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EFFECT OF LASER RADIATION ON SPRING WHEAT GENOTYPES*

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A b s t r a c t. The objective of the study was to determine the effect of different doses of laser radiation on spring wheat grain in early phases of growing. The analysed objects were control seeds and wheat seeds treated with 6 doses of laser radiation. The investigated material comprised 10 cultivars of spring wheat germinative energy and capacity were evaluated and coleoptile and roots length were measured. The results were analysed statistically. It was found that the laser doses increased germinative energy and germination capacity. Significant differences among cultivars were found for coleoptile and root length too.

K e y w o r d s: wheat grain, laser, coleoptile, germination energy, germination capacity

INTRODUCTION

An increase in plant yield can be achieved by the application of intensive systems of cultivation and by using high biological potential genotypes. The obtained data indicate high variability among cultivars in terms of their response to the environment. An appropriate preparation of seeds may be one of the ways to increase crop yields.

Chemical and physical factors are used in the pre-sowing stage of seed preparation. Physical factors such as ionising radiation, magnetic field and laser radiation effect physical processes of seeds and have no harmful influence on the environment [5,10]. Laser radiation is a mutagenic factor which can stimulate plant growth and development [2-4,9]. Laser light is used for pre-sowing irradiation of seeds, since it has been observed that laser radiation has a positive effect on the germination energy and accelerates the growth of germs, which results in faster plant development and consequently earlier harvest.

Also a better growth and development of the plant root system has been demonstrated [4,10].

The stimulating effects of laser radiation depend on the radiation dose and also on the species and cultivar of the plants subjected to it [4,11]. The aim of this research was to determine the effect of laser radiation doses on early phases of plant growing in laboratory conditions. The germination energy and capacity of wheat grain is an important problem in seed production of this plant.

MATERIALS

10 cultivars of spring wheat Alkora, Banti, Eta, Henika, Hera, Igna, Ismena, Jota, Omega and Sigma were irradiated, before the laboratory experiment, with 6 doses of laser radiation with the use of two methods - D and R [6,7]. Dose D_I - 4 x 10^{-3} J/cm^2, dose D_{II} - double dose

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D_I and dose D_{III} - triple dose D_I, dose R_I - 4 x 10^{-5} J/cm^2, dose R_{II} - double dose R_I and dose R_{III} - triple dose R_I, with the use of - Ne laser 15 mW power, equipped with the device for pre-sowing biostimulation of seeds [6,7].

The experiment was performed 2 days after the laser treatment. The germination energy and capacity (expressed in %) were evaluated according to a widely applied methodology [1]. On the 7th day the length of coleoptile was measured and on the 14th day the length of roots was measured, in the control samples and the irra-diated seeds. The results were analysed statistically in order to determine the significance of differences between the cultivars, doses applied and interaction. With respect to features in which significant differentiation occurred, the Duncan test was applied in order to determine homogeneous groups.

RESULTS

Variance analysis of the results obtained has shown that in the case of germination energy significant differences were observed between the cultivars and the effects of laser radiation (Table 1). Both methods D and R were similar. All doses of laser radiation significantly increased energy of germination in comparison with the control samples.

Comparison of germination capacity (Table 2) and homogeneous groups demonstrated that laser radiation proved to have a significant effect on their values in all the cultivars of spring wheat under study.

Variance analysis for coleoptile length showed significant differences for cultivars, doses and interaction. Homogeneous groups for coleoptile length (Table 3) showed that method R (all doses) significantly increased this feature, in method D only doses D_I and D_{II} increased coleoptile length in comparison with the value of control samples. In Table 4 homogeneous groups for coleoptile length of 10 spring wheat cultivars are presented. Reaction of cultivars is differentiated. For Alkora, Henika, Hera, Jota, Ismena and Omega cultivars all the doses of D method increased the length of coleopile. For method R (Table 5) homogeneous groups showed significant reaction to all laser radiation doses in 8 cultivars.

Analysis for variance of root length showed significant difference for doses only in D method and interaction for both methods. The comparison with the use of doses with control samples (Table 6) showed that only dose D_I significantly increased root length.

In the case of D method (Table 7) the comparison of control samples and doses for root length for 10 cultivars indicated that for Alkora,

Table 1. Comparision using doses with control for energy of germination (%). Homogeneous groups

Method D				Method R			
dose	D_{III}	95.81	|	dose	R_{III}	95.82	|
dose	D_{II}	94.80	|	dose	R_I	95.01	|
dose	D_I	93.93	|	dose	R_{II}	94.19	|
control		74.55	|	control		74.55	|
LSD = 2.35				LSD = 1.78			

Table 2. Comparision using doses with control for germination capacity (%). Homogeneous groups

Method D				Method R			
dose	D_{III}	98.40	|	dose	R_{III}	98.30	|
dose	D_{II}	98.21	|	dose	R_I	98.14	|
dose	D_I	97.52	|	dose	R_{II}	97.93	|
control		93.60	|	control		93.60	|
LSD = 1.56				LSD = 1.93			

Table 3. Homogeneous groups for doses and control - coleoptile length (mm)

Method D			Method R		
dose	D_I	41.85	dose	R_{III}	2.18
dose	D_{II}	40.07	dose	R_I	42.13
dose	D_{III}	30.83	dose	R_{II}	37.47
control		31.06	control		31.06
LSD = 1.80			LSD = 1.22		

Table 4. Reaction of 10 cultivars on 3 doses of laser radiation (method D). Homogeneous groups for coleoptile length

Alkora			Banti			Eta		
dose	D_{II}	51.8	dose	D_{III}	43.7	dose	D_{III}	52.9
dose	D_I	42.5	dose	D_I	35.8	dose	D_{II}	49.4
dose	D_{III}	40.5	control		32.3	dose	D_I	42.9
conrol		22.6	dose	D_{II}	32.1	control		34.1
Henika			**Hera**			**Igna**		
dose	D_I	38.7	dose	D_{II}	40.6	dose	D_I	48.0
dose	D_{II}	37.0	dose	D_{III}	38.9	dose	D_{III}	44.1
dose	D_{III}	35.4	dose	D_I	36.1	control		35.9
control		29.4	control		33.8	dose	D_{II}	32.3
Ismena			**Jota**			**Omega**		
dose	D_{II}	37.7	dose	D_I	42.3	dose	D_I	40.1
dose	D_{III}	36.5	dose	D_{III}	41.7	dose	D_{II}	39.0
dose	D_I	35.6	dose	D_{II}	37.4	dose	D_{III}	35.4
control		28.8	control		31.4	control		30.5
Sigma								
dose	D_I	56.9			LSD = 4.49			
dose	D_{II}	43.5						
control		31.8						
dose	D_{III}	29.2						

Banti, Henika and Omega cultivars, the influence of all laser doses was not significant. Only for Eta and Ismena the D_I dose and for Jota D_I and D_{II} doses significantly increased root length value. Table 8 comprises homogenous groups for root length (method R). Only for Omega cultivar dose R_{II} significantly increased the value of this character.

DISCUSSION

Much attention has been paid to laser exposure recently. The treatment stimulates growth and plant development [2-4,10]. Therefore investigations were conducted on mainly vegetables. In the case of cereals it has been observed that laser radiation has an effect on the mature plant characters [2,3,8,10-12], but there is no information concerning the early stages of plant development in the case of cereals especially in laboratory conditions. A relatively large number of publications can be found in Russian literature, where studies of this kind were widely conducted, but none of those provides information on the optimal time of irradiation. It has only been stated that the best results are obtained with the application of pulsating He Ne light (red-blue) [4,8,11]. In the studies on the

T a b l e 5. Reaction of 10 cultivars on 3 doses of laser radiation (method R). Homogeneous groups for coleoptile length (mm)

	Alkora			Banti			Eta	
dose	R_{I}	71.4	dose	R_{I}	54.0	dose	R_{I}	44.0
dose	R_{II}	52.8	dose	R_{III}	45.5	dose	R_{II}	41.5
dose	R_{III}	51.5	dose	R_{II}	40.9	dose	R_{III}	41.5
control		22.6	control		32.3	control		34.1
	Henika			Hera			Igna	
dose	R_{I}	37.0	dose	R_{III}	46.6	dose	R_{III}	47.8
dose	R_{III}	33.0	dose	R_{I}	39.8	control		35.9
dose	R_{II}	32.3	dose	R_{II}	34.5	dose	R_{II}	31.7
control		29.4	control		33.8	dose	R_{I}	31.5
	Ismena			Jota			Omega	
dose	R_{II}	36.3	dose	R_{I}	48.2	dose	R_{III}	45.7
dose	R_{I}	32.5	dose	R_{III}	42.0	dose	R_{II}	32.9
dose	R_{III}	31.3	dose	R_{II}	40.8	dose	R_{I}	32.1
control		28.8	control		31.4	control		30.5
	Sigma							
dose	R_{III}	37.2						
control		31.8		LSD = 3.87				
dose	R_{II}	31.0						
dose	R_{I}	30.8						

T a b l e 6. Comparision using doses with control for root lenght (cm)

	Method D	
dose	D_{I}	12.60
dose	D_{II}	10.80
control		10.29
dose	D_{III}	9.54
	LSD = 0.99	

effectiveness of laser irradiation on wheat grain, only in a few of them was there a positive effect observed on the early emergence, growth and crop yield of the plants [11]. According to Inyuschin [4] and Vasilienko [10], laser radiation causes an increase in the total and productive tillering of plants. This is supported by other authors [3,4,10] as well as by the author's own studies [2].

An effect of laser radiation on the height of plants was also observed [11]. Opalko [8] and others reported that the properties characterizing the productivity of plants the weight of grains per plant and the weight of 1000g - were significantly intensified. However, the studies of Zubal [12] showed a lack of stimulating effect of laser radiation on the morphological features of wheat which can be explained by the weather conditions in the course of vegetation period.

However, in laboratory conditions in our own investigations the effect of laser radiation is significant.

CONCLUSIONS

1. After application of laser radiation, germination energy and capacity were significantly increased (for both methods) in comparison with control samples.

2. The value of coleoptile length significantly increased in comparison with the control samples, method R was better than method D.

3. For root length only doses D_{I} and D_{II} significantly increased this character in some cultivars. Dose R_{III} increased root length only in the case of Omega cultivar.

Table 7. Comparision control and doses 10 cultivars for root lenght (cm). Homogeneous groups for interaction. Method D

	Alkora			Banti			Eta	
dose	D_{II}	12.16	dose	D_{I}	14.40	dose	D_{I}	14.55
dose	D_{I}	10.36	dose	D_{II}	11.92	dose	D_{II}	10.47
dose	D_{III}	10.01	control		11.37	control		8.30
control		9.93	dose	D_{III}	11.29	dose	D_{III}	7.45
	Henika			Hera			Igna	
dose	D_{II}	10.28	dose	D_{I}	11.48	dose	D_{I}	14.59
dose	D_{I}	9.86	dose	D_{III}	10.10	control		11.15
control		9.18	dose	D_{II}	9.64	dose	D_{III}	10.74
dose	D_{III}	8.33	control		7.45	dose	D_{II}	9.18
	Ismena			Jota			Omega	
dose	D_{I}	15.65	dose	D_{I}	13.46	dose	D_{I}	11.64
control		11.81	dose	D_{II}	13.20	dose	D_{II}	10.97
dose	D_{II}	10.67	dose	D_{III}	9.74	control		10.71
dose	D_{III}	8.94	control		9.07	dose	D_{III}	8.92
	Sigma							
control		13.91						
dose	D_{III}	10.34						
dose	D_{I}	10.03		LSD = 3.12				
dose	D_{II}	9.29						

Table 8. Homogeneous groups for interaction - root length (cm). Doses of laser radiation and control for 10 cultivars. Method R

	Alkora			Banti			Eta	
dose	R_{I}	17.78	dose	R_{I}	17.18	dose	R_{I}	18.67
dose	R_{II}	17.77	dose	R_{II}	16.12	dose	R_{III}	17.33
control		16.97	control		15.87	dose	R_{II}	15.56
dose	R_{III}	16.72	dose	R_{III}	15.64	control		13.14
	Henika			Hera			Igna	
dose	R_{I}	17.54	control		15.83	dose	R_{III}	19.94
dose	R_{II}	16.90	dose	R_{I}	11.71	control		18.47
dose	R_{III}	16.16	dose	R_{II}	11.53	dose	R_{I}	16.75
control		14.53	dose	R_{III}	10.24	dose	R_{II}	14.91
	Ismena			Jota			Omega	
dose	R_{II}	17.85	dose	R_{II}	17.31	dose	R_{II}	19.92
dose	R_{III}	17.49	control		16.40	dose	R_{III}	16.79
dose	R_{I}	16.65	dose	R_{I}	14.57	dose	R_{I}	16.51
control		15.16	dose	R_{III}	14.43	control		16.36
	Sigma							
dose	R_{III}	18.78						
control		16.47						
dose	R_{I}	16.02		LSD = 3.12				
dose	R_{II}	13.66						

REFERENCES

1. **Dorywalski R., Wojciechowicz M., Bartz J.:** Methodology of Seeds Estimation (in Polish). PWRiL, Warszawa 1964.
2. **Drozd D.:** The effect of laser radiation on spring wheat properties. Int. Agrophysics, 8, 209-213, 1994.
3. **Dziamba S., Koper R.:** Influence of laser radiation on grain yield of spring wheat (in Polish). Fragmenta Agronomica, 1(33) 80-93, 1992.
4. **Inyushin U.H., Chernova O.:** Cytological and genetic features of the action of laser radiation on seed and seedlings of durum wheat. Dept. 2726-89, 11, Referativnyi Zhurnal (sum.), 1989.
5. **Górnicki R., Grzesiuk S.:** World tendency and directions of seeds materials improvement (in Polish). Mat. Conf., Olsztyn, Poland, 1994.
6. **Koper R.:** Bulletin of Patent Office (in Polish), 9, 1994.
7. **Koper R., Dygdała Z.:** Arrangement to seeds presowing work of laser radiation (in Polish). Patent No. 162598, Patent Office in Poland, 1993.
8. **Opalko A.:** Effect of low energy physical factors physiologically active substances and low doses of mutagens on variation in winter wheat Kirov, Tezizy, Dokladow, 3-6, 86-88, 1989.
9. **Rybiński W., Patyna H., Przewoźny T.:** Mutagenic effect of laser and chemical mutagens in Barley (*Hordeum vulgare* L.). Genetica Polonica, 34(4), 337-343, 1993.
10. **Vasilienko V., Kuznietsov E.:** Physiological and ecological aspects utilization regulation chemical and luminous of plants growth (in Russian). Vestnik Selshohozyastviennoi Nauki, 7, 63-68, 1990.
11. **Volodin V., Avranienko B.:** Radiation mutation corn and perspective of his utilization in intensive sort type selection (in Russian). Vestnik Selskohozyajstviennoi Nauki, 12, 45-52, 1987.
12. **Zubal P.:** Influence of stimulation laser radiation on yield of corn and leguminaus (in Czech). Vedecke Prace Vyskumneho Ustawu Rastlinnej Vyrobu, 23, 141-156, 1990.