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Influence of disinfectant on sowing properties of winter grain crops in laboratory conditions

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Abstract
In recent years, in the conditions of the central part of the territory of Ukraine, it is important to conduct phytoexamination of grain in order to determine the suitability of batches to be called seeds from a phytopathological point of view. Among the main problems of the sowing campaign is the control of pathogens of the genus Fusarium. Maximum attention should be paid to protection against fusarium root rot in order to obtain friendly seedlings and ensure proper overwintering of plants. Fludioxonil is the most effective active ingredient that can provide adequate seed protection in the autumn. We determined the sowing quality indicators of winter wheat and barley seeds depending on their pre-sowing treatment with Celeste disinfectant in comparison with the control. During the analysis of the results of studies on the effectiveness of the pesticide, the following results were obtained: infection of winter wheat seeds (control) with fusarium wilt was 58.5%, poisoned grain - 0%; winter barley (control) - 16%, treated - 0%. Celeste Max in the laboratory proved its effectiveness against pathogens of fusarium wilt. The disinfectant also had a positive effect on germination energy and germination, the number of abnormal seedlings decreased.

Keywords: infectious background, winter wheat, winter barley, germination energy, seed germination

Introduction

In modern agriculture, high-quality seed material is of paramount importance as a means of production. High-quality seeds are one of the main conditions for obtaining high yields of crops. Seeds are formed during the life of the mother plant in certain environmental conditions. Due to the influence of various endogenous and exogenous factors in different periods of life of mother plants, the seed changes. However, even the formed healthy seeds do not always have high sowing properties - the seeds are rich in nutrients and are a good substrate for the development and preservation of phytopathogenic microorganisms. Seeds can spread many diseases that reduce yields and degrade its quality. In addition to parasitic microorganisms, saprotrophic (mold) microorganisms persist and develop on seeds, which can cause mold and death of seeds and seedlings (Zadoks et al., 2004; Stankevych et al., 2020) [1, 2].

Soft winter wheat *(Triticum aestivum L.)* is one of the most productive and valuable food crops. This crop is gaining an increased importance in the state balance of Ukraine and the world. Pathogenic organisms go with wheat from the moment of sowing to harvesting, and even after. The value of variety is a decisive factor for obtaining high and stable yields under intensification of agricultural production. The main attention should be paid to the creation of new, highly productive, adapted to growing conditions, resistant to pathogens and pests, varieties and hybrids of crops (Kovalyshyna et al., 2018; Tryhub et al., 2020) [3, 4].

The peculiarity of disease resistance selection is that new genotypes as donors can quickly lose this ability due to changes in virulence of pathogen and weather conditions (Luchna, 2014) [5]. Therefore, there is a need to constantly search for new sources of resistance to pathogens, which is relevant and requires further study of genofond (Kyrychenko et al., 2012) [6].

One of the ways to neutralize pathogens, protect seeds from mold, reduce root rot is seed treatment. Today, seed treatment with drugs not only fungicidal but also insecticidal is becoming more common (Chetveryk et al., 2021; Kovalyshyna et al., 2012) [8].

Seed treatment is an important therapeutic and preventive measure in the system of plant protection of cereals. Usually, pathogens that infect grain can be found in the middle and on the surface. A significant source of infection, of course, is the soil. To protect germinating seeds and young plants from these pathogens, it is necessary to carry out seed treatment. Chemical plant protection products can save up to 20% of crop yields and reduce the cost of mechanized and manual labor (Retman et al., 2006; Kuzmenko et al., 2015; Hryhorieva et al., 2009) [9 10, 11].

Cereals are one of the largest and most important groups of crops, which occupy about half of the arable land of Ukraine. However, obtaining high and high-quality yields of these crops depends on the use of optimal plant protection systems against pests. And the first important step in this process is seed treatment (Singh et al., 2011;

Kalytka et al., 2011; Skachok et al., 2008) [12, 13, 14]. Due to the violation of crop rotations, simplification of the system of basic tillage, reduction of plant protection products and weakening of work on the creation of complex resistant varieties in recent years deteriorating phytosanitary condition of wheat and barley, which increases seed pathology. In addition, in recent decades there have been significant climate changes, which in combination with transformations in agrocenoses have led to a significant reformatting of phytopathogenic and entomological complexes of cereals (Tsyhankova et al., 2013; Marenych et al., 2017; Herman et al., 2013) [15, 16, 17].

Materials and methods

The research was carried out in the Laboratory of grain quality of PDAA on winter wheat varieties Vodogray Bilatserkva and winter barley variety Dostoyny.

Seeds before the study were treated with insecticide-fungicide Celeste Max 165 FS, TH at a rate of 2.0 l / t.

Laboratory tests and sowing suitability of seeds (weight of 1000 seeds, germination energy and germination) were performed according to DSTU 4138-2020.

The weight of 1000 seeds was determined using the method: two repetitions of 500 seeds. From the seeds of the main culture was counted (using a calculator) without selecting two replicates of 500 seeds and weighed each with the required accuracy. The arithmetic mean of both repetitions was calculated.

Phytoexamination of seed material was performed in accordance with the requirements of DSTU 4138-2002 "Seeds of agricultural crops. Methods for determining quality (UIPVE. 2016; State Standard 4138-2002).

The seeds were germinated in rolls at the optimum temperature for crops. Germination was determined in cultures on day 7. Phytopathological analysis was performed on day 10.

During the analysis of seeds in rolls of filter paper used its two layers, moistened to its full moisture content. Four samples of 50 seeds were taken. Filter strips of 55 cm × 10 cm or 110 cm × 10 cm (± 2 cm) were used for each sample. The seeds were laid out in a single line with an interval of 1 cm at a distance of 2-3 cm from the upper and side edges of the paper strip. Seeds were placed germ down.

The seeds placed on the paper were covered with the same size strip of moistened filter paper, on which was applied a cortex or a strip of plastic wrap, and twisted into a roll. The rolls were placed vertically in the vessels and placed in a thermostat at a temperature of 22-25 ° C. In the process of germination drying of rolls is not allowed. The water in the thermostat pan was changed every 3-5 days.

Artificial damage to the nutrient medium was performed with an inoculant of fusarium wilt pathogens of the following species: F. culmorum, F. cerealis and F. oxysporum.

Potato-glucose agar (CGA) was used as an artificial medium as an artificial medium.

Method of preparation of potato-glucose agar (CGA): 200 g of washed, peeled, sliced potatoes were poured into 1 liter of water and boiled for 40 minutes, then the liquid was filtered through 2-3 layers of gauze. To the filtered liquid was added water to 1 liter, added 20 g of microbiological agar and 20 g of glucose.

To avoid growth on the medium of bacterial infection to the finished mixture was added 0.25 ml of gentamicin.

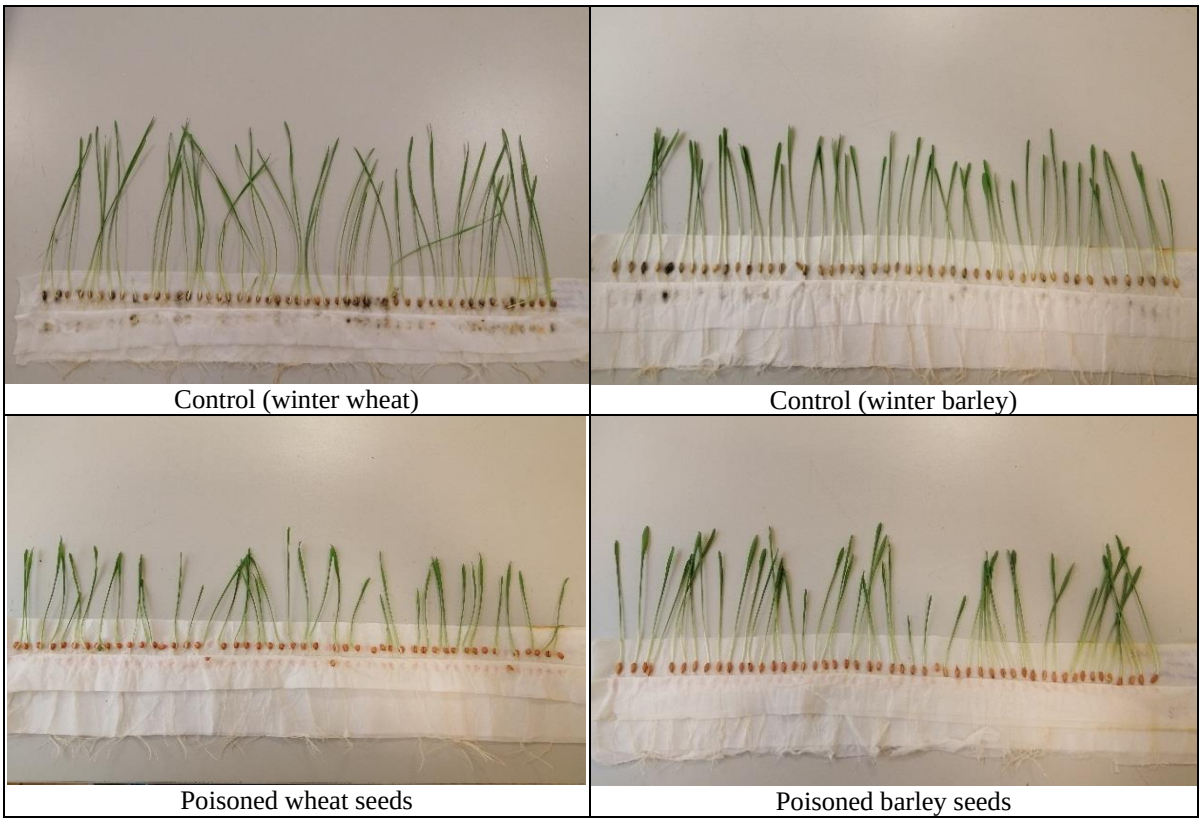


Fig 1: Analysis of the method of rolls

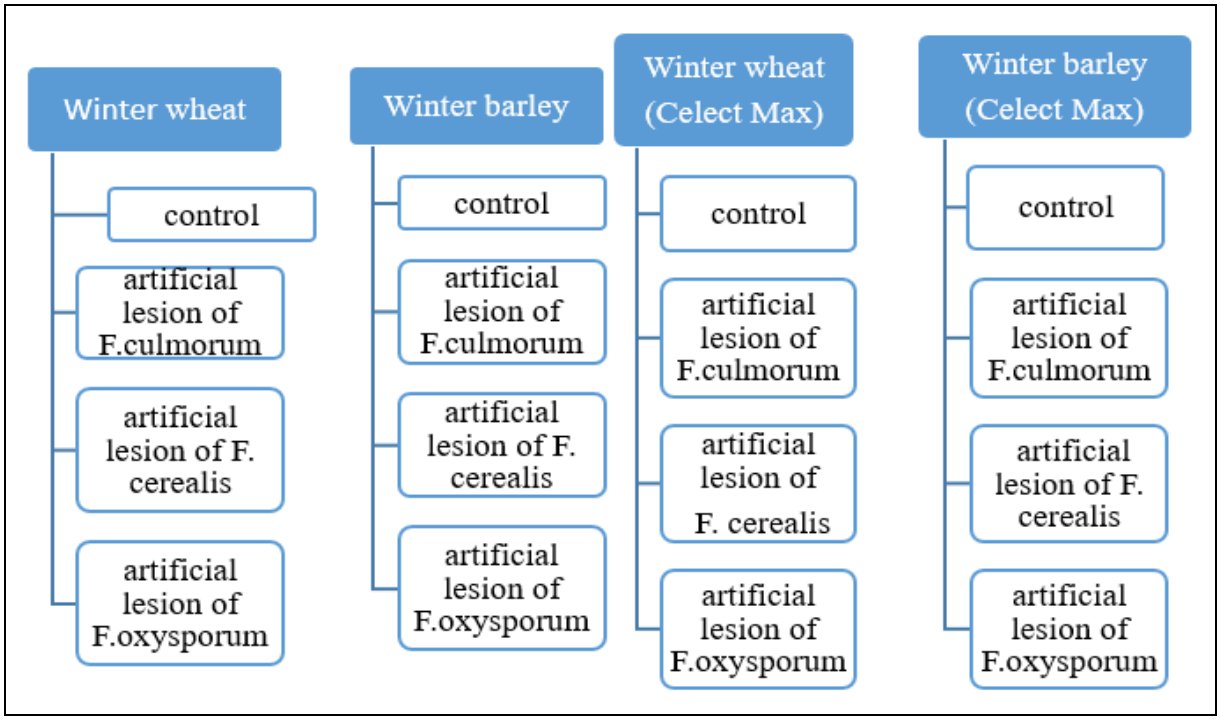


Fig 2: Scheme of laying seed samples on a nutrient medium

The finished CGA was sterilized in a pressure cooker for 30 min under a pressure of 1 atm., Cooled to 60 ° C. After cooling, the CGA was poured into sterile Petri dishes. The seeds of the test samples were planted on a nutrient medium in the amount of 4 US. for 1 Petri dish. This experiment was laid down in two replications. On the 7th day after inoculation, the experiment was analyzed.

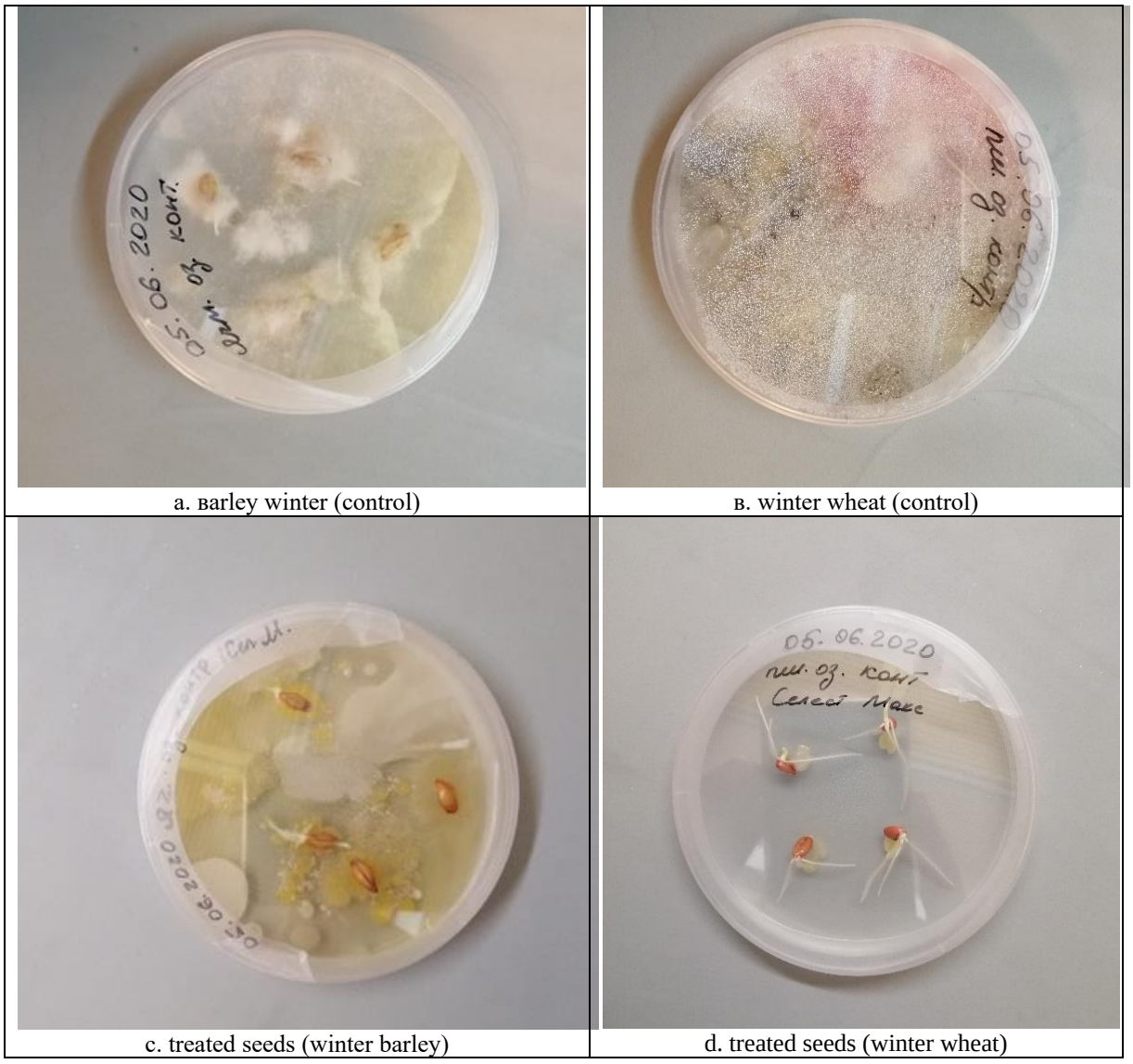
Results

Phytoexamination is important, by and large, for seed grain in order to determine whether this batch is suitable in principle to be called seeds from a phytopathological point of view or not. If you do not do phytoexamination and think that you can just take a more expensive disinfectant, and it will solve all the problems - then you are wrong (Gutiérrez 2012; Ahmad et al., 2018). All pesticides have their limits, above which no problems are solved, especially where you do not know about such problems: so you do not control the situation, but just try to pretend.

Table 1: Phytoexamination of seed material

Culture	Energy germination %	Germi-nation, %	Abnormal seedlings/ ungerminated,%	Fusarium, %	Penicillium, %	Alternaria %
Wheat winter control	44	44	3/3	30	11	9
	42	43	7/0	23	9	16
	43	44	2/4	31	13	3
	45	46	3/1	33	10	4
	87	88,5	7,5 / 4	58,5	21,5	16
Winter wheat Celect Max	49	49	0/1	-	-	2
	43	43	0/7	-	-	3
	40	41	1/8	-	-	5
	45	45	2/3	-	-	3
	88,5	89	1,5 / 9,5	-	-	6,5
Barley winter control	41	42	4/4	9	3	1
	43	44	2/4	5	2	2
	45	45	2/3	7	2	3
	44	46	2/2	11	3	3
	86,5	88,5	5 / 6,5	16	5	4,5
Barley winter Celect Max	48	48	0/2	-	-	-
	47	47	2/1	-	-	-
	45	47	2/1	-	-	1
	46	49	0/1	-	-	-
	93	95,5	2 /2,5	-	-	0,5

Winter wheat seeds had the following indicators: germination energy – 87 %, germination - 88.5 %. Infection of seeds with fungi of the genus Fusarium was 58.5 %, Penicillium - 21.5 %, Alternaria – 16 %.
Celeste seeds treated with Celest Max had the following indicators: germination energy - 88.5 % (which is 1.5 % more than in the control), germination – 89 % (an increase of 0.5 %). The pesticide Celeste Max completely controlled the development of diseases caused by fungi of the genera Fusarium and Penicillium. Infection with fungi of the genus Alternaria was 6.5 % (2.5 times less than for control).
Analyzing the seeds of winter barley (control), we obtained the following indicators: germination energy - 86.5 %, germination - 88.5 %. Infection of seeds with fungi of the genus Fusarium was 16 %, Penicillium – 5 %, Alternaria - 4.5 %.
Celeste seeds treated with winter barley Celeste had the following indicators: germination energy – 93 % (6.5 % more than in the control), germination - 95.5 % (an increase of 7 %). The development of diseases caused by fungi of the genera Fusarium and Penicillium is completely controlled by the pesticide. The incidence of fungi of the genus Alternaria decreased from 4.5 % to 0.5 % (compared with controls).

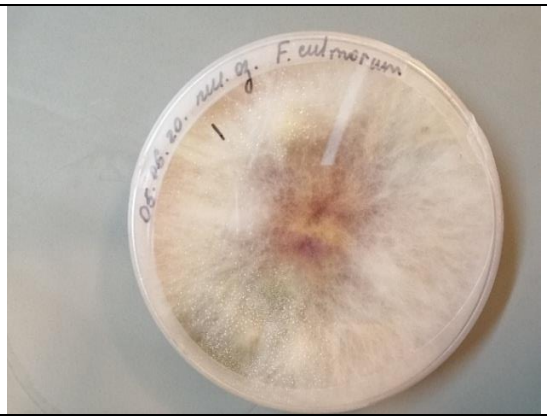


a. barley winter (control) в. winter wheat (control)

c. treated seeds (winter barley) d. treated seeds (winter wheat)

Fig 3: Samples of germinated seeds of the studied crops

During the germination of winter wheat seeds and winter barley (control) on a nutrient medium, the development of fungi of the genera Fusarium, Penicillium and Alternaria was observed. During the germination of treated seeds of both crops, the development of diseases was not detected.
When artificially contaminated the nutrient medium with inoculants of fusarium pathogens, untreated wheat and barley seeds were affected by 100%, while the pesticide Celeste Max completely controlled the development of the disease.
The main problem of the sowing campaign is the control of pathogens of the genus Fusarium. Maximum attention should be paid to protection against fusarium root rot in order to obtain friendly seedlings and ensure proper overwintering of plants. Fludioxonil is the most effective active ingredient that can provide adequate seed protection in the autumn.



Artificial defeat of wheat *Fusarium culmorum* (control)

Artificial defeat of wheat *Fusarium culmorum* (Celect Max)

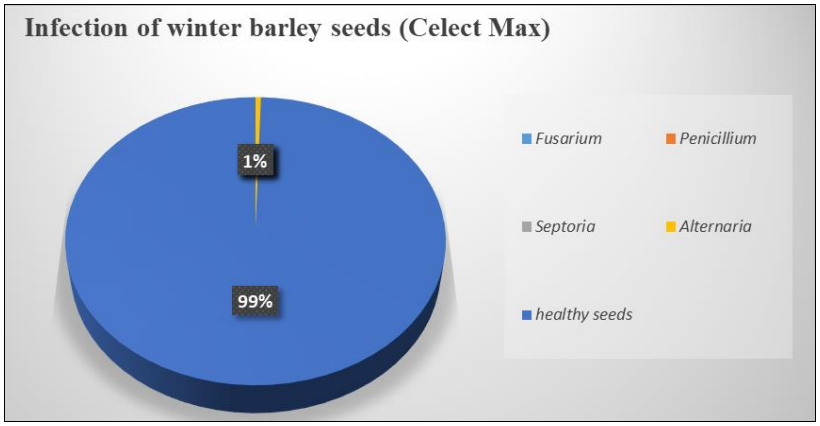
Artificial defeat of wheat *Fusarium oxysporum* (control)

Artificial defeat of wheat *Fusarium oxysporum* (Celect Max)

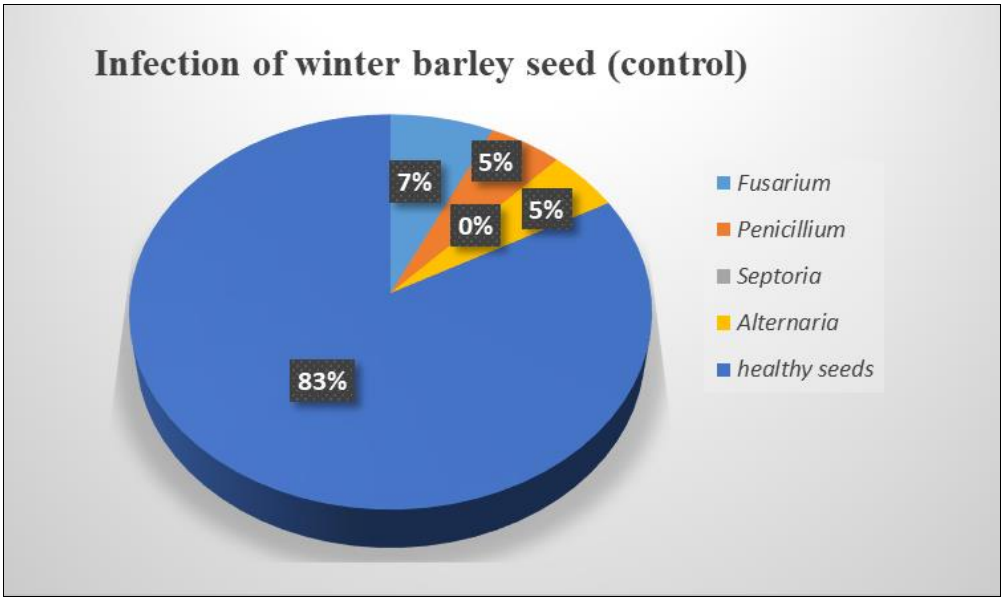
Artificial defeat of wheat *Fusarium cerealis* (control)

Artificial defeat of wheat *Fusarium cerealis* (Celect Max)

Fig 4: Artificial damage to the nutrient medium by the inoculum of Fusarium wilt pathogens (seven days after inoculation)



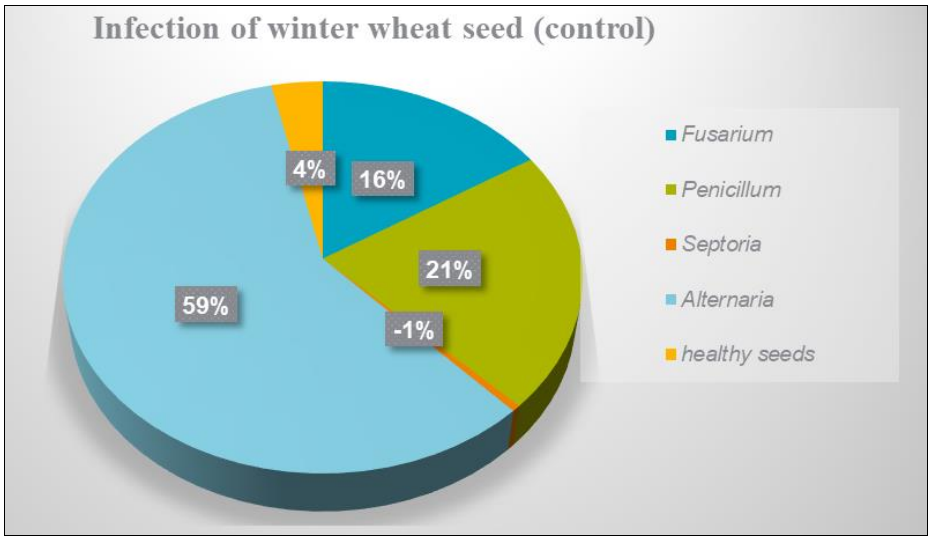
a. grain treated with disinfectant



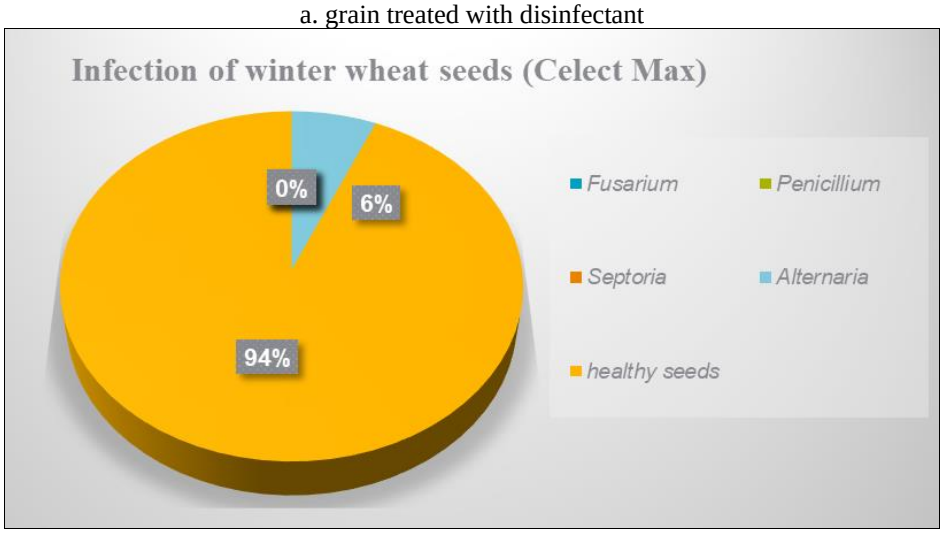
b. control

Fig 5: Analysis of the method of rolls on seed of winter barley

During the analysis of the results of studies on the effectiveness of the pesticide, the following results were obtained: infection of winter wheat seeds (control) with fusarium pathogens was 58.5 %, poisoned grain – 0 %; winter barley (control) – 16 %, treated – 0 %.



a. grain treated with disinfectant



b. control

Fig 6: Analysis of the method of rolls on seed of winter wheat

Discussion

Crop losses from diseases, weeds and pests can reach more than 30 %, of which from pests – 14 %, from diseases - 12% and from weeds – 9 %. Caring for the future harvest begins with the seed fund, which has a rich microflora. Part of this microflora is pathogenic and includes various types of viruses, bacteria and fungi, among which various types of soot, fusarium and helminthic spores, septoria, mold, various seed spots predominate. The seed stock is contaminated with pathogen toxins, which is far from safe for those who consume it. Seed infection of winter crops caused by fungi of the genus Fusarium. Fusarium head blight is a plant disease that causes both significant crop losses and deterioration. Defeat of seeds by fusarium fungi leads to a decrease in germination energy and germination. Some species of fungi produce mycotoxins, such as deoxynivalenol (DON), T-2 and HT-2 toxins, zearalenone, nivalenol and others. The mycotoxins present in the grain make it unsuitable for food and feed purposes. In conditions when a large part of arable land is not cultivated, crop rotations are almost everywhere violated, there are no disease-resistant varieties of crops, the only way to reduce significant losses from disease is pre-sowing seed treatment, which is more cost-effective than spraying crops.

Pre-sowing treatment of seeds to protect them from pests and diseases is one of the necessary and effective measures and is carried out:

- disinfection of seed material from pathogens transmitted through seeds;
- protection of sown seeds, planted tubers from mold diseases during germination.

The experience of growing wheat shows that the treatment of seed material with the drug increases the yield - by an average of 10.6%, barley - by 8.0% compared to untreated seed material. Seed treatment leads to an increase in wheat yields by 7.9%, barley by 10.8% due to increased germination, increase in the number of spikelets per 1 m2 and grain weight. In the fight against plant diseases of cereals, it is environmentally safer and more cost-effective to carry out pre-sowing treatment than many times to spray crops with pesticides, as many pests develop resistance to them in a short time, which significantly reduces the efficiency of treatment. The cost of pre-sowing treatment pays off fairly quickly in 7.4 ... 14.6 times, and with ultra-low-volume treatment with low consumption of the chemical - 70 ... 400 times compared to untreated seed material.

Conclusions

Celect Max in the laboratory has proven its effectiveness against pathogens of fusarium wilt. The disinfectant also had a positive effect on germination energy and germination, the number of abnormal seedlings decreased. During the germination of winter wheat seeds and winter barley (control) on a nutrient medium, the development of fungi of the genera Fusarium, Penicillium and Alternaria was observed. During the germination of treated seeds of both crops, the development of diseases was not detected. During the analysis of the results of studies on the effectiveness of the pesticide, the following results were obtained: contamination of winter wheat seeds (control) with fusarium wilt pathogens was 58.5 %, treated grain – 0 %; winter barley (control) – 16 %, treated – 0 %.

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