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Irrigation with magnetized water enhances growth, chemical constituent and yield of chickpea (*Cicer arietinum* L.).

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ABSTRACT

Magnetic fields are known to induce biochemical changes and could be used as a stimulator for growth related reactions. Two pot experiments were conducted during 2008/09 and 2009/2010 seasons at green hose of National Research Centre, Egypt to study the impact of magnetized water on growth, some chemical constituents (chlorophyll a and chlorophyll b, carotenoids, total pigment, total indole, total phenol contents and protein profile of plant) and productivity of chickpea plants. Chickpea seeds were irrigated with water passed through 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). Results indicated that, irrigation with magnetized water induced positive significant effect on all studied parameters. The percent of increase in seed, straw and biological yields per plant were 39.64, 41.03 and 39.85%, respectively compared with tap water (average over both seasons). Magnetic water treatment could be used to enhance growth, chemical constituents and productivity of chickpea under green house condition.
Keywords: Chickpea, magnetized water, growth, chemical constitute, yield.

INTRODUCTION

The water treated by the magnetic field or pass through 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 it. Wojcik (1995) reported that in the beginning of 1980s Japanese called Fujio Shimazaki working in Shimazaki Seed Company was the first who reported that stationary magnetic fields can improve the germination of seeds and speed up the growth of plants. According to Jones *et al.* (1986) they found that the electromagnetic fields amplify the plant growth regulator induced Phenylalanine Ammonia-Lyrase during cell differentiation in the suspended cultured plant cell.

Magnetic fields have been reported to exert a positive effect on the germination of seeds (Alexander and Doijode, 1995; Carbonell *et al*., 2000), on plant growth and development (De Souza *et al*., 1999; Martínez *et al*., 2000), on tree growth (Ruzic *et al*., 1998), on the ripening of fruits and vegetables (Boe and Salunke, 1963) and on crop yield (Pietruszewski, 1993); some review papers also mention a number of controversial, early results (Findlay and Hope, 1976; Frey, 1993).

According to the data obtained from Russia, Australia, Poland, Turkey, Portugal, England, United States, China and Japan (Yakovlev *et al*. 1990 and Cakmak *et al*. 2009), 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 constitute of chickpea under green house condition.

MATERIAL AND METHODS

Two pot experiments were conducted in the screen green house of Agronomy Department, National Research Centre, Dokki, Giza, Egypt during two successive winter season (2008/09 and 2009/2010) to study the response of growth, yield and some chemical constituents of chickpea for irrigation with

tap and magnetized water. Seeds of chickpea (*Cicer arietinum* L.) (var. Sena-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). Sowing date was in the first week of December and second week of November in first and second seasons, respectively. Half of the pots were irrigated twice on a week interval with tap water, while the other ten 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). The recommended NPK fertilizers were applied through the period of experiment.

At 55 days from sowing, plant height, fresh and oven dry weight of fifteen chickpea plants were determined. Photosynthetic Pigments (chlorophyll a, chlorophyll b and carotenoids) of leaves were determined spectrophotometrically as the method described by Moran (1982). Total indole acetic acid (IAA) as described by Larsen *et al*., (1962), and total phenol, as described by Malik and Singh (1980), were estimated in the fresh shoots. Electrophoresis protein profile of lentil shoots were analyzed according to sodium dodocyl sulphate poly acrylamide gel electrophoresis (SDS-PAGE) technique (Sheri, *et al*., 2000). 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). On the first week of May in both seasons, data on chickpea yield and its components were recorded.

Statistical analysis was conducted using SPSS program Version 16. A student test (*t*-test) was done to examine the significance between magnetic and nonmagnetic water treatments of all characters under study.

RESULTS

Chick pea growth: Data presented in Table (1) show that irrigation chick pea plant with magnetized water significantly increased tested growth parameters as compared to pots which irrigated with tap water. The improvement over control treatment reached to 11.98, 12.51, 5.76, and 1.88% for plant height, fresh and dry weight (g/plant) and percentage of water contents (%), respectively as average of two seasons.

Chemical constituents: Photosynthetic pigments (Chlorophyll a, Chlorophyll b, total chlorophyll a+b and carotenoids), total phenols and total indole in shoot plants at 45 days after sowing show obvious changes than the control in response to the irrigation with magnetized water as shown in Table 2. Significant increases in the above mentioned characters were recorded from irrigated plants with magnetized water as compared to irrigated plants with tap water. The increases in these parameters reached to 26.56, 21.83, 24.91, 42.00, 16.64, 39.22 and 8.66%, respectively over control treatment.

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

Treatment	**2008/09 season**		***t*-sign.**	**2009/2010 season**		***t*-sign.**
Character	Tap water	Magnetic water		Tap water	Magnetic water	
Plant height (cm)	20.40	23.60	*	24.20	26.20	ns
Fresh weight (g plant $^{-1}$)	1.39	1.58	**	1.55	1.73	**
Dry weight (g plant $^{-1}$)	0.32	0.35	ns	0.37	0.38	*
Water contents (%)	76.98	77.85	ns	75.93	77.93	**

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

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

Treatment / Character		Tap water	Magnetic water	*t*-sign.
Photosynthetic pigments (mg/100 g fresh weight)	Chlorophyll a	5.72	7.24	**
	Chlorophyll b	3.07	3.74	**
	Chlorophyll a+b	8.79	10.98	**
	Carotenoids	4.48	4.50	ns
	Total pigments	13.27	15.48	**
Total phenol (mg/100 g fresh weight)		312.29	434.13	**
Total indole (µg/100 g fresh weight)		9.80	9.80	**

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

Protein electrophoratic pattern: The protein electrophoratic pattern of chick pea leaves showed that, control leaves exhibited separation of 15 protein bands ranged between 329 KDa and 30 KDa. Magnetic treatment induced the increase of protein bands to 22. The new protein bands appeared at molecular weights 314, 248, 235, 226, 192, 135, 49 and 32 KDa. Magnetic treatment also, showed disappearance of one protein band at molecular weight 56 K KDa.

Chickpea yield and its components: Data presented in Table (4) show that irrigation chick-pea plants with magnetic water significantly increased all yield and yield components compared to control treatment. The percent of increments reached to 38.64, 41.03 and 39.85 in seed, straw and biological yield per plant respectively as average of both seasons.

Table 3. Relative area percent of chick pea leaves irrigated with magnetic and non magnetic water at 55 days after sowing. (2008/09 season).

M wt. K.Da.	control	Magnetic
329	3.54	2.51
323	3.61	1.47
314		2.32
322	16.97	1.46
248		7.80
235		1.31
226		2.51
192		2.68
189	4.60	2.32
148	4.23	5.38
135		1.99
124	8.00	2.06
86	4.27	5.24
66	6.89	7.70
56	6.15	
53	2.76	5.69
49		5.08
45	10.45	7.76
42	8.80	7.17
36	8.79	6.15
35	5.34	2.25
32		10.68
30	5.60	8.47
Band Number	15	22
Number of new band		8

Table 4. Effect of irrigation with magnetized water on chickpea yield and its components at 55 days after sowing compared with tap water at 2008/09 and 2009/2010 seasons.

Treatment	2008/09 season		*t*-sign.	2009/2010 season		*t*-sign.
Character	Tap water	Magnetic water		Tap water	Magnetic water	
Plant height (cm)	28.40	35.20	**	32.40	41.80	**
Branches (number plant^{-1})	2.47	3.23	**	3.20	4.40	**
Pods (number plant^{-1})	6.60	8.81	ns	7.60	11.50	**
Pods weight (g plant^{-1})	1.86	2.59	**	1.96	2.76	**
Seeds (number plant^{-1})	6.89	9.50	**	7.13	10.20	**
100-seed weight (g)	18.16	19.03	**	19.13	19.17	ns
Seed yield (g plant^{-1})	1.36	1.77	**	1.43	2.10	**
Straw yield (g plant^{-1})	1.43	1.91	**	1.98	2.94	**
Biological yield (g plant^{-1})	2.79	3.68	**	3.41	5.04	**

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

DISCUSSION

Magnetic water is considered one of several physical factors affects plant growth and its development. Results obtained in Table (1) showed that chickpea plants which irrigated with magnetic water grew taller and heavier than those irrigated with tap water. The stimulatory effect of the application of magnetic water on the growth parameters reported in this study may be attributed to the increase in photosynthetic pigments, endogenous promoters (IAA) (Table 2); increase protein biosynthesis (Table 3). In this connection, Fomicheva *et al.,* (1992 a & b) and Belyavskaya (2001) reported that magnetic water significantly induces cell metabolism and mitosis meristematic cells of pea, lentil and flax. Moreover, the formation of new protein bands in plants treated with magnetic water may be responsible for the stimulation of all growth, and promoters in treated plants. In this respect, Celik *et al.* (2008) found that the increase in the percentage of plant regeneration is due to the effect of magnetic field on cell division and protein synthesis in paulownia node cultures. Shabrangi and Majd (2009) concluded that, biomass increasing needs metabolic changes particularly increasing protein biosynthesis. Our results are in agreement with those obtained by other researchers; Hilal and Hilal (2000) they reported that magnetized water has more tripled seedling emergence of wheat than tap water. Reina *et al*. (2002) found significance increase in the rate of water absorption accompanied with an increase in total mass of lettuce with the increase of magnetic force. Moreover, Nasher (2008) found that chick pea plants irrigated with magnetized water were taller than plants irrigated with tap water

Significant increases in pigment fractions were recorded in chickpea plants irrigated with magnetized water compared to control treatment. These results may be due to the effect of magnetic field on alteration the key of cellular processes such as gene transcription which play an important role in altering cellular processes. In this respect Tian *et al*. (1991) and Atak *et al*. (2000 and 2003) who found an increase in chlorophyll content specifically appeared after exposure to a magnetic field for a short time. Moreover, Atak *et al*. (2003) suggested that, increase all photosynthetic pigment through the increase in cytokinin synthesis which induced by MF. They also added cytokinin play an important role on chloroplast development, shoot formation, axillary bud growth, and induction of number of genes involved in chloroplast development nutrient metabolism. It also may be due to the increase in growth promoters (IAA) (Table 2). Similar results were observed on rice and chick-pea when irrigated with magnetic water (Tian *et al*. 1991 and Nasher 2008). As well as the improvement of photosynthetic pigments were recorded in *Paulowria species* (Atak *et al* 2000), sunflower (Oldocay, 2002), soy bean (Atak *et al* 2003) when seeds or explants exposed to magnetic field (3.8 – 4.8 mt) for a short time.

Our results also showed the promotive effect of magnetic water treatment on total phenols and total

indole. This improvement may be attributed to the role of MT in changing the characteristic of cell membrane, effecting the cell reproduction and causing some changes in cell metabolism (Goodman *et al*., 1995 and Atak *et al*., 2003).

The formation of new protein bands in plants treated with magnetic water was accompanied with increasing growth promoters (IAA) (Table 3). In this respect, Kuba *et al*., (2000) found that IAA effect on DNA replication. Moreover, Celik *et al.* (2008) and Shabrangi and Majd (2009) reported that magnetic field is known as an environmental factor which affects on gene expression. Therefore, by augmentation of biological reactions like protein synthesis

Chickpea yield and its components were increased significantly under magnetic irrigation. These results are logical to improvement growth parameters (Table-1) and growth promoters (IAA) and photosynthetic pigments (Table 2). 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, potato and sugar beet. In these studies the crop yield were increased (Pittman,1972; Gubbels,1982; Vakharia *et al*., 1991; Pietruszowski, 1993; Namba *et al*., 1995; Atak *et al*., 1997; Özalpan *et al*., 1999; Yurttafl *et al*., 1999; Pietruszewski (1999a &b) Reina *et al*., 2001; Oldaçay, 2002,), Takac *et al*. (2002), Crnobarac *et al*. (2002) and Marinkovic *et al*. (2002).

It could be concluded from this study that, chick pea irrigation with magnetized water could effectively increase growth parameters, yield and some chemical constituents.

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