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THE INFLUENCE OF THE ULTRASOUND TREATMENT ON THE NORWAY SPRUCE (*PICEA ABIES* (L.) KARSTEN) SEED GERMINATION

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ABSTRACT - The Norway spruce seed germination is often weak (in some years, the germination rate is less than 50%). It is already known that some physical agents had a simulative influence on the germination process. For improving the spruce seed germination, the influence of the ultrasound treatment on seed germination was tested. The tests have shown that the length of plant rootlet and hypocotyl and the germination rate of seeds depended on the frequency and duration of the ultrasound treatment. For the frequency of 35 kHz, the best results, represented by the improvement of germination and an increased length of rootlets and hypocotyls for the germinated seeds, were obtained for the treatment duration longer than 40 seconds. Thus, for the treatment duration of 50 and 60 seconds, we have obtained a germination improvement by over 40 %, an augmentation of the rootlet length by 32 % and of the hypocotyls by 5-8 %, compared to the untreated control. Because these data are only preliminary, the testing conditions and the tested species must be diversified, in order to establish regularities with practical applicability.

Key words: effects, seeds, Norway spruce, ultrasounds, germination

REZUMAT - Influenţa tratamentului cu ultrasunete asupra germinaţiei seminţelor de molid (*Picea abies* (L.) Karsten). Germinaţia seminţelor de molid este adesea slabă (în unii ani aceasta scade sub 50 %). Este binecunoscut faptul că o serie de agenţi fizici au o influenţă stimulatoare asupra proceselor germinative. În scopul ameliorării germinaţiei seminţelor de molid s-a testat influenţa tratamentului cu ultrasunete asupra germinaţiei seminţelor. În urma testelor efectuate, s-a putut stabili că atât lungimea radicelei şi a hipocotilului, cât şi germinaţia seminţelor depind de frecvenţa şi de durata de expunere la ultrasunete. Pentru frecvenţa de 35 kHz, cele mai bune

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rezultate, evidenţiate printr-o îmbunătăţire a germinaţiei şi prin alungirea mai puternică a radiculelor şi a hipocotilelor la seminţele tratate, s-au obţinut pentru timpi de tratament de peste 40 de secunde. Astfel, pentru timpi de tratament de 50 şi 60 de secunde, s-a obţinut o îmbunătăţire a germinaţiei cu peste 40 %, o creştere a lungimii radiculelor cu 32 % şi a lungimii hipocotilelor cu 5-8 %, faţă de probele martor netratate. Datele fiind preliminare, se impune diversificarea atât a condiţiilor de testare cât şi a speciilor vegetale utilizate, în vederea stabilirii unor legităţi cu o eventuală aplicabilitate practică.

Cuvinte cheie: efecte, seminţe, molid, ultrasunete, germinaţie

INTRODUCTION

The biological effects of ultrasounds are multiple and complex (Scheffel and Ştiucă, 1995). In plants, ultrasounds may cause stimulations or destructions, depending on the plant nature, its development stage and ultrasound parameters (intensity, frequency and irradiation duration) (Khan, 1980; Pessarakli, 2001; Ueno, 1996).

The experiments conducted on the seeds of various plant varieties have emphasized the following favourable effects: diminution of the germination period by approximately 30%, increase of the vegetal mass, increase of the leaf formation speed, growth of more vigorous roots and increase of the productive potential (Pessarakli, 2001).

Previously, we have used ultrasounds with frequencies of 500 kHz and 1 MHz, in order to improve the germination of the Norway spruce seeds (Rîşca et al., 2007).

The stimulating action of ultrasounds on the germination is produced by some modifications of the cellulose membrane, which result in the nutrient transportation and in a better absorption of the useful elements from soil (De Castro and Capote, 2007).

MATERIALS AND METHODS

We have used the Norway spruce seeds (5.24 g/1000 seeds) harvested in 2008 from more biotypes of the Moldovița forests, which were irradiated with ultrasounds at a frequency of 35 kHz, with a BANDELIN SONOREX PLUS RK52H generator, having a maximum ultrasonic output of 240 W and a HF output of 60 W_{eff}.

The groups of 50 seeds were exposed to the following irradiation times: 3, 6, 9, 12, 15, 18, 20, 30, 40, 50 and 60 seconds.

Germination was carried out according to the valid standards [SR 1634: June 1999], in a CONVIRON 4030 – G30 growth chamber, at 21^0 C, without pre-refrigeration, 95% humidity, with a 12 hour day/night alternation. The irradiated seeds were sown in Petri dishes on filter paper, moistened periodically with distilled water.

We have determined the following parameters: the germination capacity after 21 days, the length of the hypocotyls and of the roots in the germinated plants.

RESULTS AND DISCUSSION

The experiments were conducted in order to establish the biological

response of the spruce seeds to the influence of the irradiation. The results were shown in Table 1 and *Fig. 1 and 2*. Because seeds proceeded from more genotypes (the same year and location), we found an appreciable dispersion of the values.

The duration of seed exposure to ultrasounds has resulted in length variations of the rootlet and of the hypocotyl, as well as the percent of germinated seeds. Generally, the studied parameters have shown an increase trend once with increasing seed exposure time to the ultrasound treatment.

Higher values of the control were found at treatment times of 50 and 60 seconds. In this case, the mean length of the rootlet was of 33-34 mm, compared to 25 mm at the control. The same indicator was situated at 38-39 mm, at the hypocotyl, compared to 36 mm at the control. For the same exposure time, the percent of germinated percent was of 65-68 %, compared to 46 % at the control.

Based on the preliminary results, the use of ultrasounds having a frequency of 35 kHz had a stimulating effect on Norway spruce seeds, which was shown by a greater duration of the exposure time (over 40 seconds).

Table 1 - Ultrasound effects on the germination of Norway spruce seeds (mean values)

Ultrasound frequency	Time (s)	Rootlet length (mm)			Hypocotyl length (mm)			Germinated seeds		$\overline{X}$ (%)
		r1	r2	$\overline{X}$	r1	r2	$\overline{X}$	r1	r2	
35 kHz	3	19.7	20.1	19.9	33.2	32.3	32.8	19	22	41
	6	24.3	19.8	22.1	27.4	28.3	27.9	24	19	43
	9	23.5	20.2	21.9	29.4	26.0	27.7	20	21	41
	12	24.4	22.8	23.6	28.9	31.8	30.4	22	23	45
	15	20.9	21.0	21.0	34.0	32.4	33.2	25	21	46
	18	24.6	23.5	24.1	32.9	33.9	33.4	25	25	50
	20	22.2	26.4	24.3	32.0	33.1	32.6	23	26	49
	30	26.6	24.6	25.6	34.3	34.1	34.2	28	24	52
	40	30.4	33.8	32.1	33.1	35.9	34.5	30	27	57
	50	35.4	34.2	34.8	38.1	38.5	38.3	32	36	68
	60	33.3	32.9	33.1	39.2	39.2	39.2	34	31	65
Control	C	26.2	24.6	25.4	37.0	35.7	36.4	24	22	46

Note: C -control; r1 – replicate 1; r2 - replicate 2; $\overline{X}$ - arithmetic means

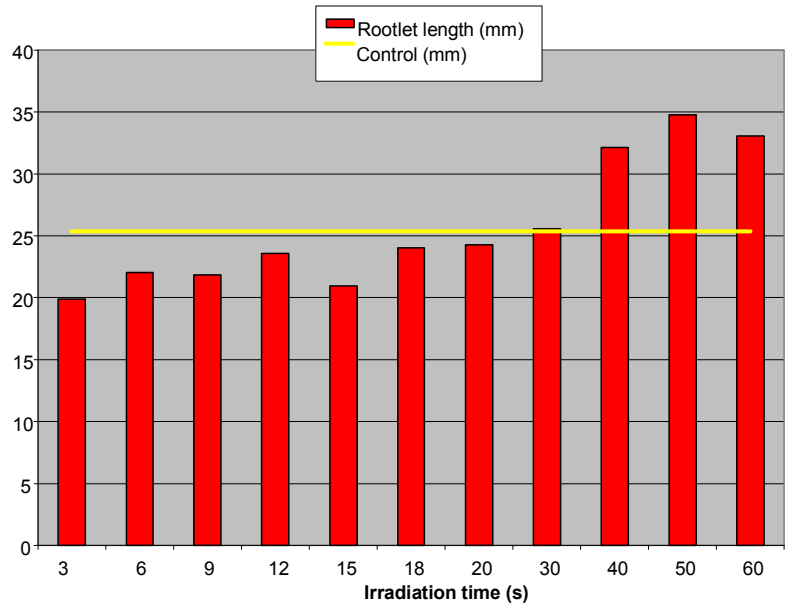

Fig. 1- Dependence between the rootlet length and the irradiation time at 35 kHz

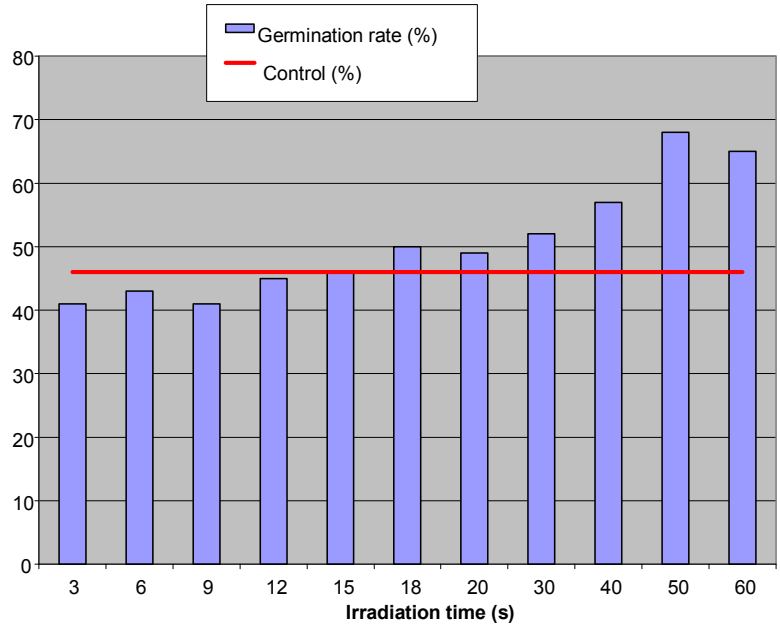

Fig. 2 - Dependence between the germination rate and the irradiation time at 35 kHz

CONCLUSIONS

The frequency and the exposure time to the ultrasound treatment of Norway spruce seeds have a differentiated influence on the length of rootlet and hypocotyl and on seed germination.

At the exposure time of 3 and 30 seconds, the studied parameters varied within the limits close to the untreated control.

At the exposure time of 50 and 60 seconds, we have noticed a good influence of the treatment, materialized by an increase in the length of the rootlet (33-34 mm, compared to 25 mm at the control) and of the hypocotyl (38-39 mm, compared to 36 mm at the control). At this exposure time of seeds to ultrasounds, the germination values were of 65-68 %, compared to 46 % at the control.

The obtained results being preliminary, the experiments should be carried out by using different parameters (frequency, exposure time and intensity) and diverse vegetal species, for establishing regularities with practical applicability.

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