THE IMPACT OF THE TREATMENT WITH NUCLEAR RADIATIONS ON THE NORWAY SPRUCE SEEDS GERMINATION. CYTOGENETIC EFFECTS

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Abstract: The paper presents the influence of the irradiations with gamma rays on the germination of the spruce seeds. The pointed out biological answer- stimulant or inhibitive, differentiate on vegetal organs and physiological characteristics – depends on the parameters of the physical stimulus (intensity and irradiations duration).
The most active cellular division was registered at seeds subjected to Americium 241 treatment during 3 hours.

INTRODUCTION

The Norway spruce represents one of the most important forestry genetic resources having a pronounced polymorphism, a large inter and intra-populational variability, a remarkable biological potential and an extremely high economical value.

Unfortunately, in a very few natural Norway spruce arboreta the seeds germination capacity achieve an adequate level (minimum 65%). On the other hand, the reforestation activities require a high quality of the seminal material and consequently it is necessary to increase the germination potential of the Norway spruce seeds.

Some physical agents influence the seeds germination and the growth of plants too (Celan, 1985; Khan, 1980). In this respect, the nuclear radiations have a significant importance by their mutagenic effect. The paper presents a series of preliminary data concerning the effect of the nuclear radiation on the seed germination.

MATERIAL AND METHOD

There were used Norway spruce seed (5,24 g/1000 seeds) harvested in 2003 from more biotypes of the Moldovita forest ward which was irradiated with one or two sources of ^{241}Am ($T_{1/2}$=432±0,5 years), with the following parameters (table 1):

Table 1: The activity of the ^{241}Am sources

Source	Activity, particles /second (Bq)	Incertitude (Bq)
(1) ^{241}Am	34425	2066
(2) ^{241}Am	34479	2069

The sources, in metallic capsules, have the following significant energies:

- gama: 59,54 keV(35,9%);
- alfa: 5442,9 keV(12,8%) , 5485,6 keV (85,2%) .

The used exposure times are: 30’, 1h, 1h 30’, 2h, 2h 30’, 3h, 3h 30’, 4h, 4h30’, 5h and 5h30’.

The 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 hours day/night alternation. The irradiated seeds were sown in three replicates of 50 each, in Petri dishes on filter paper, humectated periodically with distilled water. A blank with bi-distilled water was also carried out. It was measured the germination (G) at 21 days, the length of the hypocotyls (L_H) and of the roots (L_R).

The microscopically investigations were carried out on embrionary roots, using the Carr method and doing cytogenetic study of the mitotic index.

RESULTS

The experiments were fulfilled in order to establish the biological answer of the spruce seed under the influence of the irradiation; the results are presented in table 2. Because the seeds proceeds from more genotypes (from the same year and same location), it was found an appreciable dispersion of the values.

Table 2. The effects of the irradiation with ^{241}Am on the Norway spruce seed (medium values)

Irradiation time (h)	**L_R(mm)**		**L_H(mm)**		**G(%)**	
	(1)	**(2)**	**(1)**	**(2)**	**(1)**	**(2)**
0,5	37,26	26,47	36,21	41,43	51	38
1	28,92	35,36	32,20	33,46	45	43
1,5	35,93	24,51	37,24	38,14	61	56
2	36,10	35,32	35,51	34,75	42	61
2,5	35,17	31,01	36,80	40,60	66	55
3	41,19	38,87	38,81	40,53	48	59
3,5	32,72	23,46	33,93	41,60	38	47
4	35,03	32,76	36,03	34,91	62	56
4,5	41,52	33,05	39,94	38,41	52	59
5	29,90	35,76	30,97	33,91	59	61
5,5	40,08	17,84	38,22	34,61	52	55
0 (whitness)	35,67		36,33		46	

Note: **L_R** = length of the roots, **L_H** = length of the hypocotyls, **G** = germination, **(1)** = one source of ^{241}Am, **(2)** = two sources of ^{241}Am

The norway spruce seeds sample subjected to treatment with gamma radiations (Americium 241 during 3 hours) has registered a higher value of the mitotic index (0,17) in relation to the control sample (0,13)(tables 3 and 4).

Table 3. The dynamic of cells division at Norway spruce seeds (control sample)

Field Nr.	Cells examinated	Dividing cells										
		Total		P		M		A		T		Mitotic index
		nr	%	nr	%	nr	%	nr	%	nr	%	
1	250	27	10.8	21	77.8	2	7.4	1	3.7	3	11.1	
2	280	44	12.2	35	79.5	4	9.1	3	6.8	2	4.6	
3	150	23	15.3	18	78.2	1	5.6	2	11.1	2	11.1	
4	120	21	18.0	16	76.2	2	9.5	1	4.8	2	9.5	
5	290	27	9.0	20	74.1	1	3.7	3	11.1	3	11.1	
6	200	24	12.0	15	62.5	5	20.8	1	4.2	3	12.5	
Total	1290	166	12.9	125	75.3	15	9.0	11	6.7	15	9.0	**0.13**

Table 4. The dynamic of cells division at Norway spruce seeds irradiated with ^{241}Am – 3 hours

Field Nr.	Cells examinated	Dividing cells										
		Total		P		M		A		T		Mitotic index
		nr	%	nr	%	nr	%	nr	%	nr	%	
1	220	28	12,7	22	78,8	3	10,6	1	3,5	2	7,1	
2	240	38	15,8	31	81,5	4	10,5	2	5,3	1	2,7	
3	190-	34	17,8	26	76,5	3	8,8	3	8,8	2	5,9	
4	180	34	18,8	25	73,5	5	14,7	3	8,8	1	3,0	
5	210	40	19,0	32	80,0	2	5,0	3	7,5	3	7,5	
6	140	26	18,5	20	76,8	3	11,6	2	7,7	1	3,9	
Total	1180	200	16,9	156	78,0	20	10,0	14	7,0	10	5,0	**0,17**

DISCUSSIONS AND CONCLUSIONS:

The analysis of the data from the table 2 offers a first conclusion that for an appreciable amount of values samples it can be established an increasing of the germination’s values. The same is valuable for the other categories, especially the hypocotyls where the elongation was more obvious.

The analysis of the variables data in the experiment protocol we can establish the following:

- By doubling of the irradiation dose the dimensions of the roots decrease (9 values from 11) and the dimensions of the hypocotyls increase (7 values from 11). The germination presents an aleatory behavior.
- The modification of the exposure time did not offer revealing information in order to establish a trend for the germination or the length of hypocotyls or roots. The only notable exceptions were found for the 3 and 4.5 hours of irradiation where all the data were greater the average values.

Because the obtained data are only preliminaries, we can affirm that the use of nuclear radiation in the stimulation of the germination can be a useful instrument but only if the optimal parameters were established (irradiation dose and exposure times).

Another tendency manifested during the experiments and that could have a practical value is the hypocotyls elongation; the radiations have a bio-stimulator effect upon the caulinary system (Khan, 1980).

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