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Response of Growth, Yield, Yield Components and Some Chemical Constituents of Flax for Irrigation with Magnetized and Tap Water

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Abstract: The water treated by the magnetic field or pass through a magnetic device called magnetized water. Two pot experiments were carried out at the greenhouse of Agronomy Department, National Research Centre, Dokki, Giza, Egypt during two successive winter growth seasons (2008/09 and 2009/2010) to study the effect of irrigation with magnetized water on growth, yield, yield components and some chemical constituents of flax compared with tap water. According to average of both seasons results, flax plants which irrigated with magnetic water exhibited marked increases in the most of vegetative growth, chemical constitute i.e. photosynthetic pigments (chlorophyll a, b and carotenoids), total phenols and total indole over the control plants. The magnetized water treatment exhibited an increase in the number of protein bands as compared to the control. Moreover, the magnetized water treatment increased yield and yield component traits at harvest. The increases in seed yield/plant reached to 9.10% compared with tap water treatment. It appears that the preliminary study on utilization of magnetized water can led to improve flax yield under green house condition.

Key words: Flax · Magnetized water . Growth · Yield . Chemical constituents.

INTRODUCTION

The water treated by the magnetic field or pass through a magnetic device called magnetized water. The effect of magnetic field on the productivity of different crops has been studied by Phirke *et al.* [1], Pietruszewski [2, 3] and Aladjadjiyan [4]. It has been established that the proper combination of magnetic field induction and exposure accelerates the early stages of plant development and improves the productivity. Consequently, the magnetic field effect can be used as an alternative to the chemical methods of plant treatment for improving the production efficiency [5]. Today we know that magnetic fields have a positive effect on plant characteristics such as seed germination, seedling growth, agronomic traits and seed yield on different crops [3, 6-9]. In addition, shoot and root regeneration of paulownia plants were increased in cultured explants exposed to magnetic fields [10].

According to the data obtained from Russia, Australia, Poland, Turkey, Portugal, England, United States, China and Japan [11, 12], 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 and 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 flax under green house condition.

MATERIALS AND METHODS

Tow pot experiments were conducted in the greenhouse of Agronomy Department, National Research Centre, Dokki, Giza, Egypt during two successive winter growth seasons (2008/09 and 2009/2010) to study the response of growth, yield and some chemical constituents of flax plant for irrigation with tap and magnetized water. Seeds of flax (var. Sakha 2) were obtained from Field Crops Institute, Agriculture Research Centre, Giza,

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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 5 pots were irrigated with the tap water after magnetization through a one inch Magnetron (U.T. 3). The recommended NPK fertilizers were applied through the period of experiment.

At 55 days from sowing plant height, fresh and dry weights of 15 flax plants were determined. Photosynthetic pigments (chlorophyll a, 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 flax 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). On the first week of May in both seasons, data on flax 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 significant differences between magnetic and nonmagnetic water treatments.

RESULTS AND DISCUSSION

Data presented in Table 1 clear that irrigation flax with magnetized water increased plant height, fresh and dry weights/plant and water content at 55 days after sowing over the control treatment in 2008/09 and 2009/2010 seasons. The increases were significant only in fresh weight in both seasons and in plant height in the second season. An average of both seasons the increase reached to 6.01, 16.62, 12.58 and 1.48% in the above mentioned characters, respectively. These results may be attributed to the role of magnetic treatment in increasing absorption and assimilation of nutrients consequently increasing plant growth. In this connection, Atak *et al.* [7] concluded that, shoot and root formations were increased when soybean explants exposed to MF at 2.2 second. Also, Aladjadjiyan [5] concluded that, a maximum increase of the fresh weight and the germ length of maize were observed when seeds exposed to magnetic field. Moreover, Shabrangi and Majd [17] reported that, the greatest shoot growth and biomass were seen in lentil plants exposed to magnetic field.

Regarding the effect of MW treatment on the photosynthetic pigment contents of flax plant, season 2008/09 results in Table 2 showed that the stimulatory effect of this treatment on all pigment fractions (Ch1a, Ch1 b, Ch1(a + b), carotenoids and total pigment) contents. The percent of increase reached to 17.46, 67.8, 31.45, 8.55 and 31.45% in the above parameters, respectively compared to control treatment. These results may be due to the effect of magnetic water on alteration the key of cellular processes such as gene transcription which play an important role in altering cellular processes. It also may be due to the increase in growth promoters (IAA) (Table 2). The same result was obtained by Atak *et al.* [6] and Tian *et al.* [18] who found that an increase in chlorophyll content specifically appeared after exposure to a magnetic field for a short time. Moreover, Atak *et al.* [7] suggested that, increase all photosynthetic pigment through the increase in cytokinins synthesis which induced by MF. They also added cytokinin play an important role on chloroplast development, shoot formation, auxiliary bud growth and induction of number of genes involved in chloroplast development nutrient metabolism. Agostino and Kieber [19] and Carimi *et al.* [20] concluded that MF stimulates protein synthesis via increase cytokinins and they can promote the maturation of chloroplast. Çelik *et al.* [21], reported that, the positive effect of MF on regeneration %, shoot numbers and chlorophyll content of the explants exposed to a MF for a 2.2s period were higher than controls.

The results in Table 2 also showed the promotive effect of MT on total indole and phenol. The % of increment reached to 18.20 and 33.35%, respectively over the control treatment. These results are in good harmony with those obtained by Atak *et al.* [7] who reported that, shoot regeneration and chloroplast rate were increased at the explants exposed to MF and root formation rate and fresh weight were also increased in accordance with control. As a consequence, the increase in auxin synthesis may be induced by MF in soybean plants. The increment in total phenol content in plants treated with MW 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 [7, 22].

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

	2008/09 season			2009/2010 season		
Treatments Character	Tap water	Magnetic water	*t*-sign.	Tap water	Magnetic water	*t*-sign.
Plant height (cm)	24.00	25.00	ns	26.20	28.26	**
Fresh weight (g plant $^{-1}$)	0.61	0.71	**	0.79	0.93	**
Dry weight (g plant $^{-1}$)	0.15	0.16	ns	0.21	0.24	ns
Water contents (%)	75.47	77.09	ns	74.10	74.19	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 flax photosynthetic pigments, total indole and total phenol contents at 55 days after sowing compared with tap water at 2008/09 season.

TreatmentsCharacters		Tap water	Magneticwater	*t*-sign.
photosynthetic pigments (mg/100 g fresh weight)	Chlorophyll a	6.13	7.20	**
	Chlorophyll b	2.36	3.96	**
	Chlorophyll a+b	8.49	11.16	**
	Carotenoids	4.60	4.99	ns
	Total pigments	16.98	22.32	**
Total Indole (µg/100 g fresh weight)		1.20	1.59	**
Total phenol (mg/100 g fresh weight)		208.19	246.07	**

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

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

M wt. K.Da.	Tap Water	Magneticwater
337	2.54	3.58
318	4.49	3.03
301	--	3.42
279	2.43	3.03
267	--	3.22
251	2.37	3.26
232	4.61	3.15
223	--	3.65
210	--	2.40
143	7.40	7.60
113	--	3.86
107	--	2.56
98	--	5.49
89	15.70	--
71	6.21	2.75
59	--	6.77
53	10.61	6.03
47	11.22	10.44
45	--	5.96
41	11.36	4.75
38	7.26	2.45
33	13.80	12.60
Band number	13	21
Number of new band		9

Protein Electrophoresis: The changes in protein electrophoratic pattern of flax shoot treated with magnetic water is analyzed and recorded in Table 3. In the control leaves, the separation of 13 protein bands were appeared, their molecular weights ranged between 337 K Da. and 33 K Da. Magnetic water treatment of flax plants showed an increase in the number of protein bands to 21 bands. These results indicated that the leaves of plants irrigated with magnetic water characterized by the appearance of new ones as compared with that of the control plant (Table 3). The nine new protein bands appeared at molecular weights 301, 267, 223, 210, 113, 107, 98, 59 and 45 KDa. The induction of new protein bands in response to MWT may be as a result of the effect of MFs in increases proliferation, gene expression and protein biosynthesis [23]. Also, Çelik *et al.* [21] concluded that investigations of MF on biological systems have demonstrated generalized increases in gene transcription and changes in the levels of specific mRNAs.

Flax Yield and its Components: With respect to the effect of MT on the yield and yield component of flax, data in Table 4 cleared that MT increased all yield characters namely plant height, technical length, based branches, fruit branches, capsules numbers and weight/plant, seed number/capsule, seeds number and weight/plant and 100-seed weight, over the untreated control by 3.98, 9.42, 12.95, 5.51, 14.46, 14.00, 8.67, 24.34, 3.64 and 9.10%,

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

	2008/09 season			2009/2010 season		
Treatments Character	Tap water	Magnetic water	*t*-sign.	Tap water	Magnetic water	*t*-sign.
Plant height (cm)	56.80	58.20	*	58.30	61.40	**
Technical length (cm)	43.40	48.80	*	48.50	51.60	**
Based branches (number plant^{-1})	2.40	2.80	Ns	2.60	2.84	ns
Fruit branches (number plant^{-1})	5.60	6.00	Ns	6.20	6.44	ns
Capsules (number plant^{-1})	9.20	10.80	Ns	10.40	11.60	ns
Capsules weight (g plant^{-1})	0.44	0.53	*	0.53	0.57	ns
Seed (number capsule^{-1})	8.00	8.40	Ns	8.26	9.28	**
Seeds (number plant^{-1})	73.60	90.72	**	85.68	107.46	**
100-seed weight (g)	0.68	0.70	Ns	0.69	0.72	ns
Seed yield (g plant^{-1})	0.32	0.35	*	0.34	0.37	ns

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

respectively as the average of two seasons. These results may be attributed to the role of MT in increasing growth (Table 1), photosynthetic pigment and growth promoters (Table 2) consequently increasing yield characters. These results supported with finding of Moran and Shani [24], Moran *et al.*[25] and Shepard *et al.* [26], who recorded an increase in the yield of various agronomic crops (pepper and melon) in response to MF treatments. In addition, Podlesny *et al.* [27, 28] suggested that, the gain in seed yield resulting from the pre-sowing treatment of seeds with MF for broad bean and pea was due to the higher number of pods per plant and the fewer plant losses in the unit area in the growing season. Moreover, MF was shown to induce fruit yield per plant and average fruit weight [21].

CONCLUSION

Magnetic water treatment has stimulatory effects of growth, photosynthetic pigment, growth promoters and protein synthesis consequently increased yield components of flax plant. So, we could pay more attention to this new cheep and safe tool in increasing the production of our economic crops.

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