ECOLOGICAL METHOD FOR MODULATION OF WINTER WHEAT (*Triticum Aestivum* L.) ONTOGENESIS

ЭКОЛОГИЧЕСКИЙ СПОСОБ МОДУЛЯЦИИ ОНТОГЕНЕЗА ПШЕНИЦЫ ОЗИМОЙ (*Triticum Aestivum* L.)

M. S. Oev, V. A. Kravchenko, A. N. Batyan

М. С. Оев, В. А. Кравченко, А. Н. Батян

International Sakharov Environmental Institute of Belarusian State University, ISEI BSU, Minsk, Republic of Belarus

Учреждение образования «Международный государственный экологический институт имени А. Д. Сахарова» Белорусского государственного университета, МГЭИ им. А. Д. Сахарова БГУ, г. Минск, Республика Беларусь

mehvarshoh.oev@yandex.ru

The effect of infrared irradiation on the dynamics of growth, germination and basic biometric indicators of winter wheat has been revealed. During the experiment, an assessment was given to the experimental groups irradiated with doses of 0.45, 0.6, 0.9, 1.8, 2.7, 3.6, 4.5, 5.4, 6.6 J. To assess the proliferation activity of meristematic tissue, the mitotic index was calculated, and statistical processing of the data obtained was performed. Certain regularities have been revealed between the radiation dose and the corresponding biological effect at the stage of the initial tillering of winter wheat.

Обнаружен эффект сочетанного лазерного облучения семян пшеницы озимой на динамику роста, всхожесть и основные биометрические показатели пшеницы озимой. В ходе эксперимента дана оценка опытным группам, облученным дозами в 0,45; 0,6; 0,9; 1,8; 2,7; 3,6; 4,5; 5,4; 6,6 Дж. Для оценки активности пролиферации меристемной ткани был подсчитан митотический индекс, а также произведена статистическая обработка полученных данных. Выявлены определенные закономерности между дозой облучения и соответствующим биологическим эффектом на этапе начального кущения пшеницы озимой.

Keywords: infrared irradiation; mitotic index; germination; germination energy; dry and wet mass; phytomass increase.

Ключевые слова: инфракрасное облучение; митотический индекс; всхожесть; энергия прорастания; сухая и влажная масса; прирост фитомассы.

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Studying the influence and mechanism of action of combined laser irradiation on plant crops is a pressing problem of modern radiobiology. Literary sources indicate that IR irradiation can be used in the technology of pulsed energy-saving drying [1], to increase the light germination of seeds [4], as a means of combating diseases of horticultural crops [2], as a component of environmentally friendly pre-sowing treatment [3]. Literary sources mention that irradiation of the seeds of this crop contributed to better control of germination, lower incidence of fungal and viral infections, and changes in the content of macroelements in the phytomass. It has been established that coherent light is a universal factor that allows one to obtain greater biomass, growth rate, and also stabilizes adaptation and repair processes [5].

The purpose of the work was to study the dependence of growth processes on the dose of combined laser irradiation. Winter wheat seeds were chosen as the object of study.

The Vityaz quantum therapy apparatus (RB) was used to irradiate the seeds. The seeds were placed at the bottom of an aluminum container with an area of ≈ 1 cm^2. The radiation power was 10 mJ/s at a distance of 1 cm from the seeds. The irradiation wavelength was 620-700 nm. The control group was not exposed to radiation. Seed germination in the first week was carried out in Petri dishes at room temperature and sufficient lighting, after which the seedlings were transplanted into plastic containers on nutritious soil (fig 1).

Figure 1 – Seeds germinating in early stages

After germination of the seeds to the early tillering stage, the plants were removed from the soil, thoroughly cleaned, after which the wet mass was weighed and the lengths of above-ground shoots were measured. Next, after drying at 65°, the dry mass was re-cleaned and weighed.

The experiment was carried out in two stages. At the first stage, the effect of infrared irradiation was assessed in the range from 0.9 to 6.3 J, respectively. The experiment was carried out with one control and 7 experimental groups, each of which consisted of 20 seeds. The germination capacity of seeds and their germination energy were calculated. Next, the dry and wet mass was weighed, each seedling was measured, and the total and average length of the seedlings in the control and experimental groups was calculated.

Representativeness errors were determined for mitotic index values. Representativeness errors were calculated using the formula:

$$m = + - \sqrt{\frac{P*(100-P)}{n-1}},$$

where m – average error of the indicator, p – indicator (%), n – number of observations

The m value for the control group was ±0.145, for 0.45 J – ±0.143, for 0.6 J – ±0.172, for 0.9 J – ±0.157, for 1.8 J – ±0.142, for 2.7 J – ±0.142, for 3.2 J – ±0.139.

To determine the presence or absence of mutagenic effects of infrared irradiation, as well as to assess the activity of cell proliferation, the mitotic index was calculated for each of the study groups.

The experimental results were processed using Student's test ($p<0.05$).

In the course of the work, the growth of wheat in the experimental groups was established. Patterns of the effect of infrared irradiation on growth processes were established.

Table 1 presents the values of germination and germination energy of seeds in the studied groups; the peak of germination occurs in the group irradiated with 0.9 J, the peak of germination energy - in the group irradiated with 1.8 J. With increasing irradiation energy, both indicators decrease. In the group irradiated with 6.3 J, germination and germination energy were 73.3 and 53.3%, respectively.

Table 1

Indicators of germination energy and germination in the studied groups

Group	Control	0,9 J	1,8 J	2,7 J	3,6 J	4,5 J	5,4 J	6,3 J	σ
Germination, %	80	93,3	93,3	80	80	80	73,3	73,3	7,762
Gernination-energy, %	66,67	66,67	80	66,67	60	60	60	53.3	7,412

From table 2 it can be seen that the total lengths of seedlings are greatest in the groups irradiated with 0.9 and 1.8 J; the maximum values of dry and wet masses occur in groups irradiated with 0.9 and 3.6 J.

Table 2

Biometric indicators of winter wheat seedlings depending on the irradiation dose

Group	Total length of seedlings in a group, mm	Average length of seed-lings in a group, mm	Wet weight, g	Dry weight, g
Control	1930	160,83	1,914	0,367
0,9 J	2335	166,78	3,251	0,536
1,8 J	2252	168,85	2,613	0,449
2,7 J	2069	172,41	2,5	0,412
3,6 J	1212	193,5	2,87	0,432
4,5 J	1893	157,75	2,618	0,503
5,4 J	1699	154,45	2,543	0,432
6,3 J	1071	107,1	1,717	0,444

Since a visible effect was obtained, it was decided to conduct the second part of the experiment using doses of 0.45 and 0.6 J - it was hypothesized that the low-dose region could be informative. On the other hand, it was decided to abandon irradiation of 4.5 J or more, because the lengths of seedlings at these doses dropped below the control ones. In the second part of the experiment, it was decided to take measurements exclusively of the above-ground parts of the shoots. Table 3 shows the values of germination, germination energy, total and average lengths of seedlings, dry and wet weight; The standard deviation for each of the parameters is also given there. 55 seeds were selected for each experimental group.

Table 3 presents the main data obtained during the second part of the experiment. It is worth noting that the group irradiated with 0.9 J demonstrates the best performance in such parameters as dry and wet mass, total and average length of seedlings in the group, and germination energy. However, the germination of seeds of this group is lower than that of the control group, at the level of the group irradiated with 2.7 J. In general, in the considered biometric indicators, a wave-like effect is observed, however, in the group irradiated with 3.6 J, despite another increase in the length of the seedlings, wet and dry mass falls below control values.

Table 3

Basic biometric indicators of above-ground shoots of winter wheat

Group	Germination, %	Germination energy, %	Total length of seedlings in a group, mm	Average length of seedlings in a group, mm	Wet weight, g	Dry weight, g
Control	90,9	72,72	8236	161,49	4,553	0,564
0,45 J	87,27	74,54	8280	172,5	4,601	0,558
0,6 J	89,09	74,54	8320	169,79	4,587	0,566
0,9 J	83,63	78,18	9014	195,95	5,101	0,658
1,8 J	85,45	70,90	8938	190,17	4,915	0,638
2,7 J	83,63	69,09	8530	185,43	4,867	0,599
3,6 J	87,27	72,72	8612	179,41	4,239	0,526

The experimental results given in table 3 confirm our hypothesis. Moreover, there is a trend toward a relationship between total seedling lengths, wet and dry weight, and the mitotic cycle.

The dependence of the total lengths of seedlings in the studied groups on irradiation doses is shown in figure 2. The peak of values occurs in the group irradiated with 0.9 J. Then there is a significant decline in values, and an increase in the group irradiated with 3.6 J. However, groups with the lowest irradiation energy turned out to be uninformative, since the values of the total length, wet and dry masses differ slightly from the control indicators.

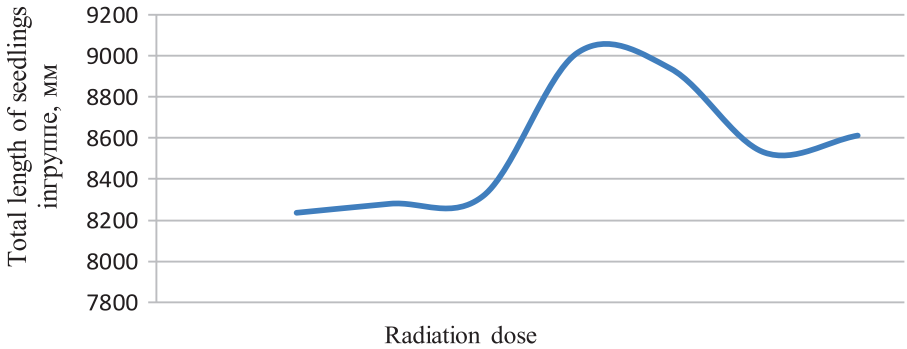

Fig. 2. – Dependence of the total lengths of seedlings in the studied groups on irradiation doses

The results obtained lead to the following conclusions:

1. Peak germination occurs in the group irradiated with 0.9, peak germination energy occurs in the group irradiated with 1.8 J. With increasing irradiation energy, both indicators decrease. In the group irradiated with 6.3 J, germination and germination energy were 73.3 and 53.3%, respectively.

2. The total lengths of seedlings are greatest in the groups irradiated with 0.9 and 1.8 J; The maximum values of dry and wet masses occur in groups irradiated with 0.9 and 3.6 J.

3. In the considered biometric indicators, a wave-like effect is observed, however, in the group irradiated with 3.6 J, despite another increase in the length of the seedlings, the wet and dry mass drops below the control values.

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