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Araştırma Makalesi / Research Article

The Effect of Magnetic Field on Three Different Varieties of Soybean Seed

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Abstract

In this study, 150 seeds from each of three soybean varieties (30 seeds for each application) have been passed through 3,8-4,8 mT magnetic flux density of the magnetic field 0, 1, 3, 9 and 15 times at a magnetic height of 0,055 m in order to determine the most suitable magnetic field strength for Defiance, General and Iraquous soybean varieties. Three different soybean seed varieties passed through magnetic field were germinated in petri dishes at 25°C on moist filter papers. The root lengths and germination percentages of the varieties were measured by making observations at the end of 24^{th}, 48^{th}, 72^{nd} and 96^{th} hours to determine the most suitable magnetic field strength. As a result, an increase was detected in the germination percentage and root length of D_1(Defiance; 1 times pass through magnetic field)and D_9(Defiance;9 times pass through magnetic field) applications of the Defiance at the end of the 72^{nd} and 96^{th} hours compared to the control(D_0,G_0,I_0), and also an increase was observed in the G_1(General; 1 times pass through magnetic field) and G_9(General; 9 times pass through magnetic field) applications of the General; whereas an increase was observed only in the germination percentage in the I_3(Iraquous; 3 times pass through magnetic field) and I_9 (Iraquous; 9 times pass through magnetic field) applications of Iraquous. No increase was detected for the root length in the I_3 at the end of the 96^{th} hours.

Keywords: Soybean,*Glycine max* (L.) *Merrill*, magnetic field, germination, root length

Manyetik Alanın Üç Farklı Soya Çeşidi Tohumları Üzerine Etkisi

Özet

Bu çalışmada Defiance, General ve Iraquous soya çeşitleri için en uygun manyetik alan şiddetlerini belirlemek amacıyla her 3 soya çeşidine ait 150'şer tohum (her muamele için 30 adet tohum kullanılmıştır) h= 0,055m'lik bir magnet yüksekliğinde saptanan 3,8-4,8 mT'lik bir manyetik akı yoğunluğunda manyetik alandan 0, 1, 3, 9 ve 15 kez geçirilmiştir. Manyetik alandan geçirilen 3 farklı soya çeşidine ait tohumlar 25^{o}C'lık etüvde, petri kutularında, nemli filtre kâğıtlarında çimlendirilmiştir. Çimlenen tohumların 24, 48, 72 ve 96. saatlerdeki gözlemleri yapılarak, soya çeşitleri için en uygun manyetik alan şiddetini belirlemek amacıyla çimlenme yüzdeleri ve kök uzunlukları ölçülmüştür. Sonuç olarak; 72. ve 96. saatlerde kontrole (D_0,G_0,I_0) göre Defiance çeşidinde D_1(Defiance;1 kere manyetik alandan geçmiş) ve D_9(Defiance;9 kere manyetik alandan geçmiş)'da, General çeşidinde G_1(General;1 kere manyetik alandan geçmiş) ve G_9(General;9 kere manyetik alandan geçmiş) uygulamalarında çimlenme yüzdesi ve kök uzunluğunda artış saptanırken Iraquous çeşidinde ise I_3(Iraquous;3 kere manyetik alandan geçmiş) ve I_9(Iraquous;9 kere manyetik alandan geçmiş) uygulamalarında çimlenme yüzdelerinde kontrole göre artış saptanırken 96. saatte I_3 uygulamasında kök uzunluğunda bir artış saptanmıştır.

Anahtar Kelimeler: Soya, *Glycine max (L.) Merrill* , Manyetik alan , Çimlenme, kök uzunluğu

Introduction

As a result of the rapid development of science and technology along with improved quality of life and industrial developments in parallel with rapid population

growth in the world that we live, the animal products are not sufficient enough to meet the protein requirements. Thus, the soybean plants have been important products in the nutrition field due to its characteristics in terms of oilseeds, vegetable protein and fat. The origin of soybean (*Glycine max (L) Merrill)* is Southeast Asia and each grain has 45% of protein, 20-22% of fat, 20-26 % carbohydrate, 5% mineral substances (phosphorus, potassium, calcium, sulfur, magnesium etc.) and many vitamins (mostly A and B); also rich and valuable amino acids are found in the protein's structure (Orthoefer, 1978;Zhang et al.,2017). The pulp is also used as human and animal food after getting the oil of the soybean. The soybean is used as green vegetable and roasted seed; also used in the soya meat production due to its high percentage of protein, flour, milk, yogurt and cheese-making and for many other industrial products such as paint, linoleum and glue manufacturing (Anaç and Ertürk, 2003).

There are various studies carried out by the researchers to get more yield from the unit area and more quality, since the soybean has gained more importance in agricultural life. In agriculture, development and improvement of new varieties with high genetic value and commercial potential with the desired characteristics are very important. Thus, the development of the plants that will contribute to the country's economy in terms of agriculture with desired characteristics will be achieved (Sun et al.,2018). In recent years, the artificially created magnetic field (MF) is applied to plants either by itself or with a combination of mutagens in order to obtain more products, improve the insufficient characteristics of the varieties and have a quick development of high quality and valued plants economically. The variety of the effects of electric and magnetic fields on the biological organisms are investigated by the studies conducted on both cells and organisms (Goodman et. al., 1995; Şeker and Korkut, 2005;Kataria et al.,2017;Nair et. al., 2018).

It is difficult to evaluate the effects on the regular functions of the plants when the biological systems are exposed to magnetic and electromagnetic fields. One of the main reasons of this difficulty is the complexity of the biological systems. According to the results of the studies, it is suggested that the chemical reactions are affected by the changes in the rotations of the electrons due to the magnetic field sequence with an intensity of 10^{-3}-10^{-2}T (Tesla) and these effects have the potential of causing some biological consequences (Belyavskaya et. al., 1992; Formicheva et. al., 1992).

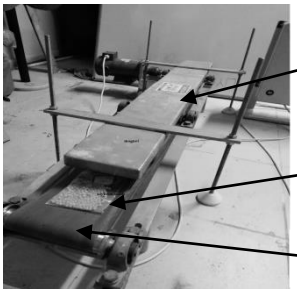
Many experiments were carried out, related to the effects of electrical and magnetic fields, both on the complex structures and simply structured livings. Such effects of electromagnetic and magnetic fields on the biological systems have attracted the attention of many researchers from the fields of biology, medicine and agriculture. Especially in recent years, many researchers around the globe have started to investigate the positive effects of magnetic fields on living creatures as well as their negative effects. According to the data obtained from the experiments, it is observed that the magnetic field causes some changes in the viability activities of the organisms. The effects of various magnetic field applications on the seed germination, yield, respiratory rate, temperature loss, chemical changes and seedling development have been the subject of many researches. The variety of effects on the cells and organisms caused by electric and magnetic fields have been investigated through the studies. It is observed that the magnetic field has increased the germination percentage and duration compared to the control for some plants such as sunflower, soybean and wheat (Atak et.al. 2000; Oldacay Yalçın 2002; Yalçın and Tayyar, 2011;Martinez et. al., 2017). In this study, it is aimed to determine the optimum magnetic field strength for three different soybean

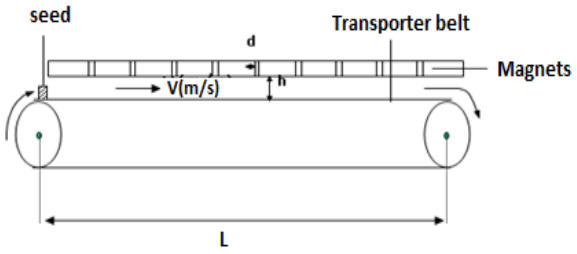
varieties by investigating the effects of the magnetic field on the germination percentages and durations of three different soybean seeds.

Material And Methods

In this study, the soybean varieties of Defiance, General and Iraquous were used as the plant material obtained from Black Sea Agricultural Research Institute. The moisture contents of soybean varieties were detected as 8.3% for Defiance, 10% for General and 6.6% for Iraquous, respectively (Conger et. al., 1966). In order to determine the most suitable magnetic field strength, 150 seeds from each of three soybean varieties (30 seeds for each application) have been passed through 3,8-4,8 mT magnetic flux density of the magnetic field 0, 1, 3, 9 and 15 times at a magnetic height of 0,055m (Gaul, 1977; Yalçın, 1992) (Figure 1).

The germination percentages and root lengths were measured after passing them through magnetic field at the room temperature between hours of 13:00 and 13:42. Three different soybean seeds passed through magnetic field and were germinated inpetri dishes at 25 °C on moist filter papers. The root lengths and germination percentages of the varieties were measured by making observations at the end of 24th, 48th, 72nd and 96th hours in order to determine the most suitable magnetic field strength





L= Length of transporter belt
h= distance between seeds and magnets
d= distance between magnets
n=Number of magnet
v= Belt system that can rotate by a speed of 1 m/s

Figure 1: Magnetic Field Mechanism

Results And Discussion

The data obtained in this study were observed in a greenhouse experiment during the 2007-2008 growing season.In this study, the root lengths and germination times of three different soybean seeds have been determined by passing them through a magnetic field. The effect of MF on the germination of soybean plant is given in Table 1. In the first 24 hours, no effect has been observed on the germinations of three soybean varieties. At the end of the 48th hours, no significant effect has been observed. However, at the end of the 72nd hours, an increase has been observed in the germination percentages of D_1 and D_9 applications on Defiance, G_1 and G_9 applications on General and I_3 and I_9 applications on Iraquous. This increase has continued at the end of the 96th hours and a significant difference was observed compared to the control. It has been revealed that the MF applied to the plants has significant effects on the parameters that

change the development of the plants (Lebedev et. al. 1975; Belyavskaya et al. 1992; Atak et al. 2007, Đukıć et al.,2017).

Carbonell et al. (2000), have determined that the magnetic flux density of 150 and 250 mT have positive effects on the germination percentage of rice plant (*Oryza sativa L.*) in their study. According to another study carried out by Aladjadjiyan and Ylieva (2003), the magnetic field affects the germination percentage of tobacco plant positively. Rochalska and Grabowska (2007), have detected some changes on the alpha amylase, beta amylase and glutathione S-transferase enzymes of the wheat seeds, which have important roles in the germination of the seeds and providing food supply during the germination, when the seeds were exposed to the magnetic field.

Several studies on plants that investigate the effect of low frequency magnetic field at various temperatures to the plants show that the MF has no effect on the germination percentage and growth of the plant at 20°C. However, the germination of soybean and corn was fastened by MF at 10°C, but no positive effect was observed on the germination of wheat at 5°C. As a result of these studies, it is introduced that the low frequency magnetic field can be used as a product development method for the seeds particularly sensitive to the low temperatures (Rochalska and Orzeszko -Rywka 2005).

Varieties	Application	The number of seeds	Germination percentage (%)			
			24^{th}hour	48^{th}hour	72^{th}hour	96^{th}hour
DEFIANCE	D_0	30	-	-	100	100
	D_1	30	-	-	100	100
	D_3	30	-	-	16.66	83.33
	D_9	30	-	23.33	86.66	100
	D_{15}	30	-	-	80	100
GENERAL	G_0	30	-	33.33	60	60
	G_1	30	-	10	60	76.66
	G_3	30	-	-	6.66	70
	G_9	30	-	-	56.66	56.66
	G_{15}	30	-	-	43.33	83.33
IRAQUOUS	I_0	30	-	23.33	56.66	60
	I_1	30	-	23.33	50	70
	I_3	30	-	-	53.33	56.66
	I_9	30	-	-	56.66	90
	I_{15}	30	-	-	40	86.66

Table 1. The effect of MF on the germination of Defiance, General and Iraquous Soybeans

However, the influence of the magnetic field on the chemical reactions of biological systems has not been detected under the physical conditions yet (Grundler et al. 1992; Belyavskaya et al. 1992; Oldacay Yalçın 2002, Poghosyan and Makhaelyan,2018). In this study, the effects of magnetic field on the root lengths of three different soybean varieties have been investigated and the results are shown in Table 2 .

Varieties	Application	The number of seeds	Root length(mm)			
			24^{th}hour	48^{th}hour	72^{th}hour	96^{th}hour
DEFIANCE	D_0	30	-	-	5.533±3.162	17.735±6.743
	D_1	30	-	-	4.883±3.423	17.750±7.649
	D_3	30	-	-	2.400±1.140	9.540±4.868
	D_9	30	-	2.30±1.414	7.346±5.039	17.187±6.007
	D_{15}	30	-	-	4.687±3.494	15.53±6.993
GENERAL	G_0	30	-	4.16±4.193	6.611±4.171	13.027±4.754
	G_1	30	-	-	6.250±2.777	14.804±7.398
	G_3	30	-	-	-	6.214±4.468
	G_9	30	-	-	7.117±4.151	13.205±7.564
	G_{15}	30	-	-	4.307±3.351	11.040±5.667
IRAQUOUS	I_0	30	-	2.5±0.707	7.411±4.062	15.388±7.113
	I_1	30	-	2.750±1.060	5.333±2.768	13.952±6.103
	I_3	30	-	-	5.750±3.473	16.352±5.024
	I_9	30	-	-	5.617±3.646	14.148±7.465
	I_{15}	30	-	-	5.250±3.768	10.557±5.957

Table2. The effect of MF on the root lenghts of Defiance, General and Iraquous Soybean

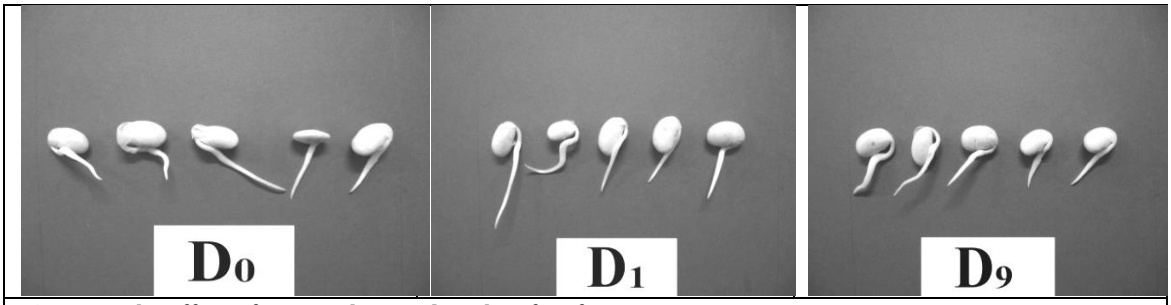


Figure2. The effect of MF on the root lengths of Defiance

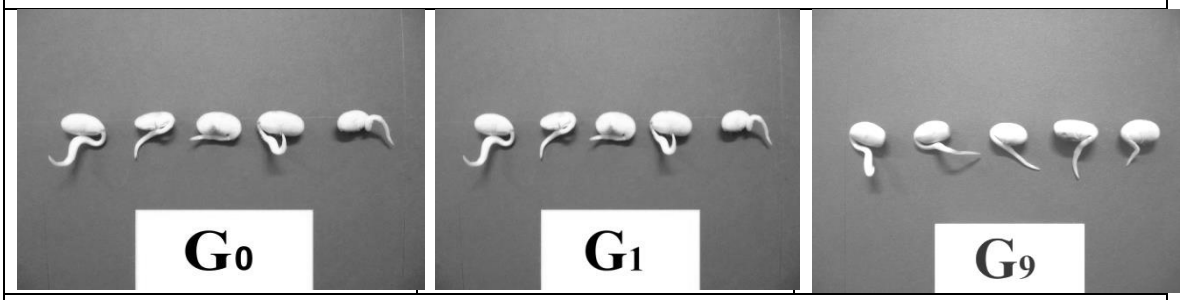


Figure3. The Effect of MF on The Root Lengths of General

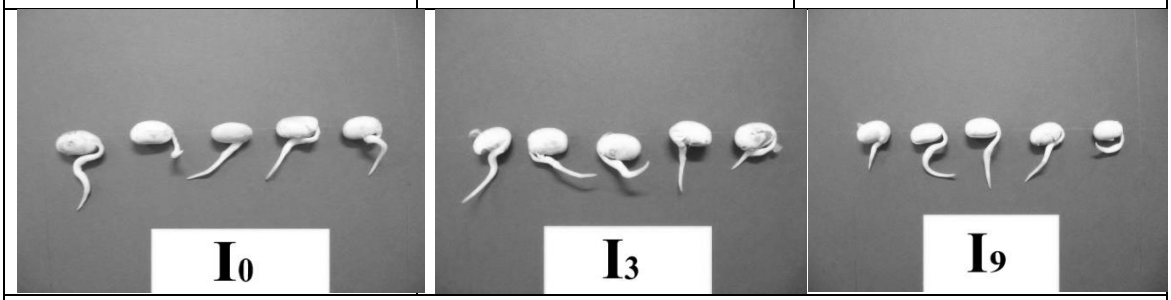


Figure4. The Effect of MF on The Root Lengths of Iraquous

In this study, the effect of magnetic field on the root lengths of three different soybean varieties was also investigated. No effect was observed in the root lengths of the soybeans in the first 24 hours. At the end of the 48th hours, an increase was observed in the root length of D_9 of Deviance compared to the control, and at the end of the 72nd hours also an increase was observed on the root length of D_1. At the 48th hours, only a root bud was observed in the control of the variety of General, and no other change was observed in the other applications. At the end of the 72nd and 96th hours, an increase was observed in G_1 and G_9 compared to the control. At the 48th hours, an increase was observed in the root length of control of Iraquous and I_9, and also an increase was observed in the root length of I_1 compared to the control in average (Figure 2, Figure 3 , Figure 4 and Figure 5).

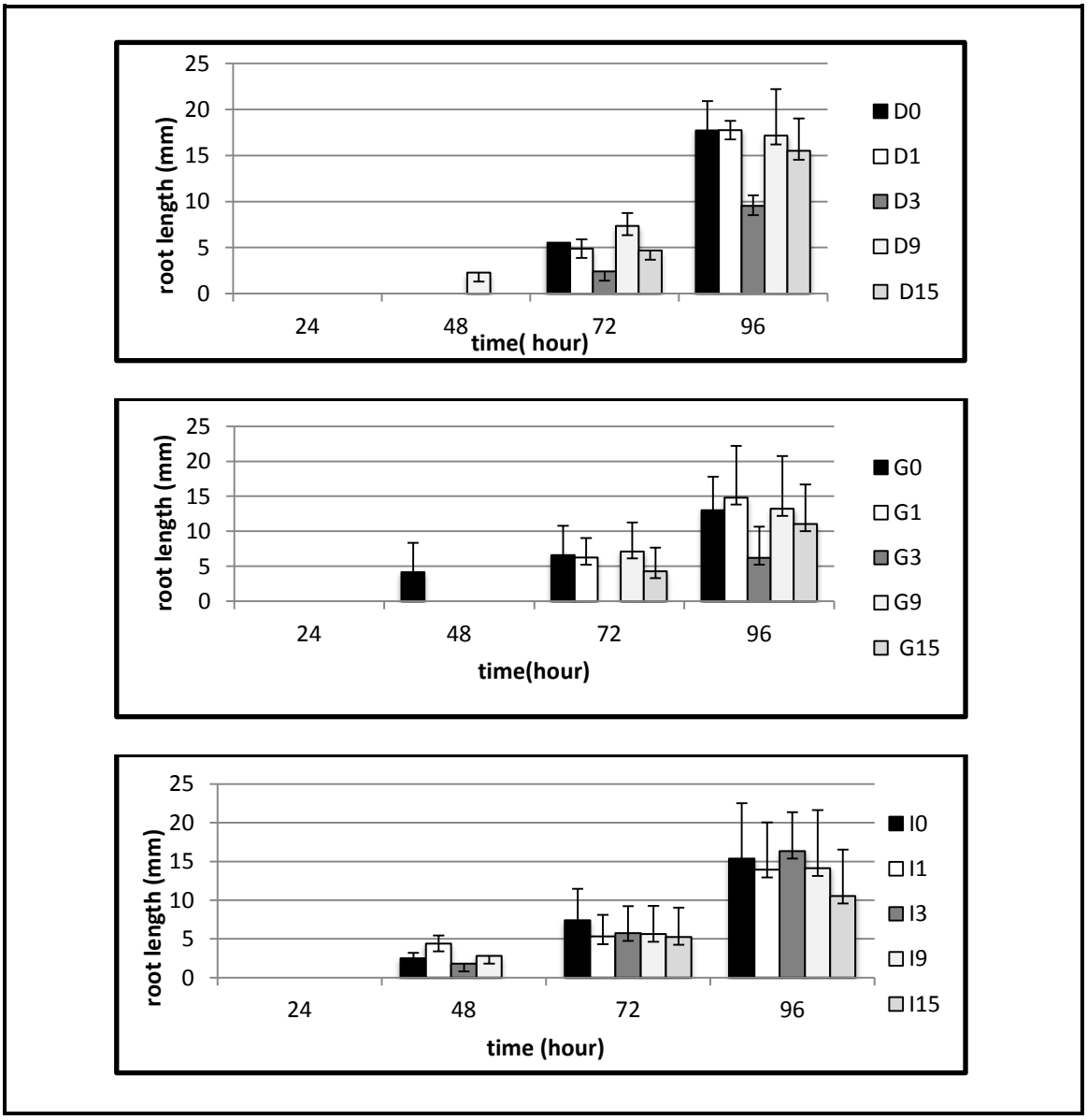


Figure 5. The Effect of MF on The Root Lengths of Defiance, General And Iraquous Soybean Varieties

According to the studies investigating the effect of magnetic field on the root length of the plants, it has been found that the magnetic field affects the root growth. In

a study, it has been showed that a 25% of more root growth is obtained in the root length of the corn plant when it is exposed to a magnetic field with an intensity of 5000 gauss.

Consequently, the positive effects of magnetic field on the root length and germination percentages of three different soybean varieties have been detected in this study. The optimum magnetic field applications are determined as follows: D_1 and D_9 magnetic field applications for the variety of Defiance; G_1 and G_9 magnetic field applications for the General, and I_1 and I_9 magnetic field applications for the Iraquous. However, it is significant to determine the optimum magnetic field intensity for each variety, since the differences of genotypes of the plants change the response of the plant to magnetic field.

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