EurAsian Journal of BioSciences
Eurasia J Biosci 13, 369-378 (2019)

Enhancement in germination, seedling attributes and yields of alfalfa (*Medicago sativa*, L.) under salinity stress using static magnetic field treatments

M. Hozayn [1*], Abeer A. Ahmed [2], A. A. El-Saady [3], A. A. Abd-Elmonem [4]

[1] Field Crops Research Department, Agricultural and Biological Research Division, National Research Centre, Giza, EGYPT
[2] Seed Technology Research Department, Field Crops Research Institute, Agriculture Research Centre, Giza, EGYPT
[3] Fertilization Technology Department, Agricultural and Biological Research Division, National Research Centre, Giza, EGYPT
[4] Botany Department, Agricultural and Biological Research Division, National Research Centre, Giza, EGYPT
*Corresponding author: m_hozien4@yahoo.com

Abstract

Laboratory and field experiments were conducted at the Laboratory of Seed Technology Department, Field Crops Research Institute, Agricultural Research Center, and at the private Farming (Osma Green Farming), Kilometer102, Desert Road of Cairo – Ismailia, Egypt, respectively. The study aims to explore the role of magnetic water technology for amelioration salinity stress on germination traits and forage yield of alfalfa irrigated with brackish and magnetic brackish water. Laboratory results showed that application of magneto hydro-priming seeds under different salinity stress levels (control, 2000, 4000, 6000 and 8000 ppm) enhance germination traits, seedling growth and vigor characteristics compared to untreated seeds under corresponding salinity levels. The improvement ranged between 4.17-5.77% in seed germination (%), 9.80-51.80% in germination speed index (GSI), 3.15-17.50, 3.00-12.43 and 6.42-14.33% in seedling shoot, root and length, respectively. Similar trends were reported in fresh and dry weight of seedling where were the heaviest by 1.02-12.11 and 8.33-12.50%, respectively. Application of magnetic technology for seeds and/or brackish water under field conditions decreased clearly salinity stress due to leaching the most dominant soluble salts (i.e., Na) away from the spread of hairy roots and increasing the most of available macro-nutrients (i.e., N, P, K and Mg) and micro-nutrients (i.e., Fe, Mn, Zn and Cu) which reflected in improving fresh and dry weight of forage yield of four cutting. Sowing hydro or magneto-hydro priming seeds of alfalfa and irrigation with magnetic brackish water improved forage yield of four cutting compared to sowing untreated seeds and irrigation with brackish water. The improvement ranged between 20.18-34.82%and 33.07-39.14% in fresh forage yield of four cutting as well as 18.60-23.51% and 26.46-29.60% in dry forage yield of four cutting regarding sowing hydro and magneto-hydro priming seeds and irrigation with magnetic brackish, respectively. It can be concluded that magnetic field treatment can be a suitable option to increase seed germination and early growth variables of alfalfa seedling under different salinity conditions. In addition, Application of magnetic technology for seeds and/or brackish water under field conditions could decrease clearly salinity stress which reflected in improving alfalfa forage yield.

Keywords: magnetic field, germination, alfalfa forage yield, brackish water, salinity

Hozayn M, Ahmed AA, El-Saady AM, Abd-Elmonem AA (2019) Enhancement in germination, seedling attributes and yields of alfalfa (*Medicago sativa*, L.) under salinity stress using static magnetic field treatments. Eurasia J Biosci 13: 369-378.

INTRODUCTION

The biotic stresses such as salinization, and drought have become the main problems in upgrading, the yield productivity and total yield of Alfalfa by a big margin in Egypt. Alfalfa (*Medicago sativa*, L.) is widely used as perennial, legume forage due to its high protein, content and biomass production (Scasta et al. 2012). Compared with, many other crops, alfalfa is relatively tolerant to salt stress (Munns and Tester 2008). However, soil salinity is still an important, environmental factor limiting yield in alfalfa. Soil salinity is an important factor, affecting growth, development, and productivity of almost all land plants, including, the forage crop alfalfa. However, little is known about how alfalfa, responds and adapts to salt stress, particularly among different salt-tolerant, cultivars. High salt levels cause ion toxicity (mainly Na^+),

Received: October 2018
Accepted: December 2018
Printed: May 2019

hyperosmotic, and secondary stresses such as, oxidative damage (Zho 2002). Na^+ stress triggers the increase in cytosolic, Ca^{+2} and thereafter Ca^{+2}-binding proteins further, activate downstream pathways (Deinlein et al. 2014). At the same time, other second, messengers linked to Ca^{+2} signaling.

All plants on the Earth live in an, electric and magnetic field because the Earth is a magnet, and there is an electric field between, clouds and the Earth. The results of these studies indicate, that Electric current has an important role in human life. Almost all human life is influenced, by electric and magnetic field, for example, the electrical and magnetic, fields are used in scientific agriculture, as a non-chemical method (Costanzo 2008). This technology was used mainly in countries, which have very little chemical industry, like Russia, China, Poland and Bulgaria, who, reported the successful use of magnets in treating water, for irrigation, industry and home use. Utilization of magnetic water technology is considered a promising technique to improve, water use efficiency and crop productivity. Application of this technology is being applied either by the magnetization of water through, passing in static magnetic devices or expose of seeds, for magnetic field. Many studies also reported that, the use of magnetic technology, whether water and/or seeds, have a positive effect on the seed germination, plant growth, maturity, and productivity of tested different crops (i.e., Hozayn and Amera (2010) and Hozayn et al. (2015). Significant enhancement in, shoot and root length of 1-month old maize, chickpea and sunflower plants produced from, seeds exposed to combinations of strength, of MF and duration (Vashisth and Nagarajan 2008). Various efforts have been made, from time to time to improve seed germination, plant growth, and yield production under saline conditions using, multidimensional approaches. One of these approaches, in addition to the breeding, and genetic approach is using magnetized, water for irrigation (Babar Ijaz, et al. 2012). As well as the improvement, in seed germination that is very important stage, in plant growth has been achieved, by magnetic field (Pietruszewski and Kania 2010).

Studies on seed germination of wheat, corn, and soybean showed that Electromagnetic field can be, used as a way to improve seedling vigor (Rochalska 2002). In peas, the use of electromagnetic fields, had a positive effect on seedling growth, and this effect depends on intensity, and duration of exposure of seeds to the field (Podlesny et al. 2003).

The present study aimed to assess the possibility of improving salt tolerance of selected cultivar under saline conditions by using magnetized seed.

MATERIALS AND METHODS

Laboratory and field experiments were conducted at Laboratory of Seed Technology Department, Field Crops Research Institute, Agricultural Research Center, and at private Farming (Osma Green Farming), Kilometer102, Desert Road of Cairo – Ismailia, Egypt, respectively. Laboratory experiment laid out in completely randomized design (CRD) with three replications. Alfalfa seeds of var. Ramah were obtained from Forage crops Department, Field Crops Research Institute, Agricultural Research Center, Giza, Egypt. Salinity was artificially created in the sterilized Petri dishes. Four appropriate amounts of artificial sea water were used by dissolving known weight of natural salt crust in distilled tap water, to manufacture four levels of salinity treatments (2000, 4000, 6000 and 8000 ppm). The source of salt crust was from the salterns of Rashid, El- Beheira Governorate, Egypt. The dry seeds were passed through the funnel of magnetic device (350 mT; 0.5 inch and made from Russia), then magnetized seeds were soaked in magnetized water for two hours. Finally, magnetic treated seeds were dried with paper towels and then seeds from the same lot were kept under non-magnetic field condition. The seeds were ready for germination test. Germination test was performed according to ISTA (1999), whereas 50 seeds of alfalfa were sown in each replication in sterilized Petri dishes covered at the bottom with two sheets of Whitman filter paper, then placed in an incubator at 20±2°C.Total numbers of seeds germinated were counted daily and percentage was calculated at 14th day. Measurements were made on shoot, root and length (cm) of seedling, fresh and dry weight (g) of seedling. Also, Seed Germination Index (SGI), Germination Rate (GR), Speed Germination Index (SGI) and Mean Germination Time (MGT) were calculated as following:

Total numbers of seeds germinated were counted daily until 14th day

Seed germination (%)= (Total number of germinated seeds /Total number of seeds evaluated) × 100

Germination rate (GR): It was calculated according to the formula of Bartllett (1937); GR= a + (a +b) + (a + b + c) …….. (a + b + c + m) / n (a + b + c + m), where a, b, c are No. of seedlings in the first, second and third count, m is No. of seedlings in final count, n is the number of counts.

Mean Germination Time (MGT): It was calculated based on the equation of Ellis and Roberts (1981). MGT= Σ Dn/ Σn, where (n) is the number of seeds, which were germinated on day, D is number of days counted from the beginning of germination test.

Speed Germination Index (SGI): It was calculated as described in the Association of Official Seed Analysis (AOSA, 1983) by following formula: SGI= (no. of germinated seed/days of first count) + (……./…….) + (no. of germinated seed/days of final count). Seeds were considered germinated when the radical was at least 2 mm. long.

Table 1. Soil physical and chemical and water irrigation analysis at experimental site before planting

Soil physical analysis:								
Soil physical analysis	pH (1:2.5)	EC (1:2.5) (ds m^{-1})	Organic Matter (%)	$CaCO_3$ (%)	Clay (%)	Silt (%)	Sand (%)	Texture
Before planting	8.52	1.60	0.61	1.61	8.80	4.00	87.20	Sandy loam
Soil chemical analysis:								
Soil chemical analysis	Macro-elements (mg. 100 g $Soil^{-1}$)				Micro-elements (mg. kg $Soil^{-1}$)			
	K	Ca	Mg	Na	Fe	Mn	Zn	Cu
Before planting	6.6	660.0	12.7	185.0	1.7	5.6	0.6	0.9
Water irrigation analysis:								
Water irrigation	pH	EC (ds m^{-1})						
	7.89	11.72						

Table 2. Effect of magnetic treatments on seed germination (%) and germination speed index (SGI) of alfalfa seeds germinated under different salinity levels

Character		Germination (%)		Increases%	Speed Germination Index (SGI)		Increases %
Treatment		Un-treated seed	Treated seed	over control	Un-treated seed	Treated seed	over control
Salinity (ppm)	Control	93.33	98.33	**5.36**	17.00	18.67	**9.80**
	2000	91.67	96.67	**5.45**	16.75	18.50	**10.47**
	4000	88.33	93.33	**5.66**	15.94	18.33	**14.99**
	6000	86.67	91.67	**5.77**	15.28	17.58	**15.10**
	8000	80.00	83.33	**4.17**	12.25	14.11	**15.18**
F-test		***			***		
$LSD_{5\%}$		**6.02**			**1.42**		
$CV_{\%}$		**3.91**			**5.08**		

Seedling root and shoot length (cm): It was measured of ten normal seedlings at 14 days after planting.

Seedling fresh and dry weight (g): Ten normal seedlings 14 days after planting were measured to determine fresh weight then the seedlings were dried in hot-air oven at 85° C for 12 hours to obtain the seedlings dry weight (g).

Data were statically analyzed by an analysis of variance (ANOVA) of completely randomized design (MSTAT-C v. 3.1. 1988). Least significant difference (LSD) was applied to compare mean values.

A field experiment was carried out at a private farm (Osma Green Farm), Kilometer102, Desert Road of Cairo – Ismailia, Egypt. The study aims to explore the role of magnetic seeds and water technology for amelioration salinity stress on forage yield of alfalfa irrigated with brackish water during the winter growing seasons2015/2016. The soil of site experiments and irrigation water were analyzed according to Chapman and Pratt (1978; **Table 1**).

The treatments were two irrigation water types (i) Brackish-water (BW) and (ii) Magnetic-BW; brackish water after magnetization through passing a two inch static-magnetic unit produced by Delta Water Company, Industrial Zone-1, Alexandria, Egypt and the three seed priming treatments (i.e. Un-priming (Control), hydro-priming and magneto-priming seeds).The two tested factors were laid out in split-plot design with three replications under drip irrigations system. The irrigation water types and priming seeds treatments were allocated in main and sub-plots, respectively.

The seeds were soaked in water, magnetized water (water after passed into static magnetic unit; 350 mT; 0.5 inch and made from Russia) for two hours. After priming, seeds were air dried at room temperature. Seeds from the same lot were kept without priming (control). The soil was ploughed twice, settled and divided into terraces (1 m width x 30m long). Recommended rates of alfalfa seeds (20 Kg fed^{-1}) were sowing by hand drilling in 5 rows 20 cm apart at the second week of November, 2017. Drip irrigation was made immediately after sowing and as plants needed during the experiment. Plots received 60 kg/fed of P_2O_5, 96 kg/fed of K_2O before emergence and 20 kg/fed nitrogen after emergence and after each cut. Other recommended agricultural practices for sowing and growing alfalfa were done according to recommendations of Agriculture Research Centre under this province conditions.

Data recorded on fresh and dry weight of plants in each plot (1 m width x 5 m long) at four cuts at 60, 100, 140 and 180 days after sowing were determined and the productivity of each treatment as ton $fed^{-1}$was calculated. Micronutrients, K and P in dry shoot in the second and third cuts were determined by Atomic absorption, Flame photometer and Spectrophotometer, respectively. Total N was determined by using Micro-Kjeldahl method. Crude protein was calculated by multiplying total nitrogen percentage by factor of 6.25.

Data were statically analyzed by an analysis of variance (ANOVA) of split plot design using MSTAT-C computer package. The least significant difference ($LSD_{5\%}$) test was applied to compare mean values.

RESULTS

Data in **Tables 2** and **3** show significant effect of magnetic treatments on seed germination (%) and germination speed index (SGI; **Table 2**), germination rate (GR; day) and mean germination time (MGT; day; **Table 3**) of alfalfa germinated under different salinity levels. The date indicated that treated seed by magnetic field caused improvement of above mentioned parameters compared to un-treated seed under

Table 3. Effect of magnetic treatments on germination rate(GR) and mean germination time (MGT) of alfalfa seeds germinated under different salinity levels

Character		Germination Rate (GR; day)		Increases % over	Mean Germination Time (MGT; day)		Decreases %
Treatment		Un-treated seed	Treated seed	control	Un-treated seed	Treated seed	compared to control
Salinity (ppm)	**Control**	0.943	0.953	**1.06**	1.23	1.20	**-2.70**
	2000	0.940	0.967	**2.87**	1.24	1.14	**-8.09**
	4000	0.920	0.990	**7.61**	1.32	1.04	**-21.27**
	6000	0.927	0.973	**4.96**	1.30	1.11	**-14.58**
	8000	0.863	0.907	**5.10**	1.54	1.38	**-10.58**
F-test		***			***		
$LSD_{5\%}$		**0.05**			**0.19**		
$CV_{\%}$		**2.91**			**8.68**		

Table 4. Effect of magnetic treatments on seedling shoot and root length (cm) of alfalfa seeds germinated under different salinity levels

Character		Shoot length (cm)		Increases %	Root length (cm)		Increases % over
Treatment		Un-treated seed	Treated seed	over control	Un-treated seed	Treated seed	control
Salinity (ppm)	**Control**	3.74	4.00	**6.79**	4.05	4.41	**8.90**
	2000	3.58	4.21	**17.50**	3.55	3.94	**11.08**
	4000	3.21	3.40	**5.92**	3.24	3.50	**7.93**
	6000	2.95	3.04	**3.15**	3.00	3.37	**12.43**
	8000	2.88	3.13	**8.78**	2.00	2.06	**3.00**
F-test		*			***		
$LSD_{5\%}$		**0.83**			**0.46**		
$CV_{\%}$		**14.22**			**8.19**		

Table 5. Effect of magnetic treatments on seedling fresh and dry weight (g) of alfalfa seeds germinated under different salinity levels

Character		Seedling fresh wt. (g)		Increases % over	Seedling dry wt. (g)		Increases % over
Treatment		Un-treated seed	Treated seed	control	Un-treated seed	Treated seed	control
Salinity (ppm)	**Control**	0.190	0.213	**12.11**	0.012	0.013	**8.33**
	2000	0.190	0.194	**2.11**	0.010	0.011	**10.00**
	4000	0.187	0.189	**1.07**	0.009	0.010	**11.11**
	6000	0.172	0.185	**7.56**	0.009	0.010	**11.11**
	8000	0.138	0.143	**3.62**	0.008	0.009	**12.50**
F-test		***			*		
$LSD_{5\%}$		**0.02**			**0.002**		
$CV_{\%}$		**6.64**			**11.79**		

corresponding salinity level. The improvement ranged between 4.17 to 5.77% in SG and GI and from 9.80 to 15.18% in SGI (**Table 2**). As well as treated seed by magnetic field gave more value compared with un-treated seed under corresponding salinity levels. The treated magnetic seed increased GR by 1.06, 2.87, 7.61, 4.96 and 5.10% compared to un-magnetic seed under corresponding salinity levels (control, 2000, 4000, 6000 and 8000 ppm, respectively). Similar trend was observed in GRE, where its faster by 2.70, 8.09, 21.27, 14.58 and 10.58% under magnetic treated seed compared to untreated seed with corresponding salinity levels (**Table 3**).

Significant increases were recorded in seedling shoot and root length (cm; **Table 4**), seedling fresh and its dry weight (g; **Table 5**). When seed treated with magnetic field compared to untreated seed under various salinity levels (**Table 5**). The increasing ranged from 3.15 – 17.50% in shoot length, 3.00 – 12.43% in root length, 1.07 – 12.11% and from 8.33 – 12.50% in seedling fresh and dry weight, respectively.

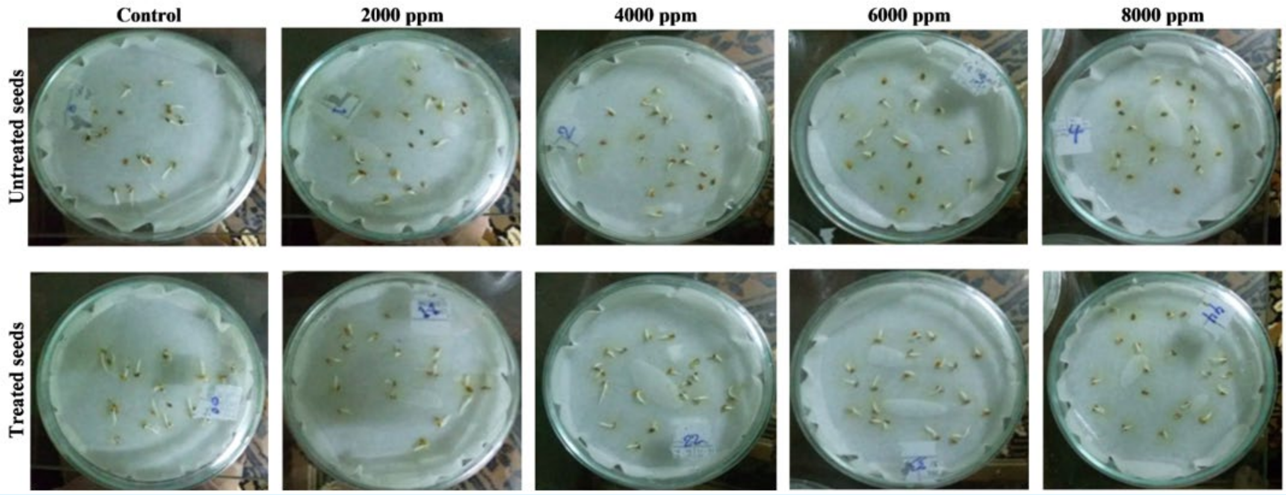

Fig. 1. Comparison of magnetic seeds and un-treated seeds under different salinity levels in starting germination

Table 6. Soil physical properties under irrigation with brackish and magnetic brackish water

Soil physical properties	Before planting	Brackish water (BW)	Magnetic-BW	Irrigation water Before planting
EC (ds m^{-1}) (1:2.5)	1.60	1.70	1.50	11.72
pH (1:2.5)	8.52	8.40	8.22	7.89
Ca CO_3 (%)	1.61	1.72	1.63	..
Organic matter (%)	0.61	0.57	0.65	..
Sand (%)	87.20	87.20	87.20	..
Silt (%)	4.00	4.00	4.00	..
Clay (%)	8.80	8.80	8.80	..
Texture	Sandy loam	Sandy loam	Sandy loam	..

Table 7. Soil chemicals properties under irrigation with brackish and magnetic brackish water

Soil chemical properties	Characters							
	Macro elements (mg 100 g $soil^{-1}$)				Micro elements (mg kg $soil^{-1}$)			
	K	Ca	Mg	Na	Fe	Mn	Zn	Cu
Brackish water	6.20	640.00	12.60	210.00	1.50	6.20	0.48	1.20
Magnetic-BW	8.00	840.00	14.00	165.00	2.05	7.60	0.57	0.90

Data in **Table 6** showed soil physical properties under magnetic-BW for. EC, pH and CaCO3 were increased with brackish water, while decreased with magnetic- BW compared with before planting. Organic matter was decreased by using magnetic BW whereas, it was low with brackish water.

Table 6 showed also changes in physical and chemical properties of water due to, magnetic treatment. The changes were observed mainly in, hydrogen bonding, polarity, surface tension, conductivity, pH, and solubility of salts which were reported to, affect the growth of plants. Reduction, in water pH and increase in EC in magnetic treated water, may be due to changes in hydrogen bonding, and increased mobility of ions (Grewal and Maheshwari 2011). Selim (2008) conducted an experiment to evaluate, the effectiveness of magnetizing underground brackish water, to salt accumulation, in soil and mobility of nutrient elements, in root zone. They found that magnetized water induced changes, in mobility of nutrient elements in root zone, and also induced changes in solubility of some soil components, such as CaCO3 and gypsum.

K, Ca, Mg, Fe, Mn and Zn were increase with using magnetic-BW, whereas decrease with brackish water, also Na and Cu were low under magnetic-BW treatment and increase with brackish water treatment (**Table 7**).

Fresh and Dry wt. (ton fed $^{-1}$) for 4 Cuts

Application of magnetic field either for seeds before sowing and/or magnetic-brackish irrigation water caused significant increases in fresh and dry forage yield (ton fed^{-1}) in the fore tested cuts after 60, 100,140 and 180 days after sowing (**Table 8**). Sowing of hydro or magneto-priming alfalfa seeds caused significant increases in fresh and dry yield of fore cuts. The increasing ranged from 15.29-21.97% and 13.34-18.49 in fresh and dry forage yield, respectively regarding sowing with magneto-priming seeds followed by hydro-priming by from 9.46-14.13% and 7.95-13.02% compared to sowing with dry seeds (control). Same table clear that irrigation with magnetic brackish-water surpassed irrigation with brackish water by increasing ranged between 13.32 - 20.36% and 9.37 – 14.48% in fresh and dry forage yield, respectively.

Table 8. Effect of magnetic treatments on fresh and dry wt. (ton fed $^{-1}$; fed=4200m^2) for 4 cuts under irrigation water salinity stress condition

Water type	Treatment	Weight (ton fed^{-1})							
		Cut 1st		Cut 2nd		Cut 3rd		Cut 4th	
	Seed priming	Fresh	Dry	Fresh	Dry	Fresh	Dry	Fresh	Dry
Brackish water (BW)	Control	3.37	0.61	5.60	1.01	7.66	1.14	6.82	1.29
	Hydro-priming	3.63	0.66	5.95	1.10	8.19	1.21	7.30	1.39
	Magneto-priming	4.03	0.70	6.31	1.15	8.43	1.25	7.60	1.43
Magnetic-BW	Control (dry)	3.78	0.65	6.30	1.07	8.55	1.27	7.34	1.36
	Hydro-priming	4.53	0.74	7.55	1.24	9.32	1.38	8.20	1.53
	Magneto-priming	4.69	0.81	7.65	1.30	10.27	1.48	9.08	1.63
	F test	**	ns	***	ns	***	ns	***	ns
	LSD5%	0.18	ns	0.20	ns	0.23	ns	0.25	ns
Seed priming	Control (dry)	3.58	0.63	5.95	1.04	8.11	1.21	7.08	1.33
	Hydro-priming	4.08	0.70	6.75	1.17	8.75	1.29	7.75	1.46
	Magneto-priming	4.36	0.76	6.98	1.23	9.35	1.37	8.34	1.53
	F test	***	***	***	***	***	**	***	*
	LSD5%	0.06	0.03	0.14	0.05	0.17	0.09	0.18	0.12
Water type	Brackish water	3.68	0.66	5.95	1.09	8.09	1.20	7.24	1.37
	Magnetic-BW	4.33	0.73	7.17	1.20	9.38	1.38	8.21	1.51
	F test	***	*	**	*	**	*	**	*
	CV%	2.37	2.95	1.59	3.20	1.43	5.09	1.71	6.23

Table 9. Effect of magnetic treatments on macro and micro elements in the second cut under irrigation water salinity stress condition

Treatment		Macro-elements (%)						Micro-elements (ppm)			
Water type	Seed priming	N	P	K	Mg	Na	Ca	Fe	Mn	Zn	Cu
Brackish water (BW)	Control (dry)	1.52	0.52	5.37	0.27	1.78	0.31	75.0	162.0	115.0	7.5
	Hydro-priming	2.10	0.62	6.00	0.32	1.50	0.32	94.0	173.0	127.0	4.5
	Magneto-priming	2.43	0.73	6.37	0.33	1.35	0.39	113.0	210.0	106.0	3.0
Magnetic-BW	Control (dry)	1.84	0.81	6.14	0.32	1.66	0.35	75.0	128.0	186.0	6.7
	Hydro-priming	2.20	0.84	6.42	0.37	1.50	0.36	102.0	135.0	139.0	9.0
	Magneto-priming	2.48	0.88	6.65	0.39	1.20	0.43	129.0	161.0	127.0	9.0
	F test	***	*	ns	ns	ns	ns	**	*	***	***
	LSD5%	0.06	0.06	ns	ns	ns	ns	4.9	7.8	6.9	0.4
Seed priming	Control (dry)	1.68	0.67	5.76	0.30	1.72	0.33	75.0	145.0	150.5	7.1
	Hydro-priming	2.15	0.73	6.21	0.35	1.50	0.34	98.0	154.0	133.0	6.8
	Magneto-priming	2.46	0.81	6.51	0.36	1.27	0.41	121.0	185.5	116.5	6.0
	F test	***	***	*	*	***	***	***	***	***	***
	LSD5%	0.04	0.04	0.56	0.06	0.08	0.02	3.4	5.5	4.9	0.3
Water type	Brackish water	2.02	0.62	5.91	0.31	1.54	0.34	94.0	181.7	116.0	5.0
	Magnetic-BW	2.17	0.84	6.40	0.36	1.45	0.38	102.0	141.3	150.7	8.2
	F test	*	**	**	**	ns	ns	**	ns	**	**
	CV%	1.33	4.99	6.87	12.38	4.34	4.02	2.6	2.6	2.7	2.6

Sowing with magneto-priming seeds and irrigation with magnetic brackish-water gave the highest values compared other treatments in all tested parameters. Conducted an experiment to evaluate the effect of magnetic treatments on tomato grown under saline irrigation conditions (Nile water, 1000, 3000, 6000, 9000 and 12000 ppm). Selim (2008) conducted an experiment to evaluate the effectiveness of, magnetized underground brackish water, on germination of test crops viz; wheat, barley and triticale. The magnetized irrigation water increased, seed germination over control in all the crops. Hozayn et al. (2011) studied the response of some food crops, (wheat, flax, chick pea and lentil) using magnetized water for, irrigation under green house condition. The magnetized water treatment increased, yield and yield component traits of all crops.

Macro and Micro Elements in Dry Forage Yield

Effect of interaction between water types and seed priming treatments for macro and micro elements in the second cut was significant for some elements (**Table 9**). Results reveal that the performance of macro and micro elements studied is greatly influenced by water types treatments and seed priming for this trait. (N, P, Fe, Mn, Zn and Cu) were significant under different treatments except (K, Mg, Na and Ca) were not significant. On the contrary, under seed priming treatments, magneto priming had highly value with (N, P, K, Mg, Ca, Fe and Mn) then hydro-priming whereas, control had highly values with (Na, Zn and Cu) then hydro-priming treatment. Water types was significant for all elements, (N, P, K, Mg, Ca, Fe and Zn) were significant with magntic –BW while, under brackish water gave smallest value. On the other hand, (Na and Mn) were significant under brackish water and had lowest values under magnetic water.

Table 10. Effect of magnetic treatments on macro and micro elements in the third cut under irrigation water salinity stress condition

Treatment		Macro-elements (%)						Micro-elements (ppm)			
Water type	Seed priming	N	P	K	Mg	Na	Ca	Fe	Mn	Zn	Cu
Brackish water (BW)	Control (dry)	1.72	0.59	4.50	0.27	1.70	0.26	75.3	207.0	136.0	1.5
	Hydro-priming	2.12	0.73	5.25	0.31	1.70	0.27	97.0	220.0	106.0	4.5
	Magneto-priming	2.21	0.87	6.00	0.32	1.60	0.31	103.7	245.0	103.0	4.5
Magnetic-BW	Control (dry)	1.99	0.62	5.00	0.36	1.40	0.31	86.0	282.3	222.0	6.0
	Hydro-priming	2.16	0.91	6.62	0.38	1.20	0.31	121.0	213.0	243.0	7.5
	Magneto-priming	2.56	0.96	6.87	0.38	1.00	0.41	129.0	210.3	186.0	9.0
	F test	ns	**	*	ns	**	*	***	***	***	***
	$LSD_{5\%}$	ns	0.06	0.40	ns	0.08	0.03	5.5	6.7	5.5	0.4
Seed priming	Control (dry)	1.86	0.61	4.75	0.32	1.55	0.29	80.7	244.7	179.0	3.8
	Hydro-priming	2.14	0.82	5.93	0.35	1.45	0.29	109.0	216.5	174.5	6.0
	Magneto-priming	2.38	0.91	6.44	0.35	1.30	0.36	116.3	227.7	144.5	6.8
	F test	***	***	***	**	***	***	***	***	***	***
	$LSD_{5\%}$	0.15	0.04	0.29	0.02	0.06	0.02	3.9	4.8	3.9	0.3
Water type	Brackish water	2.02	0.73	5.25	0.30	1.67	0.28	92.0	224.0	115.0	3.5
	Magnetic-BW	2.24	0.83	6.16	0.37	1.20	0.34	112.0	235.2	217.0	7.5
	F test	*	**	*	ns	**	***	***	**	***	**
	$CV_{\%}$	5.28	3.36	3.77	4.16	3.17	5.53	2.9	1.6	1.8	3.9

Regarding the third cut, **Table 10** show that the second order interaction between water types and seed priming treatments was significant in concentration elements, indicating that the combinations between water types by seed priming treatments affected the ranking of elements for this cut. (P, K, Na, Ca, Fe, Mn, Zn and Cu) gave highly values and was significant with magneto priming then hydro-priming under magntic – BW followed by manito –priming under brackish water (BW). While, (N and Mg) were not significant under all treatments. Seed priming trearments were different significant, magneto-priming was significant with (N, P, K, Mg, Ca, Fe and Cu)) compare with other treatment. Whereas, control (dry) was significant with (Na, Mn and Zn) compare with other treatment for seed priming. Water types were different significant, magntic (BW) gave highly significant for all elements except Na was low compared with brackish water.

DISCUSSIONS

Magnetic field treatment can be a suitable option to increase characteristics germination and early growth variables under different salinity condition of Alfalfa seeds. In addition to, improvement characteristics of cuttings using magnetic field under salinity conditions.

Germination is a crucial stage in seedling establishment and plays a key role in crop production. The germination process comprises two distinct phases the first is imbibition, mainly dependent on the physical characteristics of the seeds and the second is a heterotrophic growth phase between imbibitions and emergence (Akbarighogdi et al. 2012, Khajeh-hosseini et al. 2003). In this investigation showed that treated seed with magnetic field showed improvements in all characteristics of germination. Pre-sowing magnetic field treatment effect on germination and other characteristics have been reported earlier in other crops (Fischer et al. 2004, Florez et al. 2007, Vashisth and Nagarajan 2008).

The static and electromagnetic field mostly affects on the transport and metabolism of ions and electrons. Generally, the electric magnetic field can affect plant growth in two ways: firstly, it affects on the ions in the soil, and secondly, can have impact on the overall activities of the plants related to the metabolism of electrons and ions (Celestino et al. 2000). Podlesny et al. (2003) have reported about the significant effect of the electric field on the germination of greenhouse cucumber plants. Electric field can influence the plant metabolism and growth patterns by effecting on the electron transport chain and the dark and light reactions of photosynthesis in leaves (Bachman and Reichmanis 1973, Celestino et al. 2000). Electromagnetic field can stimulate seed germination and growth of some crops. This field has a positive effect on the germination and growth of grains (Luben et al. 2000), legumes (Labes 1993) and radish. And also in seeds treated with magnetic field, Enzyme that is stimulated certain stages of germination, show more activity (Costanzo 2008). Belyavskaya (2001) reported that magnetic water significantly induces cell metabolism and mitosis meristematic cells of pea, lentil and flax. Also, Shabrangi and Majd (2009) concluded that, biomass increasing needs metabolic changes particularly increasing protein biosynthesis. Primed-seeds gave better germination and high growth rate even under stress conditions. In this regard, priming was found to be effective for the production and substantially increased the yield of many crop species (Nawaz et al. 2013). Even though the mechanisms of how, priming enhances seed germination and growth, are still unknown, it was suggested that priming, activates a series of physiologically vital processes that, improve plant growth under stress conditions, (Abdel Latef and Tran 2016). Abu-Muriefah (2017) reported that hydro-priming, with no hormones, could, improve significantly the germination of, soybean seeds because H2O itself may act as a germination, stimulating primer and in the absence of, plant hormones it might lead to the improvement, of seed germination.

Kronenberg (2005) reported an increase in the availability, of minerals with magnetic application in soil through, increasing of solubility of salts, and minerals. Ashrafi et al. (2012) conducted an experiment to study the feasibility, of using magnetic technology to reduce the dispersion, of soil. In this study, three magnetic water devices with, different magnetic intensities (0.05, 0.16 and 0.13 tesla) were used for magnetizing, the potable water. The results showed that the magnetic field has a significant effect on, magnesium and the calcium concentrations, which were more in magnetic treatment compared, to reference treatment. Conducted a column experiment to evaluate the effect of, magnetic treated irrigation water on the movement, and availability of certain nutrients and on, the leaching of ions and salts from a sandy soil.

Tai et al. (2008) notes that water undergoing magnetic field, leads to a change in its properties as it becomes more, vigorous and able to easy flow. They added that magnetized water increases, the percentage of nutrients such as phosphorus, potassium, and zinc in plants. They also added that magnetized water, prevents the absorption of harmful metals, such as lead and nickel by the roots, and thus prevents them from reaching the fruits. They reported that total salt removal, from the soil, after six leachates and potassium concentration in soil water extract, was significantly increased with magnetized water, as compared to normal water by Mohamed and Baseem (2013).

CONCLUSION

In general, conclusion, the previous results indicated that seed germination is important process affecting alfalfa production. This process is affected by salinity stress; magneto priming is an easy and useful technique for enhancing germination rate and percentage of alfalfa. The effects of magneto priming technique can improve seedling establishment and field performance of alfalfa as an important fodder crop. We recommended treat seeds with magnetic field to improvement germination characteristics and have high yielding.

ACKNOWLEDGEMENT

This work funded through National Campaigns Program (project no.1340; entitled Applications of magnetic technology for correcting underground brackish water and improving field crops and water productivity in Sinai region) by Academy of Scientific Research and Technology, 101 Elkasr Eleny St., Cairo, Egypt.

REFERENCES

Abdel Latef AA, Tran LP (2016) Impacts of priming with silicon on the growth and tolerance of maize plants to alkaline stress. Front Plant Sci., 7: 243. https://doi.org/10.3389/fpls.2016.00243

Abdul-Baki AA, Anderson JO (1973) Vigour determination of soybean seed by multiple criteria. Crop Sci., 13: 630-633. https://doi.org/10.2135/cropsci1973.0011183X001300060013x

Abu-Muriefah SS (2017) Photohorminal priming improves germination and antioxidant enzymes of soybean (*Glycine max*) seeds under lead (pb) stress. Bio. Sci. Res. 14(1): 42-56.

Akbarighogdi E, Izadi-Darbandi A, Borzouei A (2012) Effects of salinity on some physiological traits in wheat *(Triticumaestivum,* L.) cultivars. Indian J. Sci. Technol., 5 (1).

Ashrafi S, Behzad FM, Naseri A, Ghafarian Malmiri H (2012) The Study of Improvement of Dispersive Soil Using Magnetic Field. J. Struc. Engg and Geotechnics, 2(1): 49-54.

Babar I, Shakeel AJ, Dawood A, Shahid M, Sadar US (2012) Changes in germination behavior of wheat seeds exposed to magnetic field and magnetically structured water. African J. Biotech, 11: 3575- 82. https://doi.org/10.5897/AJB11.2927

Bachman CH, Reichmanis M (1973) Some effects of high electrical fields on barley growth, Intern. J. Biometeorology, 17: 253-62. https://doi.org/10.1007/BF01804618

Bartllett MS (1937) Some samples of statical method of research in agriculture and applied biology Jour Roy Soc., 4: 2.

Belyavskaya NA (2001) Ultrastructure and calcium balance in meristem cells of pea roots exposed to extremely low magnetic fields. Adv. Space Res., 28: 645–650. https://doi.org/10.1016/S0273-1177(01)00373-8

Celestino C, Picazo ML, Toribio M (2000) Influence of chronic exposure to an electromagnetic field to germination and early growth of Quercussuber seeds: preliminary study: 115-20. https://doi.org/10.1081/JBC-100100302

Costanzo E (2008) The influence of an electric field on the growth of soy seedlings.electromagnetic stimuli on bone and bone cells in vitro: Inhibition of responses to parathyroid hormone by low-energy low-frequency fields. Proc . Natl. Acad. Sci., USA, 79: 4180-4. https://doi.org/10.1073/pnas.79.13.4180

Deinlein U, Stephan AB, Horie T, Luo W, Xu G, Schroeder JI (2014) Plant salt-tolerance mechanisms. Trends Plant Sci., 19(6): 371–9. https://doi.org/10.1016/j.tplants.2014.02.001

Ellis RH, Roberts EH (1981) The quantification of ageing and survival in orthodox seeds. Seed Sci., and Techn., 9: 373-409.

Fischer G, Tausz M, Kock M, Grill D (2004) Effects of weak 16(2/3) Hz magnetic fields on growth parameters of young sunflower and wheat seedlings. Bioelectromagnetics, 25: 638-41. https://doi.org/10.1002/bem.20058

Florez M, Carbonell MV, Martinez E (2007) Exposure of maize seeds to stationary magnetic fields: Effects on germination and early growth. Environ. Expt. Botany, 59: 68-75. https://doi.org/10.1016/j.envexpbot.2005.10.006

Grewal HS, Maheshwari BL (2011) Magnetic treatment of irrigation water and snow pea and chick pea seeds enhances early growth and nutrient contents of seedlings. Bioelectromagnetics, 32: 58-65. https://doi.org/10.1002/bem.20615

Hozayn M, Abd El-Monem AA, Abdul Qados AMS, Abd El-Hameid EM (2011) Magnetic water application for improving wheat (*Triticumaestivum*, L.) crop production. Australian J. of Basic and Applied Sci., 5(12): 29-36.

Hozayn M, Amal AA EL-Mahdy, Abdel-Rahman HMH (2015) Effect of magnetic field on germination, seedling growth and cytogenetic of onion (Allium cepa L.). African J. of Agric. Res., 10(8): 859-67. https://doi.org/10.5897/AJAR2014.9383

Hozayn M, Amera MS, Abd El-Qdoos (2010) Irrigation with magnetized water enhances growth, chemical constituent and yield of chickpea (Cicer arietinum L.). Agriculture and Biology J. of North America, 1(4): 671-6.

Khajeh-hosseini M, Powelland IAA, Bingham J (2003 (The interaction between salinity stress and seed vigour during germination of soybean seeds. Seed Sci and Technol., 31; 715-25. https://doi.org/10.15258/sst.2003.31.3.20

Kronenberg KJ (2005) Magneto hydrodynamics: The effect of magnets on fluids. GMX international.

Labes MM (1993) A possible explanation for the effect of magnetic fields on biological systems, Nature, 211: 969.

Luben RA, Cain CD, Chen MCY, Rosen DM Adey (2000) Effects of Physiochemical mechanisms of efficiency of treatment by weak ELFEMF of wheat seeds at different stages of germination. Proc 22nd Annual meeting Euro. Bioelctromagnetice Ass, Munich.

Mohamed AI, Bassem ME (2013) Effect of magnetic treated irrigation water on salt removal from a sandy soil and on the availability of certain nutrients. Int. J. Engg. Appl. Sci., 2 (2): 36-44.

MSTAT-C (1988) MSTAT-C, a microcomputer program for the design, arrangement and analysis of agronomic research. Michigan State University, East Lansing.

Munns R, Tester M (2008) Mechanisms of salinity tolerance. Annu. Rev. Plant Biol., 59: 651–81. https://doi.org/10.1146/annurev.arplant.59.032607.092911

Nawaz J, Hussain M, Jabbar A, Nadeem A, Sajid M, Subtain M, Shabbir I (2013) Seed priming a technique. Intl J. Agri. Crop Sci., 6(20): 1373-81.

Pietruszewski S, Kania K (2010) Effect of magnetic field on germination and yield of wheat. Int. Agro. phys., 24: 297-302.

Podlesny J, Lenartowicz W, Sowinski M (2003) The effect of pre-sowing treatment of seeds magnetic biostimulation on morphological feature formation and white lupine yielding (in polish). Zecz. Probl. Post. NaukRoln, 495: 399-406.

Rochalska M (2002) Magnetic field method of seeds vigor estimation (inpolish). Acta Agrophysica, 62: 103-111.

Scasta JD, Trostle CL, Foster MA (2012) Evaluating alfalfa (*Medicago sativa,* L.) cultivars for salt tolerance using laboratory, greenhouse and field methods. J. Agr. Sci., 4(6): 90–103. https://doi.org/10.5539/jas.v4n6p90

Selim MM (2008) Application of magnetic technologies in correcting underground brackish water for irrigation in the arid and semi-arid ecosystem. The 3rd Int.

Shabrangi A, Majd A (2009) Comparing Effects of Electromagnetic Fields (60 Hz) on seed germination and seedling development in Monocotyledons and Dicotyledons. Progress in Electromagnet. Res. Symp. Proceed. Moscow, Russia: 18-21.

Tai C, Chang M, Shieh R, Chen T (2008) Magnetic effects on crystal growth rate of calcite in a constant-composition environment. J. Crystal Growth, 310: 3690–7. https://doi.org/10.1016/j.jcrysgro.2008.05.024

Vashisth A, Nagarajan S (2008) Effect of magnetic field on seed performance of diverse crop species. Indian J. Agric. Sci., 78: 708-11.

Zhu JK (2002) Salt and drought stress signal transduction in plants. Annul Rev. Plant Biol., 53: 247–73. https://doi.org/10.1146/annurev.arplant.53.091401.143329