MAGNETIC TREATMENT OF IRRIGATION WATER FOR IMPROVING VEGETATIVE GROWTH, FRESH AND DRY YIELD OF BEAN (*PHASEOLUS VULGARIS* L.) GROWN UNDER PLASTIC HOUSE

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Abstract

Using magnetic water is an important environmental factor for agriculture in irrigation systems specially drip irrigation. However, its impact on plant growth is not well studied under normal conditions. Two field experiments were conducted during 2011/2012 and 2012/2013 seasons in a plastic house at Horticulture Research Institute, Kaha station, Kalyobia governorate, Egypt to study the impact of magnetized water on growth, yield and some chemical constituents of two bean (*Phaseolus vulgaris* L.) cultivars Goya and Hama. Results showed significant positive effects of magnetic water on quantity and quality of the studied parameters such as germination %, leaf area/ plant, early and total green pods and seeds weight/ plant. Irrigation with magnetic water gave more vigorous plants. Most studied traits of bean such as vegetative growth (plant height, No. of leaves/ plant, fresh & dry weight/ plant and leaf area/ plant), seed yield and NPK contents of leaves showed significant increase when magnetic water was used. The response of the two cultivars to the magnetic water has similar trend. However, "Goya" cv gave higher values of vegetative growth measurements as well early and total green pod yield/ plant and seed yield (seed weight/ plant and weight of 100 seeds). The enhancement of these studied characters may be due to that the irrigation with magnetized water make plants absorb more nutrients from soil. Increasing of soil nutrients enhancement photosynthesizes property of plants. This experiment was carried out in order to highlight the efficiency use of magnetic water on bean yield and its components.

Key words: Beans, *Phaseolus vulgaris*, magnetic water, plastic house.

INTRODUCTION

The technology of magnetic water has widely studied and adopted in field of agriculture in many countries. In spite of its importance, it is not yet explored in Egypt and available review on the application of magnetize water in agriculture is still limited (Hozayn *et al*. 2011; Hozayn and Qados 2010 a,b). Magnetized water is obtained by passing water through a strong permanent magnet installed in or on a feed pipeline (Mostafazadeh-Fard *et al* 2011). Some information that are available in the literature explain that the magnetic treatment of water modify its structural array, which increases the intercellular movement. Such process may result in greater nutrient uptake increasing the physiological processes related to the crop production (Scaloppi 2008).

The improvement of growth, yield, yield components and chemical constituents of lentil and chickpea by using magnetized water had been found by Hozayn and Qados (2010a) and Qados and Hozayn (2010). They showed that, in pot experiments carried out in a greenhouse in Egypt, irrigating chickpea and lentil plants with magnetized water significantly improved the most above mentioned parameters compared with tap water. The percentage of increment reached to 21.75, 18.18, and 15.05 for plant height, fresh weight per plant and dry weight per plant, respectively for lentil while the percentage of increase in seed, straw and biological yield per plant were 39.64, 41.03 and 39.85%, respectively, for chickpea.

Sadeghipour and Aghaei (2013) studied the effect of irrigation with magnetized water on cowpea. They detected an increase in leaf, stem and root fresh and dry weights, leaf area as well as total biomass as compared to those values obtained by using ordinary water. They also stated that, the stimulatory impact of magnetic water may be ascribed to the increasing of root growth and stomatal conductance which intern increase absorption and assimilation of nutrients.

In other trials in an open field, Al-Qaesi (2009) found that Magnetized water gave taller and heavier plants, increased total yield and the content of P in watermelon plant. Similarly, the best significant vegetative growth of tomato was obtained by magnetized water, which gave the highest number of shoots (30.23) compared with normal water (Abou El-Yazied *et al*. 2012).

In this investigation, we selected bean as a module plant to highlight the positive effects of magnetized treated water. Bean is the most important grain legume for human consumption. It provides an inexpensive food rich in macronutrients such as proteins and starch, important micronutrients such as iron, and also a number of other stored bioactive compounds endowed with positive health implications through their antioxidant, anti-tumour or phyto-oestrogenic activity (Doria *et al*. 2012).

The current research was carried out with the objectives of evaluation and clarifying the influence of magnetic treated water for bean cultivation (green pod and seed yield) so that it can be used in large scales.

MATERIALS AND METHODS

Two main experiments were carried out in the two successive winter seasons 2011-2012 and 2012-2013. The first (experiment I) was a pot experiment and was conducted to study germination percentage and germination rate for two bean (*Phaseolus vulgaris* L.) cultivars, namely, Goya and Hama under normal and magnetic water irrigation.

Each treatment (cultivar and water type) consists of 10 plastic pots 30 cm diameter under plastic house condition. Growing media was taken from of plastic house soil (clayey). Each pot contains 10 seeds. The second (experiment II), the same two cultivars were cultivated under the same plastic house of an area 360 m^2 (40 m long x 9 m width x 3 m height) at Kaha Research Station, Horticulture Res. Inst., Agriculture Research Center, Ministry of Agriculture, Egypt. The soil texture of the experimental field was loamy clay. Plants under plastic house were irrigated by drip irrigation and fertilized according to the recommendations of the Ministry of Agriculture. The experiment design was split plot with three replicates, the two cultivars (Goya and Hama) were arranged in the main plots and irrigation water types treatments (magnetized and normal) were distributed in the sup-plots. In this experiment, plants were drip irrigated either by normal water or by magnetically treated water. Magnetized water was obtained by passing water through a permanent magnet installed on a feed pipeline (magnetic water treatment system. soften, purify, clean merchant sku: mwts -010 which has a pulling force of over 69 lbs).

Seeds of bean cultivars Goya and Hama were sown in the first week of November in both seasons. The area of each experimental plot was 10 m^2 consisted of one row (10 m length with 1 m width). Seeds were planted on the two sides of each ridge at 50 cm apart.

Other cultural practices as fertilizing, harrowing and irrigation were carried out as commonly practiced for the conventional bean planting recommended by ministry of Agriculture.

The water analysis of the tow samples; normal or magnetically treated are represented in Table 1 as follows:

Table 1. Water analysis for magnetic treated water (mag) and normal water (normal)

Sample	pH	E.C. dS/m	TDS ppm	Soluble cations meq/ L				Soluble anions meq/ L				S.A.R.	R.S.C.	S.S.P. %
				Ca^+	Mg^+	Na^+	K^+	CO_3^-	HCO_3^-	Cl^-	SO_4^-			
Normal	7.9	1.2	768	3.2	5	4.73	0.45	-	5.6	3.75	4.03	2.34	-2.6	35.4
Mag	7.8	1.1	723	2.6	5.8	4.6	0.40	-	3.1	3.5	6.35	2.24	-4.8	34.2

S.A.R. = Sodium Absorption Ratio, R.S.C. = Residual Sodium Carbonate, S.S.P. = Soluble sodium Percentage, TDS = Total Dissolved Salts

Data recorded

Experiment I

A. Germination percentage and mean emergence time

Pots were checked daily and newly emerged shoots were recorded until this process was completed. Seedlings were assumed as have emerged when the plants became free above the soil surface.

Germination percentage was calculated as the following:

$$\text{Germination percentage} = \frac{\text{Number of germinated seeds}}{\text{Number of total seeds}} \text{ X } 100$$

Mean emergence time was calculated according to the following equation

$$\text{Mean emergence time} = \frac{(G1 \text{ x} N1) + (G2 \text{ x } N2) + \ldots\ldots\ldots\ldots + (Gn \text{ x } Nn)}{G1 + G2 + \ldots\ldots\ldots\ldots + Gn}$$

Where: G = Number of germinated seeds in certain day, N = Number of this certain day.

Experiment II

B. Vegetative growth

Three plant samples were randomly chosen from each experimental treatment after 75 days (end of flowering stage and beginning of fruit set) from sowing. Each plant sample was dissected into different organs (root, stem, leaves and fruits). The following growth criteria were recorded: plant height (cm), number of leaves /plant, leaf area/plant (cm^2), fresh weight/ plant (g) and dry weight/ plant (g). Total plant leaves area was measured by cutting out leaf discs from leaves using cork borer then dried in an oven at 75 C° for 48 h. Based on the known dry weigh of known surface area of leaves; i.e., leaf discs and total dry weight of leaves/ plant with known area and weight of leaf discs; leaf area was calculated. Flowering was determined as the number of days from sowing till flowering 50% of plants of each experimental plot.

C. Green pod yield and its quality

Yield and its components were determined as follows: early yield (the fruit yield of the first three harvests) and the total yield throughout the entire harvesting season. The first harvest was taken after 80 days from planting then regular harvest each seven days. Fruit measurements were: pod fresh weight (g), pod diameter (cm), pod length (cm) and dry mater % of pods.

D. Chemical analysis

Mineral concentrations were determined in plant leaves. Total nitrogen was determined using micro-Keldahl apparatus, phosphorus was estimated calorimetrically and potassium was determined by using flame-photometrically (A.O.A.C 2000).

E. Seed yield and its components and seed testing parameters

Ten plants were left without pod harvest until seed stage. Samples of plants from each treatment were used to record the following characters:

pod length (cm), number of pods/plant, number of seeds/pod, pods weight/plant (g), seeds weight/plant (g), and total seed weight (g) / m^2.

Statistical analysis

The experimental design was split plot and the statistical analysis was carried out according to the method described by Snedecor and Cochran (1980). Data were subjected to the proper analysis by using the Duncan's Multiple Range Test at 5% (Duncan, 1955).

RESULTS AND DISCUSSION

Experiment I (pot experiment)

Germination percentage and mean emergence time

Data represented in Table 2 showed that Goya recorded significant increase in both seasons in germination % and mean emergence time (Goya took fewer days for complete germination). Using magnetic water showed significant improvement in both season in germination % as well mean emergence time. Interaction between cultivars and irrigation water demonstrated that Goya recorded better results with magnetic water.

Similar results were reported by Selim *et al* (2013) as they found that magnetic field treated water increased seed germination percentage and seedling vigor index of tomato and pea. In another trial by Grewal and Maheshwari (2011) on pea and chickpea, the results showed that magnetic treated water led to a significant increase ($P<0.05$) in emergence rate index. These findings are in agreement with the results of this study where the germination rate decreases with using magnetic water.

Experiment II

A. Vegetative growth

Data presented in Table 3 showed that Goya gave greater records than Hama in most growth attributes. These improvements were significant in both seasons with number of leaves /plant and fresh and dry weight/ plant. For plant height, Goya gave significant increase in the second season only while this increase didn't reach the significant level in the first season. There is no significant difference between the two cultivars in the leave area/ plant. Using magnetic water showed significant increase in both seasons for all growth criteria illustrated except plant height in the first season, the increase wasn't significant. The interaction between cultivars and irrigation water showed that magnetically treated water gave better significant results for most growth criteria in both seasons and the highest values were obtained by Goya. In the second season, there was no significant difference between magnetic and non magnetic water with Goya variety and for leaf area/ plant. Hama recorded the highest value with magnetic water.

In another trial on tomato and pea, Selim *et al* (2013) found that magnetic field treated water increased seed germination percentage and seedling vigor index. Magnetic field treated water increased also plant height and leaf area per plant. Biochemical analysis of the plant leaves irrigated by magnetic water clarified some changes associated with the modifications in the membrane integrity of the plant leaves and the concentrations of some endogenous hormones in the plant shoots. In addition Nasher (2008) reported an increase in chick pea plants length which was irrigated with magnetized water compared with plant irrigated with tap water. Plants irrigated with magnetized water acquire more nutrients from soil.

B. Green pod yield and its quality

1. Flowering and green pod yield

In the two seasons, there was no significant deference between the two cultivars in total yield/ plant and yield/ m^2 but Goya gave a significant improvement in the flowering and early yield / plant (Table 4). Also, magnetic water had positive significant effect in the tow seasons on early and total fresh yield/ plant as well yield/ m^2. As regard to flowering, it is clear that magnetic water gave the best results (fewer days) in both seasons significantly in second only. Interaction between cultivars and water showed that Goya cultivar gave the best results with magnetic water; this improvement was significant in some growth criteria and was no significant in others.

Increase yield by irrigation with magnetic water was noticed by many authors. Abou El-Yazied *et al* (2012) reported an increase in total yield of tomato. Hozayn *et al* (2011) detected similar increase in chick-pea and lentil. Irrigation of cabbage with magnetic treated water led to a significant increase in marketable yield and head quality was positively affected (Bogoescu, 2000). In addition, tomato yield improved significantly by as much as 46% by magnetic water (Peilai *et al* 2004).

The yield of beans grown in a greenhouse irrigated by magnetized water increased by 28.9%. This yield increase may be due to that the magnetic treatment of water modifies its structural array, which increases the intercellular movement. Such process may result in greater nutrient uptake increasing the physiological processes related to the crop production (Scaloppi, 2008).

2. Pod quality

There is no significant difference between most pods quality attributes for the two cultivars of bean in both seasons (Table 5). Pod length of Hama recorded significant increase in the first season. In the second season, there was significant increase in pod fresh weight recorded by Hama and in dry matter pod percentage recorded by Goya. Application of the magnetic water had the highest significant values for pod length and pod diameter in the first season and for pod fresh weight and dry matter in the second season. Interaction between cultivars and irrigation water indicated that magnetic water irrigation gave the best results for pod length, diameter and fresh weight with Hama and for dry matter with Goya. Our results represented in Table 3 showed that the increase in pod yield came from increase in pod length, diameter and weight. Similar result was reported by Hozayn and Qados (2010a) on chickpea.

C. Chemical constitutes

Data represented in Table 6 indicated that Hama recorded the best results for nitrogen and potassium contents but Goya was superior in phosphorus content. In Hama, the high level of nitrogen was significant in the second season only while of potassium it was significant in both seasons. In Goya, its high level of phosphorous content wasn't significant in both seasons. Magnetically treated water recorded significant increase in NPK in first season only, while in second season this increase wasn't significant. Interaction between water type and cultivars clarified that, with magnetic water: Hama recorded significant increase for nitrogen and potassium in first season only, while Goya showed significant increment in phosphorus in second season.

These results were proved by Grewal and Maheshwari (2011) who found that magnetically treated water led to a significant increase ($P<0.05$) in contents of N, K, Ca, Mg, S, Na, Zn, Fe and Mn in both seedling of snow pea and chickpea compared to control. Similar finding was recorded by El Sayed (2014) who stated that magnetic water treatment could be used to enhance inorganic minerals (K^+, Na^+, Ca^{+2} and P^{+3}) contents in all parts of broad bean plant under greenhouse condition.

In addition use of magnetic treated water for cabbage irrigation improved some of the biochemical indicators such as: soluble dry matter (7.5%), titratable acidity (0.33%), soluble sugars (3.3%), ascorbic acid (33.3 mg/100 g), chlorophyll pigments (13.86 mg/100 g) and mineral salts content (1.14%) Bogoescu (2000)

D. Seed yield and seed quality

The highest mean values of seed yield and seed quality characters of bean were observed with Goya (Table 7). This increment was non significant for number of seeds/ pod and germination rate while it was significant in other traits, viz., number of pods/ plant, seed weight/ plant, seed weight / m^2, weight of 100 seed and germination percentage. Magnetic water had positive significant effect in both seasons on most studied traits. Also, it is clear from the results that magnetic water had stimulatory significant effect on the mean germination time, i.e., seeds produced from plant took fewer days to complete germination. Interaction between cultivars and irrigation water demonstrated that, Goya recorded the best results with magnetically treated water; significantly with in some criteria and non significantly in others.

In this connection, Maheshwari and Grewal (2009) reported that the use of magnetically treated irrigation water (as to soil properties after plant harvest) has some beneficial effects as it reduced soil pH but increased soil EC and available P in celery and snow pea.

Hozayn *et al*. (2011) reported that the magnetized water treatment increased seed yield/ plant reached to 26.92% for lentil and 46.62% for check-pea, compared with plants irrigated with tap water under greenhouse condition. Also, Maheshwari and Grewal (2009) found that, for snow peas, there were 7.8%, 5.9% and 6.0% increases in pod yield with magnetically treated potable water, recycled water and 1000 ppm saline water, respectively. However, El Sayed (2014) indicated that, irrigating broad bean with magnetic water induced positive significant effect on all seed parameters and seed yield components such as: legumes no. /plant, legumes wt. /plant, seeds no. / plant, 100 seeds weight and seeds yield /plant.

CONCLUSION

The results clarified the high- efficiency used of magnetically treated water in plastic house cultivation of bean (*Phaseolus vulgaris* L.). Our findings demonstrated the same response of the two cultivars under investigation. Most growth attributes of the two cultivars stimulated positively and improved significantly in response to irrigation with magnetically treated water.

Finally we emphasized that the technique of treated water magnetically in agricultural fields could be a promising technique for agricultural improvement. This technique could be applied efficiency for more vegetable crops.

Table 2. Effect of irrigation with normal tap water (normal) and magnetic water (mag) on germination percentage and mean emergence time of bean cultivars (Goya& Hama) cultivated on pots 30 cm diameter under plastic house in winter seasons of 2011-2012 and 2012-2013.

Characters / Treatments	Germination %			Mean emergence time		
First season						
Cultivar	Goya	Hama	Mean	Goya	Hama	Mean
Water type						
mag	93.3 a	87.5 ab	90.40A	7.00 b	7.56 ab	7.28B
normal	91.7 ab	75.0 b	83.35B	7.23 b	8.25 a	7.74A
Mean	92.5A	81.25B		7.12B	7.91A	
Second season						
Cultivar	Goya	Hama	Mean	Goya	Hama	Mean
Water type						
mag	88.3 a	82.5 b	85.4A	7.70 b	8.26 ab	7.98B
normal	87.3 a	70.0 c	78.65B	7.93 b	8.95 a	8.44A
Mean	87.8A	76.25B		7.82B	8.61A	

Values followed by the same letter are not significantly different, using Duncan's multiple range test at 5% level.

Table 3. Effect of irrigation with normal tap water (normal) and magnetic water (mag) on vegetative growth of bean cultivars (Goya& Hama) grown under plastic house in winter seasons of 2011-2012 and 2012-2013.

Characters / Treatments	Plant length			No. of leaves/ plant			Fresh weight/ plant (g)			Dry weight/ plant (g)			Leaf area/ plant (m^2)		
	First season														
Cultivar	Goya	Hama	Mean	Goya	Hama	Mean	Goya	Hama	Mean	Goya	Hama	Mean	Goya	Hama	Mean
Watertype															
mag	364 a	276 b	320.0A	136 a	75 c	105.5A	904.8a	542.5bc	723.7A	148.9 a	87.6 bc	118.3A	1.115 a	0.974ab	1.045A
normal	329 ab	306 ab	317.5A	104 b	73 c	88.5 B	657.4 b	435.0c	546.2B	104.1 b	73.0 c	88.55B	0.766 b	0.751 b	0.759B
Mean	346.5A	291A		120A	74 B		781.1A	488.8B		126.5A	80.3B		0.941A	0.863A	
	Second season														
Cultivar	Goya	Hama	Mean	Goya	Hama	Mean	Goya	Hama	Mean	Goya	Hama	Mean	Goya	Hama	Mean
Watertype															
mag	305 a	259 c	282A	100 a	67 c	83.5A	715.4 a	425.1 b	570.3A	115.2 a	69.1 b	92.2A	0.735ab	0.758 a	0.747A
normal	279 b	269 bc	274B	79 b	59 d	69B	469.6 b	318.8 c	394.2B	73.4 b	52.4 c	62.9B	0.475 c	0.593bc	0.534B
Mean	292A	264B		89.5A	63B		592.5A	372B		94.3A	60.8B		0.605A	0.676A	

Values followed by the same letter are not significantly different, using Duncan's multiple range test at 5% level.

Table 4. Effect of irrigation with normal tap water (normal) and magnetic water (mag) on flowering and green pod yield of bean cultivars (Goya& Hama) grown under plastic house in winter seasons of 2011-2012 and 2012-2013.

Characters / Treatments	Flowering (day)			Early yield/ plant (g)			Total yield/plant (g)			Yield /m^2 (g)		
	First season											
Cultivar	Goya	Hama	Mean	Goya	Hama	Mean	Goya	Hama	Mean	Goya	Hama	Mean
Water type												
mag	55.7 b	68.3 a	62.0A	395 a	211 b	303A	613 a	459 ab	536A	7356 a	5508 ab	6432 A
normal	60.7 b	73.7 a	67.2A	242 b	140 c	191B	475 a	305 b	390B	5700 a	3660 b	4680 B
Mean	58.2B	71.0A		318.5A	175.5B		544A	382A		6528 A	4584 A	
	second season											
Cultivar	Goya	Hama	Mean	Goya	Hama	Mean	Goya	Hama	Mean	Goya	Hama	Mean
Water type												
mag	60.1 d	67.8 b	63.95 B	300.5 a	163.7 b	232.1A	467.41 a	360.4ab	413.91A	5609 a	4325 ab	4967 A
normal	65.4 c	74.0 a	69.7 A	171.6 b	99.8 c	135.7B	334.1 ab	217.9 b	276.0 B	4009 ab	2615 b	3327 B
Mean	62.75 B	70.9 A		236.05A	131.75B		400.76 A	289.15A		4809 A	3470A	

Values followed by the same letter are not significantly different, using Duncan's multiple range test at 5% level.

Table 5. Effect of irrigation with normal tap water (normal) and magnetic water (mag) on green pod quality of bean cultivars (Goya& Hama) grown under plastic house in winter seasons of 2011-2012 and 2012-2013.

Characters / Treatments	Pod length (cm)			Pod diameter (cm)			Pod fresh weight (g)			Dry mater of pods (%)		
	First season											
Cultivar	Goya	Hama	Mean	Goya	Hama	Mean	Goya	Hama	Mean	Goya	Hama	Mean
Water type												
mag	14.7bc	16.0 a	15.35A	0.75 bc	0.81 a	0.780A	6.95 ab	7.37 a	7.16 A	12.33 a	12.11 a	12.22A
normal	13.8 c	15.0 ab	14.4B	0.74 c	0.77 b	0.755B	6.62 b	7.35 a	6.99A	12.23 a	11.87 a	12.05A
Mean	14.25B	15.5A		0.745A	0.790A		6.79 A	7.36 A		12.28A	11.99A	
	second season											
Cultivar	Goya	Hama	Mean	Goya	Hama	Mean	Goya	Hama	Mean	Goya	Hama	Mean
Water type												
mag	13.7ab	14.6 a	14.15 A	0.68 b	0.75 a	0.715 A	6.43 b	6.84 a	6.635 A	11.90 a	11.13 c	11.515A
normal	13.0 b	13.7 ab	13.35 A	0.72 ab	0.70 ab	0.710 A	5.93 c	6.71 a	6.320 B	11.15 b	11.00 d	11.075B
Mean	13.35A	14.15 A		0.700 A	0.725 A		6.180 B	6.775 A		11.525 A	11.065 B	

Values followed by the same letter are not significantly different, using Duncan's multiple range test at 5% level.

Table 6. Effect of irrigation with normal tap water (normal) and magnetic water (mag) on chemical composition of bean leaves of cultivars (Goya& Hama) cultivated grown under plastic house in winter seasons of 2011-2012 and 2012-2013.

Characters / Treatments	N %			P %			K %		
	First season								
Cultivar	Goya	Hama	Mean	Goya	Hama	Mean	Goya	Hama	Mean
Water type									
mag	1.68bc	1.87 a	1.775 A	0.44 a	0.41ab	0.425 A	1.59 c	1.87 a	1.730 A
normal	1.54 c	1.71 b	1.625 B	0.35 b	0.35 b	0.350 B	1.54 c	1.71 b	1.625 B
Mean	1.61 A	1.79 A		0.395 A	0.380 A		1.565 B	1.790 A	
	second season								
Cultivar	Goya	Hama	Mean	Goya	Hama	Mean	Goya	Hama	Mean
Water type									
mag	1.39 b	1.67 a	1.53 A	0.35 a	0.32 b	0.335 A	1.36 b	1.58 a	1.47 A
normal	1.36 b	1.58 a	1.47 A	0.28 c	0.29 c	0.285 A	1.39 b	1.67 a	1.515 A
Mean	1.375B	1.625 A		0.315 A	0.305 A		1.375 B	1.625 A	

Values followed by the same letter are not significantly different, using Duncan's multiple range test at 5% level.

Table 7. Effect of irrigation with normal tap water (normal) and magnetic water (mag) on dry seed yield and seed testing of bean cultivars (Goya& Hama) grown under plastic house in winter seasons of 2011-2012 and 2012-2013.

Characters / Treatments	No. of pods/plant			No. of seeds/ pod			Seed weight /plant (g)			Seed weight /m^2 (g)			Weight of 100 seed (g)			Germination %			Mean germination time		
	First season																				
Cultivar	Goya	Hama	Mean	Goya	Hama	Mean	Goya	Hama	Mean	Goya	Hama	Mean	Goya	Hama	Mean	Goya	Hama	Mean	Goya	Hama	Mean
Water type																					
mag	157a	12b	14A	7.3 ab	7.7 a	7.5A	177.1 a	136.9 b	157.00A	2125 a	1643 b	1256A	28.35 a	25.19 b	26.77A	96.0 a	91.3 b	93.65A	2.17 b	2.17 b	2.17B
normal	130 b	99 c	114.5B	6.0 b	6.0 b	6.0B	142.5 b	110.2 c	126.35B	1710 b	1322 c	1011B	25.52b	21.93 c	23.73B	93.3 ab	90.0 b	91.65A	2.41 a	2.32 ab	2.36A
Mean	143.5A	113B		6.65A	6.85A		159.80A	123.55B		1917A	1482B		26.94A	23.56B		94.65A	90.65B		2.290A	2.245A	
	second season																				
Cultivar	Goya	Hama	Mean	Goya	Hama	Mean	Goya	Hama	Mean	Goya	Hama	Mean	Goya	Hama	Mean	Goya	Hama	Mean	Goya	Hama	Mean
Water type																					
mag	121 a	100 ab	110.5 a	6.2 ab	6.5 a	6.35A	136.6 a	107.7 b	122.1 A	1639 a	1292 b	1465A	24.56 a	19.95 b	22.26A	96.0 a	92.0 ab	94.00A	2.12 b	2.06 c	2.09 B
normal	92 bc	71 c	81.5 b	5.8 ab	5.7 b	5.75B	100.9 bc	80.0 c	90.5 B	1211bc	960c	1085B	20.47b	17.86 c	19.17B	96.0 a	90.7 b	93.35A	2.28 a	2.18 ab	2.23A
Mean	106.5A	85.5B		6.0A	6.1A		118.8 A	93.8 B		1425A	1126B		22.52A	18.91B		96.0A	91.35B		2.20 A	2.12 A	

Values followed by the same letter are not significantly different, using Duncan's multiple range test at 5% level.

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المعالجة المغناطيسية لمياه الري لتحسين النمو الخضري والمحصول الطازج والجاف من الفاصوليا النامية بالصوب البلاستيكية

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إستخدام الماء الممغنط هو أحد العوامل البيئية الهامة فى الزراعة وخصوصاً في نظام الري بالتنقيط . ومع ذلك لم يتم دراسة تأثيرها على نمو النبات بشكل جيد. من أجل إبراز كفاءتها على محصول النبات ومكوناته، قد أجريت هذه التجربة. أجريت تجربتين حقليتين خلال الموسم الشتوى ٢٠١٢/٢٠١١ و ٢٠١٣/٢٠١٢ تحت ظروف الزراعة المحمية ، معهد بحوث البساتين ، مصر، محطة قها بمحافظة القليوبية لدراسة تأثير المياه الممغنطة على النمو ، وبعض المكونات الكيميائية لصنفين من الفاصوليا (جويا وهاما). أظهرت النتائج تأثيرات إيجابية معنوية للرى بالمياة المعالجة مغناطيسياً على كمية ونوعية الصفات المدروسة. الري بالماء الممغنط كان أفضل وأعطى نباتات أكثر قوة. كما أظهرت النتائج اثار إيجابية لمعظم الصفات المدروسة فى الفاصوليا مثل النمو الخضري والمحصول الطازج و البذرى و محتوي الأوراق من NPK عند إستخدام المياه الممغنطة. كلا الصنفين أظهرا نفس الإتجاهات أى نفس التأثيرات الإيجابية. أعطى صنف الجويا نتائج أفضل لكلٍ من المحصول الخضري (المبكر و الإجمالي والمحصول الطازج للنبات) والمحصول البذرى (وزن البذور للنبات ووزن ١٠٠ بذرة).

يمكن إستنتاج أن المعالجة المغناطيسية للمياه تعتبر تقنية واعدة و يمكن إستخدامها لتحسين النمو، و المكونات الكيميائية وإنتاجية الفاصوليا تحت ظروف الزراعة البلاستيكية. في حين أن نتائج هذه الدراسة مثيرة للإهتمام بالنسبة للزراعة تحت الصوب، فإن إمكانات العلاج المغناطيسي لمياه الري لإنتاج المحاصيل يحتاج إلى مزيد من الدراسة في الزراعات المكشوفة لتوضيح آثاره الإيجابية على إنتاجية المحاصيل.