THE EFFECT OF UV IRRADIATION OF WINTER WHEAT ON ENZYME ACTIVITY DURING GERMINATION

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Abstract

Natural ultraviolet radiation is one of the major environmental factors that have an impact on plant organisms. The article shows that the use of artificial sources of ultraviolet (UV) radiation, mercury-quartz lamps, such as BNPO 2-30-001U3.5 in crop production accelerates the processes of germination and increase the germinating power by activation of enzymes. The use of UV radiation sources for the stimulation of germinating seeds is relevant and highly-demanded, as it is an environmentally safe technology for pre-sowing seed stimulation in agricultural production.

The use of a BNPO 2-30-001U3.5 mercury-quartz lamp to stimulate physiological and biochemical processes in germinating seeds allowed us to identify different levels of enzyme activity depending on the time of exposure to irradiation.

After soaking the winter wheat seeds in distilled water, they were irradiated using a BNPO 2-30-001U 3.5 mercury-quartz lamp, and, as the seeds swelled and germinated, the activity of amylase, catalase and peroxidase was determined. During the experiment, optimal regimes of seed irradiation by an UV source were established. The seeds exposed to radiation for three and five minutes, showed a 8.2 and 10.5% increase in laboratory germination compared to the control, and a 27.8 and 29.5% increase in germinating power, respectively. Comprehensive studies of the effect of UV radiation on enzyme activity during the germination of wheat seeds under different irradiation regimes showed the maximum increase in amylase activity on the fourth day from the beginning of germination and the increase in this indicator by 58.6 and 64.1%, respectively, compared to the control condition.

Catalase activity reached its maximum by the fourth day from the beginning of seed germination in variants that had been exposed to a three- and five-minute
irradiation and was higher than that in the control variant by 14.7% and 17.7%, respectively.

The peak of peroxidase activity was observed on the eighth day from the beginning of the germination of winter wheat seeds in all variants of the experiment, but in the variants with three- and five-minute irradiation, the peroxidase activity was higher than the control values by 50%, and with a five-minute irradiation – by 55%.

**Keywords:** Winter wheat; seed quality; enzymes; amylase; catalase; peroxidase; seed material; ultraviolet irradiation.

### I. Introduction

Wheat has always been the main food crop of the Don. The biochemical composition and flour-baking properties of the Don wheat have always received high estimate in the world market [XXVI].

Winter wheat crops in the agricultural production of the Rostov region make up 40-50% of the area of all grain crops every year, and its share in gross grain production is more than 70%. The climate of the region is characterized by a lack of moisture in most zones and frequent droughts during the growing season [XXI].

Obtaining high yields while minimizing the energy input per crop unit depends on the methods of the seed quality improvement [XIII].

The development of new, environmentally friendly, electrophysical methods of seed improvement that are not inferior to pesticides and growth stimulants of various origins, and capable of minimizing their use, will significantly reduce the residual amount of pesticides in the final crop production, and, as a result – a negative impact on animals and humans [XIII]. The insufficiently studied effect of various electrophysical methods of presowing seed stimulation and the lack of recommendations for their use in agricultural complex necessitates the improvement of these methods [XIII].

In the area of unstable moistening of the south of the Rostov region, it is not always possible to obtain even and full sprouts of winter wheat. The lack of moisture in the autumn creates unfavorable conditions for the germination of seeds, of which 20-30% die without germination. [XXI] The torrential character of precipitation periodically occurring during the harvest of grain crops, delays the post-harvest ripening of seeds, reduces their laboratory germination, germinating power and growth force. Sowing of seeds with reduced laboratory germination leads to a decrease in the productivity of cultivated crops. Ripening conditions have a great influence on the process of transformation of active enzymes, including amylase. It depends on the crop variety and year, degree of grain ripeness and the conditions of ripening [VI]. Research by several authors showed that the source of the resulting amylase in the ripening seeds of a wheat ear is the vegetative parts of plants [VI]. Therefore, pre-sowing seed preparation, which involves stimulation of the sowing qualities of seeds using various biological and physical factors and accelerates the ontogenesis phases of the plant, is necessary in the unstable moistening area of the
Rostov region. The introduction of innovative, environmentally friendly methods of pre-sowing seed stimulation of crops is the key to the efficiency and competitiveness of this area of agricultural production [VI, XXVII].

Pre-sowing irradiation of grain seeds using UV sources, as a simple, energy-saving and environmentally friendly technique of germinating seeds stimulation, can be used to improve their sowing qualities [VII, XIII].

As a result of the use of different types of stimulation techniques, the rate of biochemical processes, growth and morphogenesis may change [XX].

Physiological processes in germinating seeds occur in the presence of amylolytic enzymes, which enter the active state as the seed swells [XIV]. Enzyme activity, which accelerates the processes of seed germination, is a manifestation of adaptation to stress caused by irradiation with ultraviolet radiation sources [XXIII]. Amylase is involved in the breakdown of starch into maltose, which splits to glucose, while the sucrose, formed at the same time, is used by a growing sprout [XV].

Catalase is a heme-containing tetrameric enzyme that catalyses the reaction of hydrogen peroxide conversion into water. Unlike other enzymes that contribute to the elimination of hydrogen peroxide, catalase does not need an additional substrate. Catalase is the main enzyme that eliminates excess amounts of hydrogen peroxide, but because of its low substrate affinity, it is effective only at high concentrations of \( \text{H}_2\text{O}_2 \) [VI].

The reaction of catalase to stress caused by high-intensity light may be different and depends on the duration of the stress factor and the type of plant [VI]. Catalase functions are most actively manifested under the influence of UV radiation, compared with exposure to factors such as ozone [XXXIII]. The use of seed ozonation as a pre-sowing stimulation method for grain seeds is widely used in agricultural practice. [XXVIII]

Peroxidase, which is involved in plant respiration, prevents, along with catalase, the accumulation of hydrogen peroxide in the cells, performs a protective function, and inhibits pathogenic and stress factors. Under stressful conditions, enzyme systems regulate adaptive responses at various stages of ontogenesis [XXV].

The purpose of this research was to study the effect of UV irradiation on the enzyme activity in germinating seeds of winter wheat, and to determine UV irradiation regimes that are optimal for germination stimulation.

The tasks of the research included:

- to study of the effects of UV irradiation of different duration on the activity of enzymes in germinating wheat seeds;
- to find the optimal regimes of irradiation to stimulate seed germination;
- to determine the effect of pre-sowing UV irradiation of different duration on the sowing qualities of seeds of the winter common wheat;
II. Materials and Methods

The studies were conducted in 2017–2018. The object of the studies was seeds of wheat (Triticum aestivum L.) of the Rostovchanka 5 variety.

Irradiation of seeds by UV sources is effective when pre-soaking the seeds in distilled water, after which the seeds were exposed to a UV source, and germinated in a thermostat at 20 °C [XXII].

The swollen seeds were irradiated with a UV source BNPO 2-30-001U3.5 with an irradiation intensity of 30 W/m². The seeds were exposed to irradiation for 1, 3, 5 and 7 minutes, at a distance of 25 cm from the radiation source. The purpose of seed irradiation was to stimulate the activity of enzymes.

The germinating power was measured on the third day, and germination – on the seventh day after germination began [I]. Germination and germinating power were determined in accordance with GOST 12038-84 "Seeds of agricultural crops. Methods of determination of germination".

The total activity of amylases (amylase activity) was determined by isolating them with a solution of NaCl, followed by incubation with a standard starch solution for a certain period of time and colorimetration of non-hydrolysed starch. The enzyme activity was expressed in mg of hydrolyzed starch per 1 ml of enzyme extract [XXX].

Catalase activity was measured using the gasometric method [VIII].

The total peroxidase activity (TPA) was determined by the Boyarkin method, based on the ability of benzidine to oxidise with hydrogen peroxide with the participation of peroxidase [VIII].

III. Results and Discussion

During the swelling and germination of seeds, the character and intensity of physiological processes in germinating seeds depend on the activity of the enzymatic complex of the grain and environmental conditions [X].

During the swelling and germination of seeds, metabolic processes activated by enzymes are accelerated [X].

Four stages of seed germination are distinguished: swelling, sprout emergence, sprout growth due to the heterotrophic type of nutrition and the transition to the autotrophic type of nutrition [I]. During the period of swelling, two stages are identified: physical and biological. At the physical stage, water enters the seed through the cell membranes, encircling the endosperm cells, while at the biological stage, enzyme systems of the seed become activated [V].

The sowing and physical qualities of winter wheat seeds largely depend on the conditions of growth and development of parent plants, but an important role in the improvement of the seed sowing qualities is played by endogenous substances that stimulate the germination of grain and the development of plants. Along with
internal factors, many methods of pre-sowing stimulation, including pre-sowing exposure to ultraviolet radiation sources, have a positive effect on sowing qualities of seeds [II].

The main indicator of seed quality is germination. However, this is not the only indicator that determines the biological properties and economic prospects of seeds [XXVII]. This information can be obtained from studying several indicators characterizing seeds and their potential abilities to produce powerful seedlings in different conditions [XXVII, XIII].

The key indicator for predicting field germination and quality of seeds, characterizing the speed and evenness of their germination, is the germinating power [XX]. Germinating power is the number of germinated seeds for a certain period (three to four days), which shows the ability of seeds to produce even sprouts in the field conditions, and therefore, good uniformity and survival of plants. The seeds that germinated faster have better chances to sustain adverse conditions in the autumn after sowing.

After seven days, laboratory germination is counted — the number of normally germinated seeds that have at least two roots larger than the seed and a sprout of at least half the length of the seed [XX].

Intensification of growth processes is associated with the activity of amylase that splits the starch contained in the endosperm. The more this enzyme is activated in the seeds, the higher is the rate of starch conversion into sugars used by the germinating seed [IX]. The acceleration of germination phases and emergence of sprouts is very important in the conditions of the area of unstable moistening in the south of the Rostov region. The lack of moisture in the soil at high temperatures and dry east winds is the main cause of a significant decrease in the yield of grain crops. Seeds that germinate fast in field conditions make optimal use of soil moisture reserves and form a fully-developed root system and seedling. Therefore, stimulating seeds through environmentally friendly techniques such as ultraviolet irradiation before sowing is expedient in agricultural production [XIII].

To determine the expediency of seed treatment with ultraviolet irradiation, laboratory studies of the seed sowing qualities — germinating power and laboratory germination — were carried out after irradiation with a UV source [XXIII].

Four treatment options of 1.3, 5, and 7 minutes of irradiation of winter wheat seeds were selected. The seeds that were not exposed to UV radiation were used as controls. After soaking the seeds in distilled water for subsequent germination, they were exposed to a UV radiation source in accordance with the variants of the experiment. As the water content grows, the main metabolic processes are activated in the seeds, and respiration is enhanced to the maximum level that characterizes their growth and development [XXX]. Functional substances contained in the grain tissues change when the seed dormancy is over and initiate a transformation of metabolism [XV].
As a result of the experiment, it was established that the germinating power and laboratory germination change according to the experimental options after irradiating the seeds with a source of UV radiation (Fig. 1).

Seed treatment with an exposure of 1 to 7 minutes showed an increase in laboratory germination in all variants of the experiment, but to different degrees. The highest laboratory germination was obtained in a three-minute irradiation variant and in a five-minute variant that were 8.2% and 10.5% higher compared to the control, respectively. The germination power of seeds exposed to three- and five-minute irradiation increased compared to the control by 27.8 and 29.5%, respectively.

As a result of the research, it was found that three- and five-minute treatment options are the most optimal for seed stimulation in comparison with other irradiation options.

The main characteristic of germination and its overall biochemical orientation is the disintegration of high-molecular substances in the endosperm to soluble low-molecular substances with the participation of moisture and under the influence of enzymes of the amylolytic complex with high α-amylase activity [XIV].

One of the enzymes that are actively involved in the germination of seeds is amylase [XIX]. The process of starch hydrolysis is triggered by the influence of amylases, which are intensively formed from the moment the germination begins [XX, XII]. Under the influence of amylase (consisting of α- and β-amylase), the starch in the endosperm of the caryopsis is transformed into dextrins and maltose. Maltose under the influence of maltase splits to glucose when seeds germinate [XV, I].

The study of amylase activity is usually carried out on a certain day of germination of seeds. It is known that the maximum activity of total amylases during germination of wheat seeds usually occurs on the 3-5th day [XVIII].
As a result of the experiment, general characteristics of amylase activity were found, and characteristics dependent on the different irradiation duration when the wheat seeds reached a certain stage when they germinate in the conditions of optimal moistening. Amylase activity in wheat seeds at different duration of exposure to the UV source was unequal. Figure 2 shows the average change in the activity of amylase in the seeds of winter wheat for all variants of the experiment, when they germinate in the conditions of optimal moisture.

The graph representing the change in amylase activity in germinating seeds and the position of the maximum makes it possible to make conclusions about the nature of the change in enzyme activity during five days of seed germination [XXIII]. The experimental curve indicates the irregularity of this process during seed germination under unchanged external conditions [XIX]. An increase in the activity of amylase was observed as early as at the end of the first day of wheat germination in all variants of the experiment. Each of the five days of germination of seeds, characterised by a certain level of amylase activity, corresponds to a particular section of the experimental curve.

Analysing the correspondence of amylase activity by days of germination to the sections of the curve, we can conclude that the fourth and fifth days are the key periods when amylase activity in the germinating seed reaches its maximum value, after which the level of enzyme activity decreases.

Fig. 2: Amylase activity in seeds of winter wheat after irradiation with a UV source, (mg of hydrolysed starch over 30 min/g of fresh basis weight)

Amylase activity was observed as early as at the end of the first day of germination. By the second day the amylase activity increased by 19% in the variant with the three-minute treatment compared to the control, and by 23.5% - in the variant with the five-minute treatment. The maximum amylase activity in the variants with three- and five-minute treatment was observed on the fourth day from the beginning of germination and was higher than the amylase activity in the control by 58.6 and 64.1%, respectively.

The increase in amylase activity from the beginning of the second day to the fourth day is almost linear, therefore, it is at this stage of seed germination that the major part of enzyme synthesis and the increase in its activity occur.

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During the fourth day, the amylase activity continued to increase, remaining high even on the fifth day of seed germination. As a result, it was found that in the variants with a three- and five-minute irradiation, the amylase activity was higher than in the control by 44 and 58.8%, respectively.

It can therefore be concluded that the three-and five-minute seed irradiation regimes increase the amylase activation rate more compared to other experimental options, and the embryo makes a fuller use of endosperm reserve matter. As a result, germinating power and laboratory germination increase with these treatment regimes.

Plant cells react to the stress factor by activating various defence mechanisms [XXIX].

Catalase involved in the process of respiration is contained in dormant seeds in much larger quantities than amylase [III]. Catalase activity increases during seed germination. Catalase is a part of biological systems that convert energy by participating in the antioxidant system of a plant organism [III]. Catalase prevents the accumulation of hydrogen peroxide, which is formed during aerobic oxidation [III]. The enzyme requires almost no activation energy, and the reaction rate is completely determined by diffusion. Catalase reacts with hydrogen peroxide to form a relatively stable enzyme-substrate complex [XVII]. Catalase optimum activity is at pH 6.5. In more acidic and alkaline environments, its activity decreases [XVII]. In the oxidised state, catalase can also act like peroxidase, catalysing the oxidation of alcohols or aldehydes [III]. Catalase also plays an important role in the supply of oxygen to those parts of tissues where its access is for some reason restricted. Catalase activity varies depending on the location of the enzyme. [III]. It is predominantly found in peroxisomes; a specific isoform is also found in mitochondria; its activity has been observed in plant chloroplasts [III].

Catalase activity increases in parallel with the intensity of respiration of germinating seeds, which combines all the vital processes: protein, carbohydrate and lipid metabolism [III]. (Fig. 3).

![Fig. 3: Catalase activity in germinating seeds of winter wheat, (µmol of H₂O₂ decomposed within 1 min per 1 g of dry material)](image-url)
As a result of studying the effect of UV treatment of winter wheat seeds of Rostovchanka 5 verity on catalase activity in germinating seeds, it was found that the highest enzyme activity — up to maximum values — occurs during the first four days, when it increases 7.3– 7.5 times compared with the first day of germination, after which it decreases.

Catalase activity increases in parallel with the intensity of respiration of germinating seeds, which combines all the vital processes: protein, carbohydrate and lipid metabolism [XXXI]. Catalase activity in germinating wheat seeds exceeded the control value in all variants. It was established that a relatively stable content of catalase is observed in wheat in the first hours after the beginning of germination, and then it starts fast. Catalase activity in germinating wheat seeds was higher than the control in all variants. Treatment of wheat seeds with a UV radiation source before germination increased catalase activity on the fourth day from the beginning of germination for seeds treated for three and five minutes by 14.7 and 17.7%, respectively, compared to the control. The maximum activity was registered for a five-minute exposure. By the fifth day from the moment of germination, the activity decreased both in the control and in all experimental variants.

The experimental curve we obtained is S-shaped, which indicates the unevenness of catalase activation during seed germination in a thermostat under 20 °C and optimum moistening. The level of catalase activity recorded in each of the five days of germination of winter wheat seeds corresponds to a particular section of the curve. Analyzing the correspondence of catalase activity to certain sections of the S-shaped curve by days of seed germination, it can be concluded that during the first or second day catalase begins to activate in all variants of the experiment; during the second and third days there is a logarithmic increase in enzyme activity. By the fourth, key day, the catalase activity in germinating seeds reaches a maximum, after which the level of enzyme activity decreases.

Based on the data obtained as a result of the experiments, it can be concluded that an increase in catalase activity after seed irradiation indicates an increase in the synthesis processes in wheat sprouts as a result of seed treatment with a UV source [XXVII].

Peroxidase is part of the antioxidant system, the activity of which determines the level of plant resistance to various factors during ontogenesis [XI]. The enzyme is able to catalyze the oxidation of various inorganic and organic compounds. High peroxidase activity in wheat seeds and sprouts suggests the participation of the enzyme in metabolic processes occurring during the dormancy of seeds and during their active germination [XI].

Peroxidase, along with catalase, is involved in the detoxification of H$_2$O$_2$ [XVII]. The activity of the antioxidant system, which includes peroxidase, determines the plant resistance to various environmental factors during ontogenesis [XXIV, IV]. Peroxidase is a catalyst for the oxidation of various inorganic and organic compounds [XI]. However, peroxidase is an enzyme that can act as a factor involved in the
elimination of $\text{H}_2\text{O}_2$, and in other situations as a source of oxygen-derived radicals [XXIV]. Peroxidase can display oxidase properties due to its broad substrate specificity [XI]. Thus, peroxidase, being involved in the metabolism of reactive oxygen intermediates, performs a dual function [XI]. Having antioxidant activity, peroxidase inhibits free radical oxidation of lipids [XX, XXV].

When the seeds leave the state of induced dormancy, the peroxidase activity grows as their respiration intensifies [XVII].

Available experimental data suggest that peroxidase is associated with a number of metabolic transformations in cells, with a broad spectrum of enzyme activity in the range of pH from 3 to 14. [XVII]. Peroxidase is activated by very many changes and disorders of plant metabolism, and some isoenzymes are synthesized de novo in response to stress. However, there is still no sufficiently full explanation of the regulation mechanism of isoenzyme synthesis and of the manifestations of their properties under stress and pathological factors [XVII]. The significant functional role of peroxidases in the vital processes of plants is clearly manifested in the transformation of the peroxidase complex under the influence of biotic and abiotic environmental stress factors.

Peroxidase activity was studied for nine days in dynamics, in germinating wheat seeds after exposure to a UV source. As a result, it was found that the germination process is accompanied by an increase in the enzyme activity over time. Significant differences in the level of total peroxidase activity in the seeds in different experimental variants were found.

A gradual increase in the total peroxidase activity in the control and other variants of the experiment during the first seven days reached a maximum by the eighth day. Among all the variants of the experiment, variants with three- and five-minute exposures of radiation showed the highest activation (Fig. 4).

**Fig. 4:** Total peroxidase activity (TPA) in germinating seeds of winter wheat (relative units)

Figure 4 shows the average change in total peroxidase activity in winter wheat seeds for all variants of the experiment. Analysis of the experimental curves showed that the process of swelling and germination of seeds is accompanied by an
increase in the total peroxidase activity during the nine-day period of germination. Peroxidase activity in germinating wheat seeds that were soaked at 20 ° C was manifested in a peculiar dynamics and depended on the duration of irradiation and the time of germination.

The studies have shown that peroxidase activity increases 2.8 times on average in the first seven days of swelling and seed germination compared to the beginning of germination. The maximum activity is registered on the eighth day and decreases by the ninth day.

On the eighth day of the seed germination, the peroxidase activity increased by 50% in seeds irradiated for three minutes, and by 55% - in seeds irradiated for five minutes compared to the control. The peak of peroxidase activity on the eighth day in these variants of the experiment was higher than in the variant with one-minute irradiation by 12.5 and 16.6%, and by 5.8 and 9.8% compared to the seven-minute variant, respectively.

The experimental data on peroxidase activity suggest that three- and five-minute irradiation regimes increase the sensitivity of seeds to radiation – an external stress factor, whereas one-minute and seven-minute irradiation cause reactions that are less pronounced.

The obtained data are consistent with modern concepts of the patterns of response of living systems to external factors of different nature. It is known that changes in metabolism caused by stress factors are similar in all organisms [III]. Some medium-intensity effects contribute to improving the sustainability of a living system due to non-specific adaptive transformations [XVII]. When the stress factor does not exceed the threshold value for an organism, its response tested for some kind of functional indicator over time usually includes successive phases of stimulation, partial inhibition with plateau and activation or complete suppression depending on the magnitude of the pressure [XI]. Objects that are resistant to external factors undergo similar phase changes like sensitive ones, but more extended in time, that is, occurring later at a higher dose of exposure [III].

This goes in line with our evidence of higher germination power and seed germination.

IV. Conclusion

An analysis of the experimental data suggests there is a change in the morphophysiological parameters of the germinating seed under the influence of UV radiation. The extent of this change depends on the duration of exposure to the source of UV radiation. It has been established that intense activation of growth processes in wheat is caused by exposure to UV radiation for three and five minutes.

The analysis of the sowing qualities of seeds that predict field germination showed the dependence of germinating power and laboratory germination on exposure to a UV radiation source. Laboratory germination of seeds treated with UV irradiation by a mercury-quartz source of UV radiation BNPO 2-30-001U3.5
increased by 8.2% in the three-minute variant and by 10.5% in the five-minute variant in comparison with the control. Under the same treatment regimes, the germinating power in experimental variants was higher than the control by 27.8 and 29.5%, respectively. Thus, treatment regimes for wheat seeds were identified which they are more susceptible to – three- and five-minute exposure.

When using mercury-quartz BNPO 2-30-001U3.5as a stimulating agent for the studied seeds of winter wheat of Rostovchanka 5 variety, amylase is activated to the maximum in the variants with three and five minutes treatment by 58.6-64.1% on the third day of seed germination, which accelerates the process of starch hydrolysis of seed endosperm.

Three- and five-minute radiation has a greater stimulating effect on the enzyme activation compared to other variants of the experiment, thus accelerating the germination of seeds.

As a result of the experiments, data were obtained confirming that the UV radiation increases the activity of enzymes of the redox complex (catalase and peroxidase), and the degree of this activation also depends on the duration of the exposure.

The analysis of catalase activity showed that the enzyme activity reaches the maximum during the first four days, when it increases 7.3-7.5 times compared to the initial germination stage, and then decreases in all variants of the experiment.

Catalase, which participates in the antioxidant seed protection system, is activated to the maximum by the fourth day of germination when treated with a source of UV radiation, and the catalase activation only in variants with a three- and five-minute exposure increased by 14.7 and 17.7%, respectively, compared to the control. The studies showed light-dependent modifications: ambiguous changes in the activity of the enzyme system, catalase and peroxidase, in the germinating seeds induced by exposure to ultraviolet radiation [IV].

It should be noted that all identified changes are indicators of the seed response to irradiation with an ultraviolet radiation source [XVII].

Studies have shown that peroxidase activity in the first seven days of swelling and seed germination increases 2.8 times on average compared to the beginning of germination; the activity maximum occurs on the eighth day and decreases by the ninth day.

The peak of peroxidase activity was observed on the eighth day in all variants of the experiment, but in variants of three- and five-minute irradiation, the activity of peroxidase was higher than in controls by 50 and 55%, respectively, which suggests that the seed response was higher in these two variants of irradiation UV radiation source.

Thus, in conclusion, it can be noted that the activity of the studied enzymes is manifested in all variants of the experiment, but to varying degrees.
Of the four variants of exposure to the UV source, winter wheat seeds react more intensively to a three- and five-minute exposure. Winter wheat seeds react to irradiation for one and seven minutes as well, but to a smaller degree.

A positive effect of pre-sowing irradiation with a UV source of radiation on the seeds of winter common wheat and its stimulating effect on the seed sowing qualities and biochemical parameters have been found.

The effectiveness of the recommended pre-sowing treatment method and the expediency of using the mercury-quartz source of UV radiation BNPO 2-30-001U3.5 for stimulation of seeds during their pre-sowing preparation has been experimentally proved.

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