	69.32	98.85	17.90	1.661	0.198	0.089	566.3	68.83	98.45	17.41
M_1X S_3	1.733	0.1563	0.091	705.0	52.85	63.53	19.75	1.745	0.188	0.093	701.0	51.23	59.58	18.13
M_1X S_4	1.667	0.1747	0.096	942.7	70.35	203.7	22.85	1.678	0.199	0.098	946.3	71.50	104.40	24.01
M_1X S_5	2.200	0.1793	0.113	1308.0	70.35	180.4	26.25	2.211	0.206	0.114	1312.0	70.66	181.0	6.56
M_2X N	1.150	1.1313	0.054	428.7	43.9	26.7	10.70	1.161	0.159	0.077	391.0	42.66	26.22	9.461
M_2X S_1	1.200	0.1313	0.084	483.0	43.90	78.2	13.96	1.211	0.163	0.083	478.3	43.41	77.38	13.08
M_2X S_2	1.450	0.1363	0.084	540.0	55.85	80.7	14.25	1.461	0.168	0.083	536.7	54.89	80.40	13.28
M_2X S_3	1.700	0.1470	0.090	665.3	60.10	58.7	17.29	1.711	0.172	0.090	668.7	60.40	59.00	17.35
M_2X S_4	1.400	0.1743	0.092	548.0	64.34	97.7	21.55	1.411	0.196	0.091	544.0	63.38	97.40	20.58
M_2X S_5	1.967	0.1300	0.093	1413.0	65.35	169.2	42.75	1.978	0.151	0.093	1409.0	65.30	168.80	42.70
L.S.D 0.05	0.1523	0.0017	0.002	114.9	0.572	86.98	4.942	0.1425	0.0012	0.001	125.9	6.849	6.499	8.394

M_1= Magnetic water; M_2 = non-magnetic; N= Nile water and S = Salinity

Na, Ca, Mg and B contents

Results in Table (6) reveal that the irrigation by magnetic water treatment increased significantly Na and Mg percentage of pear seedlings as compared to non magnetic one in the first season. Meanwhile, Ca, Mg and B contents increased significantly by using magnetic water as compared with non magnetic water in the second season. Maheshwari and Grewal (2009) showed increased Ca and P concentrations in celery shoots and Ca and Mg concentration in snow pea pods under magnetic water. They suggested an improved availability, uptake, assimilation and mobilization of these nutrients within plant system which may have contributed in improving the productivity of celery and snow pea plants with the magnetic treatment of water. Duarte Diaz, (1997) reported an increase in nutrient uptake by magnetic treatment in tomatoes. A marked increase in P content of citrus leaves by magnetic water was also reported by Hilal, (2002).

Table 6. Effect of different salinity levels and magnetic treatments on Na, Ca, and Mg (%) and (B) ppm of pear seedlings

Treatments	2012 Na %	Ca	Mg	B ppm	2013 Na %	Ca	Mg	B ppm
Magnetic water								
M_1	0.026	0.551	2.292	104.10	0.027	0.541	2.346	104.18
M_2	0.022	0.456	2.052	95.913	0.022	0.441	2.106	95.35
L.S.D 0.05	*	NS	*	NS	NS	*	*	*
Salinity								
N	0.019	0.460	1.748	72.12	0.019	0.445	1.1801	71.14
S_1	0.020	0.447	1.779	87.87	0.021	0.445	1.833	86.89
S_2	0.022	0.406	2.396	89.25	0.023	0.391	2.450	88.52
S_3	0.023	0.494	2.062	110.3	0.023	0.479	2.115	109.7
S_4	0.024	0.647	2.380	113.5	0.025	0.631	2.434	113.6
S_5	0.034	0.568	2.669	127.0	0.035	0.553	2.722	128.8
L.S.D 0.05	0.001	0.066	0.1826	NS	0.001	0.085	0.114	6.186
Interactions								
M_1X N	0.018	0.422	1.707	69.25	0.017	0.407	1.760	68.01
M_1X S_1	0.019	0.421	1.718	85.75	0.019	0.406	1.771	85.26
M_1X S_2	0.020	0.374	2.420	86.50	0.020	0.359	2.473	85.53
M_1X S_3	0.021	0.482	1.770	110.80	0.021	0.467	1.823	111.1
M_1X S_4	0.021	0.547	2.217	111.50	0.021	0.531	2.270	110.5
M_1X S_5	0.033	0.490	2.483	111.70	0.033	0.475	2.536	111.7
M_2X N	0.019	0.498	1.788	75.00	0.021	0.482	1.842	74.28
M_2X S_1	0.021	0.472	1.841	90.00	0.023	0.490	1.894	88.51
M_2X S_2	0.024	0.438	2.373	92.00	0.026	0.423	2.426	91.51
M_2X S_3	0.024	0.506	2.354	109.90	0.026	0.4910	2.407	108.3
M_2X S_4	0.027	0.746	2.544	115.50	0.029	0.7310	2.597	116.7
M_2X S_5	0.035	0.647	2.854	142.30	0.037	0.6313	2.908	145.9
L.S.D 0.05	0.002	0.093	0.258	15.92	0.002	0.1204	0.1616	8.749

As for the effect of salinity levels on Na, Ca, Mg and B contents of pear seedlings, results show that Na and Mg concentrations increased significantly with increasing water salinity levels up to 5000 ppm in the two seasons. Boron contents increased significantly in second season only. Whereas, irrigation with salinity levels up to 4000 ppm led to significant increase in Ca content in both ones. On the other hand, the lowest significant values of Na, Ca, Mg and B content of pear seedlings were obtained by irrigation with Nile water or lowest water salinity level of 1000 ppm in both seasons. Maheshwari, and Grewal, (2009) suggested that the magnetic water may be assisting to reduce the Na toxicity at cell level by detoxification of Na, either by restricting the entry of Na at membrane level or by reduced absorption of Na by plant roots. Otherwise, the reduction of Na concentration in snow pea pods may be associated with dilution effect of increased yield when snow peas were irrigated with magnetically treated saline water. High Na concentration is a limiting factor for plant growth in most crops (Muranaka, 2002). Excessive Na has detrimental effects on electron transport and photosynthesis, and it also affects through stomatal closure (Muranaka, 2002) which reduces assimilates supply. Excessive Na may also disrupt the cell wall and increase the permeability of the cell membrane, leading to increased solute leakage from leaves at high salt concentration. It is also interesting to note that the apparently reduced accumulation of Na in plants with magnetically treated saline water in the current study may have helped the plants to continue their growth with less detrimental effects on plant yield.

With respect to the interacted factors under study, results reveal that irrigation with highest water salinity level increased significantly under magnetic water in both seasons. Similar trend was observed by irrigation with 4000 ppm water salinity under magnetic system for Ca content in two seasons. Vice versa, in most cases, the lowest values were recorded with irrigation by fresh water and lowest water salinity level of 1000 ppm with or without magnetic water in both ones. Maheshwari (2009) demonstrated some significant effects of magnetically treated irrigation water on yield and nutrient composition of snow pea and celery plants under irrigation with saline water conditions.

CONCLUSION

From the obtained results it could be concluded that:

1- Magnetic water may affect phyto-hormone production leading to improved cell activity and plant growth as well as availability of macro and microelements in soil.

2- Magnetic water technique led to improve crop yield productivity, providing greater physical support to the developing shoot, better root growth and development in young seedlings of pears betulaefolia rootstock.

Before this technology can be recommended to farmers, could be need for more studies.

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