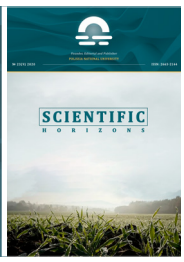
SCIENTIFIC HORIZONS
Journal homepage: https://sciencehorizon.com.ua
Scientific Horizons, 28(8), 20-29
UDC 632.93-043.2:633.15.02:632.111.6 DOI: 10.48077/scihor8.2025.20



Influence of corn seed treaters on field germination at low temperatures

Ihor Yarchuk*
Doctor of Agricultural Sciences, Professor of the Department
Dnipro State Agrarian and Economic University
49009, 25 S. Yefremov Str., Dnipro, Ukraine
https://orcid.org/0000-0002-8107-0582

Taras Melnyk
PhD in Agricultural Sciences, Director
LLC "HIKS Ukraine"
52500, 5 Gurdzhuanska Str., Synelnykove, Ukraine
https://orcid.org/0000-0002-5280-6482

Svitlana Lemishko
PhD in Agricultural Sciences, Senior Lecturer
Dnipro State Agrarian and Economic University
49009, 25 S. Yefremov Str., Dnipro, Ukraine
https://orcid.org/0000-0002-4973-7455

Svitlana Chernykh
PhD in Agricultural Sciences, Associate Professor of the Department
Dnipro State Agrarian and Economic University
49009, 25 S. Yefremov Str., Dnipro, Ukraine
https://orcid.org/0000-0002-8106-9901

Article's History:
Received: 19.02.2025
Revised: 25.07.2025
Accepted: 27.08.2025

Abstract. The relevance of the study was to establish a link between low temperatures, seed treaters and plants, and to develop technological measures to increase plant resistance to possible spring frosts. In accordance with this, the purpose of the study was to determine the effect of fungicidal seed treaters on the ability of corn seedlings to counteract low-temperature stress. Both laboratory and field methods were used to conduct studies to determine the reaction of corn plants to fungicidal seed treaters (Vencedor, Avicenna, Maxim XL, Bastion, and Fever) at low temperatures. Under optimal laboratory temperatures, treatment with all preparations did not negatively affect the germination energy and laboratory germination of seeds of the Onio corn hybrid and line B 831. It was found that despite the same high results of laboratory germination of corn seeds, field germination on the provocative low-temperature background of early sowing dates as a result of the use of different seed treaters was very different. In years with varying moisture levels and low temperatures, high germination rates were observed when using the fungicide seed dressings Vencedor,

Suggested Citation:
Yarchuk, I., Melnyk, T., Lemishko, S., & Chernykh, S. (2025). Influence of corn seed treaters on field germination at low temperatures. *Scientific Horizons*, 28(8), 20-29. doi: 10.48077/scihor8.2025.20.

*Corresponding author

Avicenna, and Maxim XL (at a level of 70-90%). Significantly lower results of field germination were obtained when using bastion and fever preparations – 45-60%. Thus, in the conditions of early sowing, and considering the risk of returning spring cold weather, it is more expedient to use Vencedor, Avicenna, and Maxim XL seed treaters. The results of this study indicate the need for pesticide originators and research institutions to conduct a more detailed study of the reaction of plants to drugs under various weather conditions and are of practical importance in production for more effective use of drugs

Keywords: seed treatment; fungicides; early crops; low temperatures; seed germination

INTRODUCTION

Seed treatment is a mandatory technological element of growing agricultural crops. Fungicidal preparations used as seed treaters negatively affect various biochemical processes in the body of fungi: they suppress the intensity of respiration, disrupt the synthesis of amino acids and other vital reactions. The aggressiveness of fungicide chemicals towards fungi cannot fail to affect the plants themselves. The activity of drugs significantly depends on external conditions, and the reaction of the plants themselves. Testing of new fungicides takes place under close to optimal hydrothermal conditions. But the conditions for growing agricultural crops are often extreme, so it is important to determine the reaction of plants to certain drugs in atypical conditions, in particular at low temperatures.

In a steppe zone with little moisture supply to plants, early sowing guarantees plants the opportunity to obtain more of this important resource. This is especially important for late spring crops. However, there is a negative downside to early sowing dates. In spring, the weather is quite changeable and it is possible to return low temperatures, a short-term cold snap. This can lead to damage to plant seedlings. The return of cold weather is difficult to predict. In order to guarantee to avoid losses from a possible decrease in temperature, farmers are forced to postpone sowing to a later date. But in the steppe, in the conditions of a short spring, when the temperature increases intensively and the top layer of soil quickly loses moisture, a delay in sowing leads to a decrease in seed germination and causes variegation of crops, which negatively affects yields. Due to the warming observed in recent years (the average annual air temperature according to weather forecasters in Ukraine increased by 1.7°C), there is an earlier onset of a stable transition of the average daily temperature through + 5°C (Meteopost, n.d.). This, in turn, forces farmers to start field work earlier. However, the risks of returning cold weather, especially in steppe conditions, increase significantly.

In the scientific literature, much attention was paid to the effect of seed treaters on the field germination of seeds. Recent studies have found that not only the seed treaters themselves can affect seed germination, but also their various compositions (Capo *et al.,* 2020). The effectiveness of seed protectants is not static, it is unstable and largely depends on weather conditions (Semenov, 2024). That is, different drugs manifest themselves differently under different conditions. Accordingly, it is likely to expect that under extreme conditions (such as low temperatures), some drugs will be more effective than others. The study by A. Meng *et al.* (2022) contains information about the negative effect of low temperatures on seed germination, but there is no information about the effect of low temperatures on the plant – seed treaters interaction. Industrial production of crops is difficult to imagine without the use of pesticides (Krachan & Nedilska, 2022). Pesticides that enter production, including seed treaters, usually pass comprehensive tests for the ability to effectively suppress pathogenic microorganisms, harmful insects, not negatively affect the beneficial flora and fauna of the soil, be as safe as possible for humans, do not pollute the environment, etc.

Seed treaters are widely used and it is possible to find many sources about their positive effect on field seed germination and yield (Yatsukh *et al.,* 2023). However, there is also information about the negative impact of seed treaters on germination energy and germination in the laboratory (Medeiros *et al.,* 2023). However, there is no alternative to seed treatment to provide effective protection against pathogens. The etching process is not a technological formality, but as indicated in the scientific and methodological recommendations of V.M. Stefkivskyi *et al.* (2024), is a measure that should be approached based on the phytosanitary condition of seeds and the spectrum of action of the drug. To prevent a decrease in seed quality, inhibit the activity of physiological and biochemical processes during germination, increase the energy of germination and, as a result, increase yield, as some researchers point out, plant growth regulators should be added to seed treaters (Alekseeva, 2019). It is also recommended to use microfertilisers together with seed treaters (Siroshtan *et al.,* 2021) or to use two-component seed treaters (Pospelova *et al.,* 2021). There is also a proposal to treat soybean seeds with Standak Top and Fever seed treaters in conjunction with pesticide-resistant nodule bacteria B. japonicum PC09 (Kukol *et al.,* 2022). According to the researchers, this will increase the activity of legume-rhizobial symbiotic systems. Attention is drawn to the need to preserve biological diversity. According to A. Dubey *et al.* (2020), treatment affects the

abundance of both soil and leaf taxa, including predators and parasitoids.

It is known that various chemical preparations used in crop production can affect not only directly for their main purpose, but also indirectly through changes in the metabolic processes of the plant itself. And such changes can be quite significant. According to O. Dermenko (2024), seed treaters can, in addition to their direct function of suppressing microorganisms, affect the physiological state of plants. So the drug Avicenna Plus can significantly stimulate natural resistance to biotic and abiotic factors. However, drug developers are not always able to comprehensively assess the indirect effect of the drug on all economically valuable features.

Seed treaters vary greatly in their intensity of action. They should not only suppress unwanted microflora, but also approach a particular type of cultivated plant as much as possible. As already noted, some of them can reduce the sowing quality of seeds. Thus, the choice of seed treaters should be based on the aggregate characteristic of the drug, which requires obtaining a wide range of information. This is what prompted the study of the indirect effect of seed treaters on the resistance of corn seedlings to a possible decrease in temperature after sowing, which is quite common in the Steppe zone. The purpose of this study was to develop an effective technological measure that contributes to the maximum field germination of corn seeds in conditions of a likely decrease in temperature.

MATERIALS AND METHODS

To solve this problem, studies of field germination of corn seeds were conducted in the conditions of early sowing dates. Such a provocative background of low temperatures could simulate the return of cold weather. Field experiments with corn were conducted in 2023 and 2024 in the educational farm of the Dnipro State Agrarian and Economic University. Its predecessor was sunflower. The Onio hybrid and the self-pollinating line B 831 were used for sowing. According to the originator, HIKS Ukraine LLC, the Onio hybrid is quite resistant to cold weather and has high initial growth rates, while line B 831, used as the parent form of this hybrid, has, on the contrary, weak growth rates at low temperatures. The line was chosen to compare plants F_1, which have heterosis, and corn lines that do not have one. Corn lines are generally less resistant to adverse conditions and are sown at a later date, but it has been included as a sensitive marker. Own laboratory studies of seed germination were determined by germination in a wet chamber in petri dishes on filter paper in accordance with DSTU 4138-2002 (2004); field – directly in the ground when manually sowing 10 treated seeds in four repetitions.

The following fungicidal preparations were used both for the hybrid and for the line: Vencedor, Bastion, Fever, Maxim XL, and Avicenna (the rate of consumption of the drug in accordance with the manufacturer's recommendations). The drugs have the following active ingredients: Vencedor – tebuconazole 25 g/l + Tiram 400 g/l; Bastion – diphenoconazole 30 g/l + ciproconazole 6.25 g/l; Fever – protioconazole, 300 g/l; Maxim XL – fludioxonyl, 25 g/l + mefenoxam, 10 g/l; Avicenna – tebuconazole, 50 g/l + prochlorase, 250 g/l + cresoxime-methyl, 50 g/l. In the field, the number of sprouted seeds was carried out on the 25th day after sowing. At this time, the temperature rose to a favourable temperature for germination. Corn of the line B 831 and the Onio hybrid was sown in two periods. In 2023, they were sown on April 15 and 19, and in 2024 – on April 12 and 19. Such sowing dates can be considered the earliest in comparison with long-term ones in this area (the Northern Steppe zone of Ukraine).

The weather conditions of spring 2023 were special and were characterised by both elevated temperatures and extremely high soil humidity. At the beginning of sowing, the soil moisture content was 139% of HB (or 72% of the total moisture capacity, or 37% of the weight of absolutely dry soil). The soil was not physically mature, so it was impossible to carry out pre-sowing cultivation. Sowing was carried out manually in waterlogged soil. Suitable temperatures for sowing (10-12°C) came very early, about a month before the usual dates for late spring crops, but later came to a multi-year norm. At the time of sowing, the air temperature fluctuated during the day from 3 to 12°C. It turned out in such a way that the second period of sowing had lower temperatures than the first. As will be shown later, this significantly affected the seed's ability to germinate. The conditions of 2024 differed significantly in their aridity, both for the entire growing season, and in particular for the sowing period. When sowing at an early stage, the soil moisture content did not exceed 20% of the total moisture capacity (38.5% of HB). At the time of sowing, the soil temperature fluctuated between 7-11°C. Lack of moisture and low temperatures significantly reduced the field germination of corn seeds. But the decrease in germination largely depended on the seed treater that was used (Meteopost, n.d.).

To objectively assess the effect of various seed treaters on the field germination of corn seeds at low temperatures, their effect on laboratory germination indicators under optimal seed germination conditions was first determined. In accordance with this, the germination energy and laboratory germination of seeds were determined. The determination was carried out as follows: twenty seeds were laid out on wet filter paper in petri dishes. Kept at a temperature of 23-25°C and determined the germination energy on the third day, and laboratory germination on the seventh day after the start of germination. The repetition was fourfold. It was also necessary to first establish the sowing qualities of the Onio hybrid and the line B 831. The determination was carried out in accordance with DSTU 2240-93 (1994). All seeds that were used in the experiment met the technical

conditions and had a laboratory germination rate of 99% of the hybrid, and 97% of the line. In their research, the researchers adhered to the standards of the Convention for the Protection of Biological Diversity (1992).

RESULTS AND DISCUSSION

Analysis by seed treater exposure was performed in accordance with DSTU 4138-2002 (2004) and as the results showed (Table 1), there was a slight decrease in the indicators of both germination energy and laboratory germination of corn seeds. Despite a slight decrease in these indicators, the sowing qualities of seeds met the requirements of DSTU 2240-93 (1994). There were no significant differences between seed treaters on the effect of these indicators. The maximum deviation in laboratory germination rates under the conditions of using mordants for the hybrid was 5.0% (Fever), and for the line – 4.0% (Maxim XL).

***Table 1**. Germination energy and laboratory germination of treated seeds, %*

Seed treater	Onio hybrid		Line B 831	
	germination energy	laboratory similarity	germination energy	laboratory similarity
Vencedor	89 ± 3	96 ± 3	84 ± 5	94 ± 5
Bastion	88 ± 3	95 ± 4	83 ± 3	94 ± 5
Fever	88 ± 7	94 ± 5	83 ± 5	94 ± 5
Maxim XL	88 ± 3	95 ± 4	84 ± 5	93 ± 3
Avicenna	90 ± 0	96 ± 3	86 ± 3	94 ± 3

***Source:** compiled by the authors*

In contrast to favourable laboratory conditions, seed germination rates in extreme conditions of early sowing periods at low temperatures significantly decreased when using all seed treaters without exception. In addition, in 2023, at low temperatures of early sowing periods, differences in field germination of seeds were found depending on the seed treaters used (Table 2). The discrepancy between the values between the variants of this indicator under the conditions of sowing on 15.04 was 15% for the hybrid, and 52.5% for the line. Sowing on 19.04 was carried out at lower temperatures than the previous one, so the indicators were obtained lower: for the hybrid – 42.5%, and for the line – 25%.

***Table 2**. Field germination of hybrid seeds and corn lines at the earliest sowing dates depending on the seed treaters in 2023, %*

Drug (B)	Sowing period 15.04.23 (counting 09.05.23)		Sowing period 19.04.23 (counting 13.05.23)	
	hybrid Onio (a)	line B 831 (a)	hybrid Onio (a)	line B 831 (a)
Vencedor	90.0 ± 11.5	77.5 ± 12.6	77.5 ± 5.0	65.0 ± 10.0
Bastion	75.0 ± 12.9	32.5 ± 12.6	45.0 ± 12.9	40.0 ± 8.2
Fever	85.0 ± 10.0	55.0± 12.9	50.0 ± 8.2	50.0 ± 11.5
Maxim XL	90.0 ± 8.2	85.0 ± 5.8	87.5 ± 12.6	47.5 ± 12.6
Avicenna	85.0 ± 5.8	75.0 ± 5.8	85.0 ± 10.0	62.5 ± 9.6
LSD_{05}	A – 7.0; B – 11.1; AB – 15.7		A – 6.6; B – 10.4; AB – 14.7	

***Source:** compiled by the authors*

It can also be noted that corn lines are more sensitive to germination conditions at low temperatures than hybrids. Among seed treaters, the best indicators of field seed germination, at conditions of lower temperatures than optimal, were found in the preparations Vencedor and Maxim XL. Thus, when using the drug Vencedor for sowing 15.04, the field germination rate of the Onio hybrid was at the level of 90.0%, and in the line B 831 – 77.5%; in the seed treater Maxim XL – 90.0% and 85.0%, respectively. Similar results were also obtained during sowing on 19.04. In the conditions of sowing on 19.04, Avicenna seed treater also performed well. The greatest decrease in field germination of seeds of both the corn line and hybrid at low temperatures was observed when using Bastion and Fever seed treaters. This decrease in relation to the indicators of Vencedor and Maxim XL seed treaters averaged 15.04 for the hybrid by 10%, and for the line by 37.5%. Under the conditions of sowing on 19.04, these indicators were 35.0% and 11.3%, respectively.

The experiment was continued in the following year 2024 (Table 3). Despite the fact that the conditions during sowing differed significantly in soil moisture, seed treaters at low temperatures showed the same effect on field germinated seeds as in the wet year 2023. At low temperatures, the seed germination rate of both the hybrid and the line decreased with the use of seed treaters such as Bastion and Fever.

When sowing on 12.04.2024, this decrease in comparison with Vencedor and Avicenna preparations on average occurred in the hybrid by 25.3%, and in the line – by 29.8%. The middle position in this gradation is occupied by Maxim XL. Similar results were obtained during sowing on 19.04.23.

***Table 3**. Field germination of hybrid seeds and corn lines at the earliest sowing dates depending on the seed treater in 2024, %*

Drug (B)	Sowing period 12.04.2024 (counting 07.05.24)		Sowing period 19.04.2024 (counting 14.05.24)	
	hybrid Onio (a)	line B 831 (a)	hybrid Onio (a)	line B 831 (a)
Vencedor	70.5 ± 8.2	55.0 ±5.8	82.5 ± 9.6	50.0 ± 8.2
Bastion	55.0 ± 10.0	45.0 ± 5.8	47.5 ± 12.6	40.0 ± 8.2
Fever	50.0 ± 8.2	37.5 ± 9.6	60.0 ± 11.5	37.5 ± 5.0
Maxim XL	65.0 ± 5.8	55.0 ± 5.8	72.5 ± 9.6	60.0 ± 8.2
Avicenna	70.0 ± 8.2	62.5 ± 9.6	77.5 ± 9.6	62.5 ± 9.6
LSD_{05}	A – 5.1; B – 8.1; AB – 11.4		A – 6.3; B – 10.0; AB – 14.1	

***Source:** compiled by the authors*

Seed germination is an extremely important stage in plant life, which largely affects their growth and development throughout the growing season. For seed germination, first of all, the necessary amount of moisture and the appropriate temperature are required. Research by V.A. Doronin *et al.* (2019) found that both insufficient and excessive moisture negatively affects seed germination. The required temperature for seed germination also has certain limitations. According to M.I. Dudka *et al.* (2024) optimal conditions for corn sowing are formed in the early stages at a temperature of 8-10°C. According to the researchers, this allows using productive moisture reserves more efficiently and reducing the impact of a possible drought in the future. In addition to the main factors necessary for seed germination, such technological measures as fertilisers (Voloshchuk *et al.,* 2021) and physiologically active drugs (Kuchmenko & Kurylenko, 2024), which under certain conditions can increase seed germination. Also in the scientific literature, much attention is paid to highlighting the varietal features of corn seed germination (Dziubetsky *et al.,* 2019; Mashchenko & Butenko, 2024).

Obtaining friendly shoots is the primary task of corn cultivation technology. But despite all the efforts of high-quality and timely implementation of all technological measures, it is not always possible to get the desired result. The return of cold weather can be an obstacle, which will lead to inhibition of seed germination and even seed failure. The shoots become liquefied, unproductive. In addition, plants develop unevenly, are more exposed to stress, and after a significant period of being in cold soil, seeds are more susceptible to disease. Since the drugs act indirectly on plants, all drugs, including fungicides, should be examined under cold stress conditions to identify the most effective conditions for these conditions. During the period of seed germination, even a slight decrease in the average daily temperature leads to negative consequences. The minimum temperature during the day is usually observed in the early morning. In addition, the resistance of plants to low temperatures during the day is not the same, the minimum value of this indicator is noted in the morning. It is the coincidence of these two factors in such a period of the day: – a decrease in air and soil temperature and minimal daily resistance of plants to low temperatures lead to a significant loss of field germination of corn seeds.

It is generally accepted that normal corn shoots can be obtained at soil temperature at a seed depth of 10-12°C. However, there are recommendations for possible seeding at a lower temperature – +7°C, but with a subsequent increase in temperature (Nesmachna, 2025). In the event of the return of cold weather, on the contrary, the temperature will decrease and the grain that has already begun to germinate will be subjected to cold stress. One of the ways to prevent the suppression and death of plants in these conditions is to use in advance exactly those chemicals that would contribute to the maximum preservation of the ability of plants to resist negative factors in low temperatures. In the experiments presented in this paper, an attempt was made to find out whether the field germination rate of corn seeds will change under various seed treatment in the event of the return of cold weather immediately after sowing. Under extreme temperature conditions artificially created due to early sowing, it was found that seed treaters significantly and differently affected the ability of plant seedlings to tolerate low temperatures. The results obtained in 2023 and 2024 were averaged and presented as graphs for better analysis. Figure 1 shows the field germination rates of the Onio hybrid for 2023 and 2024. Data for 2023 represent the average of the two early sowing dates – April 15 and 19. In addition, data for 2024 are also average indicators for April 12 and 19. This helps to more objectively assess the effect of seed treaters on the field germination of corn seeds at low temperatures. For comparison, the graph also shows data on laboratory seed germination.

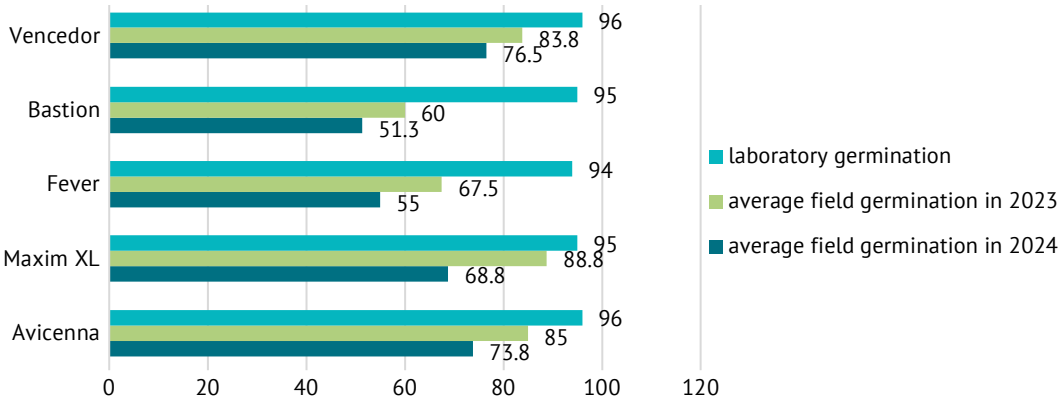


Figure 1. *Germination of seeds of the Onio corn hybrid on average over two early sowing periods*
Source: *compiled by the authors*

Under conditions of low temperatures, on average, for two sowing periods, the maximum seed germination rate was obtained in 2023 using the Maxim XL fungicide – 88.8%. In 2024, it was only slightly inferior to the drug Vencedor (by 2.7%). Vencedor seed treater in 2023 had only 1.2% lower indicators than Maxim XL. The same high rates were obtained when using the Avicenna fungicide: in 2023 – 85.0%, in 2024 – 73.8%. Thus, these three drugs: Maxim XL, Vencedor, and Avicenna were most effective at low temperatures. In contrast to these drugs, the use of fungicides Bastion and Fever led to a significant decrease in field germination of seeds of the Onio hybrid. Thus, the germination rate when using bastion fell in 2023 to 60.0%, and in 2024 – to 51.3%. Almost the same results were obtained with Fever – 67.5% and 55.0%, respectively. These drugs negatively affected the germination of corn at low temperatures.

The wet conditions of the study years (2023 with a wet spring, and 2024 with an extremely dry spring) did not significantly affect the identified patterns of dependence of the drugs used on the field germination of corn seeds at low temperatures. A similar graph (Fig. 2) was also represented for line B 831. The results obtained indicate that the line was significantly more vulnerable to low temperatures than the hybrid. These data indicate that early sowing of corn lines, without conditions for normal seed germination, is impractical. The maximum difference between field and laboratory seed germination of line B 831 was 57.7% (when using Bastion in 2023), and the minimum difference was 22.7% (when using Vencedor in 2023). Regarding drugs, there is the same dependence as in the hybrid. The greatest decrease in field germination over the years of research was observed with the use of Bastion and Fever seed treaters. Just as in the case of the hybrid, the slightest decrease in field germination at low temperatures was observed with the use of such fungicides as Vencedor, Avicenna, and Maxim XL.

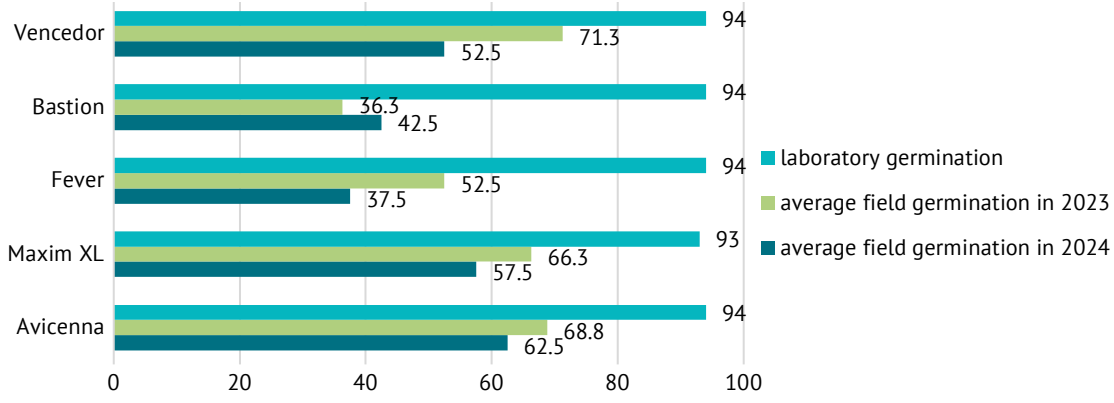


Figure 2. *Seed germination of the corn line B 831 on average over two early sowing periods*
Source: *compiled by the authors*

The use of Bastion and Fever preparations caused a decrease in resistance to low temperatures. But this does not mean that Bastion and Fever are unsuitable for treating corn seeds. This only indicates that it is better not to use these drugs when sowing at an early stage. Laboratory tests (Table 1) showed that the seeds treated with them have the same germination energy and laboratory germination as other preparations. It can be assumed that Bastion and Fever will contribute to better germination compared to other drugs at

higher temperatures. This assumption can be made based on the fact that the orientation of physiological and biochemical processes that increase the cold resistance of plants is reversed by the processes of intensive growth. If the preparations that are received for use in crop production are accompanied by more detailed information about the effect on the plant under various conditions, this will significantly increase the effectiveness of their use.

The use of fungicides becomes particularly important in conditions of the return of low temperatures, when seedlings are under stress, weakened, and delayed in growth. According to Yu. Kolupaev *et al.* (2023), changes in temperature lead to stress responses of the plant body: damage to proteins, lipids, and nucleic acids. It is likely that low temperatures affect not only the activity of the preparation, but also the reaction of the plant to this substance. Fungicidal seed treaters have a detrimental effect on the pathogen and have a different mechanism of action: blocking the activity of enzymes, violation of respiratory phosphorylation, destruction of cellular structures, etc. Such an active effect of the drug cannot but affect the plant itself.

Chemical preparations, getting into the plant's body, can change the course of biochemical processes, and thereby lead to a change in a certain desired trait. However, this correction of metabolism can automatically lead to more or less significant changes in other signs. Thus, preparations for seed treatment can affect some important signs, which happened in this experiment. Other researchers also observe the indirect effect of chemical preparations on economically important characteristics of cultivated plants (Sobchenko, 2019; Bilousova *et al.,* 2020). The active ingredients of the preparations Vencedor and Avicenna helped to increase the resistance of plants to low temperatures, and the metabolic processes of resistance and active growth are multidirectional. Based on this, bastion and fever preparations probably assume that they will have the advantage at optimal temperatures – to promote more active initial plant development. The decrease in field germination of corn seeds when using bastion and fever seed treaters can be caused both by the loss of activity of the drug due to low temperatures, and by a possible indirect effect. This issue requires further research.

Thus, research has shown that drugs, in addition to their direct action, can affect the course of other important physiological processes in plants. O. Dermenko (2024) held a similar conclusion. The researcher noted that the fungicidal preparation Avicenna Plus can improve the general condition of winter wheat plants, increase winter hardiness, and stimulate the natural resistance of plants. The researcher did not specify how winter hardiness increases, whether due to direct or indirect action. G. Peng *et al.* (2020) conducted research on a similar topic related to seed treaters. When treating rapeseed with Fluopyram, they observed not only the restriction of plant infection, but also the activation of PR proteins. They are specific plant proteins that are synthesised in response to stressful conditions, in particular, low temperatures. This allowed researchers to assume that this drug will be useful in changing weather conditions that delay seed germination. Current research also concerns the effect of seed treaters on the state of plants when weather conditions change. But in this case, the studies were conducted purposefully at low temperatures, by provocative sowing at the earliest possible time, and with various fungicidal preparations. This helped to identify the most effective fungicides. Among them were: Vencedor, Avicenna, and Maxim XL.

The relationship between weather, diseases, and seed treaters was considered by R. Semaškienė *et al.* (2025). The researchers emphasise that unstable weather conditions contribute to the spread of diseases. In addition, they emphasise the need to be extremely careful when choosing fungicides so as not to cause resistance of pathogens to them. Special attention was paid to the need to develop appropriate technological measures to the conditions of environmental change. It was this approach that guided the authors in conducting their research. According to the authors, this will raise the technology of growing agricultural crops to a new level. Unlike the study by R. Semaškienė *et al.* (2025), current experiments without assumptions have established a close relationship between seed treater activity, plant response, and weather conditions. The example of a hybrid and a corn line shows the different reaction of plants to seed treaters at low temperatures. Such knowledge is of great practical importance due to the fact that it allows using the line of mordants most effectively to ensure maximum economic effect.

CONCLUSIONS

Fungicides, depending on weather conditions, can affect seed germination in different ways. In the conditions of early spring, when there is a high probability of the return of cold weather, preparations should be used for pickling corn seeds, which in these conditions would help to increase field germination. Among the studied drugs, these are Vencedor, Avicenna, and Maxim XL. At low temperatures of early sowing periods, the field germination rate of seeds for the Onio corn hybrid varied depending on the year for the preparation: Vencedor 76.5-83.8%; Avicenna 73.8-85.0%; Maxim XL 68.8-85.0%. Under the same conditions, a significant decrease in germination was observed when using Bastion and Fever seed treaters: 51.3-60.0% and 55.0-67.5%, respectively. This indicates that in the conditions of waiting for a decrease in temperature, it is necessary to refrain from using Bastion and Fever preparations, but this does not mean that they should not be used in other weather conditions.

The value of the chosen method of conducting research in the field using a provocative background is

emphasised, which helped to obtain results as close as possible to real ones. Similar studies have the prospect of conducting with all preparations that are used in crop production, and not only for the reaction to low temperatures, but also for other negative factors for plants. This will allow using the potential of both drugs and plants more effectively. The results obtained in the course of research have shown that detailed information on the features of the action of pesticides under various weather conditions is of great importance for the transition to a higher technological level of crop cultivation. Further research should focus on studying the mechanism of action of the preparations and the biochemical processes that occur in the plant under the influence of the preparations under various hydrothermal conditions.

ACKNOWLEDGEMENTS

The authors express their gratitude to the management of the Dnipro State Agrarian and Economic University and the technical staff of the experimental field for their assistance in conducting field research.

FINANCING

None.

CONFLICT OF INTEREST

The authors of this study declare no conflict of interest.

REFERENCES

[1] Alekseieva, T. (2019). *Study of the effect of seed treatment on the germination energy of maize seeds. Advantages and disadvantages*. Retrieved from https://infoindustria.com.ua/doslidzhennya-vplivu-protruynika-na-energiyu-prorostannya-nasinnya-kukurudzi-perevagi-i-nedoliki/.

[2] Bilousova, Z.V., Keneva, V.A., & Klipakova, Yu.O. (2020). Sowing quality of winter wheat seeds depending on the component composition of seed treatments. *Ukrainian Black Sea Region Agrarian Science,* 24(3), 79-86. doi: 10.31521/2313-092X/2020-3(107)-10.

[3] Capo, L., Zappino, A., Reyneri, A., & Blandino, M. (2020). Role of the fungicide seed dressing in controlling seed-borne *Fusarium* spp. infection and in enhancing the early development and grain yield of maize. *Agronomy*, 10(6), article number 786. doi: 10.3390/agronomy10060784.

[4] Convention on Biological Diversity. (1992, June). Retrieved from https://zakon.rada.gov.ua/laws/show/995_030#Text.

[5] Dermenko, O. (2024). *Avicenna Plus: A plus for the yield and immunity of cereals*. Retrieved from https://www.agronom.com.ua/avitsenna-plyus-plyus-do-vrozhajnosti-ta-imunitetu-zernovyh/.

[6] Doronin, V.A., Kravchenko, Yu.A., Dryha, V.V., Doronin, V.V., & Karpuk, L.M. (2019). Features of determining the laboratory germination of switchgrass seeds (*Panicum virgatum* L.). *Bulletin of Uman National University of Horticulture*, 2, 12-16. doi: 10.31395/2310-0478-2019-2-12-16.

[7] DSTU 2240-93. (1994). *Seeds of agricultural crops. Varietal and sowing qualities. Technical conditions.* Retrieved from https://online.budstandart.com/ua/catalog/doc-page.html?id_doc=91422.

[8] DSTU 4138-2002. (2004). *Seeds of agricultural crops. Methods of determining quality.* Retrieved from https://online.budstandart.com/ua/catalog/doc-page?id_doc=91465.

[9] Dubey, A., Lewis, M.T., Dively, G.P., & Hamby, K.A. (2020). Ecological impacts of pesticide seed treatments on arthropod communities in grain crop rotation. *Journal of Applied Ecology,* 57(5), 936-951. doi: 10.1111/1365-2664.13595.

[10] Dudka, M.I., Kovtun, O.V., & Dudka, A.M. (2024). The formation of maize grain yield depending on sowing dates in the Northern Steppe of Ukraine. *Grain Crops,* 8(1), 67-76. doi: 10.31867/2523-4544/0313.

[11] Dziubetskyi, B.V., Cherchel, V.Yu., Kyrpa, M.Ya., Aldoshyn, A.V., Satarova, T.M., Cherenkov, A.V., Liashenko, N.O., & Bodenko, N.A. (2019). *Maize seed production. Textbook*. Kyiv: Agrarian Science.

[12] Kolupaev, Yu.E., Shakhov, I.V., & Kokorev, O.I. (2023). Seed priming by donors of gasotransmitters and compounds with hormonal activity: Growth and stress-protective effects. *Plant Physiology and Genetics,* 55(2), 119-141. doi: 10.15407/frg2023.02.119.

[13] Krachan, T.M., & Nedilska, U.I. (2022). Chemicals in the agricultural sector of production. *Podilian Bulletin: Agriculture, Engineering, Economics*, 37(2), 21-25. doi: 10.37406/2706-9052-2022-2-3.

[14] Kuchmenko, O., & Kurylenko, A. (2024). Influence of metabolically active compounds on the germination of winter rye seeds. *Scientific Notes. Biological Sciences (Mykola Gogol State University of Nizhyn),* 3-4, 7-13. doi: 10.31654/2786-8478-2023-BN-3-4-7-13.

[15] Kukol, K., Vorobey, N., Pukhtaievych, P., & Kots, S. (2022). The influence of seed-dressings on the formation and functioning of symbiotic soybean systems with fungicide-resistant rhizobia. *Scientific Reports of the National University of Life and Environmental Sciences of Ukraine,* 18(1). doi: 10.31548/dopovidi2022.01.003.

[16] Mashchenko, O.A., & Butenko, A.O. (2024). Field germination and survival of buckwheat plants depending on the elements of technology in the conditions of the northeastern Forest-Steppe of Ukraine. *Tavria Scientific Bulletin,* 135(1), 111-117. doi: 10.32782/2226-0099.2024.135.1.15.

[17] Medeiros, J.C., Carvalho, E.R., de Andrade, D.B., de Souza Moraes, L.F., Espíndola Lima, J.M., & Freitas Massa, M.A. (2023). Quality of corn seed industrial seed treatment (IST) and on-farm treatment (OFT) in Brazilian agribusiness. *Journal of Seed Science*, 45, article number e202345017. doi: 10.1590/2317-1545v45268856.
[18] Meng, A., Wen, D., & Zhang, C. (2022). Seed germination and seedling establishment of maize (*Zea mays* L.) are highly influenced by low temperature stress. *Frontiers in Plant Science*, 13, article number 843033. doi: 10.3389/fpls.2022.843033.
[19] Meteopost. (n.d.). Retrieved from https://meteopost.com/ua/mstation/dnipro/.
[20] Nesmachna, M. (2025). *Spring frosts will remain a companion of spring fieldwork for a long time: How to adapt?* Retrieved from https://superagronom.com/articles/770-vesnyani-primorozki-sche-trivaliy-chas-budut-suputnikom-vesnyano-polovih-robit-yak-pristosuvatisya.
[21] Peng, G., Liu, X., McLaren, D.L., McGregor, L., & Fengqun, Yu. (2020). Seed treatment with the fungicide fluopyram limits cotyledon infection by Leptosphaeria maculans and reduces blackleg of canola. *Canadian Journal of Plant Pathology,* 42(4), 480-492. doi: 10.1080/07060661.2020.1725132.
[22] Pospelova, H.D., Kovalenko, N.P., Nechyporenko, N.I., Stepanenko, R.O., & Sherstiuk, O.L. (2021). Influence of fungicidal seed treatments on the pathogenic complex and laboratory germination of soybean seeds. *Scientific Progress & Innovations,* 1, 72-79. doi: 10.31210/visnyk2021.01.08.
[23] Semaškienė, R., Jonavičienė, A., Venslovas, E., Lavrukaitė, K., & Almogdad, M. (2025). Effect of seed treatment and sowing time on *Microdochium spp*. Caused root rot in winter wheat cultivars. *Agronomy,* 15(2), article number 330. doi: 10.3390/agronomy15020330.
[24] Semenov, S.S. (2024). Efficiency of pre-sowing treatment of maize and sorghum seeds. *Grain Crops,* 8(2), 274-278. doi: 10.31867/2523-4544/0339.
[25] Siroshtan, A.A., Zaima, O.A., Kavunets, V.P., & Liskovskyi, S.F. (2021). Influence of seed treatment with protectants and micronutrients on sowing quality and yield of spring wheat. *Cereal Crops,* 5(2), 252-257. doi: 10.31867/2523-4544/0183.
[26] Sobchenko, O. (2019). *Pros and cons of seed treatment.* Retrieved from https://superagronom.com/blog/554-plyusi-ta-minusi-protruyuvannya-nasinnya.
[27] Stefkivskyi, V.M., Melnyk, S.I., Hryniv, S.M., Trofimova, H.V., Khomenko, T.M., Stefkivska, Yu.L., & Bobonych, Ye.F. (2024). *Scientific and methodological recommendations on evaluating the effectiveness of seed treatment products on disease-infected seeds*. Kyiv: Ukrainian Institute for Plant Variety Examination.
[28] Voloshchuk, O., Stasiv, O., Hlyva, V., & Paschak, M. (2021). Influence of pre-sowing treatment of seeds with microfertilizers on the productivity of corn hybrids in the Western Forest-Steppe of Ukraine. *Foothill and Mountain Agriculture and Animal Husbandry*, 69(1), 44-61. doi: 10.32636/01308521.2021-(69)-3.
[29] Yatsukh, K.I., Prystatska, O.N., Nikishicheva, K.S., & Tymchuk, I.S. (2023). Effect of the combined use of seed treatments, growth stimulants, and micronutrients for pre-sowing seed treatment on root rot infection and productivity of winter wheat. *Foothill and Mountain Agriculture and Animal Husbandry*, 74(1), 164-183. doi: 10.32636/01308521.2023-(74)-1-11.

Вплив протруйників насіння кукурудзи на польову схожість за низьких температур

Ігор Ярчук
Доктор сільськогосподарських наук, професор кафедри
Дніпровський державний аграрно-економічний університет
49009, вул. С. Єфремова, 25, м. Дніпро, Україна
https://orcid.org/0000-0002-8107-0582

Тарас Мельник
Кандидат сільськогосподарських наук, директор
ТОВ «ХІКС Україна»
52500, вул. Гурджуанська, 5, м. Синельникове, Україна
https://orcid.org/0000-0002-5280-6482

Світлана Лемішко
Кандидат сільськогосподарських наук, старший викладач
Дніпровський державний аграрно-економічний університет
49009, вул. С. Єфремова, 25, м. Дніпро, Україна
https://orcid.org/0000-0002-4973-7455

Світлана Черних
Кандидат сільськогосподарських наук, доцент кафедри
Дніпровський державний аграрно-економічний університет
49009, вул. С. Єфремова, 25, м. Дніпро, Україна
https://orcid.org/0000-0002-8106-9901

Анотація. Актуальність роботи полягає у встановленні зв'язку між низькими температурами, протруйниками і рослинами, а також в розробці технологічних заходів підвищення резистентності рослин до можливих весняних приморозків. Відповідно до цього, метою роботи було визначення впливу фунгіцидних протруйників на здатність проростків кукурудзи протидіяти низькотемпературному стресу. Для проведення досліджень з встановлення реакції рослин кукурудзи на протруйники фунгіцидної дії (Венцедор, Авіценна, Максим XL, Бастіон і Февер) за умов низьких температур використовували як лабораторний, так і польовий метод. В умовах оптимальних температур лабораторних досліджень обробка всіма препаратами не впливала негативно на енергію проростання і лабораторну схожість насіння гібриду кукурудзи Оніо і лінії В 831. Встановлено, що незважаючи на однакові високі результати лабораторної схожості насіння кукурудзи, польова схожість на провокаційному низькотемпературному фоні надранніх строків сівби в результаті використання різних протруйників сильно різнилась. У різні за зволоженням роки за умов низьких температур для проростання високі показники схожості відмічені при використанні фунгіцидних протруювачів Венцедор, Авіценна і Максим XL (на рівні 70-90 %). Значно нижчі результати польової схожості отримані при використання препаратів Бастіон і Февер – 45-60 %. Таким чином, за умов ранньої сівби, а також враховуючи ризик повернення весняних холодів доцільніше використовувати протруювачі Венцедор, Авіценна і Максим XL. Результати даної роботи свідчать про необхідність проведення оригінаторами пестицидів і науково-дослідними установами більш детального вивчення реакції рослин на препарати за різних погодних умов і мають практичне значення у виробництві для більш ефективного використання препаратів

Ключові слова: обробка насіння; фунгіциди; надранні посіви; низькі температури; проростання насіння