ORIGINAL ARTICLE

STUDY OF THE INFLUENCE OF MAGNETIC FIELD ON SOME BIOLOGICAL CHARACTERISTICS OF *ZEA MAIS*

ИЗСЛЕДВАНЕ ВЛИЯНИЕТО НА МАГНИТНОТО ПОЛЕ ВЪРХУ НЯКОИ БИОЛОГИЧНИ ХАРАКТЕРИСТИКИ НА ZEA MAIS

ALADJADJIYAN A.

РЕЗЮМЕ

Изследвано е влиянието на статично магнитно поле с индукция **0,15** ***T*** върху семена от царевица. Определени са кълняемата енергия и кълняемостта на семената. Измерена е свежата маса и дължината на кълновете. Снети са абсорбционните спектри и е определена специфичната електропроводимост на воден екстракт от семената. Установено е, че магнитното поле стимулира развитието на кълна, води до повишаване на кълняемата енергия, кълняемостта, свежата маса и дължината на кълновете. Екстинкцията на третираните с магнитно поле образци се повишава с около 20 %. Най-високи стойности на параметрите на третираните образци се получават за експозиция в магнитно поле 10 *min.*

ABSTRACT

The effect of the static magnetic field of **0,15** ***T*** induction on the maize seeds was studied. The germinating energy and seed germination were detected. The fresh weight and the shoot length were measured. The absorption spectra and the specific electroconductivity of the water extract from seeds were registered. It was detected that the magnetic field stimulated the shoot development and led to the increase of the germinating energy, germination, fresh weight and shoot length. The extinction of the samples treated with a magnetic field increased by about 20 %. The highest values of the treated sample parameters were obtained after 10-*min* exposure in the magnetic field.

KEY WORDS: Magnetic field, *Zea mais*, germination, absorption spectra, electroconductivity.

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DETAILED ABSTRACT

The magnetic field effect on the growth parameters and maize seed development has been studied. The germinating energy, germination, fresh weight and shoot length of control samples and of samples treated with a magnetic field of 0,15 *T* induction at 10-*min,* 15-*min,* 20-*min* and 30-*min* exposure have been detected. The absorption spectra and the specific electroconductivity of water extract from the seeds were measured. It was established that the most favourable effect on the germinating energy, germination, fresh weight and shoot length was exerted by the magnetic field at 10-*min* exposure. The least magnetic field effect on the shoot elongation – by 25 %, was exerted at the maximum treatment at 10-*min* exposure, while the most strongly expressed stimulation was registered for the fresh weight of shoots – 72 %, at the same treatment regime. It was established that the water extract extinction for the treated samples increased by 80 % compared to the control. It is supposed that is due to the substance diffusion through the seed covering under the influence of the magnetic field. A change of the specific electroconductivity of the water extract has been detected after submitting it to the magnetic field effect, the change disappearing after stopping the magnetic field treatment.

Maybe it is due to the diffusion of the ions, which change their trajectories in the magnetic field.

The established favourable effect of the magnetic field at the early stages of maize seed development is a sound reason to recommend its use for stimulating the non-standard seeds.

INTRODUCTION

Magnetic field treatment of seeds leads to acceleration of plant growth, activates proteins formation and root development [2-8]. Investigations of numerous authors show that the magnetic field treatment of seeds increases germination of non-standard seeds and improves their quality.

Magnetic field of 2000-3000 *Gs* strenght (in *SI* corresponds to 0,2-0,3 *T*) has been used for treatment of soybean seeds [4], and of 700 *Gs* strenght (in *SI* – 0,07 *T*) – for treatment of rice, wheat, barley and soybean [3]. Control measurements of the investigated parameters in both papers show the positive effect of the magnetic field treatment.

MATERIAL AND METHOD

Maize seeds have been treated by a magnetic field of strenght 0,15 *T* for a different period of time – 10 *min,* 15 *min,* 20 *min* and 30 *min*. The experiment was set on 25 seeds of each variant.

The investigated samples have been prepared as water extract - 20 seeds have been soaked in 20 *ml* water for 24 hours. The absorption and specific electroconductivity of the treated and control samples has been measured.

Optical properties have been measured by SPECOL – 11 spectrophotometer with a digital registration. Water extract has been poured in one of the cuvettes and distilled water in the other. The absorption spectra of the samples have been measured at a wavelength of 400 to 760 *nm*.

The optical extinction *E* of the water extract was defined by the equation

$$E = \ln (I/I_0),$$

where I0 is the intensity of optical emission before, I – after the sample.

Electroconductivity σ was defined by the equation

$$\sigma = C/R$$

where *R* is the sample resistance, *C* is the capacity of the holder, given by

$$C = l/S,$$

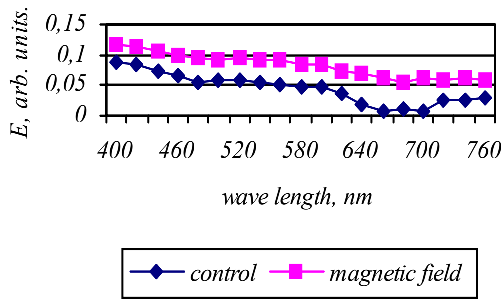
where *S* is the surface of electrodes in m^2, *l* – distance between them in *m.* Electroconductivity of samples has been measured with a standard universal device LCR (E7 –11). Water extract has been placed in a special holder for electrical measurements, which consists of a glass cylinder with two mobile Pt-electrodes, submerged in the extract and situated at a distance of 3 *cm* from each other.

RESULTS AND DISCUSSION

The germination energy (GE) and germination (G) of samples has been defined. Weight (*m*) and length (*l*) of shoots have been measured in order to estimate the influence of the magnetic exposure. Absorption spectra and specific electroconductivity of the samples have been registered. Results are shown in Figures 1 and 2 and in Tables 1 and 2.

The graphic of Figure 1 shows that the treatment of the maize samples by a magnetic field leads to an almost evenly increased extinction (from 80 to 100 %) in the whole studied range of wave lengths.

Figure 1. Absorption spectra of samples from Zea mais seeds



The increased absorption of the samples exposed to a magnetic field could be due to the magnetic properties of the substance diffusing through the seed cover. The diffusion of the molecules through the seed cover is accelerated under the influence of the magnetic field.

When exposing the maize samples to a magnetic field their specific electroconductivity is increased by 15 %. For a comparison, the change of the specific electroconductivity for a starch solution exposed to a magnetic field is 20 %.

After the magnetic field effect ceases, the specific electroconductivity σ restores its values. That behaviour of σ can be explained by curving of the trajectory of the deffunded ions, under the influence of the magnetic field. By analogy with the magnetic-resistant effect in solid bodies, the relative change of the specific electroconductivity was determined by the formula:

$$\frac{\Delta\sigma}{\sigma}=\frac{\sigma_M-\sigma_0}{\sigma_0},$$

where σ_M is the specific electroconductivity in the magnetic field and σ_0 – without a magnetic field.

The value of the relative change of the maize specific electroconductivity is 0,18.

The germination energy *GE*, germination *G* and germination uniformity *D* of the seeds were detected after 10, 15 and 20 *s* of exposure (Table 1).

The fresh weight *m* and the shoot length *l* on the 7th day were measured for the three variants.

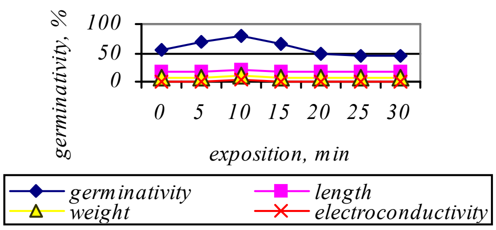
Table 1. Indices of seed vitality of *Zea mais*, treated by a magnetic field

Variety		*GE, %*	*G, %*	*D, %*	*l*		*m*		σ, $\Omega^{-1}m^{-1}$
					mm	%	*g*	%	
Control		56	85	12	15,2	100	0,59	100	0,0122
10 *min*		80	100	14	20,2	125	1,01	172	0,0131
15 *min*		64	100	14	18, 4	110	0,72	122	0,018
20 *min*		48	100	14	19,9	108	0,68	115	0,017
30 *min*		44	100	14	18,2	110	0,76	129	0,0117
	5,0%	39,64	18,581	2,477	5,499		0,43		0,008
GD	1,0%	65,82	30,857	4,114	9,133		0,72		0,013
	0,1%	98,17	46,018	6,135	13,62		1,08		0,0198

Data in Table 1 show that the treatment of maize seeds with a magnetic field of an induction of 0,15 *T* had an optimal effect at 10-*min* exposure. Then a maximal increase was observed compared to the control: by 72 % for the fresh weight and by 25 % for the shoot length.

Figure 2 presents the maize seed parameters dependence on the magnetic field exposure. Only germination is given on a real scale. For all the parameters the maximum is obvious at a 10-*min* magnetic field exposure of the seeds. Only the maximum of the specific electroconductivity is different, i.e. at a 15-*min* exposure.

Figure 2. Dependence of Zea mais seeds characteristics on the magnetic field exposure.



As it is seen from the graphic presentation in Figure 2 and from the data in Table 1, the least magnetic field effect on the elongation of the shoots - 25 %, was established at the maximum treatment with 10-*min* exposure and the strongest stimulating effect of the shoot fresh weight – 72 % at the same treatment regime.

For all the exposures the differences between the lengths of the control and the magnetic field treated samples were statistically significant for P = 0,1 %.

CONCLUSIONS

Exposure of seeds of *Zea mais* has a favuorable effect on the development of shoots in the early stages.

The exposure of *Zea mais* samples to a magnetic field of 0,15 *T* leads to a germination increase, the maximum effect being registered after a 10-*min* exposure. The effect of the magnetic field of 0,15 *T* strength on the maize samples leads to an increase of the shoot fresh weight by 72 % compared to the control, as well as an increase of their length by 25 %. The extinction of the maize seed extract is increased under the influence of the magnetic field, which is an evidence of the increased permeability of the seed cover. A change of the specific electroconductivity of the maize seed extract in the magnetic field was established.

It was found out [1], that chloroplasts have paramagnetic properties. That means, that in the magnetic field the magnetic moments of the atoms in them are oriented downwards the field direction. The influence of the magnetic field on plants, sensible to it, increases its energy. Later this energy is distributed among the atoms and causes the accelerated metabolism and, consequently, to better germination.

Table 2. Shoots length (*mm*) for *Zea mais* seeds, treated with a magnetic field

№	Control	10 min	15 min	20 min	30 min
1	14	24	18	13	23
2	20	23	19	21	20
3	20	21	12	27	18
4	20	22	16	21	20
5	14	26	26	21	12
6	16	17	17	16	16
7	21	22	17	21	17
8	17	23	20	16	20
9	17	26	17	20	24
10	10	21	20	27	17
11	13	19	22	17	13
12	18	16	24	20	13
13	18	20	18	24	16
14	19	22	17	27	19
15	16	17	14	13	17
16	23	16	14	20	22
17	8	16	20	22	21
18	7	16	20	16	16
19	18	27	16	18	19
20	17	16	18	13	17
21	21	21	23	20	22
22	21	20	14	2	21
23	13	19	26	16	16
24	-	17	16	18	16
25	-	1	17	13	20
l_{cp}	15,2	20,2	18,44	19,3	18,2
Σ	400,56	282	318,2	439,0	238
S	6,12	3,43	3,64	4,28	3,15
S_{cp}	1,22	0,69	0,73	0,86	0,63
C_v	0,08	0,03	0,04	0,04	0,03

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Aladjadjiyan Anna, anna@au-plovdiv.bg,
Department of Physics, Agricultural University,
Plovdiv,
Tel. No. 00359/32/625 097