Int. Agrophysics, 1996, 10, 51-55

EFFECTS OF MAGNETIC BIOSTIMULATION OF WHEAT SEEDS ON GERMINATION, YIELD AND PROTEINS

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Accepted February 2, 1996

A b s t r a c t. The presented investigations define the influence of the lapse of time between magnetic biostimulation and sowing on crop yield, and the influence of seed orientation in the magnetic field during pre-sowing biostimulation on yield of wheat seeds. On the basis of this study, wheat seeds should not be sown later than two weeks after pre-sowing magnetic biostimulation. The best results were obtained for the seeds sown about ten days after magnetic treatment. The orientation of seeds in the magnetic field during pre-sowing biostimulation did not influence crop yield and percentage of albumin and gluten in wheat seeds. The increase of yield and protein were the same for parallel and perpendicular orientation in the magnetic field.

K e y w o r d s: biomagnetism, presowing magnetic biostimulation, yield of wheat, gluten, albumin

INTRODUCTION

The effect of a stationary magnetic field on seeds and plants has been clearly shown and is called magnetotropism. It means that speed of seed germination, the composition of the roots and the rate of plant growth depend on the orientation of seed in a magnetic field. Geomagnetotropism has been known for a long time because its study belongs to the oldest biomagnetic phenomenons.

Audus [1] ascertained that the roots of studied plants reacted to the magnitude and orientation of a magnetic field. Pittman [7] found that early germination of seeds and plant growth depend on orientation in a geomagnetic field.

The influence of orientation of seeds in magnetic field on plant growth were also studied by Pittman and Ormrod [8], Cerdenio *et al.* [2], Mc Kenzie and Pittman [4]. Cerdonio *et al.* [2] studied the influence of magnetic field direction on the germination of seeds. In their experiment, they exposed the seeds of *Pisum arvense* in a parallel and antiparallel orientation with respect to the magnetic field. They obtained a difference in plant growth with a significant inhibition for antiparallel seeds.

Wadas [9] wrote in his monograph that the crop yield of cereals may depend on the orientation of the geomagnetic field.

While using pre-sowing magnetic biostimulation in the stationary magnetic field we should consider the effect of magnetic direction on expected results.

Drobig [3] wrote about 16 studies made from 1967 to 1986 but he did not notice any correlation between obtained results and the direction of magnetic field during pre-sowing treatment (biostimulation).

The use of alternating magnetic field in pre-sowing biostimulation exclude the effect of the direction of magnetic field on obtained results.

MATERIALS AND METHOD

The investigation made at the Department of Physics of the Agricultural University in Lublin concerned the application of an alternating magnetic field as a pre-sowing magnetic treatment on the yield of wheat. It was described by Pietruszewski [5] in his paper. The objectives of the present investigation were determined:

1) the optimum lapse of time between pre-sowing biostimulation and sowing of seeds,
2) the best orientation of wheat seeds in magnetic field during biostimulation and its influence on yield.

For study the electromagnet described by Pietruszewski [6] was used. Pre-sowing magnetic biostimulation was characterized by a magnetic exposure dose D as universal unit:

$$D = \rho_m t$$

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

In the case of an alternating magnetic field the density of magnetic field energy may be defined as:

$$\rho_m = \frac{10^7}{4\pi} \cdot B^2$$

where B - value of magnetic induction in tesla measured with a gaussmeter.

In presented investigations two exposure doses were employed: D_1= 2880 Jm^{-3}s (B=30 mT, t=4 s) and D_2=5760 Jm^{-3}s (B=30 mT, t=8 s).

In the first case the seeds of wheat, Henika cultivar, were subjected to both exposure dose 3,6,10,13,17,20 and 25 days before sowing. Then the treated seeds and control seeds were sown in the experimental field in plots of 1m x 1m with four replications. The yield obtained, was compared with the control yield.

In the next year the germination test for two magnetic exposure doses D_1 and D_2 was carried out. In this case, seed of wheat were placed parallel and perpendicularly to the magnetic field in electromagnet. Then the seeds together with the control seeds (untreated seeds) were put away for germination on Petri dishes. All experiments were repeated 5 times. Germination energy (germination capacity four days after sowing) and germination power (germination capacity seven days after sowing) were obtained.

The field test depends on the seeds of Henika cultivar and Jara cultivar being subjected to two exposure doses D_1 and D_2 in two orientation of seeds (parallel and perpendicularly) in the magnetic field during magnetic biostimulation. Then the seeds together with the control seeds were sown in the experimental field. The sowing was done eight days after magnetic treatment. This was the optimum lapse of time between pre-sowing biostimulation and sowing, on the basis of the previous year's investigations.

The harvesting for both investigations was done in August. All the normal cultivation practices for cereal growing were made. The experimental field of the field tests were near Lublin. Statistical tests were carried out for all investigations.

RESULTS

The influence of the lapse of time between pre-sowing magnetic biostimulation and crop yield in Table 1 and graph in Fig. 1 is presented. The best results for D_1 exposure dose were obtained for lapses of time between 6 days and 10 days. For the 6 days before sowing, the crop yield was greater; about 65 % more than the control yield. For 10 day it was greater than 61 %. The both results are characterized with α<0,01 significance level.

Table 1. Relationship between yields of wheat and times of magnetic biostimulation for two exposure doses D_1=2880 J m^{-3}s and D_2=5760 J m^{-3}s. Control seeds= 100 %

Yield (%) relative to control		
Days before sowing	D_1	D_2
3	153.8±17.6**	131.7±13.8**
6	165.6±16.8**	103.1±13.1-
10	161.7±17.1**	123.5±12.7*
13	126.8±13.6*	139.1±14.3**
17	117.1±11.4-	95.6±12.6-
20	104.8±18.7-	92.2±13.5-
25	110.7±12.2-	119.2±18.3-

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

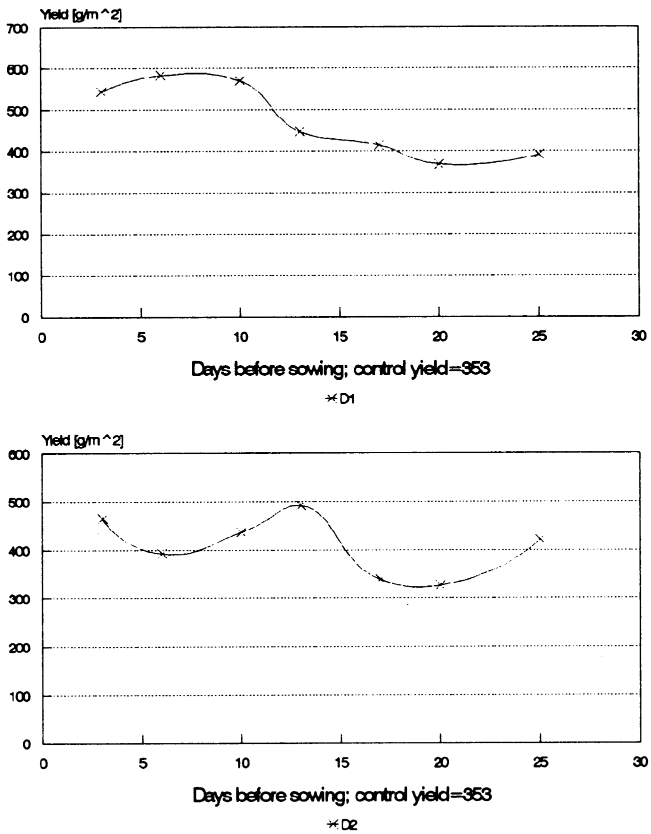

Fig. 1. Relationship between yield of wheat and time of magnetic biostimulation for D_1 and D_2 exposure doses.

When the lapse of time was 20 days between biostimulation and sowing the crop yield was minimum but better than controlled yield. For 25 days before sowing the yield increased and was about 10 per cent greater than the control yield, but with α>0,05 signficance level.

The results for D_2 exposure dose were similar. The best crop yields were obtained for lapses of time of 10 and 13 days between biostimulation and sowing. For 10 days before sowing the yield had α<0,05 significance level. For 13 days before sowing the yield was 39 % greater than the control yield with α< 0,01 significance level.

When the lapse of time was 17 days between biostimulation and sowing the crop yields were minimum and smaller by about 5-7 % than the control yield. For 25 days before sowing the yield increased and was 19 % greater than the control yield, but had α>0,05 significance level.

Germination energy and germination power in accordance with Polish Standards PN-79/R-65950 'Investigation methods of seeds' were obtained. Germination capacity has to be obtained by sowing one hundred seeds on blotting-paper in a temperature of about 20 °C (293 K) and checking, four and seven days after sowing, to see how many seeds had germinated.

The germination energy of seeds treated by parallel magnetic field in direct ratio to germination energy of seeds treated by perpendicularly magnetic field was:

$$0{,}971 \pm 0{,}086.$$

The germination power of seeds treated by parallel magnetic field in direct ratio to germination power of seeds treated by perpendicularly oriented magnetic field was:

$$0{,}950 \pm 0{,}080.$$

Again, treated seeds germinated better than control seeds.

The results of field tests are presented in Table 2. The crop yields for both cultivars and both orientations in the magnetic field were obtained and compared with the control yield. Then the results for the two orientations in the magnetic field were comapred with one another. The crop yield for all investigations were about 30 % greater than the control yield with $\alpha<0.001$ significance level. However, the ratio between the yields of seeds treated by parallel magnetic field and the yields of seeds treated by perpendicularly magnetic field were about one.

In Tables 3 and 4 the biochemical analyses are presented. The percentages of albumin and gluten were obtained. The percentages of albumin in all investigations were about just the same than in the control result.

Pre-sowing magnetic biostimulation caused an increase percentage of gluten. In all cases the percentage of gluten was about 10 % greater than in the control seeds.

Table 2. Relationship between yields of wheat and the orientation of wheat seeds in magnetic field during pre-sowing biostimulation for two exposure doses D_1=2880 J m^{-3}s and D_2=5760 J m^{-3}s, and two cultivars of wheat (Henika and Jara)

Dose	Yield (%) relative of control	
	Henika	Jara
$D_1\downarrow$	131.5±2.8***	137.6±3.2***
$D_1\rightarrow$	133.9±1.8***	140.3±5.3***
$D_1\downarrow/D_1\rightarrow$	1.00±0.02	1.02±0.03
$D_2\downarrow$	133.3±3.2***	137.8±5.4***
$D_2\rightarrow$	133.6±1.9***	138.9±2.5***
$D_2\downarrow/D_2\rightarrow$	1.02±0.02	1.01±0.03

$D_1\downarrow$ and $D_2\downarrow$ perpendicularl orientation of seeds in magnetic field for D_1 and D_2 exposure doses, $D_1\rightarrow$ and $D_2\rightarrow$ parallel orientation of seeds in magnetic field for D_1 and D_2 exposure doses. Significance level: *** $\alpha<0.001$.

Table 3. Relative percentage of albumin in wheat seeds. Control seeds = 100 %

Henika					
$D_1\downarrow$	$D_1\rightarrow$	$D_1\downarrow/D_1\rightarrow$	$D_2\downarrow$	$D_2\rightarrow$	$D_2\downarrow/D_2\rightarrow$
103.2	105.7	97.6	104.1	100.6	103.5
Jara					
$D_1\downarrow$	$D_1\rightarrow$	$D_1\downarrow/D_1\rightarrow$	$D_2\downarrow$	$D_2\rightarrow$	$D_2\downarrow/D_2\rightarrow$
98.4	99.0	100.6	97.2	98.2	98.9

Explanations as in Table 2.
Significance level: $0.01<\alpha<0.05$

Table 4. Percentage of gluten in wheat seeds. Control seeds = 100 %

Henika					
$D_1\downarrow$	$D_1\rightarrow$	$D_1\downarrow/D_1\rightarrow$	$D_2\downarrow$	$D_2\rightarrow$	$D_2\downarrow/D_2\rightarrow$
113.2	109.6	103.3	111.2	108.8	102.2
Jara					
$D_1\downarrow$	$D_1\rightarrow$	$D_1\downarrow/D_1\rightarrow$	$D_2\downarrow$	$D_2\rightarrow$	$D_2\downarrow/D_2\rightarrow$
161.1	112.5	96.9	111.6	110.7	99.2

Explanations as in Table 2.
Significance level: $0.01<\alpha<0.05$.

CONCLUSIONS

The presented investigations define the influence of lapse of time between magnetic biostimulation and sowing on crop yield, and the influence of seed orientation on yield of seeds. All the tests were made with two magnetic exposure dose D_1 2880 J m^{-3}s and D_2 5760 J m^{-3}s.

1. For D_1 exposure dose the optimum lapse of time between biostimulation and sowing was 3 to 10 days.
2. For D_2 exposure dose the optimum lapse of time between biostimulation and sowing was 10 to 13 days.
3. For all exposure doses the seeds should be not sown later than two weeks after pre-sowing biostimulation.
4. The seed orientation in the magnetic field during pre-sowing biostimulation of alternating magnetic field did not influence crop yields of wheat seeds.
5. The seed orientation in the magnetic field during pre-sowing biostimulation of alternating magnetic field did not influence the percentage of albumin and gluten.
6. The pre-sowing biostimulation of alternating magnetic field significantly increased the crop yield and the percentage of gluten in both wheat cultivars.

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