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Germination of wheat grain in an alternating magnetic field

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A b s t r a c t. The paper presents the germination of wheat grains of the variety Henika, in an alternating magnetic field. The research conducted showed that the influence of an alternating magnetic field on germination depends on the value of the magnetic induction. A magnetic field affects germination mainly during the initial 50 h of the process. The highest positive influence of the field was observed in the field with magnetic inductions of 50 and 80 mT.

K e y w o r d s: wheat grain, germination, magnetic field

INTRODUCTION

The influence of a magnetic field on the development of cultivable plants is largely determined by the exposure of the grains to the field in the pre-sowing period. For example, this was the method of the Spanish research on lentil and thistle grains [1,4]. Tests carried out in the Department of Physics at the Agricultural University in Lublin showed that the magnetic field causes the earlier emergence and a higher crop of cereal plants, especially of wheat [6]. The pre-sowing exposure of corn seeds to a weak magnetic field of the frequencies 16 and 15 Hz can have a positive effect on their germination in low temperatures (10°C) [8]. However, the germination process of rice seeds exposed to a stable magnetic field of 150 and 250 mT or watered with water magnetised by the same fields showed that the effect is dependent on the kind of exposure (magnetic field or magnetised water) and that the best effect is achieved in the initial hours of germination [2,3].

The authors of this paper show that the germination process of seeds, bio-stimulated magnetically, can be represented by means of a mathematical model described by a logistic curve [6,7]:

$$N(t) = \frac{N_k}{1+(N_k - 1)\exp\left[-\alpha \cdot N_k (t - t_o)\right]}$$

where: $N(t)$ - the number of seeds germinated during the time t, N_k - the final number of germinated seeds, α - coefficient of the germination rate, t_o - the time at which the first seed germinated.

The analysis of both the data in literature and individual research shows that the influence of bio-magnetic stimulation depends on the exposure dose, i.e., on the density of the field's energy and the length of exposure. Nevertheless, what precisely the nature of the mechanism of the magnetic field's influence on plant seeds is, remains an open issue.

AIM AND RANGE OF RESEARCH

The tests conducted aimed at the determination of the influence of a variable magnetic field with different values of magnetic induction on the germinating of wheat grain of the variety Henika exposed to this field. The number of the germinated grains was compared to the control sample. The tests were carried out according to the valid norm PN-R-65950:1994. The magnetic fields used had the following values of magnetic induction B: 7.5, 20, 35, 44, 50, 65, 80 and 100 mT.

MATERIALS AND METHOD

The magnetic field was created by means of an electromagnet present at the department of physics at Agricultural University in Lublin [5]. The required magnetic inductions were received by regulation of the intensity of the current flow in the insulation of coils feeding the electromagnet. Seeds were placed on Petri dishes at four or five repetitions,

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a hundred seeds in each sample, and then placed between the electromagnet's poles. The control sample was placed far enough to make the electric field's influence insignificant. All the seeds were placed in adequate humidity and temperature. Measurements were taken from the moment the first germs appeared and were finished when all the healthy grains had germinated. The results obtained were processed statistically in order to define the significance of the differences on the level $k = 0.05$ (T-Student test) and presented in Table 1 and as graphs (Figs 1 and 2).

RESULTS

For all the magnetic inductions used, the influence of the magnetic field on the germination of grain was significantly positive. The influence was, however, varied and depended on the power of magnetic field. In Table 1 the mean value of 5 repetitions (5×100 grains) are presented.

For some values of magnetic induction in the initial period of germination, there is no data in the table. The reason for this is that the germination process of the control grains was not observed, and as the data in the table presents the relation of the grains germinated in a magnetic field, these spaces could not be filled. The magnetic field of 7.5 mT had the weakest effect and the field of 35 mT had the strongest. For magnetic fields of 50 and 80 mT the influence was exerted throughout the period of germination observed and remained statistically significant all this time (Table 1). A very strong influence for 35 mT was exerted in the initial phase of germination. Generally, it was observed that the influence was exerted mainly in the first 50 h of germination (Fig. 1).

The analysis of the research data allowed also an interesting observation concerning a certain phenomenon, clearly shown in Fig. 2. For the magnetic inductions 35, 50 and 80 mT there appears a sort of resonance reinforcement

Table 1. Percentage of germinated grains in relation to the control in a magnetic field dependent on the induction value *B* and the time of germination

Time of germin. (h)	Magnetic induction *B* (mT)							
	7.5	20	35	44	50	65	80	100
36	-	-	-	5.00 *	-	-	4.10 *	2.70 *
38	-	-	-	2.30 *	-	-	3.00 *	1.50 *
40	-	1.73 *	-	1.80 *	3.00 *	1.70 *	2.40 *	1.30 *
42	1.35 *	1.60 *	-	1.50 *	2.70 *	1.45 *	1.80 *	1.18 *
45	1.15 *	1.40 *	10.40 *	1.30 *	2.40 *	1.23 *	1.30 *	1.05 n.s.
48	1.08 *	1.20 *	3.90 *	1.05 n.s.	2.15 *	1.13 *	1.19 *	1.00 n.s.
50	1.05 n.s.	1.15 *	2.70 *	1.00 n.s.	1.96 *	1.10 *	1.17 *	1.00 n.s.
53	1.04 n.s.	1.08 n.s.	1.70 *	1.00 n.s.	1.64 *	1.06 n.s.	1.15 *	1.00 n.s.
56	1.03 n.s.	1.06 n.s.	1.30 *	1.00 n.s.	1.47 *	1.03 n.s.	1.02 n.s.	1.00 n.s.
60	1.02 n.s.	1.00 n.s.	1.00 n.s.	1.00 n.s.	1.36 *	1.01 n.s.	1.01 n.s.	1.00 n.s.

* significance of differences on the level k=0.05, n.s. not significant.

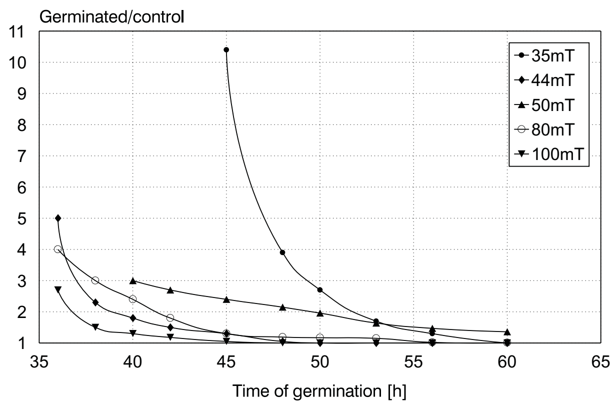

Fig. 1. Percentage of germinated grains in relation to the control in a magnetic field particular values of magnetic induction.

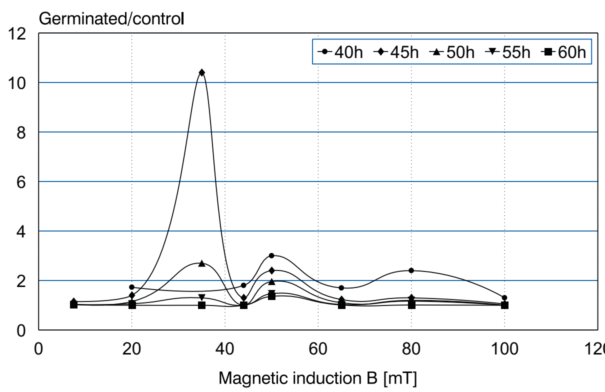

Fig. 2. Percentage of germinated grains in relation to the control in a magnetic field depending on values of magnetic induction for particular germinating times.

of the magnetic field's diminishing influence along with a rise in the value of magnetic induction. The strongest influence can be observed for 35 mT. This confirms the field results for spring wheat described in Pietruszewski's paper [6]. Although they involved the pre-sowing bio-stimulation of seed with the 30 mT variable magnetic field, the influence of this field was also very strong.

The variable magnetic field is a very significant factor in influencing the germination process of wheat grains. It must be remembered, however, that this influence is varied and depends on the power of magnetic field. Both for a weak magnetic field (7.5 mT) and for a strong one (100 mT) the effect was very short-lasting and appeared in the initial phase of germination.

CONCLUSIONS

The results allow the following conclusions to be presented:

1. Alternating magnetic fields with all the used values of magnetic induction have a positive effect in the process of germination in its initial phase.

2. It is evident that there exist three maximum values defining the influence of a magnetic field on germination for magnetic induction: 35, 50 and 80 mT.

3. A magnetic field with the magnetic induction $B = 35$ mT has the strongest positive effect.

4. Magnetic fields influence germination in the initial 50 h of the process.

Summing up the results and conclusions presented, it is possible to state that the strongest and statistically proven influence of a magnetic field appears at the initial phase of germination. This statement points at the need for research at the initial phase of germination in order to define a hypothesis for the mechanism of the influence of a magnetic field's germination on grains. Such research will start in the near future at the Department of Physics of the Agricultural University of Lublin.

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