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FUTURE OF MAGNETIC AGRICULTURE IN ARID AND SEMI ARID REGIONS (CASE STUDY)

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Abstract

A great challenge for the agricultural sector is to produce more food from less water, particularly in arid and semi-arid regions which suffer from water scarcity. Utilization of magnetic water technology is considered as a promising technique to improve water use efficiency and crop productivity. Two field trials using wheat (Var. sakha-93), faba bean (var., nubaria-1), chick-pea (var. giza-3) , lentil (var. Giza-9), canola (var. sero-6) and flax (var. sakha-1) were conducted at Research and Production Station, National Research Centre, Alemam Malek village, Al Nubaria district, Al Behaira Governorate, Egypt in 2009/10 and 2010/11 winter seasons to study and evaluate the effects of magnetizing irrigation water on growth, yield and yield components of mentioned winter crops. The results showed significant positive effect of magnetic treatment on all studied parameters. The percent of increase in economic yield (ton ha^{-1}) in response to magnetized water application reached to 13.71% at wheat, 8.25% at faba bean, 21.8% at chick pea, 29.53% at lentil, 36.02% at canola, 22.37% at flax and 19.05% at sugar beet crop as compared with normal water application. Similar trend was obtained for water use efficiency was. It appears that utilization of magnetized water can led to improve yield and water productivity of tested crops under newly reclaimed sand soil. So, using magnetic water treatment could be a promising technique for agricultural improvements but we need extensive research in this field.

Key words: *magnetic water, winter crops, pigments, yield, water use efficiency.*

INTRODUCTION

A great challenge for the agricultural sector is to produce more food from less water, particularly in arid and semi-arid regions which suffer from water scarcity.

Utilization of magnetic water technology is considered as a promising technique to improve water use efficiency and crop productivity.

Our previous and promising studies (Hozayn and Amira, 2010 a&b; Amira and Hozayn 2010 a&b; Hozayn et al., 2010) under greenhouse condition observed that, wheat, lentil, chickpeas, flax, sunflower, as well as on ground nut, faba bean and mung bean (data unpublished) irrigated with magnetized water gave more value of all recorded parameter.

The increase in yield per plant ranged between 11-47% depended on tested plants.

So, the main objective of this study to clarify the role of magnetic water on increasing yields of sugar beet yield and quality and water productivity under field conditions.

In aboard, many works have been reported to exert a positive effect of magnetic fields on the germination of seeds, plant growth and development, the ripening and yield of field crops (De Souza et al., 2006; Shabrangi and Majd 2009). Where, magnetic field was shown to induce germination traits in wheat, soybean, cotton (Phirke et al., 1996), barley (Martinez et al., 2000), rice (Carbonell et al., 2000), corn (Florez et al., 2007), and chickpea (Vashisth and Nagarajan, 2008).

When the seeds were exposed to magnetic field, the percentage of germination increased while the time required for germination decreased.

The positive effects of magnetic field were also shown on metabolic substance i.e., protein biosynthesis, cell reproduction, photochemical activity, respiration rate, enzyme activities, nucleic acid content, and growth-development period (Stange et al., 2002).

Moreover, in macro trials, application of variable electro and static magnetic fields with different frequency showed a yield increase up to 144,8% in potato (Marinkovic et al., 2002), rice by 13-23% (Tian et al., 1991), pepper by 64,9% (Takac et. al. 2002), soybean from 5 to 25%, with a higher quantity of oil and protein and at sunflower from 13,2 to 17,3% (Crnobarac et al. 2002), cereal by 20% (Marinkovic et al. 2000), wheat by 6.3 – 10.6% (Kordas 2002), broad bean and pea by 10 and 15%, respectively (Podlesny et al., 2004 and 2005). In addition, Vasilevski (2003) shows a 94% increase of the root mass of sugar beet, leaf surface up to 52%, yield to 12,88 t/ha and the percentage of sugar was increased for 0.70%.

In similar trials performed with corn a higher root mass (55.0%), vegetative mass (57.0%) and yield (18.7%) was achieved.

Consequently, the magnetic field effect can be used as an alternative to the chemical methods of plant treatment for improving the production efficiency (Aladjadjiyan, 2002 and 2003).

So, in this study will look at an innovative water treatment to study the physical, chemical and biological changes occurring in soil and water after treatment with a no uniform magnetic field and its effects on productivity of some winter crops under newly reclaimed sand soil

MATERIALS AND METHODS

Six field trials using wheat (var. Sakha-93), faba bean (var. Nubaria-1), chick-pea (var. Giza-3), lentil (var. Giza-9), canola (var. Sero-6) and flax (var. Sakha-1) were conducted at Research and Production Station, National Research Centre, Alemam Malek Village, Al Nubaria district, Al Behaira Governorate, Egypt in 2009/2010 and 2010/11 winter seasons to study and evaluate the effects of irrigation with magnetic water on growth, chemical constituent, yield and yield components of mentioned winter crops.

The experimental area is located at the North of Cairo (30.8667 N latitude and 31.1667 E longitude) at an elevation of 21 m above the sea level. It has a semi-arid climate with cool winters and hot dry summers prevailing in the experimental area.

The experimental soil and water were analyzed according to the method described by Chapman and Pratt (1978) (Table 1).

Table 1. Soil and water analysis for site experiments

	Soil depth		Irrigation water	
Parameters	**0-15**	**15-30**	**Before magnetic**	**After magnetic**
Particle size distribution				
Coarse sand	48.20	54.75	..	…
Fine sand	49.11	41.43	..	…
Clay + Silt	2.69	3.82	..	…
Texture	Sandy	Sandy	..	…
PH (1:2.5)	8.22	7.94	7.25	7.13
EC(dSm^{-1})(1:5)	0.20	0.15	0.50	0.40
Organic matter (%)	0.67	0.43	…	
Soluble cations (mq/l)				
Ca^{++}	0.60	0.50	2.15	2.05
Mg^{++}	0.50	0.30	0.50	0.65
Na^{++}	0.90	0.80	3.00	3.00
K^{+}	0.20	0.10	0.31	0.31
Soluble anions (mq/l)				
CO^{-3}	-	-	0.01	0.01
HCO^{-3}	0.60	0.40	2.33	2.46
Cl^{-}	0.75	0.70	2.17	1.72
SO^{-4}	0.85	0.60	1.45	1.82

Grains and seeds of the respective crops were obtained from Field Crop Research Institute, Agriculture Research Centre, Giza, Egypt. Recommended rates of grains and seeds of each crop were planted in plots (10 length m x 10 width m) at the last week of November. Four replications were used in each treatment. Control treatment was irrigated with normal water, while the other treatment (magnetized water) was irrigated with water after magnetization through a two inch Magnetron [U.T. 3, Magnetic Technologies LLC PO Box 27559, Dubai, UAE].

The recommended NPK fertilizers for each crop were applied through the period of experiment. Sprinkler irrigation was applied as plants needed. The layout of experiment was shown in (Figure 1).

After 85 days from sowing plant height, fresh and oven dry weight of ten plants from each crop were determined. Photosynthetic pigment contents (chlorophyll a, chlorophyll b and carotenoids) of leaves were estimated spectrophotometrically as the method described by Moran (1982). At harvest yield and yield components of tested crops were determined.

Statistical analysis was carried out using SPSS program Version 16. An independent t-test was also carried out to find the significant differences between magnetic and nonmagnetic water treatments.

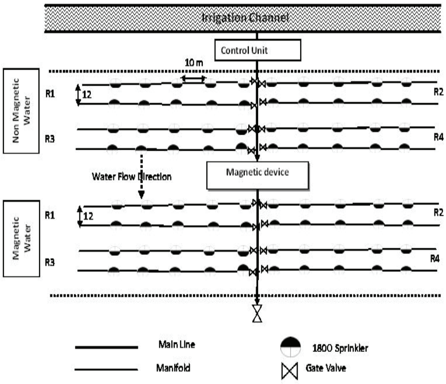

Figure 1. Layout of experiment design under solid set sprinkler system

RESULTS AND DISCUSSIONS

Dry weight

Results illustrated in Figure 2 showed the effect of using magnetized water on dry weight of plant. This parameter could use as effective indicator that reflect the increase in all growth parameters (shoot length, leaves number and area and fresh weight/plant). Dry weight/plant as a result of irrigation with normal and magnetic water ranged between 0.46-7.46 and 0.54-7.96, respectively according to the plant type. It's obvious that irrigation with magnetized water improved dry matter accumulation at all tested plants compared to control treatment. The maximum percent of increase was obtained at dry weight of flax by 23.01% followed by lentil by 15.88% and chick pea by 13.59%. The lowest percent of increase was recorded at wheat by 7.45 followed with faba bean by 7.99% and canola by 8.33%. The increase in dry weight/plant as a result of plant irrigation with magnetized water may be attributed to the increase all growth parameters (data not seen) which accompanied with increase in total pigment contents (Figure 3), increase in photosynthetic pigments, endogenous promoters (IAA) and increase protein biosynthesis (Hozayn and Amira, 2010 a&b and Amira and Hozayn 2010 a&b). These results are in good harmony with those obtained by Hozayn et al., (2011) and Ijaz et al. (2012). In this connection Also, Alikamanoğlu et al. (2007) suggested that, magnetic water treatment improved seed inhibition, vigor and germination rate, and seedling treatment promoted NPK absorption and increased root number, stem thickness, dry weight/100 plants and tillers number. Moreover, Celik et al. (2008) and Nasher (2008) concluded that, magnetized water increased growth and consider an important factor for inducing plant growth. Moreover, the influence of the magnetic field on plants, sensible to it increases its energy. Later this energy is distributed among the atoms and causes the accelerated metabolism and, consequently, to better germination. Magnetic treatment of water has been reported to change some of the physical and chemical properties of water, mainly hydrogen bonding, polarity, surface tension, conductivity, pH and solubility of salts (Amiri and Dadkhah, 2006; Otsuka and Ozeki, 2006). These changes in water properties may be capable of affecting the growth of plants.

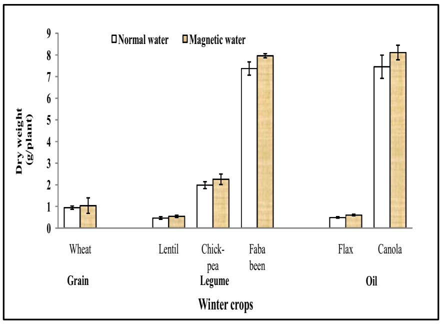

Figure 2. Dry weight (g/plant) at 85 days after sowing for winter crops irrigated with normal and magnetized water. Mean values of 2 seasons, N=8 in each crop, t-test was significant at 0.05 in all tested crops, error bars in each crop expressed as standard deviation

Pigment contents

Pigment content is an indicator of plant health and productivity. Results in figure 3 reflect the response of tested crops when irrigated with magnetized water to total pigment contents. The pigment contents ranged between 17.7-27.85 mg/100g fresh weight for irrigation with normal according to tested crops. Irrigation with magnetized water caused an increase in pigment content (22.14-35.83 mg/100 g fresh weight) according to tested crops.

Chick pea 9.14% < lentil 11.18% < canola 13.50% < flax 17.58% < wheat 36.77% and faba bean 50.68%.The increase in pigment content under irrigation with magnetized water was accompanied with the increase in growth (Figure 2).

These increments must supported by the increase in growth promoters (auxins and cytokinins) which responsible on increasing growth.

The stimulatory effect of magnetic water on photosynthetic pigment contents may be due to the effect of magnetic treatment on alteration the key of cellular processes such as gene transcription which play an important role in altering cellular processes.

The same result was obtained by Atak et al. (2003 and 2007) who found an increase in chlorophyll content specifically appeared after exposure to a magnetic field for a short time. They also suggested that, increase all photosynthetic pigment through the increase in cytokinin synthesis which accompanied by the increase in auxin synthesis that induced by magnetic field treatment of soybean plants. Recently Hozayn and Abdul Qados (2010 a and b), Abdul Qados and Hozayn (2010 a and b) and Hozayn et al., (2011) reported that, magnetic treatment increased photosynthetic pigment contents via increasing growth promoters (IAA). Helal, (2011) reported that, irrigation with magnetic water exhibited marked significant increase in the photosynthetic pigments (chlorophyll a, chlorophyll b, and carotenoids), photosynthetic activity, and translocation efficiency of the photo assimilates of common bean over the control.

These results for increasing photosynthetic activity are confirmed with that of (Mihaela et al., 2007; Mihaela et al., 2009). They showed an increase in chlorophyll and carotenoids content specifically appeared after treatment with magnetic water. Al-Khazan et al. (2011) reported that the magnetically treated water treatment has an enhancing effect on the photosynthetic pigments compared to the control treatment.

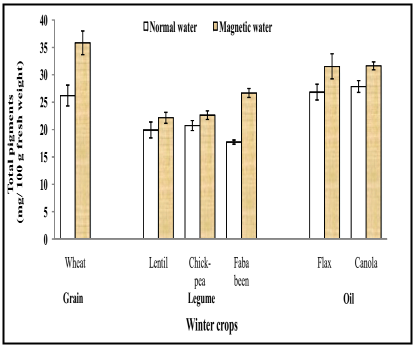

Figure 3. Total pigment contents in the leaves of winter crops irrigated with normal and magnetized water. Mean values of two seasons, N=8 in each crop, t-test was significant at 0.05 in all tested crops, error bars in each crop expressed as standard deviation.

Plant height at harvest

Figure 4 cleared the result of using magnetized water on plant height at harvest of tested crops. Plant height at harvest as a result of irrigation with normal water ranged between 38.63 – 131.63 cm according to the plant type. Magnetized water increased this range to 45.00 – 147.88 cm according to the plant type. Legume crops (chick-pea and lentil) came in the first order in response of irrigation with magnetic water where gave the maximum increase percentage (18.99% and 16.50%, respectively).

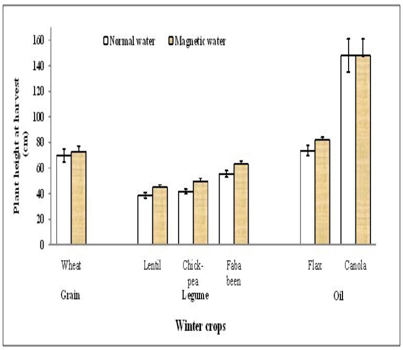

Figure 4. Plant height at harvest for winter crops irrigated with normal and magnetized water. Mean values of two seasons, N=8 in each crop, t-test was significant at 0.05 in all tested crops, error bars in each crop expressed as standard deviation

While wheat as grain crop came in the last order by 4.11% increases.

The increments in plant height for the other crops ranged between 11.56 – 13.54%.

These increments may be attributed to the role of magnetized water in increasing growth (Figure 1), photosynthetic pigment (Figure 2).

The same trend was observed by Hozayn & Abd AlQodos (2010a and b) on wheat and chick-pea and Abd Alqodos and Hozayn (2010a and b) on lentil and flax under greenhouse condition

100-seed weight

100 seeds or grains weight in gram is a measure of seed size.

Data illustrated in Table 2 showed the effect of using magnetized water on 100-seed weight of tested winter crops.

The weight of 100-seed ranged between 0.42-87.62 g according to the plant type. Irrigation of plants with magnetized water increased 100-seed weight at all crops under study except canola.

The percent of increase reached to 5.19% at wheat, 10.10 at lentil, 9.34% at chick-pea, 10.72% at faba bean and 37.88% at flax. On the other hand the reduction percent reached to 5.36% at canola.

The same trend was observed by several investigators (Abd Alqodos and Hozayn 2011a &b; Hozayn and AbdAlqodos 2011a&b and Hozayn et al. (2011) who found an increase in the yield of various agronomic crops (chick–pea, lentil, flax and wheat) in response to magnetic water treatments.

Economic yield (ton/fed)

The response of some winter crops to irrigation with magnetized water was reflected of crop yield (ton/fed) (Figure 5).

The results showed that, the yield of plant irrigated with normal water ranged between 0.5 – 1.55 ton/fed according to the plant type.

The irrigation plants with magnetized water increased these yield to range between 0.7 – 1.72 ton/fed according to the plant type. Tested winter crops differed in response for irrigation with magnetized water.

Oil crops (canola and flax) came in the first order in response of irrigation with magnetic water where gave the maximum increase percentage over control (38.72% and 42.23%, respectively), followed by legume crops (chick-pea and lentil) by increasing value (27.01% and 29.53%, respectively).

Table 2. 100-seeds or grains weight for winter crops irrigated with normal and magnetized water. Mean values of two seasons, N=8 in each crop, t-test was significant at 0.05 in all tested crops, SD standard deviation

Treatment	Mean ± SD		Increase (+) or decrease (-) (%) over control
Crop	Normal water (control)	Magnetic water	
Wheat	3.764±0.13	3.96±0.11	5.19
Lentil	2.525±0.11	2.78±0.12	10.10
Chick-pea	17.10±0.67	18.70±0.45	9.34
Faba bean	87.62±1.73	97.01±0.98	10.72
Flax	0.61±0.03	0.84±0.03	37.88
Canola	0.42±0.04	0.40±0.02	-5.36

While, wheat as grain and faba bean as legume crops came in the last order by 10.65% and 8.04% increases, respectively.

These results are logical to improvement growth parameters (Figure 1), photosynthetic pigments (Figure 2) and increases in photosynthetic pigments, endogenous promoters (IAA) and increase protein biosynthesis (Hozayn and Amira, 2010 a&b and Amira and Hozayn 2010 a&b). The remarkable improvement induced by the magnetic treatment was consistent with the results of other studies on several crops like cereal, sunflower, flax, pea, soybean, broad bean, wheat, rice, pepper, tomato, potato and sugar beet.

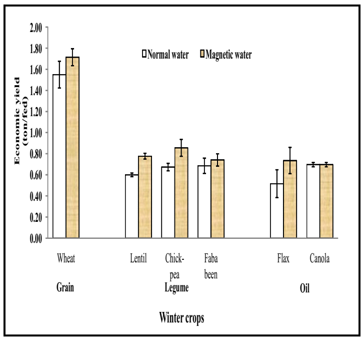

Figure 5. Economic yield (ton/fed) for winter crops irrigated with normal and magnetized water. Mean values of two seasons, N=8 in each crop, t was significant at 0.05 in all tested crops, error bars in each crop expressed as standard deviation

In these studies the crop yield were increased (e.g., Tian et al., 1991, Marinkovic et al. 2000, Marinkovic et al., 2002, Aladjadjiyan, 2002

and 2003, Vasilevski 2003, Podlesny et al., 2004 and 2005, Souza et al. 2006, Selim 2008, Hozayn et al. 2013).
Moreover, Maheshwari and Grewal (2009) suggest that the effects of magnetic treatment varied with plant type, and there were statistically significant increases in plant yield of snow pea, celery and pea plants.

Water use efficiency (WUE)
Similar to economic yield per feddan, there was differential impact of magnetic treatment on water productivity (kg of yield produced per L of water used) (Figure 6). Normal water use efficiency in this study ranged between 0.17 – 0.62 according to the plant type. Magnetized water use efficiency ranged between 0.23 - 0.69 according to the plant type. The percent of increase in water use efficiency ranged between 8.04% at faba bean to 42.23% at flax. Mulook Al-Khazan et al. (2011) recorded that irrigation of jojoba plants with magnetized water led to increase water use efficiency under normal and drought water stress as compared to the recommended irrigation. Magnetic treatment of irrigation water is an acknowledged technique for achieving high water use efficiencies due to its effect on some physical and chemical properties of water and soil (Noran, et al. 1996; Basant et al., 2007; Basant and Harsharn 2009). These changes result in an increased ability of soil to get rid of salts and consequently better assimilation of nutrients and fertilizers in plants during the vegetative period.

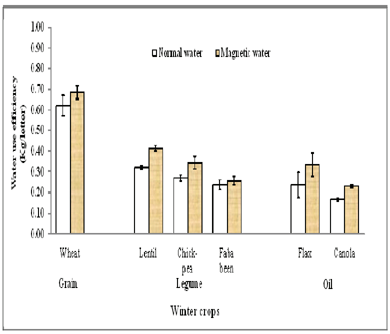

Fig. 6. Water use efficiency (kg/litter water) for winter crops irrigated with normal and magnetized water. Mean values of two seasons, N=8 in each crop, t was significant at 0.05 in all tested crops, error bars in each crop expressed as standard deviation

CONCLUSIONS

The present studies confirmed the promising and previous studies under greenhouse condition. Generally, the present findings have shown that irrigation with magnetized water can be considered as one of the most valuable modern technologies that can assist in saving irrigation water and improving yield and quality of sugar beet under newly reclaimed sandy soil. The usage of magnetic water in the agricultural production will enable intense and more quantities and qualitative production.

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