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THE INFLUENCE OF THE ELECTROMAGNETIC FIELD ON GERMINATION OF OKRA SEEDS AND EFFECT USE OF SOME TREATMENTS IMPROVING GERMINATION

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Abstract

The study was carried out within the Faculty of Horticulture, UASMV Bucharest. The biological material consisted of the Acme okra variety. Seed germination was tested under two conditions, in the laboratory and in the greenhouse. The experimental variants consisted of the treatments carried out on the okra seeds, namely keeping the seeds in a magnetic field of 6.8 Hz and 10 Hz for 1 hour, 2 hours and 24 hours, respectively, then the percentage of sprouted seeds was monitored for 12 days. Differences were noted regarding the percentage of germinated seeds but also differences regarding the duration of germination.
The study addressed in this work aimed to establish some methods to improve the germination of okra seeds and at the same time identify a solution to shorten the germination period.

Key words*: Okra, germination, electromagnetic field.*

INTRODUCTION

It is known that okra seeds germinate in a very long time up to 12-15 days only when a temperature above 20°C is ensured. Also, okra seeds have a low germination of 75-90% according to vegetable quality standards and technical conditions.
Zanini, 2021, points out that the exposure of seeds and plants to a magnetic field influences the growth of seed and plant germination, an aspect also researched and confirmed by Florez et al., 2007 claiming that the greatest increases were obtained for plants continuously exposed to 125 or 250 mT but also by Carbonell et al., 2011 as well as by Dobrescu et al., 2000.
Neo et al., 2018, analyzing the importance of using plant stimulation with different values of the magnetic field, presents many researchers who have been concerned with this aspect.
In the case of the species *Pisum sativum*, it was found that the epicotyl was longer when the seeds were exposed to a magnetic field with a lower value compared to the normal geomagnetism of the Earth (Yamashita et al., 2004). Negishi et al., 1999, suggested that the cell elongation attributed to the influence of the low frequency magnetic field may be related to the increase of the osmotic pressure in the cells.
Katarzyna et al., 2022, investigated the impact of magnetic fields on the germination of cucumber seeds using Bitter magnets with a constant magnetic field.
Belyavskaya, 2001, observed that the effects of the magnetic field on the ultrastructure of the root cells while also mentioning that the weak magnetic field causes the intensification of protein synthesis in plants.
Experiments carried out on barley seedlings (Hordeum vulgare) between Helmholtz coils with an intensity of 10 nT magnetic field showed a decrease in the fresh weight of plants (by 12%) and roots (by 35%), as well as the dry matter of plants (by 19%) and roots (by 48%) compared to the controls in the gravitational magnetic field (Lebedev et al., 1977).
Abe et al., 1997, as well as Negishi, 1999, Liu et al., 2019, mentions that the impact of the magnetic field positively influences the growth and development of plants.
De Souza et al., 2010, showed that seeds and plants exposed to the magnetic field showed higher vegetative growth but also a better rate of photosynthesis.
Shine et al., 2011, showed that by exposing seeds to different magnetic field intensities from 0 to 300 mT for 30, 60 and 90 minutes

they showed that magnetic field treatment can improve seed germination parameters.
Afshan et al., 2012, investigated the effect of pre-sowing magnetic treatments on germination, growth and yield of okra (*Abelmoschus esculentus* cv. Sapz pari). They found that the seeds exposed to the sinusoidal magnetic field induced by an electromagnet of 99 mT for 3 and 11 minutes and observed a significant increase in germination percentage, number of flowers per plant, leaf area, plant height, number of fruits per plant as well as capsule mass.
Maffei, 2014, mentions that the geomagnetic field (GMF) is a natural component of our environment and plants respond differently depending on its intensity.
Besma et al., 2014, mention that the germination of okra seeds also depends on the salinity of the culture substrate.
Through the issue addressed in this paper, we aimed to establish some methods by which to improve the germination of okra seeds and at the same time identify a solution for shortening the germination period.

MATERIALS AND METHODS

The experience was carried out at the University of Agronomic Sciences and Veterinary Medicine Bucharest, Faculty of Horticulture under laboratory conditions.
The biological material was represented by the Acme okra variety.
The device used in the experiment is an electromagnetic stimulator for changing the growth behaviour of plants (Figure 1).

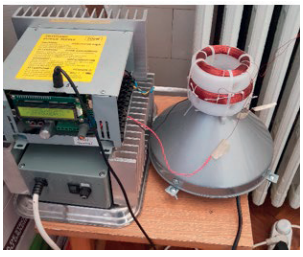

Figure 1. The appearance of the installation used for seed treatment

To accelerate growth and develop better vital qualities in plant organisms, they are subjected to a magnetic field.
According to this method, a pulsating polarized magnetic field is made to act correspondingly with different extents, generally correlated with each other, on cultivated land, seeds, plants, and irrigation water.
The installation refers to a method of improving seed germination and/or growth of plants or plant parts and/or plant harvest by subjecting seeds to a pulsed radio frequency electric field (PRF).

Experimental variants

In the experiment we used two variants of germination stimulation, unmoistened seeds and seeds moistened for 1 hour before being exposed to the magnetic field. Wetted and non-wetted okra seeds were exposed to the electromagnetic field of 10 Hz and 6.8 Hz for one hour, 2 hours and 24 hours, respectively at constant intensity with the value 10 times more than the natural magnetic field (Table 1). The ambient temperature was between 21-24°C.

Table 1. The experimental variants

Variants	Treatment seed	Time of exposure to the magnetic field	The frequency of the magnetic field
V1	Softened	Control	-
V2	Unmoistened	Control	-
V3	Softened	1 hour	10 Hz
V4	Unmoistened	1 hour	10 Hz
V5	Softened	1 hour	6.8 Hz
V6	Unmoistened	1 hour	6.8 Hz
V7	Softened	2 hours	10 Hz
V8	Unmoistened	2 hours	10 Hz
V9	Softened	2 hours	6.8 Hz
V10	Unmoistened	2 hours	6.8 Hz
V11	Softened	24 hours	10 Hz
V12	Unmoistened	24 hours	10 Hz
V13	Softened	24 hours	6.8 Hz
V14	Unmoistened	24 hours	6.8 Hz

The experiments were carried out under both laboratory and greenhouse conditions. The percentage of germinated seeds, the duration of the germination period, the length of the radicle, were monitored under laboratory conditions

RESULTS AND DISCUSSIONS

In the case of the experiment carried out under laboratory conditions, it was found that the lowest percentage of germinated seeds was in V2 control - unmoistened seeds, which was

70.33%, and in the case of moistened seeds not exposed to the field, 75.33%.

In the case of V3, seeds moistened for time then exposed to the 10 Hz field for one hour showed a germination percentage of 90.25%, but in the case of non-moistened seeds, the germination percentage was 85.33%. I noticed that, in the case of seeds moistened for one hour at 6.8 Hz, variant 6, the germination percentage was 78.55%, lower than the moistened variant of 85%. In the case of variant 8 unmoistened seeds exposed for 2 hours to a magnetic field frequency of 10 Hz, the germination percentage was higher, 90.33%, compared to variant 7 moistened seeds of 89.55%. In the case of the variants exposed for 24 hours to the magnetic field at the frequency of 10 Hz, the germination percentage was 95% for variant 11, moistened seeds, and 95.11% for variant 10, non-moistened seeds. In the case of variants 13 and 14 exposed to the magnetic field for 24 hours at a frequency of 6.8 Hz, the percentage of germination was higher in the moistened variants compared to the wetted ones of 95.25% and 94.05%, respectively (Figure 2).

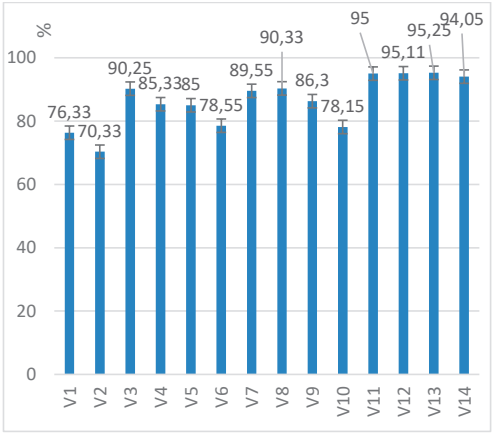

Figure 2. Percent of sprouted seeds

Analyzing the germination of the seeds from a percentage point of view, we found that, in the case of okra seeds not moistened and exposed to the field with the frequency of 10 Hz for 24 hours, the germination percentage was 35.23% higher than the non-moistened control variant, an aspect also noticed at the variant exposed to 6.8 Hz for 24 hours non-moistened seeds, this being 33.73% above the non-moistened variant (V2) taken as a control. All the experimental variants subjected to the magnetic field presented values of the percentage of emergence above 11.36 % (V5). The variants exposed for 2 hours to the magnetic field at frequencies of 10 Hz showed an increase in seed germination with values of 17.32% and 28.44%, respectively. Exposure for 24 hours resulted in an increase in the emergence percentage from 24.46% (the variant exposed to 10 hertz moistened respectively 24 79% to 6.8 kilohertz the moistened variant one. it should be noted that in the case of variants n moistened the percentage of emergence germination was higher compared to the moistened variants (Figure 3).

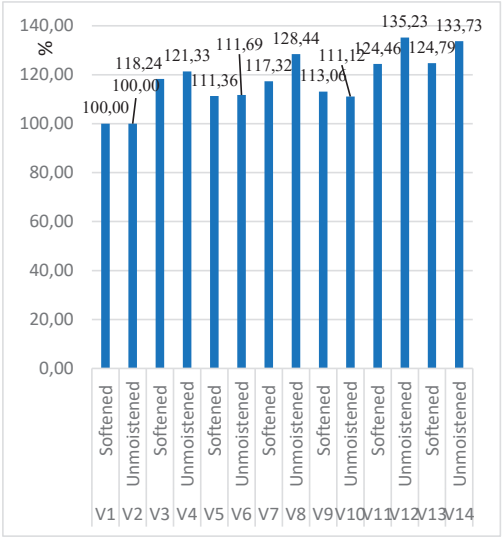

Figure 3. Percentage of germinated seeds according to control variants

In the case of the moistened variant, we found that there was a significantly positive influence on the percentage of seed germination (R^2 = 0.635) (Figure 4).

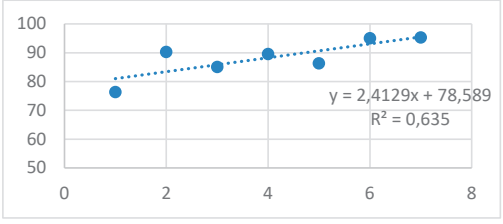

Figure 4. The influence of the magnetic treatment on percentage of germinated seeds

Also, in the case of the variant where we used the wetting of the seeds before exposure, we found that there was no significant relationship regarding the percentage of seed germination ($R^2 = 0.5658$) (Figure 5).

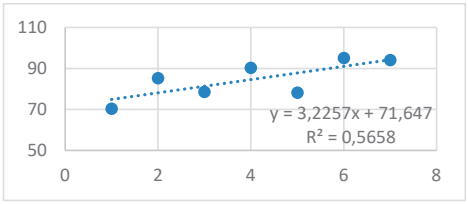

Figure 5. The influence of the treatments on the germination percentage in the case of the moistened variant

The appearance of the seedlings exposed to 6.8 Hz, is presented in the Figure 6.

Figura 6. Appearance of okra seedlings 2 days after emergence - Acme cultivar exposed to 6.8 Hz

In the case of the seeds exposed to 6.8 Hz, after 2 days from the emergence of the plants, the length of the radicle was 5.1 mm in the case of V1 - unmoistened control, and in the case of V6 - non-moistened seeds, 1.23 mm. the longest length was recorded for the moistened variant 13, of 7.55 mm, followed by V5 - moistened seeds, of 7.15 mm. In the case of variant 9, the value was 6.41 mm. In the case of non-moistened seeds, the radicle length was between 1.23 mm for variant 2 and 2.15 mm for V10 (Figure 7).

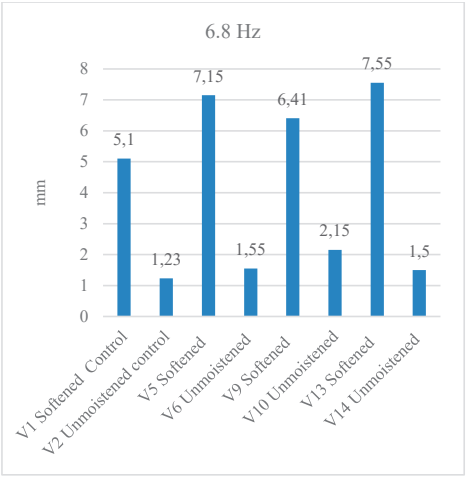

Figure 7. The influence of the treatments on the growth in the length of the radicle at 6.8 Hz

In the case of the seeds exposed to the intensity of 10 Hz, we found that the length of the radicle was greater compared to the moistened and non-moistened control variants, the values being at V 3 of 9.5 mm and at V7 of 8.3 mm. In the case of the non-moistened variants, the root length was small, regardless of the exposure time (Figure 8).

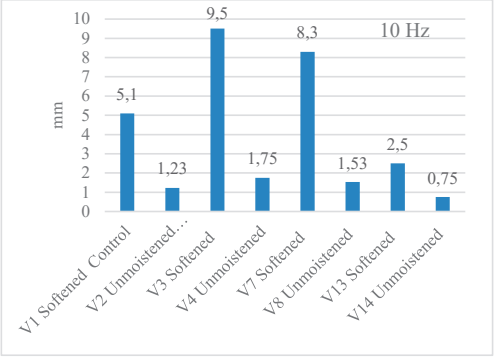

Figure 8. The influence of the treatments on the growth in the length of the radicle at 10 Hz

The appearance of the seedlings exposed to 10 Hz, is presented in the Figure 9.

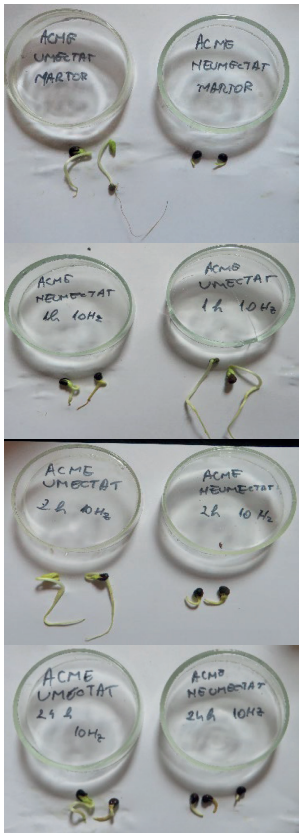

Figura 9. Appearance of okra seedlings 2 days after emergence - Acme cultivar exposed to 6.8 Hz

Analyzing the data on seed germination in greenhouse conditions, we noticed that in the case of seeds moistened and exposed to a 10 Hz magnetic field for 2 hours (V7), the seeds sprouted in greater numbers after 6 days from sowing, the percentage being 86, 2% compared to the moistened variants exposed to a 6.8 Hz field of only 16.4% (V11). In the case of the variant in which seeds moistened for one hour (V3) were used and then exposed to the 10Hz field, the percentage of sprouted seeds after 6 days was 40%, followed by V9 where the type of moistening was 24 hours, but the percentage of seeds sunrise was 68.33%. After 9 days from sowing, we found that all variants had a germination percentage between 5.18% for variant 7 seeds moistened for 2 hours and exposed to the field of 10 Hz. In the case of variant 2 control, unmoistened seeds, the germination percentage was 27% and after 12 days 52.33%. With this variant, a total germination percentage of 79.33% was recorded (Figure 10). A higher percentage of germinated seeds is noted in all the variants exposed to the magnetic field treatment with moistened seeds compared to non-moistened ones. After 12 days from sowing, in variant one, 15.8% sprouted seeds were recorded, and in variant 6, seeds n moistened for one hour exposed to 6.8 Hz, the percentage of germination was 69.66 percent.

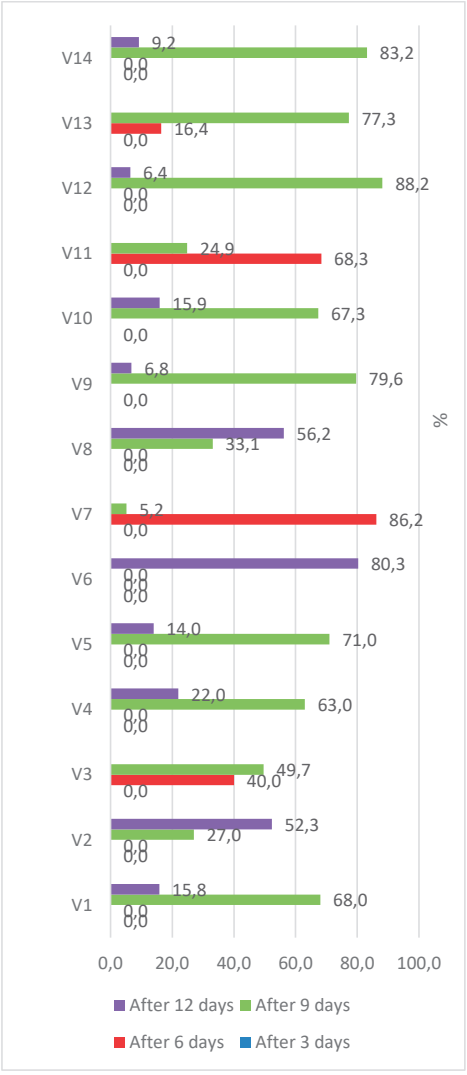

Figure 10. Emergence dynamics of okra plants in peat substrate in the greenhouse

The appearance of the seedlings in greenhouses is presented in the Figure 11.

Figure 11. Experiments performed under greenhouse conditions

Compared to the control variant, moistened and non-moistened seeds, all variants presented a higher germination percentage compared to the control variant. We noted that the highest percentage of seed germination was recorded in the variant 10 non-moistened seeds exposed for 24 hours at a frequency of 10 Hz (94.6%; Figure 12).

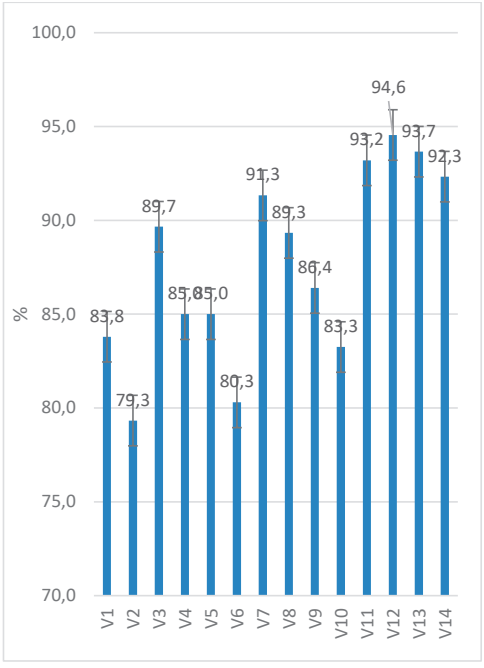

Figure 12. Percentage of seeds germinated in peat substrate in the greenhouse

Analyzing the influence of the treatment carried out, we found a positive significant relationship in the case of the germination of previously moistened seeds (R^2 = 0.5445) (Figure 13).

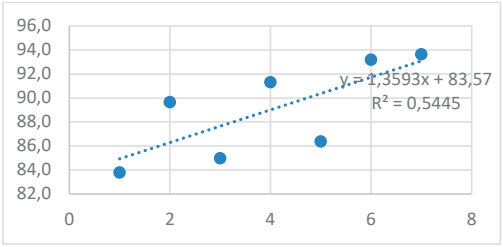

Figure 13. The influence of the treatments on the germination percentage

In the case of non-moistened seeds, a very significant relationship was also found, R^2 = 0.6364) (Figure 14).

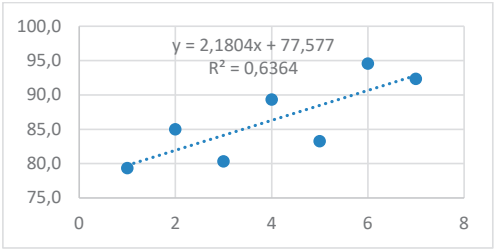

Figure 14. The influence of the treatments on the germination percentage

CONCLUSIONS

Based on the results obtained, we can conclude that, in the case of all the experimental variants moistened and exposed to the magnetic field, the percentage of germinated seeds was higher.
It was found that the exposure of okra seeds to a magnetic field of 6.8 Hz and 10 Hz led to an increase in the percentage of germinated seeds but also to a shortening of the duration of germination.
In the case of testing in greenhouse conditions, on a peat substrate, it was also found that, in the case of seeds exposed to the magnetic field, the germination was higher in the case of previously moistened seeds. Analysing the effect of the treatments it was found that there was a significant relationship in terms of the effect on seed germination.
It should be mentioned the polarized and constant character of the electromagnetic field made with the help of a Maxwell type coil.

In conclusion, to save the germination time of the okra seeds, a seed treatment can be carried out, before sowing, by exposing them to a magnetic field of 10 Hz or 6.8 Hz.

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