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EFFECTS OF MAGNETIC FIELD ON SOYBEAN (Glycine max. L.Merrill) SEEDS

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SUMMARY

In our research, the seeds, belonging to J-357 soybean variety, which have different water contents were used with the purpose of determining the effect of magnetic fields on soybean seedlings. These were exposed to magnetic field strengths in the range of 50-60 Oe on the movable ground with the velocity of 1 m/sec. Depending on the apparatus prepared at the laboratory, the strength and the period of the magnetic field were changed. Soybean seedlings were grown from the seeds exposed to magnetic field of different strengths and from the seeds of the control group, at optimum conditions in the climate chamber. The seedling heights, dry and wet weights were determined. As a result, it was seen a positive effect of magnetic field on the seedling growth with the water content of 9.6% in comparison with the water content of 7.3%.

The effects of magnetic field's small changes on the biological systems have drawn attention of many scientists in biology, medicine and agriculture. Particularly in the recent years, many scientists have also started to investigate the positive effects of the magnetic field in biological systems besides the negative one.

Alongside with the investigations made in order to determine the effect of the magnetic field on the molecules and the cells [1], the experiments pertaining to the acceleration of the growth of plants and the increase of the yield have been made as well. Recently the successful results on cotton yield have been obtained in Russia [2]; stimulation of growth in maize and wheat has been found in Romania [3]; increasing of plant growth and pod yields of groundnuts have been found in India [4], pollen germinating faster and at a higher frequency and producing longer pollen tubes of the Carica papaya has been established in India [5]; and increasing of the number of developed leaves, flowers and leaf area which leads to increasing of the yields of strawberry has been obtained in Japan [6].

The above findings show the positive effects of the magnetic fields on the plants. Moreover a number of negative experimental findings concerning the biological effects of the magnetic fields can be seen in the literature. In a greenhouse trial with tomato plants no effects of magnetic treatment have been observed [7].

Such different results obtained after the treatment of plants with magnetic field may be due to various factors such as some uncertainties in the mechanisms

of magnetic field's effect at the beginning, differences in the intensity and the period of the magnetic field and also indefinite explanation of some of the biological characteristics of the seed used.

The aim of our research carried out in corporation with the JINR Laboratory of Nuclear Problems at Dubna is to determine the effects of the magnetic field on soybean seeds having different water contents.

MATERIALS AND METHODS

In this research, the seeds belonging to J-357 soybean variety have been selected and the water contents of the seeds during the experiment have been found as 7.3%. Apart from this, at the room temperature and in a vacuum desiccator containing 60% glycerine solution, the water content of the seeds belonging to this variety has been raised up to 9.6% [8]. The soybean seeds having 7.3% and 9.6% water contents have been passed with a speed of 1 m/sec through the magnetic field of the strength of 50-60 Oe which was formed by 10 magnets of $65 \times 45 \times 22$ mm dimensions, and seeds were passed 3, 9, 15, 21 times through the plane which was 40 mm far from the magnets.

Four exposure groups of seeds which have been the subject of magnetic field influence of different duration (with two different water contents) and control group of seeds were planted into plastic boxes of 36 and 27 cm dimensions. The boxes were filled with standard experimental soils, under controlled conditions in the plant growth chamber. In the experiments, each treatment had 8 parallels and 10 seeds were employed for each parallel.

The measurements were taken when the first leaf had stopped its growth, usually after 14 days. Fourteen days after the seeds were sown, the seedlings grown from seeds having two different water contents were removed from the soil. The seedling heights, and their wet and dry weights were determined.

RESULTS AND DISCUSSION

In this research, the effects of the magnetic field's strength on germination percentages, seedling height, wet and dry weights of seedling grown from seeds having 7.3 and 9.6% water contents were investigated.

The effect of the magnetic field on the germination of J-357 soybean seeds having 7.3 and 9.6% water contents is given in Table 1. The germination percentage was determined on the seventh day and as 93% of control group's seeds with 7.3% water contents germinated, the germination of the seeds passed under the magnets 15 and 21 times were 94 and 96%, respectively. While 85% of the control group's seed having 9.6% water contents germinated, the germination of

Table 1. The effects of magnetic field on the germination percentages of soybean seeds which have different water contents

Magnetic field influence*	Seeds water contents	
	7.3%	9.6%
Control	93	85
3	91	94
9	85	96
15	94	96
21	96	96

*Passing namber through magnetic system.

the seed passed under the magnets 3 times was 94%. With the increase of the number of passing under the magnets from 9 to 21, this ratio has been found as 96% without any change at the germination per cent.

While a little increase is seen at the germination percentages of the seeds having 7.3% water contents in comparison with the control and at those which were passed under the magnets 15 and 21 times, in all the treatments, there is an increase according to the control at the seeds having 9.6% water contents. In relation to this subject, it was shown that the magnetic field increased germination of groundnuts [4]. Besides, the germination of the seeds of pea, lentil and flax

Table 2. The seedling lengths (cm) of the plants obtained from different water contents and exposed to magnetic fields of different duration

Magnetic field influence*	Seeds water contents	
	7.3%	9.6%
Control	17.96	16.23
3	18.75	18.32
9	17.09	18.49
15	16.70	19.26
21	16.18	19.99

*Passing namber through magnetic system.

under geomagnetic field influence and magnetic screen conditions were compared. It was found that the geomagnetic field has caused an acceleration of 67% rate as compared with the seeds grown up in the screen conditions [11]. On the other hand, R.P.Mericle and his colleagues found that the magnetic field has not any effect at the germination rate (12).

The heights belonging to the seedlings grown from the soybean seeds having 7.3% and 9.6% water contents and exposed to different magnetic field duration are shown in Table 2.

For the seeds at 7.3% water content the height of seedling shows an increase only for those which were passed through magnets 3 times; for those at 9.6% water content the seedling heights have shown an increase in all magnetic field duration. The relation between the seedling heights and magnetic field duration for the soybean at 7.3% water content is shown in Fig. 1 by drawing a regression line. According to the results obtained, it was observed that the seedling height decreased depending on the magnetic field's strength. For this water content, the negative effect of the magnetic field strength on the seedling height was found significant ($p < 0.05$). Alongside with the magnetic field's negative effects on the soybean seedling's heights, thickening in the seedlings and changes in the inclination towards the force of gravity were observed.

The relation between soybean seedling height and magnetic field duration at 9.6% water content is given in Fig. 2 as a regression line. It has been found that the seedling height has been effected positively by the increased magnetic field strength and also found that this effect was significant ($p < 0.05$).

According to these results, with the increase of water content from 7.3 to 9.6%, a positive effect of the magnetic field is seen. R.P.Mericle and his colleagues showed that seedling height of barley was affected by the magnetic field [12].

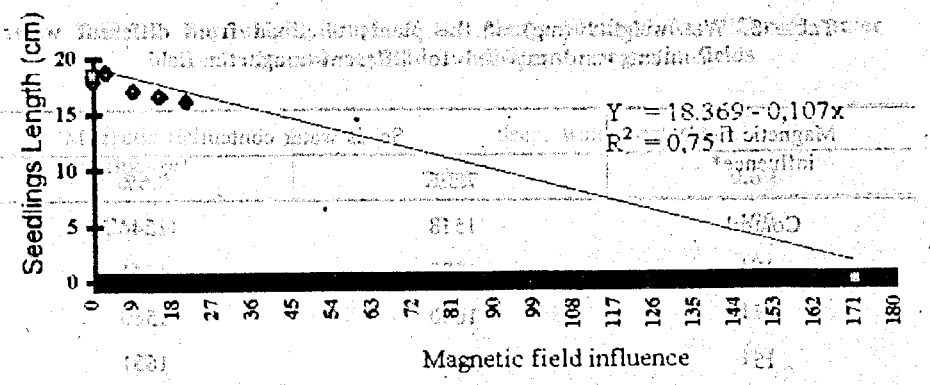

Fig.1. The relation between magnetic field influence and length of seedlings (cm) obtained from the seeds having 7.3% water contents ($p < 0.05$)

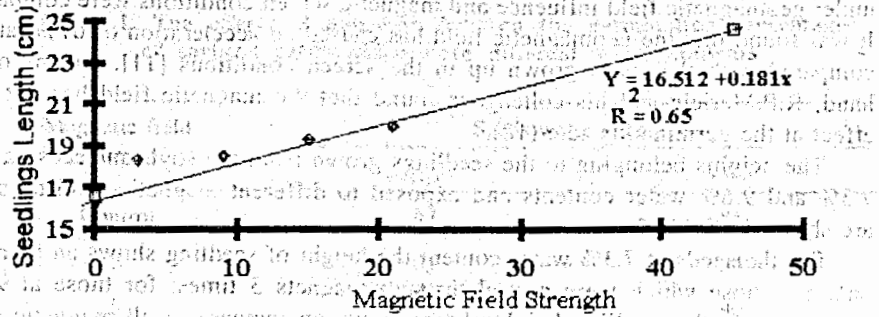

Fig.2. The relation between magnetic field strength and seedlings length (cm) obtained from the seeds having 9.6% water contents (p , 0.05)

R.D.Govorun et al. [11] showed that the seedling development was inhibited by almost at a rate of 79% under magnetic screen conditions.

The wet weights of seedlings obtained from the seeds having 7.3 and 9.6% water contents of control group and those of groups exposed to four different magnetic field duration are shown in Table 3. While the wet weight at 7.3% water content was 1518 mg at control, it was 1608, 1640, 1556 and 1563 mg in those passed through magnets 3, 9, 15 and 21 times, respectively. The wet weight at 9.6% water content is 1544 mg at control group. The wet weight of seedlings obtained from the seeds which were passed through magnets 9,15 and 21 times has exceeded the control. The regression line showing the relation between the

Table 3. Wet weights (mg) of the plants obtained from different water contents and exposed to different magnetic field

Magnetic field influence*	Seeds water contents	
	7.3%	9.6%
Control	1518	1544
3	1608	1541
9	1640	1560
15	1556	1651
21	1563	1651

*Passing namber through magnetic system.

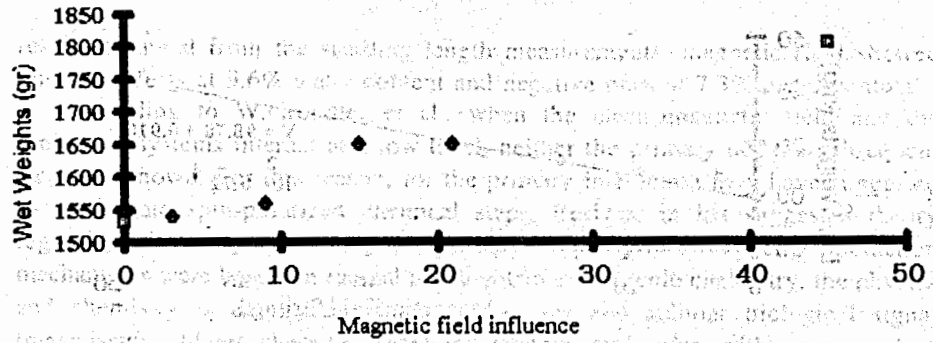

Fig.3. The relation between magnetic field influence and the wet weight (mg) obtained from the seeds having 9.6% water content ($p < 0.05$)

magnetic field strength and the wet weight of the seedlings having 9.6% water content is given in Fig. 3.

Depending on the increase of the magnetic field strength at this water content, an increase has been determined at the wet weight, and the relation between wet weight and magnetic field has been found to be significant ($p < 0.05$). But the relation between the wet weights of the seedlings grown from the seeds having 7.3% rate and magnetic field strength has been found insignificant. While the dry weight of the control plants with 7.3% water content was 92 mg, those of the controls passed through the magnets 3, 9, 15 and 21 times reached 108, 109, 113 and 116 mg, respectively.

Table 4. Dry weights (mg) of the plants obtained for different water contents and exposed to different magnetic fields

Magnetic field influence*	Seeds water contents	
	7.3%	9.6%
Control	92	109
3	108	101
9	109	110
15	113	114
21	116	117

*Passing namber through magnetic system.

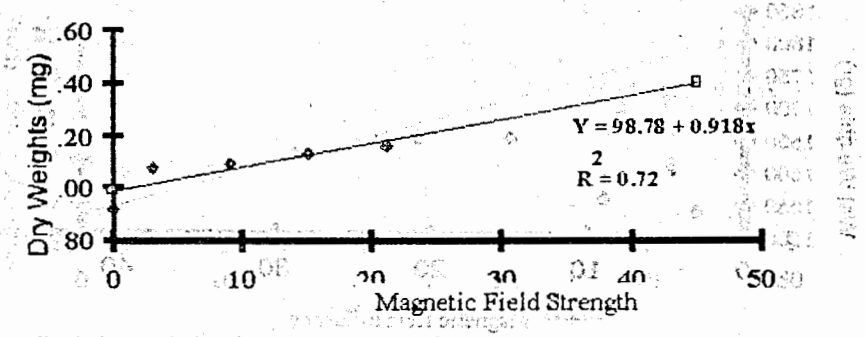

Fig.4. The relation between magnetic field influence and the dry weight (mg) obtained from the seeds having 7.3% water content ($p < 0.05$)

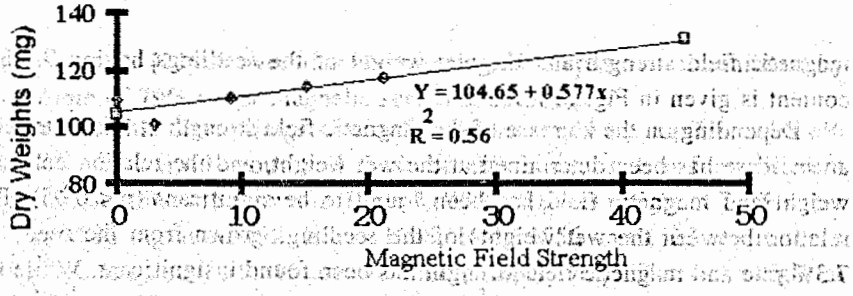

Fig.5. The relation between magnetic field influence and the dry weight (mg) obtained from the seeds having 9.6% water content ($p < 0.05$)

While the dry weight of the plants grown from the seeds having 9.6% water content is 109 mg at control, an increase of the dry weight for the seeds passed through the magnets 3, 9, 15, 21 times takes place (Table 4). The relation between magnetic field strengths and the dry weights of the seedlings having 7.3% and 9.6% water contents are shown with the regression line (Figs. 4 and 5).

The relation between the dry weights and increasing magnetic field's strengths for the seedlings at both 7.3 and 9.6% water contents has been found significant ($p < 0.05$). With the experiments done in meristem cell of plants, the magnetic field was found to be a factor affecting the normal metabolism of the cell (13,14) and the cell reproduction as well (15). For these reasons, the magnetic field has important effects on the plant growth. But, in some of the results obtained from the previous experiments, magnetic field's effects appear as positive, in other cases they were negative. In this experiment, the results obtained with the growth of the seedlings from the seeds grown at different water contents, rendered us different results at the same magnetic field strength. According to the

results obtained from the seedling length measurements, magnetic field showed positive effects at 9.6% water content and negative ones at 7.3% water content.

According to W.Grundler et al., when the electromagnetic field and the biological systems interact at a low level, neither the primary nor the subsequent steps are known. For this reason, for the primary interaction they have suggested to investigate spin-polarized chemical steps. Besides, in his suggested theory regarding the explanation of the primary steps, electromagnetic interaction mechanisms were based on radical pair and triplet molecule chemistry, the physics and chemistry of nonlinear dynamic processes and cellular biological signal transmission. Many chemical reactions contain molecules with one or more unpaired electrons. These are radicals or triplet molecules. The orientation of their spin can be influenced by an electromagnetic field. If such a molecule enters the biochemical chain, its reaction yield can be affected by the weak magnetic fields. In the primary interaction, an excitation may occur from an energy larger than an average one present in any system (16).

So a change in the magnetic field will induce chemical change. Water molecules can render Hydrogen atoms to the system by excitation and as is well known Hydrogen carries only one unpaired electron and so it has a para-magnetic characteristic. Therefore different water contents of the seeds may play a role in the change of the magnetic field effect. Consequently, the determination of the water content of the selected seeds has a great importance in the treatment of the magnetic field influence on the seeds.

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