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Stanisław PIETRUSZEWSKI

The Effect of the Magnetic Field Biostimulation on the Properties of Wheat Seeds

Wpływ biostymulacji polem magnetycznym na właściwości ziaren pszenicy

INTRODUCTION

An increase in yields of cultivated plants may be obtained in a few ways, through an extension of fertilization, plant breeding of new cultivars and use of pre-sowing seed treatment using both physical and chemical methods.

The magnetic seed treatment is one of the pre-sowing seed treatment by the physical methods. This method was used by Pittman [6] in his measurement in Southern Alberta in Canada. This investigation referred to five varieties of wheat, three varieties of barley and one variety of oat. At the beginning the seeds were subjected to an effect of stationary magnetic field, they were sowed on experimental fields. The gauge was the yields of corns.

Pre-sowing treatment of winter wheat and spring barley seeds by use of stationary magnetic field was employed by Shiyan [7]. The effect of brief magnetic exposure to seed germinations and yields in laboratory and field investigations was measured by Gubbels [1]. Miscenko [4] used alternating magnetic field with 21 kHz frequency.

In Poland magnetic treatment was used by Kopeć [2]. The effect of pre-sowing seed treatment with alternating magnetic field was described by Pietruszewski [5].

MATERIALS AND METHOD

Seeds of spring wheat Henika and Jara were the object of these investigations. The investigations were carried out in two phases — laboratory tests and field tests.

The electromagnet was made at the Chair of Physics, Agricultural University in Lublin. The diagram of this electromagnet is shown in Figure 1. Two field coils fed with alternating current of 50Hz frequency and 380 V, were wound on the magnetic core. The mobile part of magnetic core made it possible to adjust midpoint between the electromagnet (air gap) where it was able to put test sample of seeds. Between air gap a smooth adjustment of magnetic field from 30 mT to 100 mT was obtained. The heterogeneity of magnetic field was at the edge of air gap but it did not exceed 15 per cent value of magnetic induction on magnetic axis. All quoted magnetic inductions were measured with a gaussmeter TH 26 manufactured by Experimental Institution of Biocybernetic, Polish Academy of Sciences.

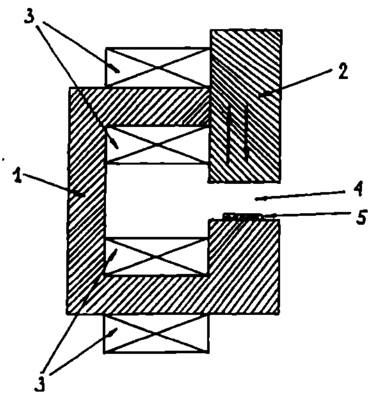


Fig. 1. Block diagram of electromagnet: 1 — magnetic core; 2 — mobile magnetic core; 3 — field coils; 4 — air gap; 5 — sample of seeds
Ryc. 1. Schemat elektromagnesu: 1 — rdzeń magnetyczny; 2 — ruchoma część rdzenia; 3 — cewki zasilające; 4 — szczelina elektromagnesu; 5 — próbka z nasionami

During the first of laboratory tests a lot of 100 seeds were placed between the air gap of electromagnet. The value of magnetic induction was 30 mT. The exposure time treatment was 4 and 8 s. Then the seeds were put away for germination on Petri dishes. Each part of seeds had identical and convenient germinations (293 K) and adequate moisture content. After three and four days germination capacities in each part of the seeds were determined. Each kind of investigated part of seeds was done in five replications.

At the same time the investigations of photo-induced luminescence (Tryka and Koper [3, 8]) helped to determine if pre-sowing magnetic treatment produced an effect on the intensity of photo-induced luminescence emitted by the seeds. In this case both varieties of seeds were put to the effect of the magnetic field. The value of magnetic induction was 30 mT and the exposure treatment time was 4, 8 and 16 s. The intensity of photo--induced luminescence emitted by the seeds was measured by the apparatus that is shown in Figure 2. [3]. The method for this investigation is described in detail in [8].

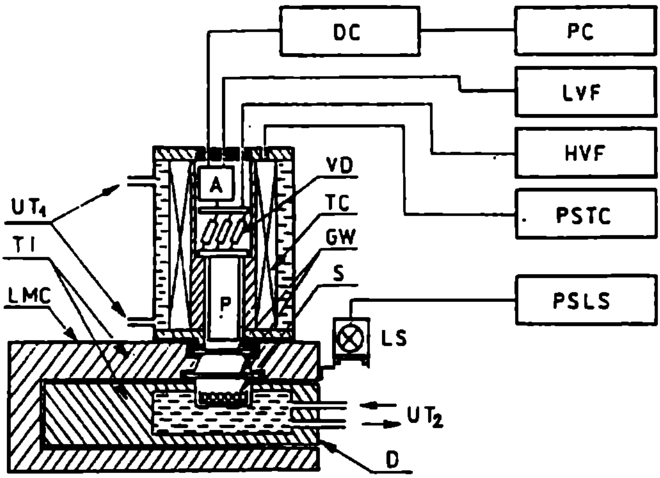


Fig. 2. Block diagram of measuring apparatus [8]: LMC — light-proof measurement chamber, TI — thermal insulator, D — drawer, S — sample, GW — glass windows, P — photomultiplier, VD — voltage divider, A — amplifier, DC — discriminator, PC — pulse counter, LVF — low-voltage feeder, HVF — high-voltage feeder, PSTC — power supply of thermoelectric cooler TC, PSLS — power supply of light source LS, UT_1 and UT_2 — stub pipe for water addition from ultrathermostats

Ryc. 2. Schemat aparatury pomiarowej [8]: LMC — światloszczelna komora pomiarowa; TI — izolator termiczny; D — szuflada; S — próbka; GW — okienko szklane; P — fotopowielacz; VD — dzielnik napięcia; A — wzmacniacz; DC — dyskryminator; PC — licznik impulsów; LVF — zasilacz niskiego napięcia; HVF — zasilacz wysokiego napięcia; PSTC — zasilacz chłodnicy termoelektrycznej TC; PSLS — zasilacz źródła światła LS; UT_1 i UT_2 — doprowadzenie wody z ultratermostatów

The field tests were made in Niemce in the neighbourhood of Lublin. The seeds of wheat were put to the effect of alternating field. At this time the value of magnetic induction was also 30 mT and the exposure treatment time was 4 and 8 s. The pre-sowing magnetic treatment took place five days before sowing.

The sowing material (a lot of 500 seeds) was sowed on the experimental field 1 m×1 m, 10 cm distance of drill. The investigations were made in three replications. All the cultivations measures connected with corngrowing were taken.

RESULTS

LABORATORY TESTS

Mean values of germination capacities of both varieties of wheat seeds obtained in germination tests are presented in Table 1.

Table 1. Mean value of germination capacity [%]
Tab. 1. Wartość średnia zdolności kiełkowania [%]

Characteristic	Jara variety		Henika variety	
	Germination capacity after			
	3 days	4 days	3 days	4 days
Controlled seeds	78	97	0	84
Magnetized by 4 s	76	94	0	86
Magnetized by 8 s	98	100	0	91

The presented results do not give an explicit answer which is the effect of pre-sowing treatment on the germination capacity. The results did not reveal any essential differences. It may be said that seeds of Jara germinated more quickly than seeds of Henika.

The change of arithmetic mean of intensity $\bar{I}$ photo-induced luminescence for three replications emitted by the seeds after the breaking action of light was shown in Figure 3. The intensity of photo-induced luminescence quickly drops and after 100 s approaches the background of the apparatus. It has been shown that the intensities of photo-induced luminescence for seeds magnetized with exposure time 4 s are almost identical. The intensities for control seeds are about the same. The seeds magnetized with exposure time 8 and 16 s have different intensities of photo-induced luminescence. From 50 to 100 s the intensities of photo-induced luminescence for seeds of Henika decay are slower than the intensities for seeds of Jara. For all the tests the intensities of photo-induced luminescence for Henika were greater than the intensities of Jara.

FIELD TESTS

The cropping of both varieties of seeds was in August. The following investigations were made:

1. the number of ears was counted from each experimental field;

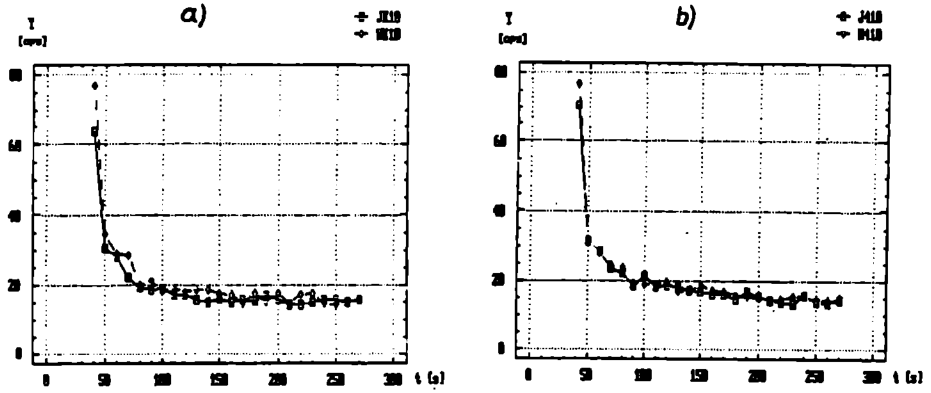
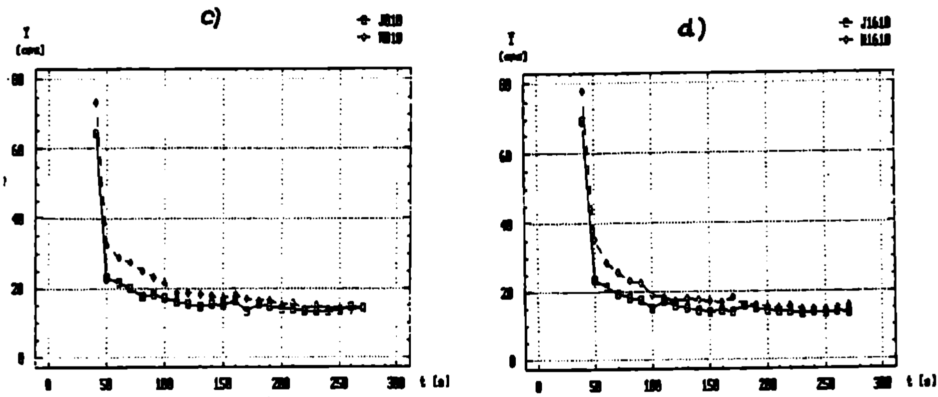


Fig. 3. Decay of photo-induced luminescences $\bar{I}$ of the seeds of wheat after breaking action of light: a) for the control seeds Jara variety — JK10 and Henika variety — HK10; b) for the seeds magnetized for 4 s Jara variety — J410 and Henika variety — H410;

Ryc. 3. Natężenie fotoindukowanej luminescencji $\bar{I}$ nasion pszenicy po przerwaniu naświetlania: a) dla nasion kontrolnych odmiany Jara JK10 i odmiany Henika HK10; b) dla nasion magnesowanych 4 s odmiany Jara J410 i odmiany Henika H410



c) for the seeds magnetized for 8 s Jara variety — J810 and Henika variety — H810;
d) for the seeds magnetized for 16 s Jara variety — J1610 and Henika variety — H1610

c) dla nasion magnesowanych 8 s odmiany Jara J810 i odmiany Henika H810;
d) dla nasion magnesowanych 16 s odmiany Jara J1610 i odmiany Henika H1610

2. a random selection of 20 ears was made from the ears in the experimental field and their length was measured and number of seeds in ear was counted;

3. weight of seeds from selected ears of experimental field;

4. weight of 1000 seeds was determined (MTS).

The results are presented in Tables 2 and 3. The test of significance was carried out for all investigations.

Table 2. Obtained results of Henika
Tab. 2. Wyniki dla odmiany Henika

Characteristic	Control	4 s	8 s	4/c	8/c
Length of ear [cm]	10,4	10,4	11,0	0% —	+5,8% **
Number of seeds per ear	39,5	43,9	44,5	+11,2% ***	+12,7% ***
Weight of 20 ears [g]	30,7	37,6	36,4	+22,5% ***	+18,6%
MTS [g]	38,8	42,8	40,7	+10,3% ***	+4,9% ***

Significance level: — $0.05 \leqslant \alpha$; * $0.01 \leqslant \alpha \leqslant 0.05$; ** $0.001 \leqslant \alpha \leqslant 0.01$; *** $\alpha \leqslant 0.001$.

Table 3. Obtained results of Jara
Tab. 3. Wyniki dla odmiany Jara

Characteristic	Control	4 s	8 s	4/c	8/c
Length ear [cm]	8,2	8,4	8,4	+2,4% —	+2,4% —
Number of seeds per ear	45,2	49,4	47,6	+9,3% **	+5,3% **
Weight of 20 ears [g]	34,8	36,9	36,6	+6,0% **	+5,2% **
MTS [g]	38,5	38,6	38,5	+0,26% —	0% —

The effect of pre-sowing treatment with alternating magnetic field on yields is positively clear for Henika. Three out of the investigated characteristics of exposure time 4s have grown in comparison with control, characterised by the highest significance level, $\alpha \leqslant 0.001$. The number of seeds per ear and weight of 20 ears for exposure time 8 s were characterised by the highest significance level too. The length of ear amd MTS was characterised by the significance level of $0.001 \leqslant \alpha \leqslant 0.01$.

The effect of pre-sowing treatment with alternating magnetic field on yields for Jara was different. The number of seeds per ear and weight of 20 ears increased but other qualities were on the same level as control.

DISCUSSION

The results presented in this paper were to display the effect of pre--sowing treatment with alternating magnetic field on yields of wheat. It was said that this effect was generally positive. It was not visible in the germination tests but field tests displayed it.

Investigation intensity $\bar{I}$ of photo-induced luminescence displayed investigated intervarietal differences for exposure time 8 and 16 s. On the basis of the results it is impossible to state univocally that there exists a relationship between $\bar{I}$ photo-induced luminescence and obtained yields of wheat. One conclusion is certain — the effect of magnetic field depends on the kind of seed variety within a species.

The obtained results should be treated as introductory. Because of this, further investigations and both laboratory tests and field tests are continued. In these investigations the seeds subjected to pre-sowing magnetic treatment of alternating field are tested with physical-chemical analysis. In the field test the effect of climatic, meteorologic and soil conditions will be defined.

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STRESZCZENIE

W niniejszej pracy przedstawiono wpływ przedsiewnej magnetycznej biostymulacji na plony i własności biofizyczne nasion pszenicy. Stwierdzono, że ten wpływ generalnie był pozytywny. Uzyskane wyniki dla odmiany pszenicy Henika były lepsze niż dla odmiany Jara. Przedsiewna biostymulacja zmiennym polem magnetycznym powoduje szybsze kiełkowanie i lepsze plony dla obu odmian. Badano również wpływ pola magnetycznego na natężenie fotoindukowanej luminescencji emitowanej przez ziarna pszenicy poddane działaniu pola magnetycznego. Stwierdzono różnice między odmianami w emisji promieniowania dla ośmio- i szesnastosekundowej ekspozycji pola magnetycznego.