American-Eurasian J. Agric. & Environ. Sci., 7 (4): 457-462, 2010
ISSN 1818-6769

Magntic Water Technology, a Novel Tool to Increase Growth, Yield and Chemical Constituents of Lentil (*Lens esculenta*) under Greenhouse Condition

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Abstract: Two pot experiments were carried out in a greenhouse of Agronomy Department, National Research Centre, Giza, Egypt during 2008/09 and 2009/2010 winter seasons to comparison between irrigation with magnetize and tap water on growth, yield, yield components and chemical constituents of lentil (*lens esculenta* Moench). Irrigation lentil plant with magnetized water significantly improvement the most above mentioned parameter compared with tap water. On average of both seasons, the percent of increment reached to 21.75, 18.18, 15.05 and 1.37% for plant height, fresh and dry weight per plant and water contents (%), respectively and was 13.58, 44.67, 21.4, 2.7, 21.4, 20 and 148.19% for Chl a, Chl. b, Chl. a+b, carotenoids, total pigment, total phenols and total indole, respectively. Also the 7 new protein bands formed in the plants that irrigated with magnetized water compared with tap water. The improvement in growth and chemical constituent parameters reflected in increasing seed, straw and biological yield per plant by 24.98, 26.69 and 25.82%, respectively over the control treatment. It appears that utilization of magnetized water technology me be considered a promising technique to improving lentil yield productivity.

Key words: Lentil · Magnetized water · Growth · Yield · Chemical constituents

INTRODUCTION

Agricultural sciences take an interest not only in the common and valued crop-forming factors, but also in those less expensive and generally underestimated, though more pro-ecological ones, such as ionizing, laser or ultraviolet radiation and electric and magnetic fields. The water treated by the magnetic field or pass through a magnetic device called magnetized water. There have been many investigations on the effects of low frequency electric and magnetic fields on plants. It has been shown that a magnetic field (MF) has effects on the normal functions of living things. A magnetic field was shown to induce seed germination, reproduction and growth of the meristem cells and chlorophyll quantities, shoot development, fresh weight, plant height, fruit yield per plant, average fruit weight and yield of different crops i.e., paulownia, barley, maize, strawberry, rice, soybean, wheat and pea [1-9]. The effects of magnetic field cause increases in proliferation, gene expression and protein biosynthesis and alterations in cell membrane properties on tissue, cellular and sub cellular levels [10]. Investigations of magnetic field on biological systems have demonstrated generalized increases in gene transcription and changes in the levels of specific mRNAs [11].Utilization of magnetized water have bean studied and applied widely in many centuries (Russia, Australia, Poland, Turkey, Portugal, England, United States, China and Japan [9, 12]. Data recorded from these studies showed that, decrease of soil alkalinity, increase in mobile forms of fertilizers, increase in crop yields and earlier vegetation periods can be achieved by magnetized water treatment. However, in Egypt the available studies and application of this technology in agriculture is very limited. Therefore, the present work aim to study the effect of irrigation with magnetized water on growth, yield, yield components and some chemical constituent of lentil under green house condition.

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MATERIALS AND METHODS

Two pot experiments was conducted in the green house of Agronomy Department, National Research Centre, Dokki, Giza, Egypt during 2008/09 and 2009/2010 winter seasons to study the response of growth, yield and some chemical constituents of lentil plants for irrigation with tap and magnetized water. Seeds of lentil (var. Sinai-1) were obtained from Legume Research Department, Field Crops Institute, Agriculture Research Centre, Giza, Egypt. Seeds without visible defect, insect damage and malformation were selected and planted in ten pots (30 cm in diameter and 50 cm depth) containing a mixture of clay and sandy soil (2:1). Half of the pots were irrigated once a week interval with tap water, while the other five pots were irrigated with the tap water after magnetization through passing in magnetic device (U050 mg, 0.5 inch, output 4-6 m^3/hr, production by Magnetic Technologies L.C.C., Russia, branch United Arab Emirates). Sowing date was in the first week of December and second week of November in first and second seasons, respectively. The recommended of NPK fertilizers were applied through the period of experiment. At 55 days from sowing plant height, fresh and oven dry weight of 15 lentil plants were determined. Photosynthetic Pigments (chlorophyll a, chlorophyll b and carotenoids) of leaves were determined spectrophotometrically as the method described by Moran [13]. Total indole acetic acid (IAA) as described by Larsen *et al.* [14] and total phenol, as described by Malik and Singh [15], were estimated in the fresh shoots. Electrophoresis protein profile of lentil shoots were analyzed according to sodium dodocylsulphate polyacrylamide gel electrophoresis (SDS-PAGE) technique [16]. Polypeptide maps, molecular protein markers, percentage of band intensity, molecular weight and mobility rate of each polypeptide were related to standard markers using gel protein analyzer version 3 (MEDIA CYBERNE TICE, USA).

Statistical analysis was conducted using SPSS program Version 16. A student test (*t*-test) was done to find the significant differences between magnetic and nonmagnetic water treatments.

RESULTS AND DISCUSSION

The changes of growth characters i.e. plant height, fresh and dry weights / plant and water content (%) of lentil plants irrigated with magnetized water are recorded in Table 1. Lentil plants irrigated with magnetized water exhibited significant increases in all above growth parameters except dry weight in the second season and water contents (%) in both seasons, where the increases were not significant. On average of both seasons, the percent of increments reached to 21.75, 18.18, 15.05 and 1.37% in the above mentioned parameters, respectively. The simulative effect of magnetized water on growth parameters may be attributed to the induction of cell metabolism and mitosis. These results are in good harmony with those obtained by Belyavskaya [17]. Several investigators indicated that the stimulatory role of magnetic water on growth of different plant species [7, 11, 18, 19]. The stimulatory effect of MW on growth criteria of this study may be also attributed to the increase in photosynthetic pigment, endogenous promoters (IAA), total phenol (Table 2) and increase in protein biosynthesis (Table 4). In this connection, Shabrangi and Majd [20] concluded that, biomass increasing needs metabolic changes particularly increasing protein biosynthesis.

Data in Table 2 show that, irrigated lentil plants with magnetized water significantly increased chemical constituents in fresh shoot at 55 days after sowing i.e., Chl a, Chl. b, Chl. a+b, carotenoids, total pigment, total phenols and total indole contents by 13.58, 44.67, 21.4, 2.7, 21.4, 20 and 148.19% in the above parameters, respectively. These results may be attributed to the role of magnetic water in increasing growth parameters (Table 1), or growth promoters (Table 2). In this respect, Atak *et al.* [4] and Tian *et al.* [21] concluded that, chlorophyll content of paulownia was increased in plants after short period of exposure to MF. Also, Çelik *et al.* [11] and Carimi *et al.* [22] concluded that, MF stimulates protein synthesis via increase cytokinins and auxins and they can promote the maturation of chloroplast. In addition, Atak *et al.* [5] showed that, the increase in shoot regeneration, chloroplast rate, root formation and fresh weight of soybean were accompanied by the increase in auxin synthesis which induced by magnetic field treatment. Moreover, Atak *et al.* [5] and Goodman *et al.* [23] described the role of MF in changing the characteristics of cell membrane, affecting the cell reproduction and causing some changes in cell metabolism. So the increase in total phenol under this study may be attributed to the role of MT in changing the cell membrane properties.

The protein electrophoratic pattern of lentil leaves showed that, control leaves exhibited separation of 11 protein bands ranged between 342 Kda and 20 KDa.

Table 1: Effect of irrigation with magnetized water on lentil growth at 55 days after sowing compared with tap water at 2008/09 and 2009/2010 seasons

	Treatments					
	2008/09 season			2009/2010 season		
Characters	Tap water	Magnetic water	*t*-sign.	Tap water	Magnetic water	*t*-sign.
Plant height (cm)	15.20	18.40	*	17.16	21.00	**
Fresh weight (g plant^{-1})	0.56	0.66	**	0.67	0.79	*
Dry weight (g plant^{-1})	0.17	0.19	**	0.24	0.27	ns
Water contents (%)	70.12	70.61	Ns	64.18	65.49	ns

*, ** *t* is Significant at the 0.05 and 0.01 levels, respectively, ns: non significant

Table 2: Effect of irrigation with magnetized water on lentil photosynthetic pigments, total phenol and total indole contents at 55 days after sowing compared with tap water at 2008/09 season

		Treatments		
Characters		Tap water	Magnetic water	*t*-sign.
photosynthetic pigments (mg/100 g fresh weight)	Chlorophyll a	3.71	4.22	*
	Chlorophyll b	1.25	1.80	*
	Chlorophyll a+b	4.96	6.02	*
	Carotenoids	4.77	4.90	Ns
	Total pigments	9.92	12.04	*
	Total phenol (mg/100 g fresh weight)	179.18	215.02	**
	Total Indole (μg/100 g fresh weight)	0.83	2.06	**

*, ** *t* is Significant at the 0.05 and 0.01 levels, respectively, ns: non significant.

Table 3: The relative area % of protein bands in lentil leaves irrigated with magnetic water at 55 days after sowing

M wt. K.Da.	Tap water	Magnetic water
342	1.76	1.83
332		2.44
323	2.72	2.58
307	--	2.00
301	--	1.27
242	10.23	12.75
151	8.60	4.97
135	4.55	2.15
127	6.17	--
93	--	10.35
75	--	7.85
65	17.32	2.85
55	--	6.05
52	8.11	4.73
47	13.30	14.96
38	--	6.59
33	18.31	16.63
20	8.93	--
Band number	11	16
Number of new band	7	

Table 4: Effect of irrigation with magnetized water on lentil yield and its components at harvest compared with tap water at 2008/09 and 2009/2010 seasons

	Treatments					
	2008/09 season			2009/2010 season		
Characters	Tap water	Magnetic water	*t*-sign.	Tap water	Magnetic water	*t*-sign.
Plant height (cm)	16.40	20.60	**	23.20	25.60	*
Branches (number plant^{-1})	2.71	3.60	*	3.32	3.92	*
Pods (number plant^{-1})	4.78	6.40	**	6.76	8.40	**
Pods weight (g plant^{-1})	0.63	0.72	*	0.74	0.88	**
Seeds (number plant^{-1})	8.75	10.50	**	10.66	12.34	**
100-seed weight (g)	5.20	5.62	**	5.45	5.69	**
Seed yield (g plant^{-1})	0.52	0.66	**	0.63	0.78	**
Straw yield (g plant^{-1})	0.54	0.71	**	0.75	0.91	*
Biological yield (g plant^{-1})	1.06	1.37	**	1.38	1.69	**

*, ** *t* is Significant at the 0.05 and 0.01 levels, respectively, ns: non significant.

Magnetic treatment induced the increase of protein bands to 16. The new protein bands appeared at molecular weights 332, 307, 301, 93, 75, 55 and 38 KDa. Magnetic treatment also, showed disappearance of two protein bands at molecular weights 127 and 20 K Da. The induction of new protein bands in lentil plants treated with magnetic water could explain the stimulatory role of this physical tool in increasing growth, photosynthetic pigment, total phenol, total indole consequently yield components of lentil plants. Tenforde [10] postulated that, magnetic field increase proliferation, gene expression and protein biosynthesis. Also, Çelik *et al.* [11] found that, the effect of MF on biological systems has explained by the increases in gene transcription and changes in the levels of specific mRNA.

Regarding to the effect of magnetic water on lentil yield and its components, data in Table 3 showed the promotive effect of this tool in increasing all yield components such as number of branches, pods and seeds per plant and weight of pods, seeds, straw and biological yields per plant and 100-seed weight significantly in 2008/09 and 2009/2010 seasons. An average of both seasons the percent of increase reached to 17.98, 25.48, 29.08, 17.03, 17.88, 24.98, 26.69, 25.82 and 6.24 % for above mentioned parameters, respectively. These results reflect the stimulatory role of magnetic water on increasing growth criteria (Table 1), photosynthetic pigment and growth promoters (IAA and total phenols) (Table 2) and the increase in protein biosynthesis (Table 3). In this connection, Tian *et al.* [21] indicated that, MW increased yield of rice by 13.23%. This was accompanied with the stimulation effect of magnetic water on leaf chlorophyll content. Kordas [24] found that, the exposure of green tops and root systems of wheat plant to MF increased quantity of coarse grain by 10.6 and 6.3%, respectively. Moreover, De Souza *et al.* [25] showed that, MT on tomato increased significantly the mean fruit weight, the fruit yield/plant, the fruit yield per area and the equatorial diameter of fruits in comparison with the controls. Also, Çelik *et al.* [11] concluded that, MF was shown to induce fruit yield/plant and average fruit weight. In addition, Vashisth and Nagarajan [26] suggested that, the effect of MW may be resonance like phenomenon which increases the internal energy of seeds to get higher yields. In addition, the remarkable improvement induced by the magnetic treatment was consistent with the results of other studies on other crops like cereal, sunflower, flax, pea, wheat, pepper, tomato, soybean and potato. In these studies the crop yields were increased [6, 27-32].

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