INFLUENCE OF MICROWAVE IRRADIATION ON SOME VITALITY INDICES AND ELECTROCONDUCTIVITY OF ORNAMENTAL PERENNIAL CROPS

ВЛИЯНИЕ НА МИКРОВЪЛНОВО ЕЛЕКТРОМАГНИТНО ЛЪЧЕНИЕ ВЪРХУ ПОКАЗАТЕЛИ НА ЖИЗНЕНОСТТА И ЕЛЕКТРОПРОВОДИМОСТТА НА ДЕКОРАТИВНИ ДЪРВЕСНИ ВИДОВЕ

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РЕЗЮМЕ

Изследвано е влиянието на микровълново електромагнитно лъчение с дължина на вълната 12 *cm* върху кълняемостта и дружността на покълнване на семена от *Gleditschia triacanthos L., Caragana arborescens*, *Laburnum anagiroides Med., Robinia pseudoacacia L*. Измерена е специфичната електропроводимост на спиртен извлек от листата и е определена зависимостта й от мощността на микровълновото лъчение.

КЛЮЧОВИ ДУМИ: микровълново облъчване, кълняемост, електропроводимост, Gleditschia, Caragana, Laburnum, Robinia

ABSTRACT

The effect of microwave irradiation with a wavelength of 12 *cm* on the germinating energy and germination of seeds of *Gleditschia triacanthos L., Caragana arborescens*, *Laburnum anagiroides Med., Robinia pseudoacacia L*. has been studied. The specific electroconductivity of leaf extracts has been measured and its dependence on the microwave radiation power has been determined.

KEY WORDS: Microwave irradiation, germination, electroconductivity, *Gleditschia, Caragana*, *Laburnum, Robinia*

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DETAILED ABSTRACT

The microwave irradiation effect on the growth parameters and electroconductivity of seeds of *Gleditschia triacanthos L., Caragana arborescens*, *Laburnum anagiroides Med., Robinia pseudoacacia L.* has been studied. The germinating energy and germination of seeds treated by microwave irradiation with a wavelength of 12 *cm* and an output power of 255, 425, 595, 850 *W* at exposition 30 s has been measured. In *Gleditschia triacanthos* and *Robinia pseudoacacia* the irradiation led to increasing the germinating energy and germination proportionally to the output power. In *Caragana arborescens* and *Laburnum anagiroides* the maximum effect on germinating energy and germination was registered at an output power of 425 *W*. The specific electroconductivity of leaf extracts has been measured and its dependence on the microwave radiation power has been determined. It is established that the increase of the output microwave radiation power leads to the decrease of the specific electroconductivity. The correlation dependence between both characteristics, i.e. the specific electroconductivity σ and the radiation power P can be described by the power function

$$\sigma = aP^{b}.$$

The possible explanation suggests a hypothesis about the absorption of the microwave radiation energy by the hydrogen or magnesium atom's electrons in the chlorophyll molecule. The energy absorbed is redistributed and it causes changes in the chlorophyll molecule. By increasing the radiation power used for the treatment of the samples, the amount of free ions in the extract decreases and hence its electroconductivity, too.

INTRODUCTION

The effect of electromagnetic microwave irradiation on agricultural crops has scarcely been studied yet.

Borodin et al. ([1]) used super high-frequency electromagnetic irradiation for obtaining a virus-free material before sowing the cereals and they reported increased yields. Similar studies on the effect of electromagnetic microwave irradiation (2,45 *GHz*) on wheat were conducted by Bhaskara Reddy et al. ([5]) who also detected increased germination.

Bhaskara Reddy et al. ([4]) used successfully electromagnetic irradiation of the radio-frequency range (10-40 *MHz*) and of the microwave range (2,45 *GHz*) on seeds of charlock, wheat, soybeans, peas and rice with the aim of pre-storage destroying of the microorganisms.

Yoshida et al. ([7]) treated soybean seeds with microwave rays (2,45 *GHz*) for 6 to 12 *min* for improving the triglycerides distribution in the seed coat.

Ponomarev et al. ([2]) studied the direct effect of electromagnetic radiation of the microwave range on the germination of cereals (winter and spring wheat, spring barley, oats). The applied treatment included a wavelength of $\lambda = 1$ *cm* and up to 40 *min* exposure. Increased germination was observed in all the tested seeds, the optimal stimulating effect being reported at 20 *min* exposure.

Studies on the effect of electromagnetic irradiation of the microwave range on some major characteristics of beans have also been conducted by Aladjadjiyan A. and D. Svetleva ([3]).

The literature review shows that the studies of the effect of non-optic electromagnetic radiation on plants are at an initial stage. The effect of microwave treatment on the seeds and their characteristics of vitality has not been fully explained. There are no data about the correlation between the applied microwave radiation power and the sowing qualities of the treated seeds.

MATERIALS AND METHODS

The study was conducted on leaves and seeds of ornamental perennial species *Gleditschia triacanthos L., Caragana arborescens*, *Laburnum anagiroides Med., Robinia pseudoacacia L.* spread in South-Eastern Europe ([6]) and being of interest as a source of biomass for energy supply, pharmacy and park design. The effect of electromagnetic irradiation of the microwave range was studied, the wavelength being 12 *cm,* the initial power 255, 425, 850 *W* and period of exposure 30 *s*.

The germinating energy and germination of the tested seeds have been determined.

The specific electroconductivity of the alcoholic extract of the leaves of the studied species has been measured. The alcoholic extract of the leaves was prepared by grinding 0,5 *g* of fresh leaves in a mortar with quartz sand and dissolving the obtained mixture in 20 *ml* of pure ethanol. After that the solution was filtered and further diluted with alcohol until reaching a certain concentration.

The electroconductivity of samples has been measured by a standard universal device LCR (E7 – 11) following the Kohlrausch method.

RESULTS AND DISCUSSION

In order to assess the influence efficiency, the germination *G* and the germinating energy *GE* were detected for 25 seeds of each species submitted to microwave electromagnetic treatment.

The seeds were placed in moist germination beds. Data obtained by measurements are presented in Table 1.

The data in Table 1 show that the microwave electromagnetic treatment of seeds of the species *Gleditschia triacanthos* and *Robinia pseudoacacia* leads to an obviously expressed gradual increase of germination and germinating energy, proportional to the treatment power. In *Caragana arborescens* and *Laburnum anagiroides* an increase of germination and germinating energy was reported at an initial radiation power of 425 *W*. At 850 *W* the seed germination was lower compared to that at 425 *W* while the germinating energy of *Caragana* was lower compared to the control.

The accelerated germination and improved germinating energy could be due to the eventual disturbance of the seed coat under the influence of the microwave electromagnetic treatment, which facilitated water penetration into the seeds and the start of the initial development stages.

Table 1. Indices of seeds of the studied species after microwave electromagnetic irradiation

Species		Caragana	Laburnum	Gleditschia	Robinia
Control	G, %	8	12	0	16
	GE, %	0,57	2	0	1,14
425 W	G, %	24	32	12	36
	GE, %	2,36	2,3	1,2	2,57
850 W	G, %	16	20	18	44
	GE, %	1,71	1,43	1,8	3,12
$(GD)_G$	5,0%	22,16	27,88	25,38	39,94
	1,0 %	36,8	46,30	42,15	66,34
	0,1%	54,88	69,05	62,87	98,93

The effect of the microwave electromagnetic treatment on the specific electroconductivity of alcoholic extract of leaves of *Gleditschia triacanthos L., Sofora japonica Lam. Gymnocladus dioica C.Koch.*, *Laburnum anagiroides Med., Robinia pseudoacacia L.* was also studied. Samples from the studied species were subjected to microwave electromagnetic treatment of 30 *s* duration and different radiation power. It was established that the longer duration of leaf treatment led to burning.

The values of the specific electroconductivity σ of the studied species varied within the range 0,9 and $1,4x10^{-3}$ Ω^{-1} m^{-1}. The interdependence between σ and the microwave electromagnetic treatment power was investigated.

The results obtained for *Gleditschia triacanthos, Sofora japonica* and *Gymnocladus dioica* are presented in Figure 1 and for *Laburnum anagiroides* and *Robinia pseudoacacia* – in Figure 2. It is obvious that at the increase of radiation power during microwave treatment the specific electroconductivity σ decreased for the species *Gleditschia triacanthos*, *Gymnocladus dioica, Robinia pseudoacacia*, *Laburnum anagiroides* and *Sofora japonica.*

The correlation dependence between both characteristics – the specific electroconductivity σ and the radiation power P – is described by the power function the parameters of which for the studied species are given in Table 2.

$$\sigma = aP^{b},$$

Table 2. Regression dependence parameters

Species	a	b	R^2
Gleditschia triacanthos	0,9847	-0,3825	0,8803
Gymnocladus dioica	0,9445	-0,151	0,6756
Robinia pseudoacacia	1,3303	-0,2394	0,7311
Laburnum anagiroides	0,7348	-0,3825	0,0821
Sofora japonica	0,9017	-0,0251	0,2545

As it is seen in the table, the correlation is good for four of the tested five species, the correlation coefficients being 0,94±0,05 for *Gleditschia triacanthos;* 0,82±0,13 for *Gymnocladus dioica ;* 0,86±0,07 for *Robinia pseudoacacia;* 0,5±0,1 for *Sofora japonica,* respectively. As for *Laburnum anagiroides* with a coefficient of 0,29±0,38, the correlation between the experimental data and the calculated interdependence is insignificant.

The dependence of the specific electroconductivity on the electromagnetic radiation power in *Gleditschia triacanthos, Robinia pseudoacacia*, *Laburnum anagiroides* and *Gymnocladus dioica* is strong, as it is seen by the values of the parameter *b* (Table 2).

The dependence of the specific electroconductivity on the electromagnetic radiation power in *Sofora Japonica* is weak.

Figure 1. Dependence of the specific electroconductivity on the microwave radiation power in the species *Gleditschia triacanthos L.*, *Sofora japonica* and *Gymnocladus dioica C. Koch*.

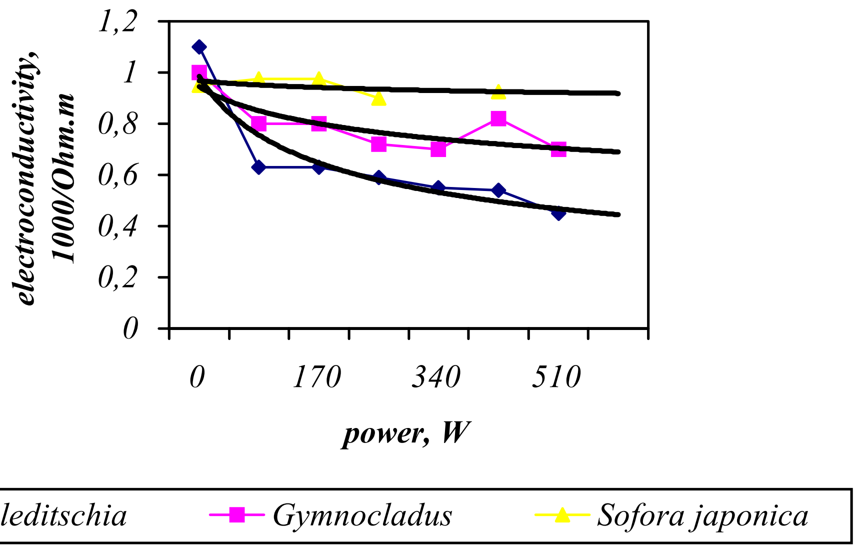
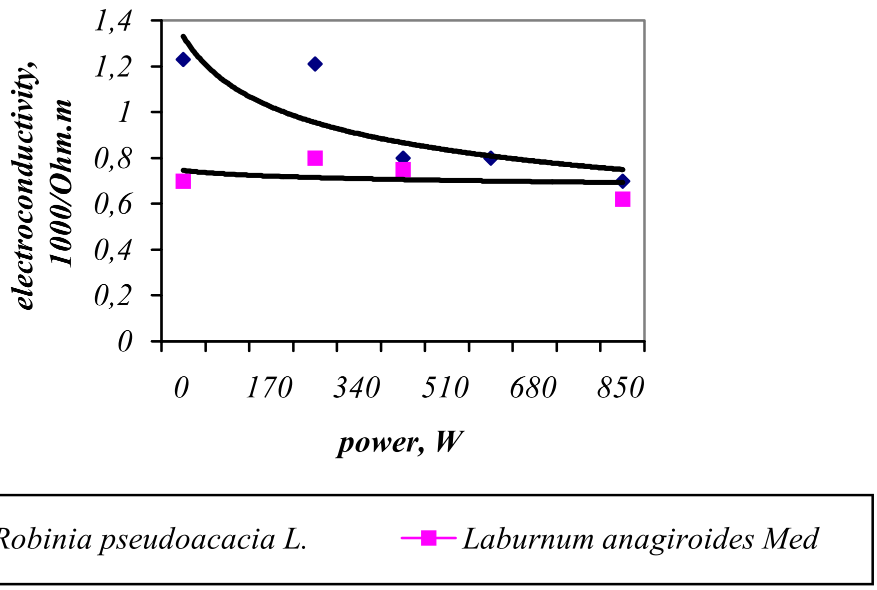


Figure 2. Dependence of the specific electroconductivity on the radiation power in *Laburnum anagiroides Med.* and *Robinia pseudoacacia L.*



The possible explanation of the observed dependence suggests a hypothesis about the absorption of the microwave radiation energy by the hydrogen or magnesium atom electrons in the chlorophyll molecule. The energy absorbed is redistributed and it causes changes in the chlorophyll molecule. By increasing the radiation power used for the treatment of the samples, the amount of free ions in the extract decreases and hence its electroconductivity, too.

CONCLUSIONS

The microwave electromagnetic treatment of seeds of the species *Gleditschia triacanthos, Caragana arborescens*, *Laburnum anagiroides* and *Robinia pseudoacacia* leads to an increase of germination and germinating energy.

The specific electroconductivity of the chlorophyll leaf extract for most of the studied species decreases when the microwave electromagnetic radiation power for treatment of the samples increases.

The regression dependence of the specific electroconductivity on the electromagnetic radiation power was detected. It is a power function of the model

$$\sigma = aP^{b}.$$

The detected dependencies create conditions for developing a method in which the specific electroconductivity would be used as a control parameter of the effect of non-optic electromagnetic radiation on plant vitality.

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