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INFLUENCE OF MICROWAVE RADIATION ON GERMINATION CAPACITY OF FLAX SEEDS

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Summary. In this work, the results of an investigation of the influence of microwave radiation on the germination capacity of flax seeds are presented. The changes in the first count of germination capacity and germination capacity of seeds depend on the conditions of microwave exposure. It is found that the germination of seeds and further evolution of the plants is stimulated under certain conditions.

Keywords: Microwaves, germination capacity, flax seeds.

INTRODUCTION

The need to increase plant yield and improve their quality stimulates the search for new methods of seed treatment before their seeding. Recently, the seeds were treated mainly using physical methods, such as magnetic fields [2], laser radiation or ionising radiation as well as a chemical methods. The chemical methods usually deals with some specific substances which are often strongly toxic. It was proved that the applied chemical compounds penetrate interior of the seeds, modifying their structure and chemical composition. The physical factors do not change the chemical composition of the germ but stimulate physiological processes inside the seeds. Moreover, they are more acceptable in ecological aspects. Therefore, it is reasonable to search for new physical methods of activation of first count of germination capacity and germination capacity of seeds, especially for seeds with decreased germination capacity. Stimulating

effects of the microwave radiation on the germination power of cucumber seeds was observed previously [1].

In this work, the results of an investigation of the influence of microwave radiation at nonthermal power level on the first count of germination capacity and germination capacity of flax seeds are presented. An increase in the germination capacity of the flax is the first visible effect of seeds stimulation. Radiation also can stimulate the further evolution of plants, which leads to increase of the number of active extracts as well as plant yields.

MATERIAL AND METHOD

Linum usitatissimum L. seeds were used for the investigations. Before sowing, the seeds were exposed to microwave radiation with frequency f from 37.5 to 54.4 GHz at different power density and exposition time. The G4 - 141-type generator (made in Lithuania) was used as a radiation source. The seeds were divided into seven -eight groups, each containing 100 seeds and then they were placed at 1-cm distance in front of opened wave-guide of generator and irradiated.

Germination of the seeds was estimated accordingly to international norms. The seeds, which ware sowed immediately after irradiation and those, which were sowed during four months period after irradiation at two-week intervals were germinated on the tissue-paper support, placed in Petri dishes. The germination process was realised at a temperature of $T = 20^{\circ}C$ and at a constant environment humidity. First count of germination capacity was estimated after three days, excluding the normally germinated seeds. Germination capacity was estimated after seven days. Both the first count of germination capacity and germination capacity were calculated statistically, as the average value from the six series.

RESULTS AND DISCUSSION

The method of seed treatment before seeding, presented above, showed both an increase as well as decrease of the first count of germination capacity and germination capacity. The magnitude of such changes depended on the frequency of microwave irradiation (Fig.1, Fig.2). The maximal increase of the germination energy and power was observed at the frequencies of 42.13 and 53.57 GHz. This effect did not depend on the exposure time. After exposure of 60 seconds at $f = 42.13$ GHz, the first count of germination capacity increased up to about 10% and the germination capacity up to about 9%. However, at $f = 53.57$ GHz, the first

count of germination capacity increased up to about 5% and the germination capacity up to about 6%. It should be emphasised that within the microwave spectrum of the applied frequencies, suppression of vitality of seeds was observed too.

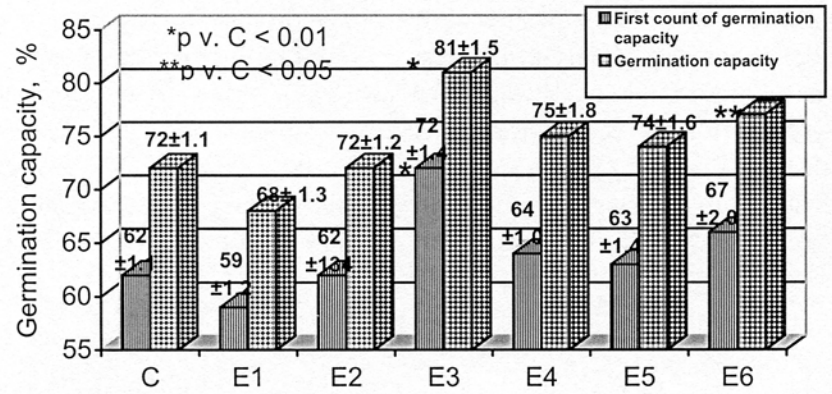

Fig. 1. Germination capacity of the flax seeds of control (C) and irradiated groups (E): E1 - 38.46 GHz, E2 - 40.18 GHz, E3 - 42.13 GHz, E4- 48.78 GHz. , E5 - 52.63 GHz, E6 - 53.57 GHz; time of irradiation - 60s.

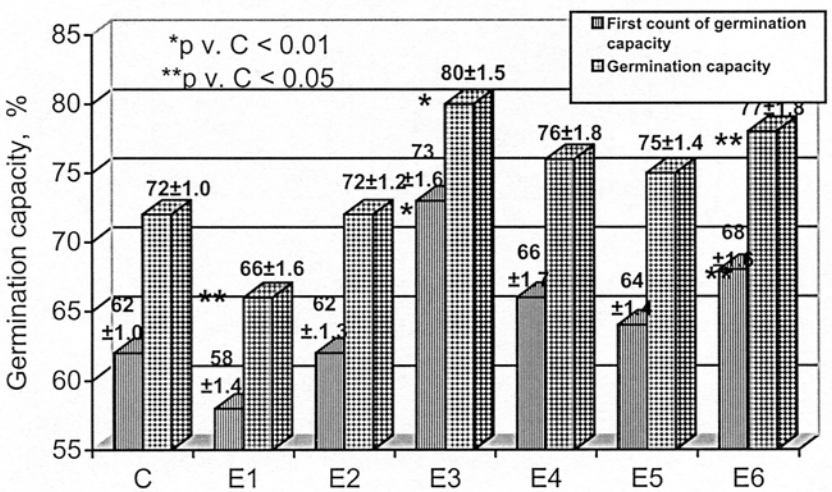

Fig. 2. Germination capacity of the flax seeds of control (C) and irradiated groups (E): E1 - 38.46 GHz, E2 - 40.18 GHz, E3 - 42.13 GHz, E4- 48.78 GHz. , E5 - 52.63 GHz, E6 - 53.57 GHz; time of irradiation - 20min.

In some cases, the first count of germination capacity and germination capacity of irradiated seeds was a few per cent lower than these, from the control group. These disadvantageous changes took place after the irradiation of the seeds at $f = 38.46$ GHz. Therefore, for further investigation electromagnetic fields were used, which caused only positive effects. The irradiation exposure time was determined also accordingly to the positive reaction. In the case of seeds sowed immediately after the microwave treatment, a positive effect for irradiation exposure time of 60 seconds was observed (Fig. 3). In the case of seeds sowed later then two weeks, an exposition time exceeding 20 minutes was necessary. However, relatively long exposure times caused decrease in the vitality of the seeds, registered by lower germination capacity. These effects ware caused by thermal destruction of seeds germ.

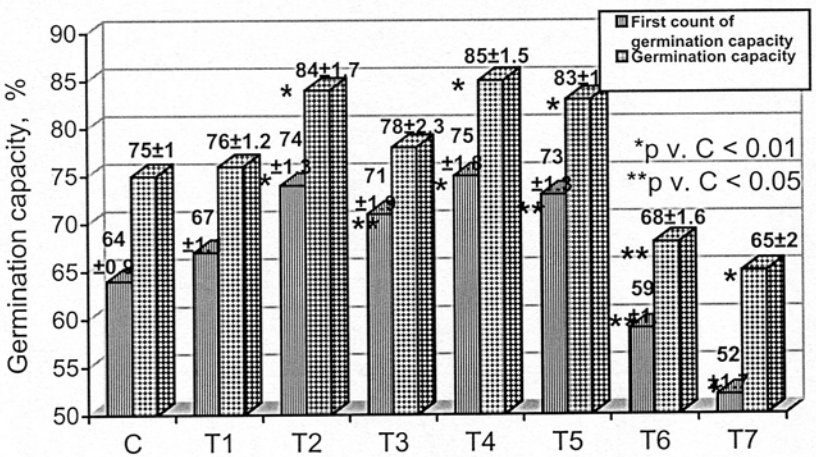

Fig. 3. Germination capacity of the flax seeds of control (C) and irradiated groups (T): time of irradiation - T1 - 30s, T2 - 60s, T3 - 2min., T4- 5 min. , T6 – 45 min., T7 - 60 min.

Level of the power density of such radiation was the third parameter of microwave irradiation stimulating biological effects (Fig. 4). The positive result in the treatment of seeds was observed at the power density between 1 and 10 mW/cm^2. At power density exceeding 10 mW/cm^2 suppressing effects of the flax seed germination was observed. Such effects are probably induced by thermal destruction of the seed germs.

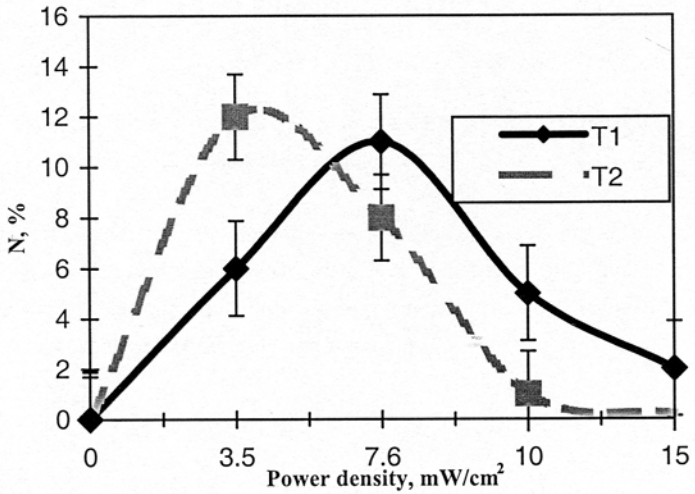

Fig. 4. Comparative changes (in respect to control group) of germination capacity of flax seeds as a function of microwave power density; f = 42.13 GHz, time of irradiation – $T1$ = 60s and $T2$ = 20min.

CONCLUSIONS

From the results presented in this work it may be concluded that microwave radiation in the millimetre range of the waves cause changes in the germination energy capacity. It is possible to find the parameters of the microwave irradiation stimulating the positive biological effects in the seeds. The optimal parameters of such radiation to the treatment of the flax seeds are following:

- irradiation frequency of 42.13 GHz,
- power irradiation density of 3.5 – 7.6 mW/cm^2,
- in the case of seeds sowed immediately after the microwave treatment - exposure time of 60 seconds, and
- exposure time of 20 minutes for the sowing of seeds at two weeks after irradiation.

REFERENCES

1. **Olchowik G., Dziamba Sz., Gawda H., Grigoriew A.D., Miejew W.A., Podoroznaja L.A.:** Polish Patent 1686691 B1, 22.03. 1996 WUP 03/96.
2. **Pietruszewski S.:** Effect of magnetic seed treatment on yields of wheat. Seed Sci. & Technol., 21, 621-626, 1993.

WPŁYW PROMIENIOWANIA MIKROFALOWEGO NA ZDOLNOŚĆ KIEŁKOWANIA NASION LNU

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Streszczenie. W pracy badano wpływ promieniowania mikrofalowego na szybkość i zdolność kiełkowania nasion lnu. Stwierdzono, że zmiany tych parametrów zależą od częstotliwości promieniowania zastosowanego w przedsiewnej obróbce nasion oraz warunków ekspozycji.

Słowa kluczowe: len, promieniowanie mikrofalowe, energia i zdolność kiełkowania.