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Effect of Water and Seeds Magnetization on Root Rot and Wilt Diseases of Faba Bean

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Thirty-eight isolates of fungi belonging to genera *Rhizoctonia*, *Fusarium* and *Macrophomina* were isolated from diseased faba bean plants, collected from different localities in New Valley governorate, showing root rot and wilt symptoms. The isolates proved to be pathogenic on Masr 1 faba bean cultivar under greenhouse conditions. *R. solani*, *F. solani*, *M. phaseolina* and *Fusarium* spp. isolates caused root rot diseases; however, isolates of *F. oxysporum* caused wilt. The virulence of isolates on the tested faba bean cultivar was varied. The highly pathogenic isolates of these fungi were employed in this study. The effect of magnetized tap water (MTW), magnetized agricultural drainage water (MADW) and magnetized seeds (MS) on the severity of root rot caused by R. *solani*, *F. solani* and *M. phaseolina* and wilt diseases caused by *F. oxysporum* of faba bean was tested under greenhouse and field conditions as well as its effect on plant growth and yield components in the field. The obtained data indicated that faba bean plants derived from (MS) then irrigated with magnetized water, either tap or agricultural drainage water recorded the lowest root rot and wilt severity under artificial soil infestation with any of the tested fungi and/or natural infection in the field compared with non-magnetized seeds (NMS) then irrigated with non-monetized water (NMW), respectively. Plants derived from MS and irrigated with magnetized water (MTW and MADW) gave the highest plant growth parameters (plant height, number of branches/plant) and yield components (number of pods and seeds/plant, weight of 100 seeds and total yield/feddan) compared with those grown from non-magnetized seeds and irrigated with non-magnetized water (tap and agricultural drainage water, respectively). Generally, plants derived from magnetized faba bean seeds and irrigated with magnetized tap water recorded the lowest root rot and wilt severity under greenhouse and field conditions and increased plant growth and yield parameters.

Keywords: Faba bean, root rot and wilt, magnetized water and seeds, plant growth and yield parameters.

Faba bean (*Vicia faba,* L.) is considered the most important legume crop in Egypt. The economic importance of faba bean in the world can be explained by its high nutritional value due to its richness in vitamins, protein (20-41%), carbohydrates (45%) and some other useful compounds. Thus, it is a rich available source of food for both human and animals (Sahile *et al*., 2011). In addition, faba bean helps in improvement the soil fertility through nitrogen fixation. Therefore, improving the production of this crop is one of the objectives in agriculture in many countries (Boubekeur *et al.*, 2012). The total area cultivated with this crop in Egypt was about 88000 feddan (feddan =4200 m^2) in 2015 and the gross seed yield produced was about 153000 ton (Anonymous, 2015).

Soil-borne diseases are a major limitation to improve production efficiency and crop quality of faba bean. In Egypt, root rots and vascular wilt are the most diseases responsible for high reduction in faba bean yield, sometimes total loss of the yield (Abdel-Kader *et al*., 2011; Abdel-Monaim, 2013 and Mahmoud, 2016). Infection with fungal diseases usually leads to decrease in productivity due to the damage which occurs in roots, leaves, stems and pods as well as discoloration of seeds.
These pathogens are difficult to control because of their persistence in the soil and their wide range of hosts. Some chemicals are effective in controlling these diseases but these chemicals are expensive and not environmentally friendly. Therefore alternative measures are being tested, including induction of resistance by using magnetized water as a new strategy for controlling root rot and wilt diseases in many crops. Several studies concerning the influence of the magnetized field on plants or microorganisms (Zhang *et al*., 2002; Gorczyca *et al*., 2011 and Mateescu *et al*., 2011). Pal (2005) found that magnetized field decreased the growth of *Alternaria alternata* and *Curvularia inaequalis* and *F. oxysporum* colonies by 10%. Also, the magnetized water inhibited the growth of *M. phaseolina*, *R. solani* and *F. oxysporum in vitro*. Magnetized water and/or magnetized seeds reduced disease incidence and severity and activated seed germination and seedling emergence under field conditions. The combination of magnetized seeds and magnetized water resulted in optimization of plant growth and induced plant disease resistance (Mukhtar, 2003).

Magnetized treatments of soil proved to have a favorable effect on plant growth and development. In general, the enhancement of plant growth, chemical composition and yield production under magnetized conditions have been confirmed by many investigators (Bilalis *et al.*, 2013; Majd and Farzpourmachiani, 2013 and El Sayed, 2014). Aladjadjiyan (2002) reported that exposure to a 150 mT magnetized field stimulated shoot development and led to increase the germination, fresh weight and shoot length of maize plants. Magnetized field beneficial effects on plants have been discussed for more than a decade (Aladjadjiyan and Ylieva, 2003). Magnetized fields have a highly stimulating effect on cell multiplication, growth and development (Yokatani *et al*., 2001).

The mode of action of magnetized water and seeds for controlling root rot and wilt diseases was studied in few investigations. Albertini *et al*. (2003) studied the effect of the constant high magnetized field on the observed physiological and morphological changes in *F. culmorum*, *i.e.* weakening of mycelial growth, spore germination and a decrease in enzymatic activity. They described the occurring of morphological changes as like those caused by the contact of these fungi with chemical pesticides.

The present work was planned to study the effect of magnetized water and seeds as a new tool to induce plant resistance against root rots and wilt diseases of faba bean as well as its effect on plant growth and yield components.

Materials and Methods

Isolation, purification and identification of the causal organism(s):

Samples of faba bean plants showing root rot and wilt symptoms were collected from different farms located in New Valley governorate. The infected roots were thoroughly washed with running tap water, cut into small fragments, superficially sterilized with sodium hypochlorite (1%) for 2 min, washed several times with sterile distilled water and dried between sterilized filter paper. The sterilized pieces were transferred onto potato dextrose agar (PDA) medium supplemented with penicillin (20 Iu/mL) in Petri dishes and incubated at 25 ± 1℃, then examined daily for fungal growth. The fungal colonies were purified using the single spore or the hyphal tip techniques suggested by Dhingra and Sinclair (1985), then identified according to their morphological and microscopical characters as described by Booth (1985) and Barnett and Hunter (1986). Identification was reified at Assiut University Mycological Centre (AUMC), Assiut University, Assiut, Egypt. The obtained isolates were maintained on PDA slants and kept at 5℃ for further study.

Pathogenicity tests:

Pathogenic potentiality of the obtained fungal isolates was carried out using Masr 1 faba bean cultivar under greenhouse conditions at El-Kharga Agric. Res. station, in 2013/2014 growing seasons. Inocula of the tested isolates were prepared by inoculating sterilized conical flasks (1000 ml) containing Barley medium (150 g barley seeds, 50 g clean sand, 4 g glucose, 0.2 g yeast extract and 200 ml water) with equal discs (0.5 cm) taken from cultures (3-7-day-old) of fungi grown on PDA media at 25±1ºC. Incubation was made at 25±1ºC for two weeks and then mixed with autoclaved loamy sandy soil at the rate of 5% w/w. Sterilized plastic pots (25 cm in diameter) were filled with infested soil seven days before sowing. Non-infested control soil was considered. The seeds of Masr 1 faba bean (*V. faba* L.) cultivar were obtained from the Legume Crop Res. Depart., Field Crop Res. Inst., ARC, Ministry of Agriculture, Egypt. Seeds were surface disinfected by dipping in 3% sodium hypochlorite solution for 3 min followed by washing with sterilized water and seeded in infested and non-infested soil. Seeds were planted in plastic pots 25 cm diameter (2.4 kg soil), filled with loamy sandy soil. Five seeds were sown in each pot, and the pots were irrigated every three days. Four replicates were used for each isolate.

The disease severity values were recorded after 60 days from planting date for root rot and wilt diseases. The disease index scale (0–5) described by Grunwald *et al*. (2003) was used to determine severity of Fusarium root rot, in which 0 indicated no visible symptoms; 1, slight hypocotyls lesions; 2, lesions coalescing around epicotyls and hypocotyls; 3, lesions starting to spread into the root system with root tips starting to be infected; 4, epicotyls, hypocotyls and root system almost completely infected and only slight amount of white, uninfected tissue was left; and 5, completely infected root. The disease index scale (0–5) based on disease progress as modified by Abdel-Razik (2011) was used to determine severity of Rhizoctonia root rot, in which 0 indicated no visible symptoms; 1, a few small soft lesions on a part of the root system and hypocotyls; 2, elongated, discolored lesions spread on the entire root system and hypocotyls; 3, deep brown necrosis grind the stem, partial root disintegration and yellowing of leaves; 4, stem canker, root disintegration, yellowing of leaves and stunting; and 5, collapse and death of the plants.

To determine the disease severity of Fusarium wilt, the scale (0–5) based on disease progress was used, in which 0 indicated no visible symptoms; 1, light vein-clearing and chlorosis of the leaves; 2, yellowing and wilting of lower leaves and extend to upper leaves; 3, brown (discoloration) of the vascular systems of the tap root and stem; 4, necrotic streaks on the stem base spread towards the stem apex; and 5, premature plant death. The following equation was used to calculate the percentage of disease severity index (DSI) for each tested isolate:

$$DSI (\%) = \Sigma d / (d\ max \times n) \times 100.$$

Where: d is the sum of disease rating of each plant, d max is the maximum disease grade and n the total number of tested plants/samples examined in each replicate.

Effect of magnetized water and seeds on root rot and wilt severity under greenhouse conditions:

A pot experiment was conducted on the screen of the Plant Pathology Greenhouse, Agric. Res. Station of New Valley, Egypt during one winter's growth season to study the effect of different treatments on root rot and wilt severity caused by *R. solani*, *F. solani* and *M. phaseolina* and wilt severity caused by *F. oxysporum*. In this experiment, the pots were infested with the highly pathogenic isolates of each of *R. solani* (isolate 8), *F. solani* (isolate 1), *M. phaseolina* (isolate 1) and *F. oxysporum* (isolate 1), separately at the rate of 5% w/w per pot as previously mentioned. After 7 days from pot infestation, half of pots were planted with non-magnetized seeds (5 seeds/pot), while the others were planted with magnetized seeds. Pots planted with non-magnetized and /or magnetized seeds were irrigated with four types of water (non-magnetized tap water, magnetized tap water, non-magnetized agricultural drainage water, magnetized agricultural drainage water) twice weekly as follows:

1-Non-magnetized tap water (NMTW) + Non- magnetized seeds (NMS).
2-Non-magnetized tap water (NMTW) + Magnetized seeds (MS).
3-Magnetized tap water (MTW) + Non- magnetized seeds (NMS).
4-Magnetized tap water (MTW) + Magnetized seeds (MS).
5-Non-magnetized agricultural drainage water (NMDW) Non-magnetized seeds (NMS).
6-Non-magnetized agricultural drainage water (NMDW) + Magnetized seeds (MS).
7-Magnetized Agricultural drainage water (MADW)+Non-magnetized seeds (NMS).
8-Magnetized agricultural drainage water (MADW) + Magnetized seeds (MS).

Delta water system for magnetizing water is shown in Fig. 1 and seed magnetization was made through passing in magnetized device capacity 14700 Gauss (14.7 T) as shown in Fig. 2 for 10 minutes. Water was magnetized through passing in magnetized device (Fig.3).

Fig. 1. Delta Water System used in experiments (Walta Water R magnetic water treatment, Seventh Area - New Mansheya– Alexandria, www.deltawater.net).

Fig. 2. Seeds magnetized through passing in magnetized device capacity 14700- Gauss (14.7 T)

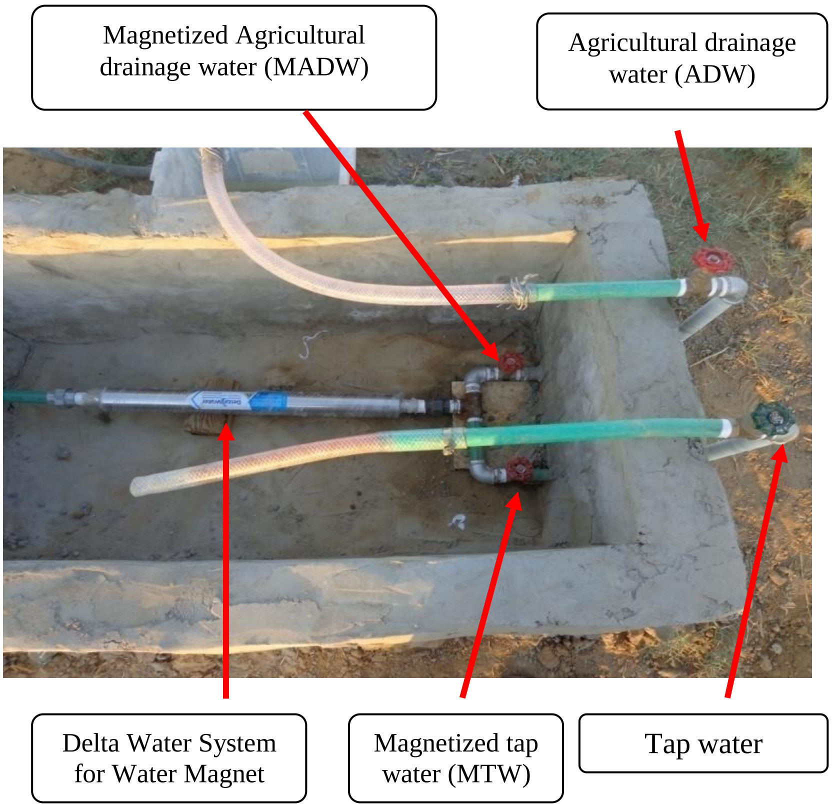

Fig. 3. Delta Water System for Water Magnetization and four types of water used in the experiment

Water properties before and after magnetizations are presented in Table (1). The physical and chemical soil properties of the experimental field plots in the two growing seasons are listed in Tables (2 and 3). After 60 days from planting, root rot and wilt disease severity percentages were recorded as mentioned before.

Table 1. Water properties before and after magnetization during growing seas(2015-2016 and 2016-2017)

Water properties	Season 2015-2016				Season 2016-2017			
	NMTW	MTW	NMDW	MDW	NMTW	MTW	NMDW	MDW
pH	7.17	7.23	8.36	8.28	7.18	7.25	7.60	7.88
E.C.(ppm)	289.9	282.9	2636.8	2630.4	290.9	284.5	2637.0	2670.0
Ca^{++}	16	16	152	108	16.2	16.1	345.0	334.0
Mg^{++}	19.2	26.4	146.4	160.8	19.3	26.8	231.4	271.0
Na^{+}	11.96	13.11	239.2	259.9	12.05	13.21	309.5	321.0
K^{+}	35.97	33.24	159.92	150.14	36.05	33.51	215.5	221.0
Cl^{-}	56.8	49.7	514.75	532.5	56.9	50.02	946.0	974.0
HCO^{-3}	73.2	97.6	414.8	414.8	73.9	97.9	338.0	349.0

Table 2. Some physical and chemical soil properties of the soil at depth of 30 cm before and after irrigation with magnetic water during growing seasons 2015-2016

Properties		Season 2015-2016				
		Before planting	After irrigation with:			
			NMTW	MTW	NMDW	MDW
Physical analysis	Sand%	84.27	84.27	84.33	84.65	84.33
	Silt %	8.25	8.25	8.65	8.62	8.72
	Clay %	7.48	7.48	7.02	6.73	6.95
	Texture	Loamy sand	Loamy sand	Loamy sand	Loamy sand	Loamy sand
Chemical analysis	pH(in1:5soilwater suspension extract)	8.16	7.99	8.01	8.07	8.00
	E.C. (ppm)	1561.6	1721.6	2291.2	4960.0	7078.4
	Ca^{++}	16.0	150.0	150.0	150.0	300.0
	Mg^{++}	50.4	30.0	30.0	60.0	150.0
	Na^{+}	48.3	48.3	64.4	294.4	439.3
	K^{+}	58.65	78.2	89.9	261.9	328.4
	Cl^{-}	92.3	177.5	177.5	355.0	798.7
	HCO^{-3}	122.0	610	610	610.0	610.0

Table 3. Some physical and chemical soil properties of the soil at depth of 30 cm before and after irrigation with magnetic water during growing seasons 2016-2017

Properties		Season 2016-2017				
		Before planting	After irrigation with:			
			NMTW	MTW	NMDW	MDW
Physical analysis	Sand%	83.86	84.02	83.99	84.15	84.17
	Silt %	8.05	8.15	8.36	8.34	8.29
	Clay %	8.09	7.83	7.65	7.51	7.54
	Texture	Loamy sand	Loamy sand	Loamy sand	Loamy sand	Loamy sand
Chemical analysis	pH (in 1:5soil water uspension extract)	8.19	8.01	8.03	8.12	8.02
	E.C. (ppm)	1583.3	1785.6	2365.8	4998.3	7124.4
	Ca^{++}	16.2	153.2	155.2	153.9	321.6
	Mg^{++}	51.2	30.8	30.4	61.4	152.4
	Na^{+}	48.6	48.5	66.3	296.6	442.2
	K^{+}	59.2	79.1	90.1	263.2	330.2
	Cl^{-}	93.0	178.9	178.9	355.2	798.9
	HCO^{-3}	122.1	612.0	612.0	613.2	613.5

Effect of magnetized water and magnetized seeds on root rot, wilt severity, growth parameters and yield components under field conditions:

This experiment was carried out in the Farm of El-Kharga Agriculture Station, New Valley governorate during winter growing seasons (2015/16 and 2016/17). The effect of non-magnetized and magnetized seeds and water (tap water, agricultural drainage water) on the incidence of root rot and wilt diseases of faba bean was evaluated as well as their effect on growth parameters and yield components under field conditions and natural infection. Eight treatments were followed as described before under greenhouse experiments.

A split plot design with four replicates was used in these experiments. The main plots represented magnetized and non-magnetized water, while sub-plots represented magnetized and non-magnetized seeds. The area of each sub-plot was 10.5 m^2 (3.5 × 3 m). Each unit included 5 rows; each row was 3.5 m in length and 60 cm width. The magnetized and non-magnetized seeds were sown in hills 25 cm apart on both sides of 6 cm ridges in both seasons, 2 seed per hill. The main plot was irrigated with non-magnetized tap water (NMTW), magnetized tap water (MTW), non-magnetized agricultural drainage water (NMDW), magnetized agricultural drainage water (MDW) every 12-15 days. The normal cultural practices for growing faba bean were followed. After 60 days from sowing date, root rot and wilt severity was determined as described previously. At harvest, plant height (cm), number of branches, pods and seeds plant^{-1}, 100- seed weight and total yield (kg feddan $^{-1}$) were measured.

Statistical analysis:

Analyses of variance were carried out using MSTATC, 1991 program (Ver. 2.10). Least significant difference was employed to test for significant differences among treatments means at $p \leq 0.05$ (Gomez and Gomez, 1984).

Results

Isolation and Identification of the Causal Organisms:

Thirty-eight isolates of different soil-borne fungi were isolated from diseased faba bean plants (Table 4). Plants with root-rot and wilt symptoms, cultivated in different locations in New Valley governorate were sampled. These isolates were identified as *Rhizoctonia solani* (14 isolates), *Fusarium solani* (4 isolates), *F. oxysporum* (7 isolates), *Macrophomina phaseolina* (3 isolates) and 10 isolates were identified as *Fusarium* spp.

Pathogenicity Tests :

The recovered isolates were tested for their pathogenic potentialities on faba bean cv. Misr 1, under greenhouse conditions in pots. Results presented in Table (4) show that all tested isolates were able to infect faba bean plants and causing root rot and wilt symptoms and thus decreased the number of survived plants. The highest root rot caused by *R. solani* (100%) was recorded by isolates 8 and 11 isolated from Balat and Mott locations, respectively followed by isolates 5 (91.37%) and isolate 7 (89.92%) isolated from El-Kharga location. *F. solani*, isolate 1 isolated from El-Kharga location recorded the highest root rot severity (100%). While, *M. phaseolina* isolates 1 and 3 isolated from Mott and Paris were highly pathogenic isolates and caused 78.81 and 77.45%, respectively. On the other hand, *F. oxysporum* isolates 1, 5, 6 isolated from El-Kharga, Mott and El-Farafra locations caused 83.17, 80.78 and 80.57% wilt severity, respectively. According to their pathogenic potentialities, *Rhizoctonia solani* (isolate 8), *Fusarium solani* (isolate 1), *M. phaseolina* (isolate 1) and *F. oxysporum* (isolate 1) were chosen for further studies as mentioned before .

Effect of magnetized water and magnetized seeds on root rot and wilt severity under greenhouse and field conditions:

Data presented in Table 5 show that using magnetized water (tap and agricultural drainage water) and magnetized seeds significantly deceased severity of root rot caused by *R. solani*, *F. solani* and *M. phaseolina* as well as wilt severity caused by *F. oxysporum* in pots compared to non-magnetized water and seeds .

Magnetized water was more effective in decreasing root rot and wilt as compared with non-magnetized water. Magnetized tap water was more effective than magnetized agricultural drainage water in decreasing root rot and Fusarium wilt severity. Also, data in Table 5 showed that planting the magnetized seeds recorded the lowest percentage of root rot and wilt severity compared to non-magnetized seeds either irrigated with tap or agricultural drainage water. Generally, sowing magnetized seeds irrigated with magnetized tap water recorded the lowest root rot caused by *R. solani*, *F. solani* and *M. phaseolina* and wilt caused by *F. oxysporum*.

Sowing the non-magnetized seeds irrigated with non-magnetized tap water and magnetized seeds irrigated with agricultural drainage water came after.

Table 4. Pathogenicity of the isolated fungi on Masr 1 faba bean cultivar under greenhouse conditions

Fungal isolates No.			Locality	Disease	Disease severity %
R. solani,	No.	1	El-Kharga	Root Rot	80.78
		2	El-Kharga	Root Rot	62.40
		3	El-Kharga	Root Rot	67.70
		4	El-Kharga	Root Rot	47.87
		5	El-Kharga	Root Rot	91.37
		6	El-Kharga	Root Rot	58.56
		7	El-Kharga	Root Rot	89.92
		8	Balat	Root Rot	100.00
		9	Balat	Root Rot	32.91
		10	Balat	Root Rot	60.01
		11	Mott	Root Rot	100.00
		12	Mott	Root Rot	32.91
		13	Paris	Root Rot	76.42
		14	Paris	Root Rot	51.29
F. solani,	No.	1	El-Kharga	Root Rot	100.00
		2	El-Kharga	Root Rot	77.36
		3	Mott	Root Rot	74.54
		4	El- Farafra	Root Rot	47.44
Fusarium spp,	No.	1	El-Kharga	Root Rot	58.56
		2	El-Kharga	Root Rot	36.33
		3	El-Kharga	Root Rot	68.97
		4	El-Kharga	Root Rot	32.91
		5	Balat	Root Rot	21.80
		6	Paris	Root Rot	21.80
		7	Paris	Root Rot	51.29
		8	Paris	Root Rot	82.23
		9	El- Farafra	Root Rot	51.29
		10	El- Farafra	Root Rot	47.44
M. phaseolina,	No.	1	Mott	Root Rot	78.81
		2	Balat	Root Rot	71.12
		3	Paris	Root Rot	77.45
F. oxysporum,	No.	1	El-Kharga	Wilt	83.17
		2	El-Kharga	Wilt	77.66
		3	Mott	Wilt	14.53
		4	Mott	Wilt	40.18
		5	Mott	Wilt	80.78
		6	El- Farafra	Wilt	80.57
		7	El- Farafra	Wilt	51.29
Control			-	-	0.0
LSD at 0.05					5.11

Pot size 25 cm wide. Seeds number per pot= 5 seeds- 4 pots per isolate

Table 5. Effect of using magnetized water and magnetized seeds on infection by *R. solani*, *F. solani*, *M. phaseolina* and *F. oxysporum* pot experiment under greenhouse conditions

Water treatment [a]	Seed treatment	Root rot severity (%) caused by			Wilt severity (%) caused by *F. oxysporum*
		R. solani	*F. solani*	*M. phaseolina*	
NMTW	Non-magnetized	95.25	78.69	88.36	77.36
	magnetized	18.25	25.24	21.67	15.36
	Mean	56.75	51.97	55.02	46.36
MTW	Non-magnetized	27.36	35.24	30.36	28.47
	magnetized	11.54	13.56	15.59	12.55
	Mean	19.45	24.40	22.98	20.51
NMDW	Non-magnetized	95.34	92.25	87.85	70.33
	magnetized	38.36	44.35	32.36	24.54
	Mean	66.85	68.30	60.11	47.44
MADW	Non-magnetized	47.24	42.45	35.69	27.34
	magnetized	22.54	25.25	19.86	10.85
	Mean	34.89	33.85	27.78	19.10
Mean	Non-magnetized	66.30	62.16	60.57	50.88
	magnetized	22.67	27.10	22.37	15.83
LSD at 0.05 for:					
Water treatments (A)	=	2.14	2.13	1.32	1.20
Seed treatments (B)	=	**	**	**	**
Interactions (A×B)	=	4.65	3.35	4.62	2.67

[a]NMTW=None magnetized tap water, MTW =Magnetized tap water, NMDW =Non-magnetized agricultural drainage water , MADW =Magnetized agricultural drainage water

The same trend was obtained under field conditions during growing seasons 2015-2016 and 2016-2017 (Table 6).

Effect of magnetized water and magnetized seeds on growth parameters and yield components under field conditions

Data presented in Tables 7 and 8 show that sowing magnetized faba bean seeds and irrigated with magnetized tap water recorded the best plant growth parameters (plant height, No. of branches per plant) and yield components (No. of pods, seeds per plant, weight of 100 seeds and total yield per feddan) compared to other treatments in both growing seasons (2015-16 and 2016-17). Faba bean plants irrigated with tap water either magnetized or non-magnetized recorded high plant growth parameters and yield components in comparison with those irrigated with agricultural drainage water in both growing seasons. Faba bean plants irrigated with magnetized water either tap water or agricultural drainage water increased plant growth parameters and yield components more than using the non-magnetized water in both growing seasons. Generally, sowing magnetized seeds irrigated with magnetized tap water recorded the highest plant growth parameters (plant height and No. of branches per plant) and yield components (No. of pods and seeds per plant, weight of 100 seeds and total yield per feddan) in both growing seasons. Planting non-magnetized seeds and irrigated with non-magnetized agricultural drainage water recorded the lowest plant growth parameters and yield components.

Table 6. Effect of sowing magnetized seeds and irrigation with magnetized water on root rot and wilt severity under field conditions during 2015-2016 and 2016-2017 seasons

Water treatment	Seed treatment	Season 2015-2016		Season 2016-2017	
		% Root rot Severity	% Wilt severity	% Root rot Severity	% Wilt severity
NMTW	Non-magnetized	33.70	23.9	35.67	20.14
	magnetized	10.72	7.42	9.67	6.34
	Mean	22.21	15.66	22.67	13.24
MTW	Non-magnetized	16.12	10.99	15.33	12.47
	magnetized	6.43	4.71	5.67	5.67
	Mean	11.28	7.85	10.50	9.07
NMDW	Non-magnetized	42.93	33.9	39.25	30.12
	magnetized	16.20	14.79	15.02	12.47
	Mean	29.57	24.35	27.14	21.30
MADW	Non-magnetized	19.53	14.73	17.45	13.67
	magnetized	10.57	7.70	8.67	6.67
	Mean	15.05	11.22	13.06	10.17
Mean	Non-magnetized	28.07	20.88	26.93	19.10
	magnetized	10.98	8.66	9.76	7.79
LSD at 0.05 for:					
Water treatments (A)	=	2.33	1.71	2.28	1.25
Seed treatments (B)	=	**	**	**	**
Interactions (A × B)	=	3.48	2.45	4.11	1.98

Table 7. Effect of sowing magnetized seeds and irrigation with magnetized water on plant growth and yield parameters under field conditions during 2015-2016 seasons

Water treatment	Seed treatment	Plant height (cm)	No. of branches /plant	No. of pods/ plant	No. of seeds/ plant	Weight of 100 seeds	Seed yield / feddan (Kg)
NMTW	Non-magnetized	109.0	4.8	22.3	54.8	76.0	1840.0
	magnetized	128.9	5.8	31.5	64.5	75.6	2461.6
	Mean	118.95	5.3	26.9	59.65	75.8	2150.8
MTW	Non-magnetized	132.5	4.5	27.2	60.4	76.8	2125.6
	magnetized	144.7	5.9	34.0	70.4	78.8	2635.5
	Mean	138.6	5.2	30.6	65.4	77.8	2380.55
NMDW	Non-magnetized	82.5	2.3	8.6	20.4	66.9	685.6
	magnetized	87.6	3.7	15.8	43.5	72.4	1306.8
	Mean	85.05	3.0	12.2	31.95	69.65	996.2
MADW	Non-magnetized	91.6	3.3	15.6	44.5	75.5	1102.0
	magnetized	99.6	4.2	19.2	57.8	71.5	1690.8
	Mean	95.6	3.75	17.4	51.15	73.5	1396.4
Mean	Non-magnetized	103.90	3.73	18.43	45.03	73.80	1438.30
	magnetized	115.20	4.90	25.13	59.05	74.58	2023.68
LSD at 0.05 for:							
Water treatments (A) =		3.36	0.21	1.81	4.02	1.84	100.0
Seed treatments (B) =		**	**	**	**	**	**
Interactions (A×B) =		3.91	0.45	2.89	4.64	3.49	128.3

Table 8. Effect of sowing magnetized seeds and irrigation with magnetized water on plant growth parameters and yield components under field conditions during 2016-2017 seasons

Water treatment	Seed treatment	Plant height (cm)	No. of branches /plant	No. of pods/ plant	No. of seeds/ plant	Weight of 100 seeds	Seed yield / feddan (Kg)
NMTW	Non-magnetized	115.6	4.9	23.4	55.9	76.5	1862.5
	magnetized	133.9	5.7	33.2	66.8	75.9	2478.9
	Mean	124.75	5.3	28.3	61.35	76.2	2170.7
MTW	Non-magnetized	145.4	4.6	28.4	62.5	77.2	2136.9
	magnetized	149.6	6.2	36.5	72.9	79	2662.8
	Mean	147.5	5.4	32.45	67.7	78.1	2399.85
NMDW	Non-magnetized	77.5	2.4	8.2	19.8	67.2	675.4
	magnetized	82.5	3.2	14.5	40.2	72.59	1296.8
	Mean	80.0	2.8	11.35	30	69.85	986.1
MADW	Non-magnetized	90.4	2.8	15.5	42.1	76.2	1099.6
	magnetized	102.3	4	18.7	56.4	72.5	1682.4
	Mean	96.35	3.4	17.1	49.25	74.35	1391
Mean	Non-magnetized	107.23	3.68	18.88	45.08	74.28	1443.60
	magnetized	117.08	4.78	25.73	59.08	75.00	2030.23
LSD at 0.05 for:							
Water treatments (A) =		3.26	0.27	1.31	3.44	2.35	67.72
Seed treatments (B) =		**	**	**	**	**	**
Interactions (A×B) =		5.05	0.59	5.19	4.83	4.85	111.4

Discussion

Faba bean (*Vicia faba* L.) is one of the most important legume crops. It is liable to infection with many fungal pathogens causing considerable yield losses. Damping-off, root rots and wilt diseases are the most important fungal diseases affecting faba bean production in Egypt (Abdel-Razik, 2011 and Abdel-Monaim, 2013). Thirty-eight isolates of different soil-borne fungi were isolated from different locations in New Valley governorate showing root rot and wilt symptoms. Results indicate that the most dominant fungi were precisely identified as *R. solani* (14 isolates), *F. solani* (4 isolates), *M. phaseolina* (3 isolates), *Fusarium* spp. (10 isolates) and *F. oxysporum* (7 isolates). Pathogenicity tests indicate that all fungal isolates were able to attack faba bean plants (cv. Misr 1) causing root rot (*R. solani*, *F. solani*, *M. phaseolina*, *Fusarium* spp.) and wilt caused by *F. oxysporum*. *Rhizoctonia solani* (isolate 8), *Fusarium solani* (isolate 1), *M. phaseolina* (isolate 1) *F. oxysporum* (isolate 1) were the most virulent ones. These results are in line with those previously obtained by Abdel-Kader *et al.* (2011); Abdel-Razik (2011); Abdel-Monaim (2013) and Mahmoud (2016).

The obtained results show that magnetized faba bean seeds planted in pots under artificial infection and in field under natural infection with history of the tested fungi, and were irrigated with magnetized water either tap water or agricultural drainage water decreased root rot and wilt severity. The combination of using magnetized faba bean seeds and irrigated with magnetized tap water recorded the lowest disease severity. These results are in line with those obtained by several investigators (Gorczyca, *et al*., 2011 and Mateescu *et al.*, 2011). Many researchers studied the effect of magnetized seeds and magnetized water on root rots and wilts diseases in different plants. Pal (2005) found that magnetized field decreased the growth of *A. alternata* and *C. inaequalis* and *F. oxysporum* colonies by 10%. Also, the magnetized water inhibited the growth of *M. phaseolina*, *R. solani* and *F. oxysporum in vitro*. Magnetized water and/or magnetized seeds reduced disease incidence and severity and activated of seed germination and seedling emergence under field conditions. The combination of magnetized seeds plus magnetized water resulted in optimization of plant growth and plant disease resistance (Mukhtar, 2003).

On the other hand, faba bean seeds and water magnetized with strongly 14700 gauss significantly increased faba bean growth parameters and yield components under field conditions. Faba bean grown from magnetized seeds then irrigated with magnetized tap water recorded the highest plant growth and yield components during both growing seasons. Generally, magnetized seeds and magnetized water were more effective for increasing plant growth and seed yield than non-magnetized seeds and water. These results are in line with those obtained by De Souza *et al*. (1999 and 2006). They stated that the enhancement in growth and yield of many plants derived from magnetized treated seeds with full-wave rectified sinusoidal non-uniform MFs may be attributed to an energetic excitement of one or more parameters of the cellular substratum (proteins and carbohydrates) or water inside the dry seeds by the direct effect of MFs. Once the magnetizedally exposed seeds acquire water, the activation and production process of enzymes and hormones and the level of seed-store auxin could be enhanced as a result of the initial stimulation, leading to an improvement of the seed germination, vegetative growth, and yield. An experimental study on water absorption by lettuce (*Lactuca sativa* L.) seeds previously treated in stationary magnetized field of 0–10 lT showed a significant increase in the rate of water absorption (Reina *et al*., 2001 and De Souza *et al*., 2008). Amira and Hozayn (2010) found that irrigation with magnetized water significantly improved growth, yield, yield components and chemical constituents of lentil plant. The improvement in growth and chemical constituents reflected in increasing seed, straw and biological yield per plant (Mohamed and Ebead, 2013).

It could be concluded from this study that planting magnetized faba bean seeds and irrigated with magnetized water could effectively increase growth parameters, yield components and decreased root rot and wilt severity. It could be employed as one of the most valuable modern technologies that can assist in saving irrigation water and improving yield and quality under newly reclaimed sandy soil. Further detailed and comprehensive studies are needed.

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تأثير مغنطة المياه والبذور على أمراض اعفان الجذور والذبول فى الفول البلدى

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تم الحصول على عدد ٣٨ عزلة فطرية تتبع الأجناس الفطرية *Rhizoctonia* و*Fusarium* و*Macrophomina* تم عزلها من نباتات الفول المصابة بأمراض أعفان الجذور والذبول التي تم جمعها من مناطق مختلفة في محافظة الوادي الجديد. تبين من اختبار القدرة المرضية أن جميع هذه العزلات قادرة على إصابة الفول صنف مصر ١ تحت ظروف الصوبة. وكانت فطريات *Rhizoctonia solani* و*Fusarium solani* و *Macrophomina phaseolina* هي المسبب لأمراض أعفان الجذور في حين كان فطر *F. oxysporum* هو المسبب لمرض الذبول الفيوزاريومى.

تم دراسة تأثير مغنطة مصدرين من مصادر المياه المستخدمة فى الرى وهى مياه الشرب ومياه الصرف الزراعى بالإضافة إلى مغنطة البذور المستخدمة كتقاوى على شدة الإصابة بأمراض أعفان الجذور والذبول تحت ظروف العدوى الصناعية فى الصوبة والعدوى الطبيعية فى الحقل، بالإضافة إلى تأثيرها على صفات النمو ومكونات المحصول فى الحقل. تبين من النتائج المتحصل عليها أن نباتات الفول المنبثقة من بذور ممغنطة وتم ريها بمياه ممغنطة سواء" كانت مياه شرب او مياه الصرف الزراعى إنها أقل إصابة بأمراض أعفان الجذور والذبول سواء فى الصوبة أو الحقل مقارنة بالبذور غير الممغنطة والمروية بمياه الشرب أو مياه صرف زراعى غير ممغنطة على التوالى. كذلك أعطت النباتات النامية من بذور ممغنطة ومروية بمياه الشرب أو مياه صرف زراعي ممغنطة أعلى قيم صفات النمو والمحصول مقارنة بالنباتات النامية من بذور غير ممغنطة ومروية بمياه شرب أو مياه صرف زراعى غير ممغنطة على التوالى. عموما" فإن النباتات النامية من بذور ممغنطة ومروية بمياه شرب ممغنطة أظهرت أقل شدة إصابة بأمراض أعفان الجذور والذبول وكانت أعلى فى صفات النمو ومكونات المحصول.

والدراسة توصى باستخدام تكنيك مغنطة بذور الفول المستخدمة كتقاوى ومغنطة المياه كتكنيك جديد فى مجال مكافحة أمراض النباتات وجودة المحصول كماً وكيفاً، كما انها تحافظ على مياه الري فى الأراضي الرملية حديثة الاستصلاح.