UDC: 633.31-211.82 ; 581.142
ID: 195759884
Original research paper

Acta Agriculturae Serbica, Vol. XVII, 34 (2012) 105-115

The Effect of Electric Field on the Germination and Growth of *Medicago Sativa Planet,* as a native Iranian alfalfa seed

Saeed Rezaei-Zarchi, Saber Imani, Hekmate Alikhani Mehrjerdi, Mohammad Reza Mohebbifar

Chemical Injuries Research Center, Baqiyatallah Medical Sciences University, Tehran, Iran

Abstract: Access the top agricultural Products that can tolerate different climatic conditions, is part of the new science goals of agriculture. Therefore, the new sciences fields such as electric in agricultural can be usefor productivity of any products. In this regard, this study examines has been the impact of electric and magnetic fields on the growth of alfalfa seeds. In this experiment, were tested four voltage V_1=1, V_2=3, V_3=5 and V_4= 7 as a major factor in both h_1=2.5 and h_2=5 control sample. All calculation analysis by the software of SPSS and means having characteristics were compared that with probability 1%by Duncan test.

The results showed that the maximum germination is owned treatment of V_4h_1 and V_3h_2. The highest and lowest root is in V_4h_1 and control groups, respectively. The electric field effectively impact on root length and most effective treatment was V_4h_1. The highest fresh weight of plant obtained in at V_7 and 2/5 hours. The highest and lowest plant dry weight, respectively, is owned to the $v_4h_1$treatment and control group. The highest and lowest germination rate is owned to treatment of V_4h_1 and V_2h_1, respectively.

The most seed vigor is owned to treatments of V_7 and 2/5 hours. The results of this paper showed electric field has had significant impact of growth characteristics and seed alfalfa. And with the treatments can be achieved to the Seeds suited to the climate zone.

Keywords: Electric Field Effects - Germination - Saffron Bulbs - Stem Length

Received: 20.03. 2012. / Accepted: 25. 08. 2012.

Introduction

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. Investigations into electromagnetic effects on plants have already been carried out with some remarkable results (Nechitailo and Gordeev 2004; Balouchi and ModarresSanavy 2009). In recent years, extensive studies have been conducted upon effects of electric fields on living organisms. 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. For example, the electrical and magnetic fields are used in scientific agriculture as a non-chemical method (Costanzo 2008).

Living cells for survive need to the electrical activity and tissues of these cells show a wide range of electrical properties. According to research, biological behavior, roots, seeds, pollen and buds of some plants waschange the exposure to electromagnetic fields and electromagnetic fields can to stimulate seed germination of some seeds and grow crops. So that the field has a positive effect on seed germination and growth of legumes (Aksyonov *et al.* 2000), cereals (Angersbach *et al.* 2000) and radish (Gusbeth *et al.* 2009).

Has been demonstrated that rice seeds have been subjected to electric fieldhave higher growth rates (about 5-10 per cent) but electric field has no effect on the germination (Kerdonfagetal, 2002). Lettuce seed germination increases exposed to 7.5 v/cm of artificial electrostatic field for 2 min (Stefa and Pozeliene 2003). Electric field does stimulate the germination of cotton seedsand the greatest increase in germination has been reported in the field 3-3.5 kV/cm. But with increasing intensity, does not increase the germination rate (Pietruszewki, 1999). In peas, the seeds of electromagnetic fields have a positive effect on seedling growth andthis effect depends on intensity and duration of exposure of seeds to the field (Podlesny *et al.* 2003). Studies on the germination of wheat, corn and soybean showed that Electromagnetic field can be used as a way to improve seed vigor (Rochalska 2002). Magnetic fields of 0.66-1.1 Tesla With intervals 0-120 min, has been changedgrowth of radish seedlings and Magnetic fields of 0.88 Tesla for 80 min further stimulated the germination of radish (Das and Bhattacharya, 2006).

The above example shows that electric field has different results in different plants.In this study was to assess the effect of electric field upon Alfalfa crop native of *Yazd*, *Iran*.In addition,other cases investigated in this experiment are study of different voltages of the electric field,find the Effective (possible impact) of alfalfas, investigation of efficiency of this methodto increase the quantity and qualityand economic returns for farmers. We hope to be able to reach the hay resistant to environmental conditions to achieved high yields of product.

Materials and Methods

This experiment was conducted in the *Marvast* region of *Yazd*, *Iran*. This region is semi-dry with hot weather. Test area was located 180 Km South of *Yazd* with the longitude of 30 degrees and the latitude of 54 degrees with the height of 1546.6 m above sea level. The average annual temperature of *Marvast* region is 17° C, average annual precipitation is 75 mm and average moisture content is 27 % and annual evaporation is about 3500.

Plant tested was Native hay Native alfalfas of *Yazd*, *Iran* with scientific name of *Medicagosativa* from *Fabaceae* (*Leguminosae*) family. That previously had been planted in the area and had good performance. Also for the disinfection, all seeds were rinsed with distilled water in a strainer and then were exposed for 10 second in 95% ethanoland again for 3 min in a solution of 2% of mercuric chloride.

In this experiment have been tested four voltages of 1, 3, 5 and 7 volts as the main factor in both the 2.5 and 5 hours (secondary factor). Reduction of the Trans model *Haoxin* (TXN-1502D)was used to generate electric fields with different voltages.

After testing on three consecutive days, the numbers of germinated seeds were counted in three days and allowed root seedlings and seeds to grow for 14 days and then measure the length of root and shoot. The numbers of seeds germinated were counted in each treatment group and a control test on the first day to third day. And using equation (1) the percentage of germinated seeds was calculated and the results of analysis of variance.

Equ. 1: $$\text{Germination} = \frac{\text{The number of germinated seeds}}{\text{The total number}} \times 100$$

Root length and shoot, Fresh weight and dry weight measured and record 14 days after the test. For the measurement, were selected 5 samples from each treatment and was calculated the average. The coefficient of germination rate was calculated according to equation (2), for each treatment and each replication. The G1-Gn Shows number of germinated seeds from the first day to last day.

Equ.2: $$\text{Coefficient of Germination Rate} = \frac{G1+G2+G3+\ldots+Gn}{(1\times G1)+(2\times G2)+(3\times G3)+\ldots+(n\times Gn)}$$

Seed vigor index was another quantity measured that has been measured from (3) Formula.

Equ.3: $$\text{Seed Vigor Index} = \frac{\text{The average length of seedlings} \times \text{Germination}}{100}$$

To determine the germination rate were used from equation (4) for 3 days. In this equation, N_n is represents the number of seeds germinated at n day, and W_n shows nday.

Equ.4: Germination Rate = $\{(n_1/w_1) + (n_2/w_2) + (n_3/w_3) + \ldots + (N_n/w_n)\}$

Data of the parameters studied were analyzed by SPSS software and the parameters that were significant were compared by using the Duncan test at the 1% level.

Results and Discussion

Table 1 shows the results of the treatments at 1% level is the effect on germination. The average of Germination rate in Table 2 shown $V_3h_2$and V_4h_1treatment were highest germination rate and lowest percentage of germination rate was seen in control treatment.

Table 1. Analysis of variance of germination of all treatments evaluated in alfalfa seed

Mean Square					
Fresh weight of the plant (g)	Stem length (cm)	Root length (cm)	Germination percent (%)	df	Variable sources
**0.15	**0.19	**0.27	**85.70	8	Treatment
0.01	0.03	0.02	4.33	18	Error
1.62	4.55	2.68	2.32	-	Cv (%)
Mean Square					
Germination rate (day)	Seed vigor (cm)	Coefficient of germination rate (day)	Dry weight of the plant (g)	df	Variable sources
**119.62	**0.63	**0.015	0.02	8	Treatment
6.47	0.01	0.004	0.01	18	Error
3.39	3.00	4.53	6.48	-	Cv (%)
Significant level 1%					

The average of germination treatments were compared in three groups. Comparison of these groups together shown voltage of 1 V at 2.5 and 5 hours are no difference with the control treatment. Also results showed that increasing the voltage of 3 V to top has been an increase in germination (See Table 2).

Table 2. Comparison of the average characteristics of the different treatments on germination of alfalfa seed

Fresh weight of the plant (g)	Stem length (cm)	Root length (cm)	Germination percent (%)	Parameters Treatment
4.43f	3.53e	4.23e	82.33c	Control
4.75e	3.80cde	4.70d	82.67c	V_1h_1
4.76de	3.70ed	4.70d	85.33c	V_1h_2
4.89cde	3.83cde	4.90bcd	90.33b	V_2h_1
4.89cde	3.76cde	4.80cd	90.66b	V_2h_2
4.90cd	3.79cde	5.00bc	92.33b	V_3h_1
4.91c	4.10abc	5.10ab	96.67a	V_3h_2
5.26a	4.30a	5.30a	96.67a	V_4h_1
5.05b	4.23ab	5.00bc	90.33b	V_4h_2
Germination rate (day)	Seed vigor (cm)	Coefficient of germination rate (day)	Dry weight of the plant (gr)	Parameters Treatment
66.89g	3.19f	1.47ab	1.44b	Control
67.89gf	3.51e	1.45ab	1.55ab	V_1h_1
70.05efg	3.58e	1.44ab	1.57ab	V_1h_2
72.44def	3.94cd	1.53a	1.63ab	V_2h_1
76.00cd	3.88d	1.42ab	1.62ab	V_2h_2
79.72bc	4.13bc	1.35bc	1.63ab	V_3h_1
82.28ab	4.44a	1.38bc	1.63ab	V_3h_2
84.72a	4.63a	1.29c	1.67a	V_4h_1
74.00de	4.17b	1.48ab	1.62a	V_4h_2

- Same letters in each column indicate no significant difference on the effect of treatments

Correlation coefficients between the parameters studied are shown in Table 3. The highest positive correlation and significant was observed in root length, shoot length, fresh weight of the plant, seed vigor and germination. A modest and negative correlation was with the germination rate.

Root length showed a significant difference in the 1% level among the treatments studied (Table 1).The average root length between treatments (Table 2) showed maximum length is V_4h_1 treatment.Based treatments, this property are located in five different statistical groups. These results suggest that treatments have different effects on root traits. Lowest root belong to the control group. Comparison of average treatments showed that electric field can significantly affect the root length and effective treatment was V_4h_1 treatment. Higher voltage (7 V) and more time have a negative effect.

Root lengths has a significant positive correlation with shoot length, seedling fresh and dry weight, the coefficient of germination rate, seed vigor and germination (see Table 3).

Table 3: Correlation coefficients between characteristics of different treatments on germination of alfalfa seed

Germination rate (day)	Seed vigor (cm)	Coefficient of germination rate (day)	Dry weight of the plant (g)	Fresh weight of the plant (g)	Stem length (cm)	Rootlet length (cm)	Germination percent (%)
							1
						1	**0.81
					1	**0.75	**0.56
				1	**0.71	**0.89	**0.74
			1	**0.49	**0.56	**0.63	0.35
		1	-0.21	-0.34	*-046	*-0.41	*-0.44
	1	**-0.49	**0.53	**0.85	**0.81	**0.93	**0.92
1	**0.89	**-0.74	0.35	**0.70	**0.61	**0.78	**0.92

* ،**Significant level of 5% and 1%

Analysis of variance of stem length (Table 1) show that different treatments on the meaning of this attribute is significant at the 1% level.Based treatments, this variable were statistically different from 5 groups this suggests that effect of different treatments had on this character (Table 2).The changes data in these parameters show that with increasing voltage and duration of growth has increased stem length. The maximum and minimum stem length respectively was achieved in $V_4h_1$and control treatment. Compare treatments says that $V_3h_2$and V_4h_1treatments was higher than control group and other treatments were not significantly different from control groups (Table 2).Stem length is a strong positive correlation with root length, fresh weight of seedlings and seed vigor and a moderate positive correlation with germination, seedling dry weight and germination (Table 3).

Analysis of variance for fresh weight of seedlings (Table 1) shows that there is a significant difference between treatments used in this experiment with fresh weight of seedlings. According to the average (Table 2) is clear that treatments of this variable located in six different statistical groups. Trend dataes was liked characteristics of the germination and root length. Most plant fresh weight was obtained in treatments 7 V and 2.5 hours.

The relationship between Fresh weight of seedlings with seedling germination, root length, stem length, seed vigor and germination was positive, meaningful and very strong and with seedling dry weight was a positive, moderate and significant correlation. With germination rate variables a non-significant and negative relationship (Table 3).

Seedling dry weight in the 1% level Showed significant differences among the treatments studied (Table 1).The averages of these characters treatments were in the two statistically different groups (Table 2).The highest and lowest plant dry weight, respectively, were observed in V_4h_1 treatment and control groups. Other treatments were applied to seedling dry weights were not significant differences on the characters. This variable has a significant positive correlation with root length, fresh weight of seedlings and seed vigor (Table 3).

Also the results show that voltage of 3 V and 5 V during 5 and 2.5hourshas not caused any significant difference in the weight of the seedlings. According to this table these voltages are different from the controls groups (Table 2).

Germination rates Coefficient at Significant of 1% were affected by different treatments (Table 1).The average germination rate (Table 3-2) shows that based on treatments, this character were statistically different in the three groups. The highest germination rate was in V_2h_1 treatment and the lowest was V_4h_1.The correlation coefficient varies with other variables studied shown in Table 3 that this variable has a significant negative correlation.

Seed vigor influenced by different treatments, showed significant differences in the 1% level (Table 1). Average seed vigor (Table 2) show that this varies has changed from 3.19 to 4.63cm.The highest seed vigor was in treatment of 7 volts and 2.5 hours and lowest was in control groups. Between $V_3h_2$and V_4h_1treatment was no significant difference about seed vigor and in both cases is the highest seed vigor.

Analysis of variance for germination by different treatments showed significant differences in the 1% level (Table 1).The average of this variable (Table 2) shows that based on treatments, germination rate were statistically different in the seven groups. The highest germination rate was in treatment of 7 volts and 2.5 hours and lowest was in control groups. The results show that treatments of 1 volt in during different times have not had much effect on germination rate. The correlation coefficient for this variable with other variables (Table 3) shows that germination rate has a significant positive correlation with other variables.

The electric field mostly affects on the transport and metabolism of ions and electrons.Generally, the electric 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). Safari et al. (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). Electron transport chain is one of the respiratory pathways in plant

tissues, which can be affected by the electric field, which creates changes in the cellular respiration(Allen *et al.* 1985). According to previous studies, biological treatment of seeds, roots, pollen and buds of some plants could be changed after their exposure to the electromagnetic field (Isobe *et al.* 1998). 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.

The effect of electric field, *Isobe* and et al. stated that electric polarization of the membrane system causes have abnormal accumulation of water in the plant. And some macromolecular was Molecules be aqueous. These factors lead to inflation, excessive storage macro molecule and lead to break the membrane systems and tissues of irregular shape and thus may increase germination rate (Isobe *et al.* 1998).

Low-frequency electric field in the oak causes to increases Germination rate but final germination percentage did not change after 13 weeks. Increased plant growth parameters were effective in increasing the biomass of oak seedlings (Luben *et al.* 2000).

Electromagnetic fields can affect cell membrane structure and thereby increased ion transport and permeability of the membrane. And the impact of some key metabolic functions (Labes, M.M. 1993). And also in seeds treated with magnetic field, Enzyme that is stimulated certain stages of germination, show more activity (Costanzo 2008).

Conclusions

It can be noted that electric field affects on the movement of ions, electrons and other charged species and causes changes in cell division and growth of the plant. The results of the present study show that the cellular metabolism can be positively affected by the application of appropriate intensity of the electric field. So, a positive effect of 3V intensity of the electric field was seen for some parameters involved in the alfalfas plant growth and germination while, the administration of 7 V electric field could effectively enhance the overall germination process in the alfalfas plant, which shows that increased crop yield can be achieved by this technique and without using harmful chemical methods.

Acknowledgments: The present work was supported by the Research Institute of Science and Nanotechnology, Payame Noor University, Yazd, Iran and the Research and Clinical Center for Infertility, Shahid Sadoughi University of Medical Sciences, and Yazd, Iran.

References

Aksyonov S.I., Grunina, A. Goryachev, T. Yu. and Turovetsky, V.B. (2000): Physiochemical mechanisms of efficiency of treatment by weak ELF-EMF of wheat seeds at different stages of germination. *Proc 22nd Annual meeting Euro.Bioelctromagnetice Ass*, Munich.

Allen, S.G., Dobrenz, A.K., Schon M.H., and Stoner, J.E. (1985): Heretability of NaCl tolerance in germination of alfalfa seed .*AgronJurnal*, **77**:99-101.

Angersbach, A. Heinz, V. and Knorr, D. (2000): Effects of pulsed electric fields on cell membranes in real food systems, *Innovative food Science and Emerging Technologies*, no. **2, 1**: 135-149.

Bachman, C. H. and Reichmanis, M. (1973): Some effects of high electrical fields on barley growth, Intern. *J. Biometeorology*, **17**: 253-262.

Balouchi H.R., Modarres Sanavy S.A.M. (2009): Electromagnetic field impact on annual medics and dodder seed germination. *International Agrophysics*, **23**: 111-115.

Celestino, C., Picazo, M. L., Toribio, M. (2000): Influence of chronic exposure to an electromagnetic field to germination and early growth of Quercussuber seeds: preliminary study. *Electro-Magnetobiol*, **19**: 115-120.

Costanzo. E. (2008): The influence of an electric field on the growth of soy seedlings. *Electrostatics*, **66**: 417–420.

Das R. and R. Bhattacharya(2006): Impact of electromagnetic field on seed germination. *Proceedings of the International Conference on Modern Electrostatics*, Beijing, China, pp. 141-145.

Gusbeth, C. Frey, W. Volkmann, H. Schwartz T. and Bluhm, H. (2009): Pulsed electric field treatment for bacteria reduction and its impact on hospital wastewater, *Chemosphere*, **75**: 228-233.

Isobe, S., Ishida, N., Koizumi, M., Kano, H.and Hazelwood, C. F. (1998) Effect of Electric Field on Physical States of Cell-Associated Water in Germinating Morning Glory Seeds Observed by H-NMR. *Biochimica et biophysica acta*. **1426**: 17- 31.

Kerdonfag, P., Klinsa-ard, C., Khan-ngern, W., and Ketkaew (2002): Effect of electric field from the electric field Rice grain separation unit on growth stages of the rice plant. Faculty of engineering and EMC laboratory.**5**: 250-253.

Labes, M.M. (1993): A possible explanation forthe effect of magnetic fields on biologicalsystems, *Nature*, 211: 969.

Luben, R.A., Cain, CD., Chen MC-Y., Rosen D.M., Adey (2000): Effects of electromagnetic stimuli on bone and bone cells in vitro: Inhibition of responses to parathyroid hormone by low-energy low-frequency fields. *ProcNatlAcadSc*i USA **79**:4180—4184.

Nechitailo G., Gordeev A. (2004): The use of an electric field in increasing the resistance of plants to the action of unfavorable space flight factors. *Advances in Space Research*. **34**: 1562–1565.

Pietruszewki, S. (1999): Influence of pre-sowing magnetic biostimulation on germination and yield of wheat. *IntAgrophysics*, **13**: 241-244.

Podlesny, J., Lenartowicz, W., and 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). *ActaAgrophysica*, **62**:103-111.

Sale, A. H. J. and Hamilton, W. A. (1967): Effects of high electric fields on microorganisms I. Killing of bacteria and yeasts", *Biochimica et BiophysicaActa*, **148**: 781-788.

Stefa, L. and A. Pozeliene (2003): Effect of Electrical Field on Barley Seed Germination Stimulation. *Agricultural Engineering International* **2**: 3-7.

UTICAJ ELEKTRIČNOG POLJA NA KLIJAVOST I RAST *Medicago Sativa Planet*, LOKALNE IRANSKE LUCERKE

-originalni naučni rad-

Saeed Rezaei-Zarchi, Saber Imani, Hekmate Alikhani Mehrjerdi, Mohammad Reza Mohebbifar

Centar za ispitivanje hemijskih oštećenja, Univerzitet medicinskih nauka Bakijatalah, Teheran, Iran

Rezime

Istraživanje glavnih poljoprivrednih proizvoda koji ispoljavaju tolerantnost prema različitim klimatskim uslovima predstavlja deo novih naučnih ciljeva poljoprivrede. U skladu s tim, nove naučne oblasti, kao što je primena električnih polja u poljoprivredi, mogu se koristiti za podsticanje produktivnosti svih useva. U tom pogledu, u ovom radu ispitan je uticaj električnih i magnetnih polja na rast i seme lucerke. U ogledu su primenjena četiri električna napona V_1=1, V_2=3, V_3=5 i V_4= 7 kao glavni faktor u kontrolnim uzorcima h_1=2.5 i h_2=5. Statistička obrada podataka izvršena je primenom SPSS softvera, a poređenje sredina sa verovatnoćom 1% pomoću Dankanovog testa. Rezultati su pokazali da je najveća klijavost postignuta u varijantama V_4h_1 and V_3h_2. Najveća dužina korena dobijena je u V_4h_1 varijanti, a najmanja u kontrolnoj varijanti. Električno polje ispoljilo je značajan uticaj na dužinu korena, a najveći uticaj ostvaren je u varijanti V_4h_1. Zelena masa biljaka lucerke bila je najveća u varijanti V_7 i 2/5 časa. Suva masa biljaka bila je najveća u varijanti v_4h_1, a najmanja u kontrolnoj varijanti. U varijanti V_4h_1 zabeležena je najveća klijavost semena, a u varijanti V_2h_1 najmanja klijavost.

Najviše vrednosti vitalnosti semena postignute su u varijanti V_7 i 2/5 časa. Rezultati pokazuju da električno polje ima značajan uticaj na karakteristike rasta i seme lucerke i da se može primeniti na seme prilagođeno odgovarajućoj klimatskoj zoni.

Ključne reči: uticaj električnog polja, klijavost, lucerka, dužina stabljike