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Original article

# STUDY OF THE EFFECT OF UV IRRADIATION OF SEED-BEARING WHEAT ON ENZYME ACTIVITY DURING GERMINATION

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***Abstract***

**Background.** In this article, the study is devoted to the influence of UV irradiation on the activity of enzymes (amylase, catalase and peroxidase) in germinating seeds of winter wheat variety Rostovchanka 5. The aim of the study was to select the optimal modes of UV irradiation to stimulate germination. The results of the study indicate that short-term UV irradiation (3-5 minutes) can effectively stimulate enzyme activity in germinating winter wheat seeds, which can potentially increase germination and germination energy. These results may be useful for the development of innovative environmentally safe methods of pre-sowing seed stimulation. In this article, the study is devoted to the influence of UV irradiation on the activity of enzymes (amylase, catalase and peroxidase) in germinating seeds of winter wheat variety Rostovchanka 5. The aim of the study is to select the optimal modes of UV irradiation to stimulate germination.

**Purpose.** The aim of the study was to select the optimal modes of UV irradiation to stimulate germination

**Materials and methods.** In 2022-2024, research was conducted on wheat seeds of the Rostovchanka 5 variety bred in the Rostov region

Irradiation of seeds with UV rays after soaking in distilled water accelerates germination by 20%. The laboratory conducted experiments with repetition of 100 grains, moistening them every day with a tray of water in the thermostat.

**Results.** The results of the study indicate that short-term UV irradiation (3-5 minutes) can effectively stimulate enzyme activity in germinating winter wheat seeds, which can potentially increase germination and germination energy.

**Conclusion.** A mercury-quartz lamp for irradiation of winter soft wheat seeds was used for the study. The activity of enzymes (amylase, catalase, peroxidase) depending on irradiation time was determined.

The study showed that the use of UV irradiation to irradiate seeds improves their germination, activates biochemical processes and promotes plant growth. This demonstrates the importance of using UV irradiation in agriculture.

**Keywords:** wheat; UV rays; lamp BNPO 2-30-001U3,5; enzymes

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Научная статья

# ИССЛЕДОВАНИЕ ВЛИЯНИЯ УФ-ОБЛУЧЕНИЯ СЕМЯНОЗИМОЙ ПШЕНИЦЫ НА АКТИВНОСТЬ ФЕРМЕНТОВ ПРИ ПРОРАСТАНИИ

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***Аннотация***

**Обоснование.** В данной статье исследование посвящено изучению влияния УФ-излучения на активность ферментов (амилазы, каталазы и пероксидазы) в прорастающих семенах озимой пшеницы сорта Ростовчанка 5. Цель исследования – выбор оптимальных режимов УФ-облучения для стимуляции прорастания.

Результаты исследования указывают на то, что кратковременное УФ-облучение (3-5 минут) может эффективно стимулировать активность ферментов в прорастающих семенах озимой пшеницы, что потенциально может повысить всхожесть и энергию прорастания. Данные результаты могут быть полезны для разработки инновационных экологически безопасных приемов предпосевной стимуляции семян.

**Цель.** Цель исследования – выбор оптимальных режимов УФ-облучения для стимуляции прорастания

**Материалы и методы.** В 2022-2024 годах проводились исследования на семенах пшеницы сорта Ростовчанка 5, выведенного в Ростовской области.

Облучение семян УФ лучами после замачивания в дистиллированной воде ускоряет прорастание на 20%. В лаборатории проводили эксперименты с повторением по 100 зерен, увлажняя их каждый день с помощью поддона с водой в термостате.

**Результаты.** Результаты исследования указывают на то, что кратковременное УФ-облучение (3-5 минут) может эффективно стимулировать активность ферментов в прорастающих семенах озимой пшеницы, что потенциально может повысить всхожесть и энергию прорастания.

**Заключение.** Для изучения была использована ртутно-кварцевая лампа для облучения семян озимой мягкой пшеницы. Определена активность ферментов (амилаза, каталаза, пероксидаза) в зависимости от времени облучения.

Исследование показало, что использование УФ-излучения для облучения семян улучшает их прорастание, активирует биохимические процессы и способствует росту растений. Это демонстрирует важность применения УФ-облучения в сельском хозяйстве.

**Ключевые слова**: пшеница; УФ лучи; лампа БНПО 2-30-001У3,5; ферменты

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## Introduction

Wheat is the main crop in the Rostov region. The use of innovative environmentally safe methods of seed treatment increases the efficiency and competitiveness of agriculture.

Various stimulation methods can accelerate biochemical processes, growth and formation. Seed germination is related to the activity of enzymes that are activated by swelling. This enzyme activity that promotes germination is a response to stress from ultraviolet radiation.

Amylase breaks down starch into maltose, which is then converted to glucose. Catalase converts hydrogen peroxide to water, and peroxidase, in conjunction with catalase, protects cells from hydrogen peroxide accumulation, preventing exposure to pathogens and stressors. The response to stress may vary with duration and plant species. Investigation of the effect of UV light on enzymes in wheat seeds and search for optimal conditions to accelerate germination. Study of the effect of different duration of UV irradiation on enzyme activity in germinating wheat seeds. Study of optimal irradiation conditions for improving seed germination.

## Materials and methods

In 2022-2024, research was conducted on wheat seeds of the Rostovchanka 5 variety bred in the Rostov region. This semi-dwarf variety has a mass of 1000

grains from 35 to 44 grams. The yield is 49.7 c/ha, a medium-early variety with a vegetation period of 228 to 286 days. Rostovchanka 5 is resistant to lodging, diseases and drought, has excellent baking characteristics.

Irradiation of seeds with UV rays after soaking in distilled water accelerates germination by 20%. The laboratory conducted experiments with repetition of 100 grains, moistening them every day with a tray of water in the thermostat.

The seeds were irradiated with UV light at an intensity of 30 W/m² for different time intervals to stimulate enzyme activity.

A method with NaCl addition and incubation with starch was used to measure amylase activity. The amount of hydrolyzed starch was measured in milligrams per milliliter of enzyme extract.

Gasometric method was used to measure the activity of catalase. Total peroxidase activity was determined using the Boyarkin method, which is based on the oxidation of benzidine by hydrogen peroxide with the participation of peroxidase.

**Results**

Successful germination requires that seeds swell and germinate under optimal environmental conditions. The germination process involves four stages: swelling, germination, seedling growth using external nutrition and transition to an autotrophic type of nutrition. Water plays a key role by penetrating the seed, moisturizing and activating enzyme systems.

Amylase is essential for the breakdown of starch in seeds during germination. The highest amylase activity during wheat germination is usually reached after 3-5 days.

In the experiment, the effect of UV irradiation on amylase activity in winter wheat seeds was investigated. It was found that the peak of enzyme activity occurs on the fourth and fifth day of germination, after which it begins to decrease. On the first day of germination there is an increase in amylase activity in all groups of the experiment.

Amylase showed high activity at the beginning of seed germination. After 3 minutes treatment, the activity increased by 19%, and after 5 minutes it increased by 23.5%.

Maximum amylase activity was reached on the fourth day of germination, exceeding the control values by 58.6% and 64.1% in samples with UV irradiation of 3 and 5 minutes duration.

After irradiating the seeds with UV irradiation for three or five minutes, the level of amylase activity increased, which promotes rapid germination of the embryo and increases growth vigor.

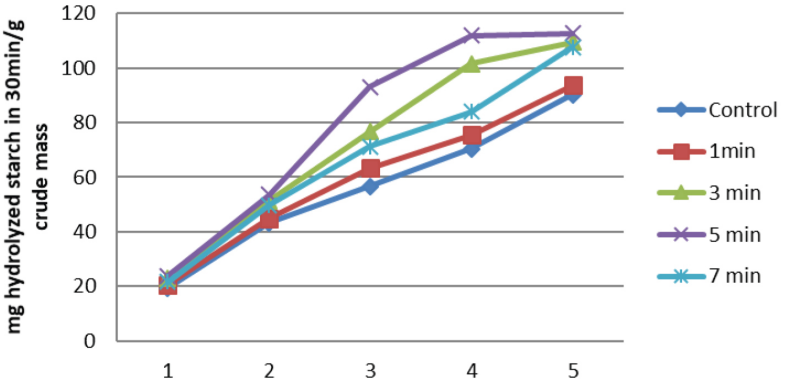


**Fig. 1.** Amylase activity in winter wheat seeds increased after UV irradiation

Catalase in seeds prevents the formation of hydrogen peroxide, having optimum activity at pH 6.5. In the oxidized state, it catalyzes the oxidation of alcohols and aldehydes, acting as a peroxidase. The activity of catalase increases during intense respiration of germinating seeds.

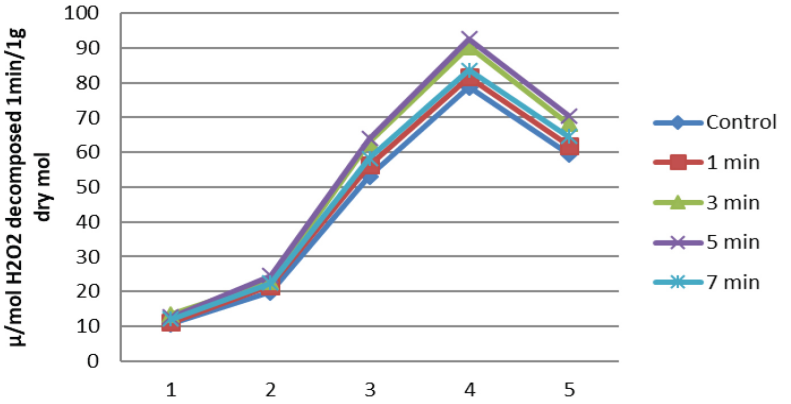


**Fig. 2.** Catalase enzyme shows activity in germinating winter wheat seeds

The study showed that UV irradiation increases the activity of catalase in germinating seeds of winter wheat variety Rostovchanka 5. The maximum activity is reached after 4 days and gradually decreases.

Irradiation with ultraviolet light increased catalase activity in wheat seedlings. The maximum effect was achieved in five-minute treatment.

After five days, catalase activity decreases in both control group and all the experiment variants, but the short period of irradiation helps to improve catalase activity, which may contribute to more efficient respiration and seed survival during germination.

When seeds are germinated in a thermostat at 20°C, catalase activation occurs unevenly, as shown by the experimental curve. When seeds are moistened, catalase is activated. Activation begins on the first to second day, increases on the second and third day, peaks on the fourth day, and then decreases.

Studies have shown that irradiation of wheat seeds with ultraviolet radiation increases catalase activity and enhances synthesis processes in seedlings).

Peroxidase helps plants to be resilient and plays an important role in their development. $_2O_2$ peroxidase is an important component of the plant defense system against oxidative stress due to its ability to catalyze the oxidation of various compounds and prevent lipid oxidation.

Peroxidase activity increases during seed awakening, which is associated with respiration. Experiments show that peroxidase plays an important role in cellular metabolism and can act at different levels of acidity.

UV-irradiated wheat seeds showed an increase in peroxidase activity during germination. Differences were found in the level of enzyme activity under different conditions and with time.

Peroxidase activity increased gradually during the first seven days in all groups of the experiment and reached a peak by the eighth day. The activity was highest in the groups with three and five-minute exposure to irradiation.

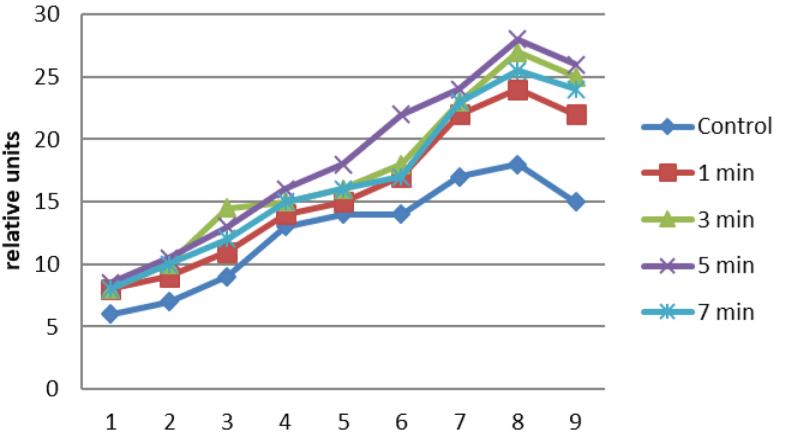


**Fig. 3.** Peroxidase activity in germinating winter wheat seeds was studied

Figure 3 shows how peroxidase activity in winter wheat seeds changes during nine days of germination. An increase in peroxidase activity is observed during seed germination when seeds are soaked at 20°C.

The study confirmed that the level of peroxidase activity in seeds increases significantly at the beginning of germination, reaches a maximum on the eighth day and then decreases by the ninth day.

Eight days after seed planting, peroxidase enzyme activity increased by 50% at three-minute irradiation and 55% at five-minute irradiation, exceeding the control level. The peak activity was reached at longer irradiation.

Studies have shown that prolonged irradiation makes seeds more sensitive to UV rays, while short irradiation induces less vivid responses.

Fresh evidence shows that stress affects the metabolism of organisms, causing changes. Moderate stress can stimulate adaptation and improve the resilience of living systems.

Under stress, an organism goes through several stages: stimulation, inhibition, plateauing, and activation or suppression. Stress-resistant entities also go through these changes, but with a delay and at higher exposures. Understanding stress responses helps to optimize conditions for growth and development of living systems.

**Conclusion**

The use of BNPO 2-30-001U3.5 lamps for enzyme activation accelerates seed germination and germination, which makes it an environmentally safe method of seed stimulation in agriculture.

A mercury-quartz lamp for irradiation of winter soft wheat seeds was used for the study. The activity of enzymes (amylase, catalase, peroxidase) depending on irradiation time was determined.

The study showed that the use of UV irradiation to irradiate seeds improves their germination, activates biochemical processes and promotes plant growth. This demonstrates the importance of using UV irradiation in agriculture.

New electrophysical methods of seed stimulation can increase yields by 10-20%, so it is necessary to establish installations with electro-optical transducers for seed treatment before sowing in agriculture.

**Conflict of interest information.** The authors declare that they have no conflict of interest.

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The authors contributed equally to this article.

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