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INFLUENCE OF PRE-SOWING MAGNETIC BIOSTIMULATION ON GERMINATION AND YIELD OF WHEAT*

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A b s t r a c t. The effect of pre-sowing magnetic biostimulation of wheat grains on germination and yield is presented. Two magnetic exposure doses were used. The results show that a magnetic field influenced the germination of wheat seeds. The treated seeds germinated faster than untreated ones. Also, the infiltration rates of water by treated and untreated seeds were almost the same. The germination capacity depended on magnetic exposure dose and moisture content. The field tests revealed that the pre-sowing magnetic biostimulation increased the crop yield in case of both investigated wheat cultivars. The yields were higher than control for Henika cultivar by about 37 % ($D_1 = 2880$ J m^{-3}s, exposure dose) and 25.5 % ($D_2 = 5760$ J m^{-3}s, exposure dose) and for Jara cultivar about 19 % ($D_1 = 2880$ J m^{-3}s) and 21.3 % ($D_2 = 5760$ J m^{-3}s). Also, the percentage of gluten in the flour for both wheat cultivars was greater than the control.

K e y w o r d s: magnetic field, magnetic biostimulation, magnetic exposure dose, germination of wheat, yield of wheat

INTRODUCTION

Magnetic seed treatment (magnetic biostimulation) is one of the physical pre-sowing treatments. At the beginning seeds were subjected to a magnetic field and then sown in an experimental field, flower-pots, green-house or put for germination on Petri dishes. The influence of the magnetic field on germination, growth and yield were observed. These effects depended on the energy of the magnetic field and the time of exposure. The pre-sowing biostimulation is described by the magnetic exposure dose D as the universal unit:

$$D = \rho_m t$$

where ρ_m is density of magnetic field energy and t - exposure time.

Two magnetic exposure doses $D_1 = 2880$ J m^{-3}s ($B = 30$ mT, $t = 4$ s) and $D_2 = 5760$ J m^{-3}s ($B = 30$ mT, $t = 8$ s) giving optimum results for germination were selected [2].

The research presented here had to define the effect of the pre-sowing magnetic biostimulation on the germination and yield of wheat.

MATERIAL AND METHOD

The investigations carried out in the Department of Physics at the University of Agriculture in Lublin consisted in the application of an alternating magnetic field (50 Hz, harmonic vibration) for the biostimulation of wheat seeds. For the study the electromagnet described by Pietruszewski was used [1].

The seeds of spring wheat Henika cultivar was the object of the germination tests. The investigations consisted in determining the effect of an alternating magnetic field on the speed of germination of wheat seeds, the infiltration rate of water by treated and untreated seeds, and the germination of seeds at different seed moisture.

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The seeds of spring wheat cultivars Henika and Jara were the object of the field tests. They were carried out on the area of the Experimental Farm in Felin near Lublin in 1990-1994. On the basis of field tests it was determined that the optimum lapse of time between magnetic biostimulation and sowing was from 7 to 10 days [3]. Therefore, the seeds were sown seven days after magnetic treatment in the experimental fields in a plot 1x1 m with four and five replications. The harvesting of both wheat cultivars was done in August. The biometric features of ears (length of ear, number of seeds per ear, weight of 1000 seeds) were measured. After the harvest the number of ear per 1 m^2 and weight of seeds per 1 m^2 were counted. Because, the obtained results depended on weather conditions they are presented in comparison with the control yield, which is described as 100 %. Also, the biochemical analyses from harvested seed were made. These investigations aimed to determine the effect of alternating magnetic field on biometric features of ears, crop yield and chemical composition of wheat grains.

RESULTS

The results of the speed germination of wheat seeds are shown in Fig. 1. The seeds after magnetic biostimulation germinated faster than the control ones. The highest differences between treated and untreated seeds occurred 35 h after sowing up to 12% for D_1 exposure dose and 12.5% for D_2 exposure dose ($\alpha < 0.001$) 42 h after biostimulation, the speed of germination was reduced and 45 h after sowing the differences between the treated and untreated seeds were not much (6% for D_1 and about 10% for D_2 exposure doses).

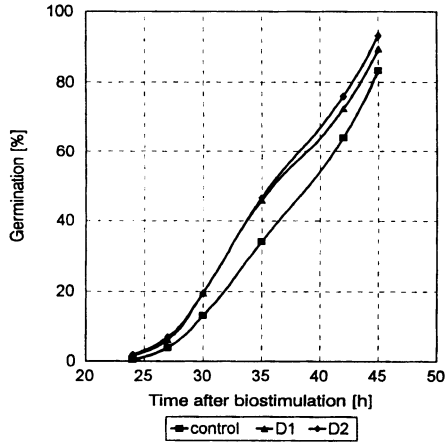

Fig. 1. Germination of seeds after biostimulation (speed of germination).

The results of treated and untreated seeds showed that the magnetic treatment had a non-significant influence on infiltration rate of water to the wheat seeds.

The next investigations were based on germination of dry and soaked seeds before magnetic biostimulation. The germination percentages for different seeds were obtained four and seven days after magnetic treatment. The results are shown in Table 1. It was observed, that the dry seeds and seeds soaked in water before the magnetic treatment germinated better than control ones. The soaked seeds with the dose D_2 germinated better than dry ones. It may be supposed that the high moisture content of seeds (3 h soaked in water) increases the mobility of ion. In this case the large influence of the magnetic field gives occasion for greater activity of ions and in such cases faster germination.

The obtained results from field tests and biochemical analyses of harvested seeds are shown in Tables 2 and 3 and in Fig. 2.

The pre-sowing magnetic biostimulation increased the length of ear (8.4 % - 11.4%) and number of seeds per ear (27.7% - 29.1%) in both wheat cultivars. Weight of 1000 seeds for Henika cultivar remained unaltered but for Jara cultivar it was reduced to a great extent (12-16%) as compared with the control results. The crop yield for the Henika cultivar was higher by 37 % for D_1 magnetic exposure dose and 28.5 % for D_2 dose than control yield ($\alpha = 0.001$). The crop yield for Jara cultivar was 19 % for D_1 magnetic exposure dose and 21.3 % for D_2 dose ($0.001 < \alpha < 0.01$).

On the basis of the above results it is abvious that the pre-sowing magnetic biostimulation had a positive effect in the case of all

Table 1. Effect of soaking biostimulated wheat seeds in water on germination percentage with two exposure doses (D_1 = 2880 Jm^{-3} and D_2 = 5760 Jm^{-3} s)

	Germination percentage			
	after 4 days		after 7 days	
	D_1		D_1	
Control	82.3±6.8		90.4±2.2	
Dry seeds	92.1±1.8	90.1±1.4	952±1.5	93.6±1.8 **
Soaking in water for				
0.5h	89.8±2.1 *	93.8±1.0 **	93.3±1.9 *	95.5±0.6 **
1h	92.8±1.5 -	89.3±0.8 -	95.8±1.4 -	92.4±1.0 -
2h	91.5±1.2 -	92.3±1.9 *	94.1±1.4 -	95.4±1.3 *
3h	91.8±1.2 -	94.2±1.1 ***	95.4±1.5 -	96.4±0.7 ***

Significance level in relation to dry seeds: - $\alpha > 0.5$; * $0.01 < \alpha$ 0.05; ** $0.001 < \alpha < 0.01$; *** $\alpha < 0.001$.

Table 2. Effect on crop yield parameters (percentage) due to pre-sowing magnetic biostimulation (control = 100%)

Biometric factor	Henika (1990-1994)		Jara (1990-1992)	
	D_1	D_2	D_1	D_2
Length of ear	109.2±2.8 **	111.0±2.4 **	108.4±4.4 **	111.4±3.2 **
Number of seeds per ear	129.1±5.2 ***	127.7±4.3 ***	129.0±4.2 ***	127.7±4.9 ***
Weight of 1000 seeds	98.1±4.8 -	97.9±3.4 -	84.5±2.7 ***	88.1±3.9 ***
Number of ears per 1 m^2	112.6±3.7 **	107.6±4.1 *	116.7±3.0 **	114.9±4.8 **
Weight of seeds per 1 m^2	137.0±7.9 ***	128.5±5.8 ***	119.0±4.3 **	121.3±5.2 **

*For explanation see Table 1.

investigated combinations. The crop yield (weight of seeds per 1 m^2) increased for Henika and Jara cultivars. This effect was obtained at the cost of faster seed germination, greater length of ear and number of seeds per ear.

The percentage of albumin and starch for both the cultivars was relatively static. The percentage of starch for Jara cultivar was greater than the control in 1991 only. However, the biostimulation under the alternating magnetic field increased the percentage of gluten in both wheat cultivars under study.

CONCLUSIONS

The results presented in this paper concern the study of effect of pre-sowing biostimulation with alternating magnetic field on germination and yield of wheat. It was observed that this effect was positive. From germination tests it revealed that the:

a) treated wheat seeds germinated faster than untreated ones,

b) infiltration rates of water by treated and untreated seeds were almost the same,

c) germination percentage of the wheat seeds soaked in water before magnetic biostimulation depends on magnetic exposure dose, better results were obtained for D_2 (5760 J m^{-3}s) exposure dose and soaking for 3 h.

The field tests revealed that the pre-sowing magnetic biostimulation caused the mean crop yield increase for Henika cultivar about 37.0 ±

Table 3. Effect of pre-sowing magnetic biostimulation (percentage) on chemical composition in grain yielded (control = 100%)

Year	Jara					
	Albumin		Starch		Gluten	
	D_1	D_2	D_1	D_2	D_1	D_2
1991	106.9	104.9	119.3	142.8	104.8	113.0
1992	98.6	98.6	104.9	95.6	116.1	112.5
			Henika			
1991	100.0	112.8	104.5	87.1	118.8	146.2
1992	103.2	104.1	97.5	91.0	113.2	111.2
1993	101.6	104.8			116.1	112.5

Significance level: $0.05 < \alpha < 0.01$.

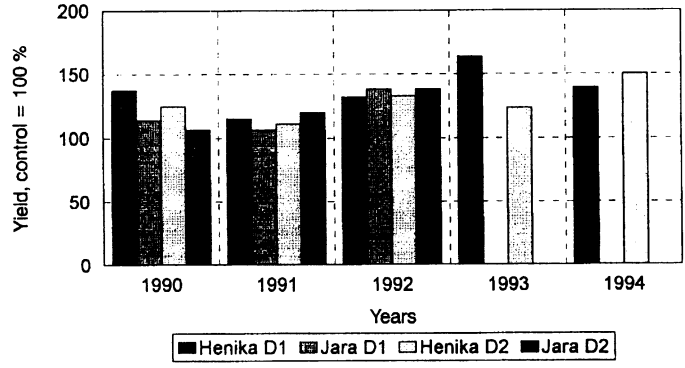

Fig. 2. Crop yield (weight of seeds per $1m^2$) for Henika and Jara during five years.

7.9 % and 28.5 ± 5.8% and for Jara cultivar about 19.0 ± 4.3% and 21.3 ± 5.2% for 2880 and 5760 $Jm^{-3}s$, respectively in comparison with the control. This effect was obtained at the cost of faster germination on field, greater length of ear and number of seeds per ear.

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