Journal of Plant Production

Journal homepage: www.jpp.mans.edu.eg
Available online at: www. jpp.journals.ekb.eg

Effect of Magnetic Field Treatments on Seedling Growth Characteristics of Some Pea *(Pisum sativum)* Genotypes

Hero Fatih Hamakareem*

Department of Biotechnology and Crop Sciences, College of Agricultural Engineering Sciences, University of Sulaimani, Sulaimani City, Kurdistan Region, Iraq.

Cross Mark

ABSTRACT

In this study, the effects of exposing pre-sown pea seeds to magnetic fields on plant growth parameters have been studied under field conditions. Seeds from five different varieties (Javor, Desier, Mamoth, Oregon Sugar Pod, and Purple Pod) were batch exposed to static magnetic fields for 15, 30, and 45 minutes. Then, the magnetically treated seeds were sown in plastic cups and watered under running water. After 30 days of germination, three plants were marked for the collection of morphological data, different plant growth parameters were tested based on normal seedlings, such as root length, shoot length, fresh root weight, dry weight root and shoot dry weight. The results obtained indicated that the fresh weight of the root, the fresh weight of the shoot and the dry weight of the shoot for the varieties were significantly affected by the time of exposure to the magnetic field, as the duration of the magnetic fields increased. All seeds pretreated by magnetic field showed higher root weight, fresh shoot and dry weight compared to the control condition, and the highest root weight and fresh shoot was reported by treating seeds for 45 minutes under magnetic field conditions. However, the highest shoot dry weight was reported by seed treatment for 30 min. The reports indicated that the application of magnetic fields improved the growth characteristics of the treated group compared to the unexposed group.

Keywords: Magnetic field, Pea seeds, germination, morphological characteristic.

INTRODUCTION

The pea (*Pisum sativum* L.) is one of the cultivated legume crops that belong to the Fabaceae family, a diploid crop with the number of chromosomes (2n = 14). (Sato *et al*., 2010). The pea is an important legume cultivated and widely consumed throughout the world. As a rich source of protein, carbohydrates, and vitamins, peas are important in human nutrition. Consumed mainly as green peas, total production worldwide is around 21.22 million tons (FAO, 2018). Over the years, the impacts of the static magnetic field on the life of plants and their functions have been the subject of different research studies. (Subber *et al*., 2012). In the last decades, physical techniques based on the application of magnetic fields in the agricultural sector are being developed (Flórez *et al*., 2012). Over the last few years, the quality and status of research on the effect of the magnetic field on plant life has been verified (Belyavskaya, 2004; Galland and Pazur, 2005; Occhipinti *et al*., 2014; Vanderstraeten and Burda, 2012). Numerous authors have reported on the positive influence of the stationary magnetic field on plant seeds. Magnetic field treatment accelerates plant development, improves seedling growth and germination characteristics, and activates protein formation and enzyme activity (Aladjadjiyan , 2010). The investigations indicated that the application of magnetic fields and the treatment of the seeds with a magnetic field increases the germination of the seeds and improves their quality. Positive effects of the stationary magnetic field on the germination of plant seeds have been recorded with various plant species (Subber *et al*., 2012). The effects of magnetic fields on plant growth were observed in seed germination, early growth, root and shoot growth, seedling growth, seed vigor, fresh weights, dry weights, and seed yield (Balouchi and Sanavy, 2009; Gholami and Sharafi, 2010). The main objective of this study is to evaluate the effects of magnetic treatment on seed germination and seedling growth, as well as ion absorption in pea plants, exposing the seeds to the 3T magnetic field at different periods of time and exposure prior to planting.

MATERIALS AND METHODS

The experiment is laid out in a completely randomized design (CRD) with 4 treatments under three replications. The study will conduct checking the performance of magnetic devices on each pea species.

Seed source

The plant material composes of five species of Pea including Javor, Desier, Mamoth , Oregon sugar pod and Purple podded All of the above materials were obtained from Sulaymaniyah Agricultural Research Center, Sulaymaniyah. Healthy and uniform-sized seeds will be used in this experiment.

Seed treatment

Pea seeds will be placed in magnetron (3 tesla of magnetic force). Twenty five visibly mature, uniform and healthy seeds were treated by magnetic field for various durations ranging from 15 min , 30 min and 45 min. Seed germinations were achieved in three replications, in each plastic pot 5 seeds will be planted and the size of each one is (12 cm height, 13 cm diameter) in 2 cm depth of soil containing mix (1 soil: 1 peat moss).

Quantitative morphological traits

After 30 days of seeds germination the following plants characteristic will be measured: Seedling growth parameters: shoot length (cm), root length (cm), root biomass and shoot biomass (g).

* **Corresponding author.**
E-mail address: hero.hamakareem@univsul.edu.iq
DOI: 10.21608/jpp.2020.110549

RESULTS AND DISCUSSION

Impact of magnetized seeds on root and shoot length

Concerning the time of exposure, exposure of pea seeds to different time of magnetic field showed significant difference between the control and others treatments for all varieties in terms of root and shoot length according to Duncan test (Table 1). The root length was ranged from 18.98 to 21.06 cm, while the shoot length was varied from 24.56 to 26.15 cm. regarding the varieties, it was found that the average length of root of Mamoth was more than the average length of rest of varieties (Table 2). The interaction between the varieties and exposure time of magnetic field revealed the significant variations in terms of root and shoot length (Table 3). The highest value of root length (26.07 cm) was observed by Desier at level T30. Whereas, the lowest was recorded by Oregon sugar pod at level of T0 (14.77 cm). From these results, an increase of root length in Javor, Purple podded and Mamoth was stated in seeds exposred to magnetic field (T30) compared to control treatment (T0). Shoot length showed a sigmificant difference among different varieties. The greates value was noticed by Mamoth, while the lowest was registered by Oregon sugar pod over all treatments (Table 2). Significant effects were noted among varieties and different time of exposures. The maximum value of shoot length was determined by the Desier with T30 (26.07 cm). Interaction of Javor with T30 displayed the minimum value of shoot length (18.33 cm) (Table 3). We can conclude that the impact of magnetic field depends on the variety.

Table 1. Effect of seed pretreatment by magnetic field on the root and shoot length.

Magnetic power	Root length (cm)	Shoot length (cm)
T0	18.03 b	24.56 a
T15	18.98 ab	26.15 a
T30	21.06 a	25.03 a
T45	20.45 ab	25.73 a

" Each value represents the average of three replicates. Different letters within a column indicate significant variation in treatments according to the Duncan test."

Table 2. Impact of different varieties on the seedling growth.

Variety	Root length (cm)	Shoot length (cm)
Javor	18.18 b	20.33 cd
Purple podded	20.28 ab	23.57 b
Desier	19.57 b	21.99 bc
Mamoth	22.58 a	41.49 a
Oregon sugar pod	17.55 b	19.46 d

" Each value represents the average of three replicates. Different letters within a column indicate significant variation in treatments according to the Duncan test."

Influence of seeds pretreatment by magnetic field on root and shoot fresh weight

Root and shoot fresh weight were significantly affected by the exposure time to magnetic field, varieties and their interactions (Tables 4, 5 and 6). A different behavior among the varieties was found by increasing duration of the magnetic fields. All seeds pretreated by magnetic field showed higher root and shoot freah weight compared to control condition. The highest root and shoot fresh weight were reported by the treatment of seeds for 45 min under magnetic field condition. Purple podded exhibited the greatest values of root and shoot fresh weight (1.78 and 2.85 g, respectively). The interaction between varieties and magnetic duration was impacted significantly the root and shoot fresh weight. The maximum root (1.94 g) and shoot (3.43 g) fresh weight was demonstrated by Purple podded under 30 min of magnetic field. The minimum values of root (1.02 g) and shoot (1.75 g) fresh weight was scored by Desier under T0 condition. As seen in these results, all varieties reacted positively to magnetic field duration (Table 6).

Table 3. Influence of interaction between variety and exposure time to magnetic field on the root and shoot length.

Variety	Magnetic power	Root length (cm)	Shoot length (cm)
Javor	T0	17.57 bcde	20.70 def
	T15	19.07 bcde	21.03 def
	T30	16.17 de	18.33 f
	T45	19.93 abcde	21.23 def
Purple podded	T0	19.67 bcde	23.03 cde
	T15	18.63 bcde	22.13 cdef
	T30	20.80 abcde	25.50 c
	T45	22.00 abcd	23.60 cd
Desier	T0	17.50 bcde	21.27 def
	T15	16.93 cde	22.47 cdef
	T30	26.07 a	21.40 def
	T45	17.77 bcde	22.83 cde
Mamoth	T0	20.63 abcde	38.97 b
	T15	22.70 abc	45.23 a
	T30	23.13 abc	39.87 b
	T45	23.83 ab	41.90 ab
Oregon sugar pod	T0	14.77 e	18.83 ef
	T15	17.57 bcde	19.87 def
	T30	19.13 bcde	20.03 def
	T45	18.73 bcde	19.10 ef

" Each value represents the average of three replicates. Different letters within a column indicate significant variation in treatments according to the Duncan test."

Table 4. Effect of magnetic field duration on root and shoot fresh weight.

Magnetic field duration(min)	Root fresh weight (g)	Shoot fresh eight (g)
T0	1.21 b	2.25 b
T15	1.47 a	2.58 a
T30	1.46 a	2.58 a
T45	1.60 a	2.58 a

" Each value represents the average of three replicates. Different letters within a column indicate significant variation in treatments according to the Duncan test."

Table 5. Response of different varieties to magnetic field based on root and shoot fresh weight.

Variety	Root fresh weight (g)	Shoot fresh eight (g)
Javor	1.63 a	2.41 ab
Purple podded	1.78 a	2.85 a
Desier	1.22 b	2.06 b
Mamoth	1.39 b	2.64 a
Oregon sugar pod	1.15 b	2.54 ab

" Each value represents the average of three replicates. Different letters within a column indicate significant variation in treatments according to the Duncan test."

Effect of magnetic field duration on root and shoot dry weight

Table 7 shows the effect of the magnetic field duration on the biomass, where the seeds treated with magnetic field at different duration significantly higher in the dry weight. Root dry weight and shoot dry weight was varied from 0.14 to 0.20 g and from 0.38 to 0.46 g, respectively. The most significant magnetic field duration for root dry weight and shoot dry weight was T35 and T15, respectively. The results obtained in Table 8 disclosed significant differences between the different varieties. The maximum root dry weight and shoot dry was obtained by Javor and Mamoth, respectively, while the lowest values were stated by Desier and Oregon sugar pod, respectively. Interaction between the variety and magnetic field duration was explained that Oregon sugar pod achieved a significant advantage in root dry weight (0.24 g) when the seeds exposed for 45 min under magnetic field condition, followed by Javor and magnetic duration for 15 min (0.23 g). Interaction between Mamoth and T15 scored the highest value of shoot dry weight (0.51 g) followed by the interaction between Purple podded and T30 (0.56 g) (Table 9).

Table 6. Effect of the combination of varieties and magnetic duration on root and shoot fresh weight.

Variety	Magnetic power	Root fresh weight (g)	Shoot fresh eight (g)
Javor	T0	1.23 cd	2.10 b
	T15	1.86 ab	2.50 ab
	T30	1.47 abcd	2.20 ab
	T45	1.94 a	2.81 ab
Purple podded	T0	1.63 abc	2.56 ab
	T15	1.64 abc	2.74 ab
	T30	1.94 a	3.43 a
	T45	1.93 ab	2.68 ab
Desier	T0	1.02 d	1.75 b
	T15	1.14 cd	2.34 ab
	T30	1.26 cd	1.97 b
	T45	1.47 abcd	2.19 b
Mamoth	T0	1.09 cd	2.19 b
	T15	1.45 abcd	2.74 ab
	T30	1.38 bcd	2.76 ab
	T45	1.63 abc	2.87 ab
Oregon sugar pod	T0	1.10 cd	2.49 ab
	T15	1.24 cd	2.78 ab
	T30	1.24 cd	2.54 ab
	T45	1.03 d	2.34 ab

" Each value represents the average of three replicates. Different letters within a column indicate significant variation in treatments according to the Duncan test."

Table 7. Influence of magnetic field duration on root and shoot dry weight.

	Root dry weight (g)	Shoot dry weight (g)
T0	0.14 b	0.38 b
T15	0.17 ab	0.46 a
T30	0.16 b	0.45 a
T45	0.20 a	0.43 a

" Each value represents the average of three replicates. Different letters within a column indicate significant variation in treatments according to the Duncan test."

Table 8. Response of different varieties to magnetic field duration based on root and shoot dry weight.

Variety	Root dry weight (g)	Shoot dry weight (g)
Javor	0.20 a	0.42 abc
Purple podded	0.18 ab	0.48 ab
Desier	0.12 c	0.38 bc
Mamoth	0.18 ab	0.52 a
Oregon sugar pod	0.15 bc	0.34 c

" Each value represents the average of three replicates. Different letters within a column indicate significant variation in treatments according to the Duncan test."

Relationship between the treatments and studied traits

Principal component analysis (PCA) was performed using the various phenotypic characteristics and the four treatments as factors (Figure 1). The first two components explained 94.43% of the total variation. A biplot description of the association between the various phenotypic characteristics revealed that along axis 1, the length of the root, the length of the shoot, the fresh weight of the root, the fresh weight of the shoot, the dry weight of the root and shoot dry weight were positively associated. Furthermore, the biplot showed a negative T0 relationship and the rest of the treatments, indicating that the magnetic field treatments have a positive impact on growth traits. The magnetic field is known to be an environmental factor that affects the number of cluster biological reactions, such as the synthesis of RNA and proteins (Maffei, 2014). Several researchers have previously carried out experimental studies on seeds treated with a magnetic field. (Tahir and Hama Karim, 2010) showed that chickpea seedlings from magnetically pretreated seeds grew better than untreated ones, and also significantly increased biomass and shoot growth. They recorded an increase in the water absorption rate due to the applied magnetic field, which may explain the increase in germination of the treated seeds. A magnetic field exposed to dormant seeds has been found to increase the growth of barley, corn (*Zea mays*), beans, wheat, certain tree fruits, and other tree species (Rochalska and Orzeszko-Rywka, 2005). Pea shoot length was longer in the weak magnetic field (1.12 cm) compared to control treatment (0.88 cm) (Yamashita *et al.*, 2004). Microscopic observation identified the elongation of the pea sprout as a result of the elongation of the cells and the increase in the osmotic pressure of the seedlings in magnetic field treatments than the control condition (Negishi *et al.*, 1999).

Table 9. Combination effect of variety and magnetic field duration on root and shoot dry weight.

Variety	Magnetic power	Root dry weight (g)	Shoot dry weight (g)
Javor	T0	0.20 abc	0.42 abcd
	T15	0.23 ab	0.44 abcd
	T30	0.16 abcd	0.41 abcd
	T45	0.20 abc	0.43 abcd
Purple podded	T0	0.15 bcd	0.41 abcd
	T15	0.19 abcd	0.43 abcd
	T30	0.20 abc	0.56 abc
	T45	0.19 abcd	0.50 abcd
Desier	T0	0.11 d	0.32 d
	T15	0.11 d	0.43 abcd
	T30	0.13 cd	0.37 bcd
	T45	0.15 bcd	0.40 abcd
Mamoth	T0	0.12 cd	0.39 abcd
	T15	0.18 abcd	0.61 a
	T30	0.19 abcd	0.57 ab
	T45	0.21 ab	0.50 abcd
Oregon sugar pod	T0	0.11 d	0.34 cd
	T15	0.13 cd	0.37 bcd
	T30	0.13 cd	0.34 cd
	T45	0.24 a	0.30 d

" Each value represents the average of three replicates. Different letters within a column indicate significant variation in treatments according to the Duncan test."

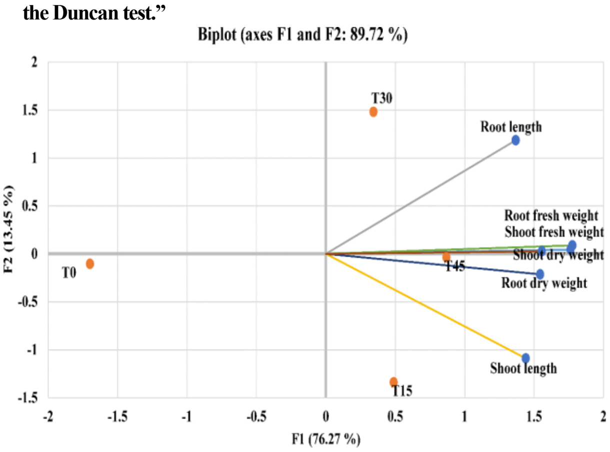

Figure 1. PCA plot showing the association between different treatments and traits.

CONCLUSION

The magnetic field duration had a positive effect on the plant growth traits along all varieties and the T45 had the maximum impact on all studied characters followed by T30 and T15.

REFERENCES

Aladjadjiyan, A. (2010). Influence of stationary magnetic field on lentil seeds. *Int. Agrophys*, *24*(3), 321-324.

Balouchi, H. R. (2009). Electromagnetic field impact on annual medics and dodder seed germination. *International Agrophysics*, *23*(2), 111-115.

Belyavskaya, N. A. (2004). Biological effects due to weak magnetic field on plants. *Advances in space Research*, *34*(7), 1566-1574.

Food and Agriculture Organization of United Nations (FAO) (2018). FAOSTAT Database. Crop Statistics Rome, Italy. Retrieved May 20, 2018 from http://www. fao.org/ faostat/en/#data/QC

Flórez, M., Martínez, E., & Carbonell, M. V. (2012). Effect of magnetic field treatment on germination of medicinal plants Salvia officinalis L. and Calendula officinalis L. *Polish Journal of Environmental Studies*, *21*(1).

Galland, P., & Pazur, A. (2005). Magnetoreception in plants. *Journal of plant research*, *118*(6), 371-389.

Gholami, A., Sharafi, S., & Abbasdokht, H. (2010). Effect of magnetic field on seed germination of two wheat cultivars. *World Academy of Science, Engineering and Technology*, *62*, 279-282.

Maffei, M. E. (2014). Magnetic field effects on plant growth, development, and evolution. *Frontiers in plant science*, *5*, 445.

Negishi, Y., Hashimoto, A., Tsushima, M., Dobrota, C., Yamashita, M., & Nakamura, T. (1999). Growth of pea epicotyl in low magnetic field implication for space research. Advances in Space Research, 23(12), 2029-2032.

Occhipinti, A., De Santis, A., & Maffei, M. E. (2014). Magnetoreception: an unavoidable step for plant evolution?. *Trends in plant science*, *19*(1), 1-4.

Rochalska, M., & Orzeszko-Rywka, A. (2005). Magnetic field treatment improves seed performance. *Seed Science and Technology*, *33*(3), 669-674.

Sato, S., Isobe, S., & Tabata, S. (2010). Structural analyses of the genomes in legumes. *Current opinion in plant biology*, *13*(2), 146-152.

Tahir, N. A. R., & Karim, H. F. H. (2010). Impact of magnetic application on the parameters related to growth of chickpea (Cicer arietinum L.). *Jordan Journal of Biological Sciences*, *147*(616), 1-19.

Vanderstraeten, J., & Burda, H. (2012). Does magnetoreception mediate biological effects of power-frequency magnetic fields?. *Science of the total Environment*, *417*, 299-304.

Yamashita, M., Tomita-Yokotani, K., Hashimoto, H., Takai, M., Tsushima, M., & Nakamura, T. (2004). Experimental concept for examination of biological effects of magnetic field concealed by gravity. *Advances in Space Research*, *34*(7), 1575-1578.

تأثير المجال المغناطيسى علي صفات النمو الشتلات لبعض التراكيب الوراثية للبازلاء *(Pisum sativum)*

هيرۆ فاتح حمەكريم*

قسم التكنولوجيا الحيوية وعلوم المحاصيل الحقلية، كلية علوم الهندسة الزراعية، جامعة السليمانية، مدينة السليمانية، إقليم كوردستان، العراق

فى هذه الدراسة تم دراسة تأثيرات تعريض بذور البازلاء قبل زرعها الى حقل مغناطيسى على قرائات نمو النبات تحت الظروف الحقلية. البذور من خمسة أضناف مختلفة من البازلاء (Javor, Desier, Mamoth, Oregon sugar pod, and Purple podded) التى تعرضت بالتوالى الى حقل مغناطيسى ساكن ل15,30,45 دقيقة. بعدها البذور المعاملة مغناطيسيا زرعت فى السنادين بلاستكية و بعد 30 يوما من انبات , تم أخذ المعلومات المورفولوجية من 3 نباتات, قرائات نمو النباتات المختلفة المدروسة قورنت مع القرائات لنمو أشتال غير معاملة. كطول المجموع الجذري وطول المجموع الخضرى والوزن الطرى للمجموع الجذرى والوزن الطرى للمجموع الخضرى والوزن الجاف للمجموع الجذرى والوزن الجاف للمجموع الخضرى. النتائج المحصلة تبين ان الوزن الطرى للمجموع الجذرى و الخضرى مع الوزن الجاف الخضرى لكل الاصناف تأثرت بصورة معنوية بلمدة التنتعضت للحقل المغنلطيسى كل البذور المعاملة بالمجال المغناطيسى لها اكبر قيمة فى الوزن الطرى للمجموع الجذري و الخضرى و الوزن الجاف مقارنة بالغير المعاملة.و أعلى القيمة لوزن الطرى للمجموع الجذري و الخضرى سجلت عند المعاملة بالتعريض 45 دقيقة لحقل المغناطيسى و كذلك سجلت أعلى قيمة للوزن الجاف للمجموع الخضرى عند المعاملة بالتعريض البذور ل 30 دقيقة للحقا الموغناطيسى التقارير تشير الى ان تنشط صفات النمو للمجاميع المعاملة بالحقل الموغناطيسى مقارنة بالغير المعاملة.