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EFFECT OF COMBINED OPTICAL RADIATION ON TOMATO SEEDS

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Abstract. *The article presents the results of research of pre-seed treatment of seed material for increasing the yield of agricultural crops. As seed treatment with optical radiation is considered one of the most environmentally friendly technologies for increasing yield, a multifactorial experiment on the effects of combined optical radiation on tomato seeds was conducted.*

The results of research on the influence of time, dose and temperature of treatment with combined optical radiation of tomato seeds on the energy of germination and yield are given in the paper. The most effective seed treatment is determined. The regression equation of coded variables for a 5 % level of significance is obtained.

Keywords: ***ultraviolet radiation, infrared radiation, seeds, sowing qualities, processing mode***

Introduction. Modern technologies for growing crops anticipate for pre-sowing treatment of seed material to increase yields [1, 4]. Such technologies include stimulation of germination of seeds under the influence of growth regulators, physical factors such as ultraviolet, infrared and laser irradiation, irradiation by electromagnetic field, etc.

Analysis of recent researches and publications. Seed treatment with optical radiation is considered one of the most environmentally friendly technologies for increasing the productivity of agricultural crops [2].

Purpose – determination of the effect of combined optical radiation on tomato seeds.

Methods. In determining the parameters of seed treatment (DRT lamp voltage, seed treatment temperature, and exposure), a multifactorial experiment was conducted. Germination energy was used as a seed response to the combined optical radiation.

For analysis, averaged samples of seeds were taken, selected according to GOST 12036-85, with a moisture content of 12%. Seed germination was carried out in Petri

dishes on filter paper, dampened with water, at a temperature of 28 °C in accordance with GOST 12038-84 "Seeds of crops. Method of determination of similarity". Every day spent recalculation of germinated seeds as a percentage relative to the total number of seeds in the sample.

To obtain the regression equation used planning complete factorial experiment of the second order. The value of factors and their ranges of variation are given in Table 1.

The standard methodology for constructing second-order plans, calculating regression coefficients, determining the adequacy and results of processing experimental data was used below.

1. The value of factors in the experiment

Variation interval and level of factors	**Seed temperature**, °C	**Exposure, min**
	X_1	X_2
Level zero – $X_i=0$	35	3
Variation interval – λ_i	15	2
Upper level – $X_i=+1$	50	5
Lower level –$X_i=-1$	20	1

Results. According to the results of a multivariate experiment, a regression equation was obtained:

$$Y= b_0+1,4\, b_1 X_1+ b_2 X_2+ b_3 X_1 X_2+ b_4 X_1^2+ b_5 X_3^2 \quad (1)$$

here Y – seed germination energy, %; X_1 – seed temperature, °C; X_2 – exposure, min.

Testing the significance of the regression coefficients was carried out according to Student's criterion for the significance level $\alpha = 0.01$. All coefficients in equation (1) turned out to be significant.

As an estimation method, the Levenberg-Marquardt algorithm was used, which is the most common algorithm for minimizing the mean-square deviations. Its advantage, in comparison with the Gauss-Newton method and other methods of conjugate gradients, is a higher computation speed and providing matches [3].

The method consists in calculating such estimates of the coefficients b_1, b_2, b_3,…, b_n of the polynomial regression $f(\tau)$ that provided the minimum of the quadratic function:

$J = \sum_{i=1}^{n}(Y_i - f(\tau_i))^2$, here Y_i, τ_i, – experimental data.. The search for regression coefficients was carried out in the mathematical environment Statistica 6.0 in which there is a Levenberg-Marquardt algorithm..

According to the results of the experiment, a regression equation of coded variables was obtained which for the 5 % level of significance is:

$$Y= 65,07+0,92\ X_1-1,35\ X_2+0,21\ X_1\ X_2-0,02\ X_1^2-1,2X_2^2$$

Testing the regression equation for adequacy using the Fisher criterion showed that it describes the real process and, accordingly, makes it possible to evaluate the nature of the influence of each factor on the fluctuation of the response.

The multifactorial experiment conducted made it possible to establish the effect of the energy dose of the treatment on the change in the biopotential of sprouts of tomato seeds. The energy dose of the treatment is determined by:

$$H = \frac{K_a}{kL^2(1+\beta)}\sum_{\lambda_2}^{\lambda_1}\tau\lambda E_\lambda,$$

here L – distance from the axis of the lamp to the surface of the irradiated seeds, m; E_λ – actual exposure at a distance of 1 m; K_a – correction factor taking into account the effect of mounting on the redistribution of radiation; β – coefficient characterizing the magnitude of the deviation of the radiation power from the law of squares; λ_1, λ_2 – wavelengths of the effective range of the emission spectrum; k – seed shape factor.

From the obtained results, it follows that the germination of seeds treated with a DRT lamp with a seed heating temperature of 35 C and an exposure time of 3 min is 96 %, and in the control it is 67 %. With increasing exposure to 5 min, field germination decreased by 2 %. Reducing exposure to 1 min reduces germination to 88 %.

Discussion. Optical radiation treatment of tomato seeds has shown the effectiveness of using the combined effect of ultraviolet and infrared radiation from a DRT-400 lamp.

Field studies have confirmed that pre-sowing treatment of seeds of greenhouse crops with optical radiation can increase yields by 15…20 %.

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ВПЛИВ КОМБІНОВАНОГО ОПТИЧНОГО ВИПРОМІНЮВАННЯ НА НАСІННЯ ТОМАТА

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Анотація. *У статті наведені результати дослідження передпосівної обробки насіннєвого матеріалу для підвищення укрожайності сільськогосподарських культур. Оскільки обробка насіння оптичним випромінюванням вважається однією з екологічно чистих технологій підвищення врожайності, був проведений багатофакторний експеримент по впливу комбінованого оптичного випромінювання на насіння томата.*

У роботі наведені результати досліджень впливу часу, дози і температури обробки комбінованим оптичним випромінюванням насіння томата на енергію проростання і врожайність. Визначено найбільш ефективний режим обробки насіння. Отримано рівняння регресії кодованих змінних для 5 % -вого рівня значимості.

Ключові слова: ***ультрафіолетове випромінювання, інфрачервоне випромінювання, насіння, посівні якості, режими обробки***

ВЛИЯНИЕ КОМБИНИРОВАННОГО ОПТИЧЕСКОГО ИЗЛУЧЕНИЯ НА СЕМЕНА ТОМАТОВ

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Аннотация. *В статье приведены результаты исследования предпосевной обработки семенного материала для повышения урожайности сельскохозяйственных культур. Поскольку обработка семян оптическим излучением считается одной из экологически чистых технологий повышения урожайности то*

был проведен многофакторный эксперимент по влиянию комбинированного оптического излучения на семена томата.

В работе приведены результаты исследований влияния времени, дозы и температуры обработки комбинированным оптическим излучением семян томатов на энергию прорастания и урожайность. Определён наиболее эффективный режим обработки семян. Получено уравнение регрессии кодированных переменных для 5 %-ного уровня значимости.

Ключевые слова: ***ультрафиолетовое излучение, инфракрасное излучение, семена, посевные качества, режим обработки***