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MAGNETIC BIOSTIMULATION OF WHEAT SEEDS

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A b s t r a c t. Investigation carried out at the Department of Physics, University of Agriculture in Lublin consisted in the application of an alternating magnetic field (50 Hz, harmonic vibration) for the biostimulation of wheat seeds.The purpose of research was to define the effect of the magnetic biostimulation on the germination of seeds. The wheat seeds were subjected to 18 different magnetic exposure doses. For the next investigation two magnetic exposure doses were selected. On the basis of the research, it can be said that germination capacity of wheat seeds depends on the magnetic exposure dose. The speed of germination of the treated seeds was higher than in the case of untreated ones. The seeds with the highest moisture content and subjected to a higher magnetic exposure dose had the highest speed of germination. Maximum speed of germination for all the studied combinations was observed 35 h after magnetic biostimulation.

K e y w o r d s: magnetic biostimulation, magnetic exposure time, germination capacity, speed of germination

INTRODUCTION

Magnetic biostimulation is one of the physical pre-sowing seed treatments. In the beginning seeds were subjected to magnetic field and then sown in an experimental field, in flower -pots in a plant house or put for germination on Petri dishes. Drobig [1] wrote about 16 studies carried out from 1967 to 1986 in which the magnetic or electromagnetic field were used in a pre-sowing treatment (biostimulation). He did not notice any correlation between the results obtained and the direction of magnetic field during pre-sowing biostimulation.

Phirke *et al.* [2] used the magnetic field from 0.072 to 0.128 T (tesla) in the combination with seed exposure time varing from 13 to 27 min. The study revealed that seed exposure time was found to be a more effective factor than the magnetic field strength for soybean, cotton and wheat seeds sown in the field. Magnetic field strength of 0.1 T was the optimum level for all the three crops and seed exposure optimum time levels of 25 min were obtained for soybean and cotton but only 13 min for wheat seed.

For a few years studies on the application of an alternating magnetic field for the pre-sowing biostimulation have been carried out in the Department of Physics, University of Agriculture in Lublin.

MATERIAL AND METHOD

The effect of magnetic field on germination, growth and yield depends on its energy and the exposure time. Therefore, the magnetic exposure dose D was defined. It was described as:

$$D = \frac{10^7}{4\pi} B^2 t \qquad (\mathrm{J\,m^{-3}s})$$

where: B - magnetic induction (T), t - exposure time (s).

In order to investigate a special electromagnet was made (Fig. 1).

Two field coils (2) were wound on the core fed with an alternating current with 50 Hz frequency (harmonic vibration) and 380 V. The mobile part of the magnetic core (3) made it

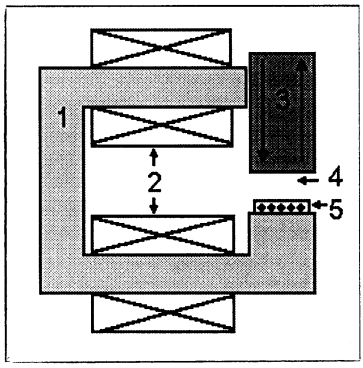

Fig. 1. Block diagram of electromagnet: 1 - magnetic core; 2 - field coils; 3 - mobile magnetic core; 4 - air gap; 5 - seed sample.

possible to adjust the midpoint between the electromagnet (air gap - 4) where it was possible to put test samples of seeds (5). Within the air gap a smooth adjustment of magnetic field from 30 to 100 mT could be obtained (Fig. 2). The heterogenity of magnetic field was at the edge of the air gap but did not exceed 15% of the value of the magnetic induction of the magnetic axis. As the investigated seeds were in the air gap near the magnetic axis it was possible that the magnetic field in this case was homogeneous.

Seeds of Henika spring wheat cultivar were the object od these investigations. The research consisted of determining:

- effect of alternating magnetic field on the germination of seeds for the different exposure dose,
- effect of the alternating magnetic field on the germination od seeds for the different moisture of seeds,
- effect of the alternating magnetic field on the germination speed of wheat seeds (dynamic process of germination).

At first, the doses were increased by prolonging exposure time from 2 to 240 s with the constant magnetic induction, B = 30 mT. The magnetic exposure doses were from:

$$D_{11} = 1440 \text{ J m}^{-3}\text{s} \text{ to } D_{110} = 171\,890 \text{ J m}^{-3}\text{s}.$$

Then the doses were increased by prolonging magnetic induction from 30 to 90 mT with the constant exposure time, t_1 = 4s and t_2 = 8 s. This time the magnetic exposure doses ranged from:

$$D_{21} = 2880 \text{ J m}^{-3}\text{s} \text{ to } D_{210} = 51\,570 \text{ J m}^{-3}\text{s}.$$

The treated seeds were sown together with the control ones for the germination in flower -pots in a plant house. Each group of seeds had identical germination condition, i.e., temperature of 20°C (293 K) and adequate moisture content. After four and eight days the number of germinated seeds in each lot was counted. The whole investigation was repeated 10 times.

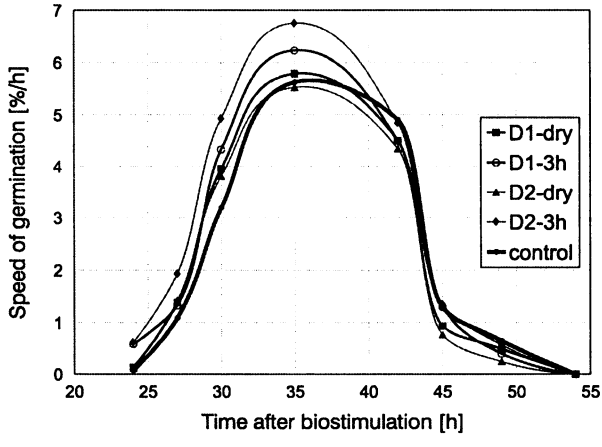

Fig. 2. Speed of germination in the selected cases. D_1- dry: dry seeds bistimulated D_1 exposure dose, D_1 - 3 h: 3 h soaking and bistimulated D_1 exposure dose, D_2 - dry: dry seeds biostimulated D_2 exposure dose, D_2 - 3 h: 3 h soaking and biostimulated D_2 exposure dose.

The next test included germination of dry and soaked seeds before magnetic biostimulation. The first count of germination capacity (for wheat seeds four days after sowing) and the second count of germination capacity (eight days after sowing) according to obligatory international standards have not given information about the speed of seed germination. Therefore germination capacities 24 h and later after sowing were determined.

RESULTS

The results of the effect of different magnetic exposure doses on germination of wheat seeds are shown in the Table 1. Two magnetic exposure doses were selected on the basis of the results obtained. They were:

$$D_{12} = D_{21} = D_1 = 2880 \text{ J m}^{-3}\text{s}$$

and

$$D_{14} = D_{22} = D_2 = 5760 \text{ J m}^{-3}\text{s}.$$

The effect of these doses on the germination of wheat seeds was the same. The mean values of these doses were respectively:

$$60.40 \pm 5.22 \ (0.01 < \alpha < 0.05)$$

and

$$65.69 \pm 4.33 \ (0.001 < \alpha < 0.01).$$

In this case the value of magnetic induction was 30 mT (the lowest current intensity in field of electromegnet coils economical element).

The effect of the magnetic field on the germination capacity of wheat seeds with different moisture contents are shown in Table 2.

On the basis of these results the speed of germination was defined. It was shown for selected cases in Fig. 2. The maximum speed for all the cases was observed 35 h after biostimulation. The treated seeds germinated faster than untreated ones in the first 42 h after biostimulation. Then the speed of germination for all the cases was the same.

Table 1. Relationship between germination capacity and magnetic exposure dose

Dose (J m^{-3}s)	Germination capacity			
	4 days		8 days	
	germination (%)	germination/ control	germination (%)	germination/ control
Control	55.67±4.50	1.00	82.66±4.65	1.00
D_{11} = 1440	45.65±4.17**	0.82	69.43±4.00**	0.84
D_{12} = 2880	60.12±5.88*	1.08	84.31±2.82 -	1.02
D_{13} = 4320	64.58±4.66**	1.16	85.14±4.10 -	1.03
D_{14} = 5760	66.80±3.99**	1.20	86.79±6.44 -	1.05
D_{15} = 7160	63.46±2.93**	1.14	89.27±4.16*	1.08
D_{16} = 10740	60.12±2.89*	1.08	90.93±5.85*	1.10
D_{17} = 21480	58.45±4.77 -	1.05	85.14±4.53 -	1.03
D_{18} = 42960	55.34±4.46 -	1.00	82.34±5.21 -	1.00
D_{19} = 85920	62.91±4.93*	1.13	85.14±4.76 -	1.03
D_{110} = 171840	63.46±3.99*	1.14	84.31±4.51 -	1.02
D_{21} = 2880	60.68±4.57*	1.09	85.14±5.22 -	1.03
D_{22} = 5760	64.58±4.66**	1.16	85.97±5.32 -	1.04
D_{23} = 6440	57.90±4.38 -	1.04	81.01±3.79 -	0.98
D_{24} = 11460	51.22±4.39*	0.92	74.39±4.92 *	0.90
D_{25} = 12880	52.33±7.32*	0.94	76.05±5.54 *	0.92
D_{26} = 17900	54.00±4.82 -	0.97	81.01±5.46 -	0.98
D_{27} = 22920	51.77±4.39*	0.93	78.53±2.92 -	0.95
D_{28} = 25780	51.77±3.79*	0.93	74.39±3.16 *	0.90
D_{29} = 35800	51.22±6.09*	0.92	72.74±5.39***	0.88
D_{210} = 51560	53.44±3.85 -	0.96	76.87±7.86*	0.93

Significance level: - α>0.05, *0.01<α<0.05, **0.001<α<0.01, ***α<0.001.

Table 2. Effect of soaking in water on the germination capacity of wheat seeds after magnetic biostimulation at two exposure doses $D_1 = 2880$ J m^{-3} s and $D_2 = 5760$ J m^{-3} s

Time after biost.	Dry seeds	Germination capacity (%)			
		Soaking in water by (h)			
		3	2	1	0.5
			Dose D_1		
24	0.50±1.68	2.25±1.50	1.75±1.50	1.50±1.68	0.75±1.50
27	5.57±1.50	5.25±2.28	5.50±1.74	6.75±1.50	4.74±1.50
30	19.01±3.45	20.49±1.74	19.99±2.46	20.43±3.00	18.76±2.88
42	66.77±2.88	71.85±2.46	68.95±2.88	67.47±4.50	66.76±2.88
45	85.91±3.48	88.59±2.88	84.19±2.46	85.98±2.88	83.50±2.46
49	87.71±2.25	92.19±3.00	87.91±1.74	88.74±3.00	85.34±2.88
54	89.61±1.50	93.69±3.45	89.91±1.75	90.24±3.48	87.49±3.87
			Dose D_2		
24	0.50±1.68	2.75±1.50	1.75±1.50	1.75±1.50	1.00±2.46
27	5.96±1.50	7.49±2.46	6.25±1.50	6.76±1.50	4.99±2.46
30	18.92±2.88	23.15±2.46	20.56±2.46	21.37±2.88	19.12±1.68
42	65.48±2.88	74.75±5.49	71.56±2.88	69.37±5.19	68.32±4.23
45	85.22±1.50	92.24±2.88	86.05±1.50	86.41±2.88	83.83±2.25
49	87.42±2.46	95.24±1.50	90.57±1.74	88.65±3.78	85.83±2.55
54	88.37±3.76	97.34±2.88	91.57±3.90	90.90±3.78	87.33±3.45
	Control				
24	0.25±1.50				
27	4.24±1.50				
30	14.08±3.87				
42	65.08±3.87				
45	85.33±4.50				
49	87.93±6.63				
54	90.43±4.71				

The soaked seeds (3 h soaking time) germinated better than the dry ones. Maximum speed of germination was observed for the soaked seeds and D_2 magnetic exposure time. It may be supposed than high moisture content of seeds increases the ion activity. In this case the large influence of magnetic field increases activity and hence make germination quicker. The magnetic field is an impulse which induces faster germination of seeds. The results were verified by field test in the period 1990-1994 [4].

DISCUSSION

The present study determined that germination capacity depends on the magnetic exposure dose. It was shown that in the first period of the germination the treated seeds germinated faster than the unterated ones. We can assume that germination of wheat seeds depends on magnetic exposure dose and its moisture content.

Wadas [5], a Polish biophysicist, wrote in his monograph that three physical aspects of the influence of magnetic field on living organisms can be distinguished:

1) magnetic field action on uncompensated electron spin,

2) magnetic field action on diamagnetic substance, including biological liquid crystal,

3) the action of magnetic field on moving charges.

In this case the influence of magnetic biostimulation would depend on the action of magnetic field on moving charges and perhapes on eddy currents in biological materials. The last effect is caused by the fact, that the magnetic field was an alternating one.

It is necessary to remember that the results obtained refer only to the applied magnetic exposure doses. The conclusion can not be generalized for any other exposure doses. In this case the results can be negative.

CONCLUSIONS

1. Germination capacity of wheat seeds depended on the magnetic exposure dose.

2. The speed of germination of treated seeds was higher than in case of untreated ones.

3. The seeds with the highest moisture content and subjected to greater magnetic expo sure dose had the highest speed of germination.

4. Maximum speed of germination for all studied combinations was observed 35 h after magnetis biostimulation.

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